Advisory Meeting, 10/23/90, 12pm

Goal: To approve the basic contents and topics of the exhibit

<u>*Agenda*</u>

- Introduction of participants (5 min.)
- Presentation of agenda (2 min.)
- Staff presentions of exhibit progress (60 min.)
    - Progress review
    - Reaching the Museum's audience
    - Central message and structure of exhibit
    - Entry feature
    - Role, approach, and content of interactive video
    - Implementing in design
- Content and presentation suggestions (120 min.)

Milestone: 1: Of Clerks, Cards, and Collators

Time Tunnel:

1930s, Depression, New Deal

Photos: Bread line, FDR

Vignette:

Social Security Administration's use of IBM punched card machines c. 1937

Text rail:
- Necessary to run national bureacracy
- What was it like to work here? - video of SSA operations
- "So What?"—many gov't services impossible w/out such tech., therefore affects us all

Inter-active: *"Punch your own card"* - shows how names are punched on a card and examines limitations of the technology

Tangential Displays

People: T. J. Watson Sr., 2-D display portraying character and philosophy if IBM's founder and connecting with bureacracy-building of period.

At Issue: *What's in a name?* A 2-D and interactive display investigating the implications and necessity of substituting a number for an individual's name.

Milestone: 2: Born of the War: The Pioneering Years

Time Tunnel:

World War II, social mobilization, technology and science serve military

Photos: Battleship, planes overhead, computer manned by soldiers.

Vignette:

Whirlwind at MIT - military research c. 1947

Text rail:
- WWII demand for computation
- most early, experimental computers developed at universities with military support
- video showing calculation of missile trajectory
- "So What?"—computer's importance to code breaking?

Inter-active: *"Can You Hit the Target?"* shows visitors the factors and calculations involved in determining a ball's trajectory and the strength and direction to throw it to hit a target—underscoring the need for a computer.

Tangential Displays

People: *"The Inventors"*—answers the question "who invented the computer?" by answering "they all did"—Atanasoff, Aiken, Stibitz, Zuse, Eckert&Mauchly, Wilkes, etc.—showing the simultaneity of invention and the number of developments that led to the modern computer

Tech: *"The Stored Program and the memory crunch,"* a series of artifacts and an interactive display illustrating the defining feature of the computer and the numerous attempts to build a memory which could facilitate it.

"Core Memory" an interactive explaining how core memory works

Perception: *"Prometheus or Frankenstein?"* a 2-D display (maybe video?) showing various popular depictions of the new technology.

Milestone: 3: Computer For Sale!

Time Tunnel:

1950s economic boom, consumerism

Photos: ad for Cadillac, households appliances, .

Vignette:

UNIVAC I at General Electric used for payroll and inventory control, c. 1954

Text rail:
- economic growth spurred big business, business demand fueled growth of computer industry
- only largest corporations could afford computers, prestige played a part in purchases
- "So What?"—an examinination of all the part in a GE toaster, information processing essential to large-scale mass production

Inter-active: Push-button starts audio of operators arguing over why computer won't run, under pressure to get payroll out the next day.

Tangential Displays

At Issue: "Automation: Life of Leisure or Lose Our Jobs?" video display of differing perspective on the implications of automation. Congressional hearings on automation's impact even before a technological reality.

Tech: "Birth of an Industry"—2-D display depicting the diversity of companies that entered the computer business: Lyons, Remington Rand, ERA, IBM

Milestone: 4: Try to Tell It What to Do

Time Tunnel:

Demand for programmers c. 1960

Photos: Ads for programming schools, want ads for programmers

Vignette:

Film dramatizing the needs that spurred development of COBOL c. 1960

Text rail: • Introduction to film:
- difficulty of programming and lack of standards pressed development of higher level languages
- customers and manufacturers worked together

Inter-active: *"What is a Programming Langauge?"* program illustrating different levels of languages from machine code to COBOL.

Tangential Displays

People: *"Early Programming Gurus"* Backus, Hopper, others, particularly women

Tech: *"The Search for the Holy Standard"* 2-D display of the proliferation of programming languages

Computer culture: The professionalization of programming and women's loss of status therein, emergence of computer education
(how to present this?)

Milestone: 5: Computers Mind Your Business

Time Tunnel:	Rise of the multinational corporation and civil unrest **Photos:** City skyline, headlines of student attacks on computing centers

Vignette:	IBM/360 at the Travelers c. 1967 **Text rail:** • data processing became a vital function in the corporate body • many resented computers, seen as symbols of the Establishment • "So What?"— process claim data after disaster, keep data about you. **Inter-active:** Push-button starts audio: programmer begging for time to use the machine, operator saying isn't even allowed to be in computer room, etc.

Tangential Displays	**At Issues:** *"Databases in a Free Society"* a 2-D presentation contrasts the positions and concerns that lead to the Privacy Act of 1974. **Tech:** *"For Every Breakthrough, a Dozen Dead Ends"* a 2-D presentation of technologies which didn't yield their promise: Photodigital store, Cryotron, Josephson junction, etc.

Milestone: 6: Doing It on the Spot and in Time

Time Tunnel:

"Small is Beautiful"

Photos: VW Bug, miniskirt, others?

Vignette:

PDP-8 at Yale in neurosurgery/ Siemens mini in industrial control (c. 1973)

Text rail:
- "less is more" was the fashion in clothes, cars, and computers
- transistors and later ICs permitted smaller, cheaper computers
- computers left the "computer room" and entered new areas
- begins decentralization of computer power
- "So what?"—computers started to creep into people's lives?

Interactive: measure your pulse?

Tangential Displays

Tech: *"Solid state: Transistor to IC "* a 2-D presentation illustrating the dramatic impact of solid state circuitry and the influence of the space program on the miniaturization of componentry. (Apollo Guidance Computer)

At Issue: *"Automation Revisited: Occupational Impact"* A presentation showing how on aggregate level automation neither increased leisure time, nor displaced significant numbers of workers. Statistics will show shift in composition of labor force. A video of NYT pressing being computerized will show cost of automation to individual.

Milestone: 7: Big Science and Supercomputers

Time Tunnel:

The world modeled on computer

Photos: Large computer-generated image

Vignette:

CRAY-1 computer used by ECMWF for weather forecasting

Text rail:
- Ever insatiable demand for computation by science pushes barrier to computational speeds
- need for fast computers in weather forecasting
- supercomputers as strategic technologies
- "So what?"—global modeling? weather forecasts you see come from computer?

Inter-active: change the weather? or video of computers used in weather prediction?

Tangential Displays

Tech: *"How Fast Are Computers?"* interactive display comparing speeds of different computers (including the visitor) at various size problems (integrate qualitative change affected by quantitative increases in computer speed.)

Perception: *"Creating new Worlds"* a display focussed on how computer modeling is changing our understanding of the world. Club of Rome.

"Falsify this picture" an interactive showing how realistic computer modeling and graphics have changed our notion of reality, by allowing visitors to falsify a photograph.

Milestone: 8: "A Computer on Every Desk"

Time Tunnel:	Photos:

Vignette:	IBM PC w/ Lotus 1-2-3 / child at Apple II+ playing games/using network Text rail: • Computers become professional tool and personal hobby • packaged software reshapes industry • Context: machine of the year. • "So what?"—made computer essential tool? Inter-active: comparison of PC to early computers?

Tangential Displays	Tech: " *Good ideas don't always make it*" artifacts and photos of some of the early PC makers that survivied and many that didn't At Issue: "*Security, dependency and vulnerability*"headlines of virus attacks and arrest of hackers introduce the pros and cons of decentralization of power over computers. "Find the virus" interactive? The Community and the Subculture: Magazines, t-shirts, comic books, electronic romances, all evidence of the growing subculture surrounding computers.

Milestone: 9: Computers, Computers, Everywhere

Time Tunnel:

Photos:

Vignette:

Tokyo street corner featuring electronics shop, car, etc.

Text rail:
- Computers now control most all electronic and electrical devices and systems whether large or small
- the microprocessor is everywhere
- has become a commodity, like coal and steel were to earlier economic eras.

Inter-active: Guess how many computers? Reveal inner workings of a camera

Tangential Displays

Tech.: *"What is a microprocessor?"* an interactive program explains and allows visitors to reprogram a camera's microprocessor

At Issue: Investigation of rise in protectionism in response to Japan's rise in international semiconductor commodity market

The
Computer
Museum

300 Congress Street
Boston, MA 02210

(617) 426-2800

February 15, 1991

Mr. Gardner Hendrie
Sigma Partners
300 Commercial St., Unit 705
Boston, MA 02109

Dear Mr. Hendrie:

I have enclosed a copy of the content outline and the floor plan of the Milestones exhibit to accompany the text of the exhibit which you should have received by now.

Just to remind you, the Milestones Committee Meeting will be held at the Museum on February 28 beginning at 12 noon. I hope to see you there.

Sincerely,

Rachel Hellenga

Rachel Hellenga
Research Assistant

Milestones Content as of 1/7/91

Milestone: 1: Of Clerks, Cards, and Collators

Time Tunnel:	1930s, Depression, New Deal **Photos:** Bread line, FDR, Audio: "Brother Can You Spare aDime" (A)

Vignette:		Social Security Administration's use of IBM punched card machines c. 1937
	Intro. Panel	• Connection between New Deal national bureacracy building and mechanized data processing. • Machines essential to aiding a whole population.
	Text rail:	• Punched card machines, amd their use by SSA
	Inter-active:	*What was it like to work here?* - video of SSA operations with voice over of clerk reminising? (V)

Flanking Displays	**Pers. Impact**	Mirror: reveals "Look below" how *NOW* computers are integral to gov't provision of services s.a. sidewalks.
	Soc. Impact	Photo of group of elderly people: how affect? Lift to reveal Rosa Parks—computers helped gov't meet their needs
	Cult. Impact	Punch card as emblem of scientific management/system building mentality: IBM ad w/ Colossus manager—tie in "Feel like a number"?
	Tech. Display	Display of myriad custom printed cards. "Punched cards basic currency of information for many organizations for many years."
	Tech. Intact.	*"Punch your own card"* - shows how names are punched on a card and examines limitations of the technology, i.e. limited field length, and connection with need to assign standard-length number. (PC) "Feel like a number"? physical and symbolic encoding. What was it like to use this machine? Recreate feel.

Milestones Content as of 1/7/91

Milestone: 2: Born of the War: The Pioneering Years

Time Tunnel:

World War II, social mobilization, technology and science serve military

Photos: Battleship, planes overhead, computer manned by soldiers.

Vignette:

Whirlwind at MIT - military research c. 1947

Intro. Panel Connection between war, increased demand for calculation, social mobilization and early successful dev. of experimental computers.

Text rail:
- hist. dev. of Whirlwind, significance
- most early, experimental computers developed at universities with military support
- vacuum tube as central component (mount one on rail)

Inter-active:
- *Murrow interview of Whirlwind* (synchrozie with Flexowriter and scope in vignette) (VM+FX)
- *Can You Hit the Target?"* shows visitors the factors and calculations involved in determining a ball's trajectory in order to hit a target—underscoring the need for a computer. (PC)

Flanking Displays

Pers. Impact Mirror reveals mushroom cloud. Connection between early computers and nuclear age

Soc. Impact Image? Computers, such as Colussus, contributed to victory of Allies. (check Hut 6 story.) Enigma w/ demo (PC?)

Cult. Impact Prometheus vs. Frankenstein: early popular depictions of the computer. (VM?)

Tech. Display Variety of early memory devices. Process of experimentation. Pressing button reveals that which survived: core memory. (FX)

Tech. Intact. Core memory interactive. (PC)

Milestones Content as of 1/7/91

Milestone: 3: Computer For Sale!

Time Tunnel:

1950s economic boom, consumerism

Photos: ad for Chevorlet, households appliances, .

Vignette: UNIVAC I at General Electric used for payroll and inventory control, c. 1954

Intro. Panel Connection between post-War econmomic boom and increased production and capital investment in new technologies. Computers became symbolic of the "modern" corporation.

Text rail:
- economic growth spurred big business, business demand fueled growth of computer industry
- only largest corporations could afford computers, prestige played a part in purchases (Harvard reprint, IBMers quote?)

Inter-active: Display of toaster parts? Push-button starts audio of operators arguing over why factory has run out of part X. (AD+)

- Identify parts of the UNIVAC

Flanking Displays

Pers. Impact Mirror reveals picture of large department store. Bringing such a diversity of goods to market today depends upon computers.

Soc. Impact Photo of people having tea at Lyons tea room in the early 1950s. Revel: video of LEO developedto monitor stocks of tea etc. (VM)

Cult. Impact Automation debate: Life of Leisure or Lose our Jobs. Vintage cartoons of guy in hammock vs. man begging outside factory manned by robots. Video of GE VP vs. Twilt Zone (VM)

Tech. Display Birth of an industry: collections of company logos

Tech. Intact.

Milestones Content as of 1/7/91

Milestone: 4: Try to Tell It What to Do

Time Tunnel:

Demand for programmers c. 1960

Photos: Ads for programming schools, want ads for programmers

Vignette: Film dramatizing the needs that spurred development of COBOL c. 1960

Intro. Panel

Text rail:
- Introduction to film:
  - difficulty of programming and lack of standards pressed development of higher level languages
  - customers and manufacturers worked together

Inter-active: *"What is a Programming Langauge?"* program illustrating different levels of languages from machine code to COBOL.

Flanking Displays

Pers. Impact

Soc. Impact

Cult. Impact

Tech. Display

Tech. Intact.

Milestones Content as of 1/7/91

Milestone: 5: Computers Mind Your Busines

Time Tunnel:

Rise of the multinational corporation and civil unrest

Photos: City skyline, headlines of student attacks on computing centers

Vignette: IBM/360 at the Travelers c. 1967

Intro. Panel Connection between growth of lrg corporations and computers as central to corporate organizations.

Text rail:
- data processing became a vital function in the corporate body
- many resented computers, seen as symbols of the Establishment

Inter-active:
- Opening door triggers tape of computer room din.
- video of Travelers operation? (VM?)
- Push-button starts audio: programmer begging for time to use the machine, operator saying isn't even allowed to be in computer room, etc.

Flanking Displays

Pers. Impact Pile of junk mail. Recording keeping vital to all aspects of business. We see in junk mail.

Soc. Impact Photo line of students waiting to register.

Cult. Impact
- The Privacy dabte: Start w/ Swedish law *(What Show?)*
- The computer as scapegoat. Cartoons. Remember people behind. Board for visitors to tell own stories (PC?)

Tech. Display Examples of many promising technologies of the 60s that failed. The IC survived. AGC example of early IC use. (FX)

Tech. Intact. The shrinking computer. Interactive showing decreasing size and increasing power of comptuer components? (PC?)

Milestones Content as of 1/7/91

Milestone: 6: Doing It on the Spot and in Time

Time Tunnel:

"Small is Beautiful"
Photos: VW Bug, miniskirt, ...?

Vignette:

PDP-8 at Yale in neurosurgery/ LS-8 lighting controller for Chorus Line

Intro. Panel The move toward smaller systems, popular in society at large, affected computers also. Smaller cheaper computers found their way into many new fields of applications.

Text rail:
- "less is more" was the fashion in clothes, cars, and computers
- transistors and later ICs permitted smaller, cheaper computers
- computers left the "computer room" and entered new areas
- begins decentralization of computer power
- same computer here used in surgury and to control theater light

Inter-active:
- Pressing button triggers simulation of computer operation.

Lights pulse from computer, to arm, to exposed brain tissue, to computer. (FX) • Is there a video? (VM?)
- control the lights on a Broadway stage!

Flanking Displays

Pers. Impact Mirror reveals Cat scan of skull. Computers now integral to mdeical research and diagnosis.

Soc. Impact Fans cheering at ball game—reveals computer controlling score board

Cult. Impact Impact of Automation: at aggregate new jobs created offset jobs displaced. On personal level, depends how individual affected. (PC/VM) Perception: took on friendlier, personal mein (VM?)

Tech. Display The Disappearing computer: Spot the computer in these photos (i.e. the potatoe picker, textile mill, Nabisco factory). Pressing button reveals the embedded minicomputers.

Tech. Intact. Interactive comparison of vacuum tube, transistor and IC.

Milestones Content as of 1/7/91

Milestone: 7: Big Science and Supercomputers

Time Tunnel:

The world modeled on computer

Photos: period images

Vignette:

CRAY-1 computer used by ECMWF for weather forecasting (DG interface?)

Intro. Panel

Text rail:
- Ever insatiable demand for computation by science pushes barrier to computational speeds
- need for fast computers in weather forecasting
- supercomputers as strategic technologies
- term supercomputer relative to time (compare w/ present)

Inter-active:
- interactive view of weather model (PC)

Flanking Displays

Pers. Impact Video monitor and camera shows visitor's face. Pressing button freezes image, zooms out rapidly to view of earth from space which is replaced by computer model of Earth. Comptuer essential to studying global problems, such as Greenhouse effect.

Soc. Impact Picture of farmers harvesting. The weather report that guides farmers is generated by computer.

Cult. Impact Simulation and Rendering—Modeling the world and Creating new ones. Collection of faked photos, computer animated films (VM)

Tech. Display Limits of computing (GIGO). Blind faith in computers. Interactive? PC?

Tech. Intact. *How fast are computers?* (PC)

Milestones Content as of 1/7/91

Milestone: 8: "A Computer on Every Desk"

Time Tunnel:

?????

Photos: ??????

Vignette: IBM PC w/ Lotus 1-2-3 / Macintosh used by designer

Intro. Panel Small, inexpensive computers with easy to use interfaces opened the use of computers to more people than ever before.

Text rail:
- Computers become professional tool and personal hobby
- packaged software reshapes industry
- Context: machine of the year.

Inter-active:
- Structured interaction with 1-2-3 and Click Art or other graphics program (2 PC)

Flanking Displays

Pers. Impact Interactive visitor survey and feedback. (PC)

Soc. Impact Enabling the differently abled. (video from CAST?) (VM?)

Cult. Impact
- Haves vs. Have nots (collection of job listings for computer skills)
- Computer Culture (identify the computer terms in language)
- Security, Dependency, and Vulnerability; Computer Ethics

Tech. Display Collection of "classic" microcomputers, rotating (CS)

Tech. Intact. Interactive: computer census (PC) ***Update!***

Milestones Content as of 1/7/91

Milestone: 9: Computers, Computers, Everywhere

Time Tunnel:

Photos:

Vignette:

Car of tourists, filled with electronic gadgets.

Intro. Panel

Text rail:
- Computers now control most all electronic and electrical devices and systems whether large or small
- the microprocessor is everywhere
- has become a commodity, like coal and steel were to earlier economic eras.

Inter-active: Guess how many computers? Reveal inner workings of a camera.

Flanking Displays

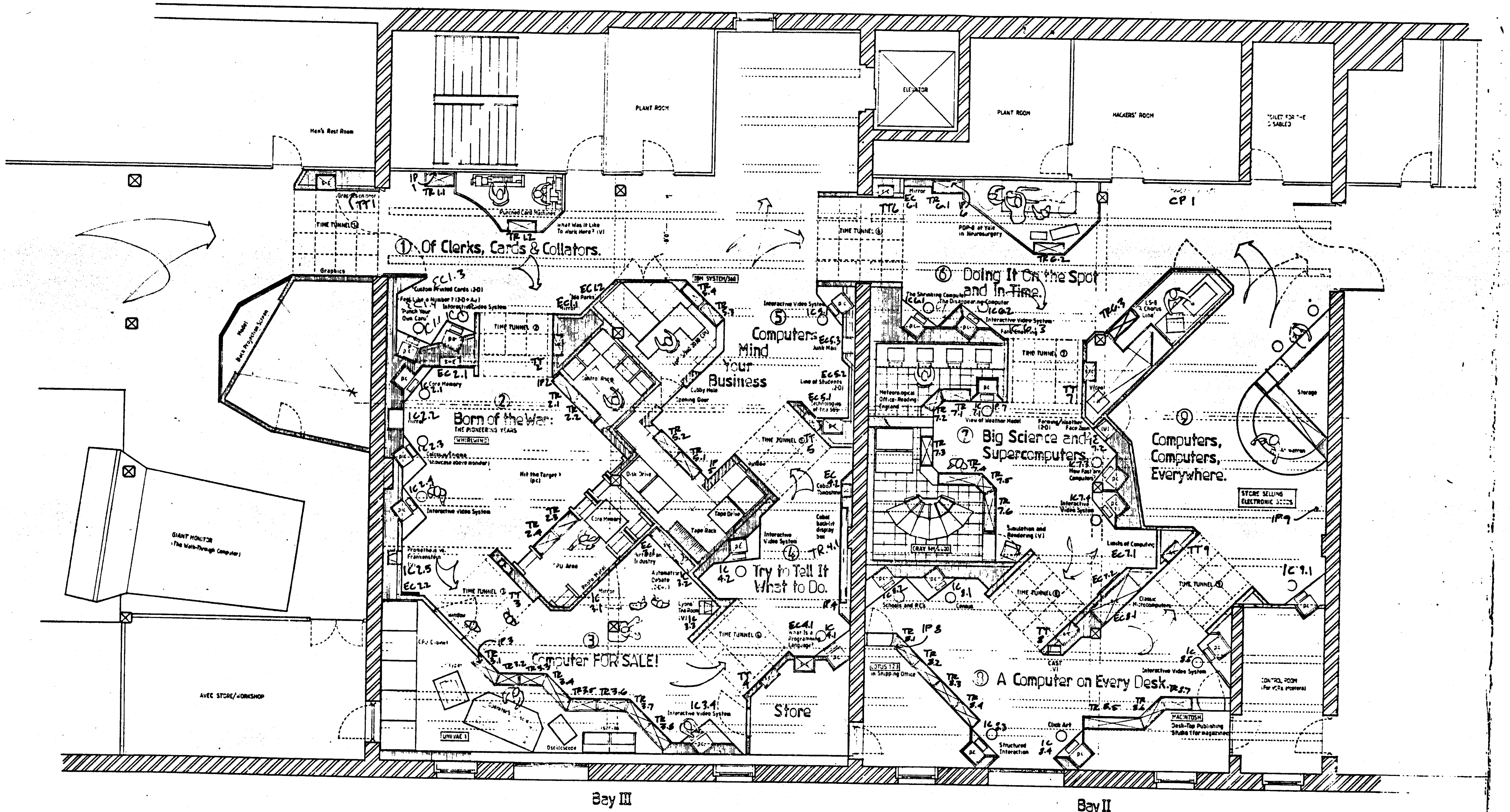
Pers. Impact Click and Clack commenting on computer in cars.

Soc. Impact

Cult. Impact

Tech. Display

Tech. Intact.



IP - INTRODUCTORY PANEL
EC - EXHIBIT CAPTION
TR - TEXT RAIL PANEL
TT - TIME TUNNEL TEXT
IC - INTERACTIVE CAPTION
CP - CREDIT PANEL

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Milestones of a Revolution	
SCALE:	APPROVED:
DATE:	DRAWN:
DRAWING TITLE:	REVISION:

The
Computer
Museum

300 Congress Street
Boston, MA 02210

(617) 426-2800

February 14, 1991

You're not going to that, are you? that's the brain storming mtg I told you about -

Mr. Gardner Hendrie
Sigma Partners
300 Commercial St., Unit 705
Boston, MA 02109

Dear Gardner:

In preparation for our meeting on the 28th, I have enclosed the first draft of the text for milestones, along with an updated floor plan and content outline. I welcome your comments.

The text closely follows the content outline and is keyed to the location codes on the floor plan so that you can see how everything fits together. Please understand that this is still a very rough draft. I have indicated where I am experiencing difficulties in the text, but I welcome your general comments as well. I am counting upon your input to help me refine this very important element of the exhibit.

Things are going very well with the exhibit. Only a few issues remain to be finally resolved, which we shall discuss. Construction is progressing at a rapid pace, as you shall see.

I look forward to seeing you, or, if you cannot attend the meeting, to receiving your written suggestions in the mail.

Regards,

Greg

Gregory W. Welch
Director of Exhibits

Entry to the Exhibit

<headline>
People and Computers: Milestones of <in?> a Revolution

<body text> [I'm open to suggestions here]

The Computer Revolution. How has it happened, and what does it mean?

It has happened through a process of experimentation and innovation that has dramatically reduced the size and cost of computers. What this means is that more people are able to use computers for work and play. The benefits of this are many and wide spread. However, as with any technology, every advance in computers has its price. Therefore, we as a society

Text for Milestones 1: Of Clerks, Cards, and Collators

<Time tunnel: TT1>

<headline>

The 1930s: The Great Depression

<body text>

Times were tough in the 1930s. Banks and factories closed, and unemployment rose. In the U.S., President Franklin D. Roosevelt created the National Recovery Administration to spur the recovery. Under these programs the federal government grew until it employed and served many more people than ever before. Running such a large national government required the use of machines for processing information—the grandparents of today's computers.

<Intro panel: IP1>

<headline>

Money to Millions [better headline?]

<body text>

A government must keep records on its citizens in order to serve them. But imagine keeping records on *millions* of people by hand! The national bureaucracies that arose during the Great Depression of the 1930s came to depend upon machines to help them. These machines processed information using gears, switches, and paper cards—they were the ancestors of modern computers.

In 1935, the Social Security system was created to ensure income for people who had reached the age of retirement or were unable to work. To keep track of their contributions to the system, the Social Security Administration maintained files on over 17 millions <verify> American workers! Without the use of mechanical punched card machines this would have been impossible.

<Text Rail: 1.1>

<headline> [?]

<body text>
In the 1930s the world was in an economic crisis. The President of the U.S. signed a law to provide income to millions of retired workers. But how? Even an army of clerks would need help keeping track of all the payments to be made. The Social Security Administration turned to punched card machines like the ones in front of you.

Records of payments, addresses, and other data for over 17 million American workers were all stored on punched paper cards like the one to the right. The various machines processed these cards—some punched information onto the cards, others sorted cards, and others printed out reports. Hundreds of clerks carried many thousands of cards from one machine to the next every day. Together machines and people made possible the distribution of pension checks to over XX million Americans every month.

The Social Security Administration, though perhaps the largest, was not the only user of punched card equipment. Most government agencies and large businesses also depended upon the machines for their recording keeping and accounting operations.

<caption: punched card>
Can you see how the machines recorded and read information from the punched card? (Hint: the secret is in the square holes.)

Examine this card to see how the name and number printed along the top edge of the card are represented by the holes punched beneath them. The position of a single hole or a combination of holes within a column represents a specific number or letter. The printed letters were for human clerks to read—the holes were for machines to read.

<u><Text rail: TR1.2></u>

<caption: SSA video>

<headline>

What was it like to work here?

<body>

Press the button and see. Notice how people and machines form one system. Would you like to have worked here?

<caption: 031 Card Punch>

<headline>

Punch that card!

<body >

The machine in front of you enters information onto punched cards. It is an IBM 031 Card Punch, similar to those used by the Social Security Administration. When its operators pressed a number or letter on the keyboard, this machine punched the corresponding arrangement of holes into the card. To see one in operation watch the video to your left, try it yourself on the computer behind you, or ask a staff member in a blue vest for a demonstration.

<caption: IBM 080 Sorter>

<headline>

Sorting it all out

<body>

Have you ever tried putting a deck of cards in order? Rather tedious isn't it? Imagine how difficult it would be if you had to arrange hundreds or thousands cards in order. That's what this machine is for.

Punched cards could be arranged in numerical order by running them through this IBM 080 Sorter <verify>. A clerk placed a stack of cards in the bin on the left end of the machine. One by one XX cards whizzed through the machine every second. If the machine detected a 1, the card fell in the first bin, a 2 and it fell in the second bin, and so forth. <verify>

The clerk then gathered up the stacks of cards in order from the bins, set the machine to the examine the next column on the cards, and fed them through again. This procedure was repeated as many times as there were digits in the number of cards being sorted. For example, sorting 10,000 cards required 5 passes through the machine (there are 5 digits in the number 10,000). It was still *much* faster than sorting them by hand.

<Personal Impact on you now: EC1.1>

<text>
The descendents of the early punched card machines still affect you today. How?

<pressing button reveals behind mirror, caption: City of Boston Public Works repairing a road? >
Federal, state, and even local governments depend upon computers to coordinate efforts that provide you with sidewalks, roads, and other services.

<Social Impact on people then: EC1.2>

<caption: period photo of elderly people>
How were these people affected by the use of punched card equipment?

<caption: photo of Ida May Fuller receiving first SS check>
Punched card equipment made possible the distribution of retirement income to millions of elderly Americans. Here Ida May Fuller receives the first Social Security check from President Roosevelt.

<Cultural Impact: EC1.4>

<headline>
Feel Like a Number

"Good morning 675-12-9073."
"Why hello 453. How are you?"
While this conversation may sound strange, there are many times we substitute a number for someone's name. Can you think of any?

We often replace a name with a number when we have lots of people to keep track of and must rely on machines for help. In many countries every citizen is assigned an identification number. In the U.S., the Social Security Administration gives all participants in the program a number by which they were identified. That way even people with the same name will have unique numbers, and everyone's number is the same length—an important point when filling out forms or using punched cards.

Do you have a Social Security or national identification number? How would you feel if someone called you by that number?

Sometimes calling a person by a number has sinister connotations. To illustrate how dehumanizing was the society in which they lived Aldus Huxley gave the characters in his *Brave New World* numbers instead of surnames.

<caption: case of dogs tags, Social Security card, photo of C3PO, etc.>
[caption describing contents of case]

<Tech. Display: EC1.3>

<headline>
Do Not Fold, Spindle, or Mutilate
[Is this headline appropriate? Does it require explanation?]

<body text>
Wherever there was a need to keep many records, you probably found punched cards. The familiar rectangular card, used for everything from phone bills to paychecks, became symbolic of business and management. Punched cards became the basic currency of information for government and business alike.

So handy was this technology that it continued to be widely used through the early 1970s, even though faster, less bulky ways of storing information had long been available. In fact, the Social Security Administration issued checks on punched cards and the Massachusetts Turnpike Authority used punched cards to collect tolls clear until the mid-1980s.

<caption: IBM Advertisement>
Punched cards were used by managers to study the information necessary for a broad vision of business activity.

<caption: assortment of custom printed cards>
Punched cards became an important tool for many businesses. Phone bills, inventory records, paychecks, equipment orders and the like were often recorded and issued on custom-printed punched cards.

<Technology interactive: IC1.1>

<text: Punch Your Own card interactive>
What does your name look like on a punched card? Use this computer to find out.

Text for Milestone 2: Born of the War

<Time Tunnel: TT2>

<headline>

The 1940s: A World at War

<body text>

In World War II the might of nations was embodied in machines. Planes, tanks, and ships, were built in a greater variety and number than ever before. This placed unprecedented demands upon the engineers and scientists of the warring countries and focused money and minds on the development of new technologies. From these efforts emerged jet airplanes, the atomic bomb, radar, rockets, and the computer.

<Intro panel: IP2>

<headline>

The Computer is Born

<body text>

Before World War II, only a handful of independent inventors tinkered with devices for automatic calculation. However, the War fueled the demand for such machines and focussed resources on their development.

Innovators on both sides of the conflict nurtured experimental projects to create computers. These early machines were used for tasks where the volume of calculations involved was immense. For example, in Germany the Z-2 computer was used for refining the wings of flying bombs, in Britain the Colossus was used for cracking enemy codes, and in the U.S. the ENIAC calculated tables for aiming artillery.

The Whirlwind computer you are about to see was the outgrowth of such a project at the Massachusetts Institute of Technology.

<Text rail: TR.2.1>

<headline>

The 1940s: An Era of Experimentation

<body text>

In many ways the Whirlwind was typical of early computers: it was produced by a university with military sponsorship; its developers continually experimented with new techniques to enhance its performance; and, its size was enormous.

What you see in front of you is a portion of the control room of the Whirlwind computer as it looked when shut down in 1954 [date?]. To your right is a part of the computer itself. Together control room and computer would have filled a house!

Early computers required an operator to be on duty at all times. The operator fed data and programs to Whirlwind, checked its circuitry to make sure it was running correctly, and, most importantly, scheduled when programmers could run their projects on the computer. Such an expensive machine as Whirlwind was kept running around the clock. Here, one of Whirlwind's operators, <name?>, is loading a reel of paper tape into a machine called a "Flexowriter." The Flexowriter detects the position of holes punched on the paper tape and feeds that information into Whirlwind's memory. When the program is ready to run <name> will start it.

<u><Text rail: TR.2.2></u>

[History of Project Whirlwind]

<caption: Murrow video>
What did Whirlwind look like in operation? Press the button and see.

<u><Text rail: CPU racks: TR2.3></u>

<headline>
The guts of the machine

<body text>

This is where the real work gets done. These racks contain Whirlwind's basic calculating and control circuits.

Can you spot the small glass tubes among Whirlwind's circuits? Those are *vacuum tubes,* like the one to the right. Vacuum tubes were the basic component used in Whirlwind and most all other computers through the late 1950s. Can you feel the heat it gives off? Imagine how much heat all of Whirlwind's 10,000 [check #] vacuum tubes generated! Not only did running all these vacuum tubes consume as much power as X households, but Whirlwind required tons of air conditioning equipment to keep from overheating. Even so, vacuum tubes had a tendency to burn out. Notice how the circuits are built of modules that could be easily removed from the racks and replaced. [story of Whirlwind dimming lights in Cambridge?]

The square unit between the rows to your left is Whirlwind's *core memory*. That's where its programs and data were stored. See the core memory plane mounted to the right.

<Text rail: TR2.4>

<headline>
Not an economy model!

<body text>

Keeping a machine such as Whirlwind operating was not cheap. Through the early 1950s, in fact, only the government could afford it. During this era there were only XX computers in the entire world and most all were used by the military. [Figures on what Whirlwind cost]

<caption: Vacuum tube>

<headline>
The Switch that Made the Computer

<body text>
Vacuum tubes were the basic components for early computers and other electronic devices, such as radios. Most vacuum tubes were essentially switches that could be turned on and off thousands of times [verify] a second. This made them useful for constructing computers. When "on" the vacuum tube represented a 1, when "off" a 0, the binary number system used by most all computers.

<caption: core memory plane>

<headline>
Core Plane

<body text>
Look closely. See the little "doughnuts" strung on this grid of wires? Those are little magnets called *"cores."* These magnetic cores were used to

store information inside the computer. To see how, try the computer behind you.

Core memory was invented for the Whirlwind. You can see its stack of core planes in the center of the square unit between the module racks to your left. Core memory was widely used in computers for over 25 years.

<Personal impact now: IC2.2>

<body text>
Even from their beginnings computers have shaped the conditions under which we all live. How? Press the button.
<reveals mushroom cloud>
From an early stage computers have been integral to the development of nuclear weapons. Under whose shadow we all live.

<Social impact then: IC2.3>

<headline>
Giant Electronic Brains!

<body text>
People marvelled at the first computers. Calculating at speeds that boggled the human mind, the computers almost seemed to think for themselves. They were utterly unlike any machine invented before. But

they also aroused age-old fears. Would they outwit their human creators or be our loyal servants? Depictions of computers in movies, cartoons, and television reflected this wariness: sometimes the computer was a benign sage, more often a robotic Frankenstein.

<Tech. display: case of early memory devices: EC2.1>

[Some snappy title]

<body text>

Without a good memory a computer can't calculate quickly. In the earliest computers this was a real problem. Their memories were considerably slower than their calculating circuitry, and so the computer often had to wait for information from its memory. It took several years of experimentation and many different approaches before this problem was adequately addressed.

This case contains an array of different technologies which were developed as memories for computers. Each had its advantages and disadvantages, but only one replaced all the others. Can you guess which?

<caption: Williams's Tube>

Williams' Tube, Manchester Mark I

This storage device was developed in England by <name?> Williams and operated on much the same principle as a television screen. Information was stored in the form of glowing dots on the phosphorous coating of the screen. Data could could be retrieved very rapidly from the Williams tube, but as the dots faded the memory had to be refreshed and this slowed it down and decreased its reliability.

<caption: Whirlwind Electrostatic tube>
Electrostatic Tube, Whirlwind I
This memory was developed for the Whirlwind based upon Williams' design, and though it was used for several years, it suffered from the same shortcomings as Williams' Tube and was eventually replaced.

<caption: Selectron Tube>
This is the Selectron. It was developed by <name?> Rajchman <sp?> at RCA. Though it had great promise, this experimental memories was used on only a few machines.

<caption: Acoustic Delay line>
The Acoustic Delay Line was used on several early British computers. This one is from the Pilot Ace developed by Alan Turing among others. This device took advantage of the same principle upon which digital watches are based today. An electrical signal was applied to a crystal mounted at one end of the tube. The crystal vibrated and sent a shock wave through the mercury-filled tube. At the other end, a second crystal, when struck by the shock wave, emitted a electrical signal identical to the original. This cycle was repeated as long as the computer needed to store the information encoded by that signal. However, if the computer needed information that was in transit along the tube, it just had to wait. The speed of the shock wave, compared to the speed of electricity, was very

slow. This was used in such early computers as the EDSAC at Cambridge University in England. [UNIVAC?]

<caption: Magneto Restrictive delay line>
Magneto-restrictive delay line, Ferranti This device operated in a manner similar to an acoustic delay line, but substituted a coil of resistant wire for the tube of mercury. It was not widely used.

<caption: Harvard Mark IV Magnetic Shift Register>
Magnetic Shift Register, Harvard Mark IV. This experimental memory was developed by An Wang and pioneered the use of magnetic cores for the storage of information. However, <operation?>

<caption: Whirlwind Core Memory plane>
Core Memory, Whirlwind—this is the one. Core memory was patented by Jay Forrester, head of Project Whirlwind. Magnetic cores stored information very reliably, and, by arranging them in a grid pattern, Forrester was able to retrieve with equal speed any piece of information, regardless of where it was stored.

Originally hand-threaded by skilled <weavers?> the manufacture of core memories was soon automated. Over a span of 20 years the cores were made smaller, and the mesh of wires finer. Indeed, core memories remained in wide spread use until the mid 1970s, when silicon-chip memories finally displaced them. Even today they are still used in certain applications, such as on the Space Shuttle, where it is essential that the contents of the memory be retained even if the power fails.

<Technology Interactive: Core Memory: IC2.1>

<caption>

Use this computer to understand how core memory works.

Milestone 3: Computer For Sale!

<time tunnel: TT3>

<headline>

The early 1950s: An Era of Abundance

<body text>

The post-War period was one of great economic growth. Toasters, cars, refrigerators, and waffle irons were purchased in unprecedented numbers as assembly lines reverted to consumer production and poured forth an abundance of goods. A small handful of large companies began to look to the emerging computer as a tool for managing their vast operations. Thus computers became a commercial product.

<Intro panel: IP3>

<Headline>

[suggestions?]

<body text>

Imagine keeping track of all the wire, plastic, steel, springs, and other materials needed to manufacture 1,000 toasters, refrigerators, and XX a day. When General Electric consolidated all its appliance manufacturing in one factory in the early 1950s, it faced just that problem. Maintaining a smooth supply of raw materials was a gargantuan task. So GE bought one of the very first computers offered for sale, the UNIVAC I. Tracking inventories and calculating payrolls that would have required hundreds of clerks, was accomplished by one computer and XX technicians. Not everyone saw this as progress.

<Text rail: TR3.1>

<heading>
Blazing New Trails

<body text>
In 1954, General Electric installed a UNIVAC I in its colossal plant in Louisville, Kentucky. It was the first electronic computer in the Untied States to be purchased by a private company. But spending $1 million for the machine was only the beginning; then GE had to get it running. Would it turn out to be a wise investment?

A team of XX technicians and consultants worked feverishly to program the UNIVAC I. In front of you an operator and a programmer are preparing to test a program. To the left, programmer, <Betty Holberton?>, is loading a reel of *Unitape* into a *Uniservo*. This reel of metal tape (similar to an audio tape made of metal foil) contains the program and data for the computer. When the tape is loaded, operator, <name?>, flicks switches on the operator's console, telling the computer to begin reading the tape and executing the program. The results will be printed on the

UNITYPER to his right. To his left is an oscilloscope used to test the UNIVAC's circuitry in the event of an error. Many times if a program "crashed" or stopped running, it was difficult to tell if the fault lay with the program or the computer. This made getting UNIVAC to do useful work all the more difficult.

Finally, after XX months of work, UNIVAC I was keeping track of the millions of parts in the factory's inventory and <verify> calculating paychecks for the plant's 40,000 <verify> employees.

<Text rail: TR3.2, TR3.3>

<headline>
[??]

<body text>
The UNIVAC I was a direct outgrowth of the early development of computers during the Second World War. John Mauchly and J. Presper Eckert, <sp?> who founded the company which built the UNIVAC, had designed one of the first electronic computers, the ENIAC, under an Army contract at the University of Pennsylvania. While many still thought of the computer as a tool exclusively for science and engineering, Eckert and Mauchly were among the first to envision the computer's potential for business.

Others soon caught on. Remington Rand, an office equipment manufacturer, bought Eckert and Mauchly's struggling company, and other large companies were not far behind GE in lining up as customers. By the mid-1950s, many managers saw the computer as the hallmark of a thriving, modern enterprise—the latest tool for scientific business administration. Orders soared from the tens to the hundreds. <verify> Soon IBM and other companies, including GE itself, began to manufacture computers.

<caption: photo of GE plant?>
General Electric's Louisville factory concentrated all its appliance manufacturing in one place. At close to $1 million each, there was no way GE could have afforded UNIVACs for all its plants spread throughout the country.

<u><Text rail: TR3.5></u>

[history of development Eckert and Mauchly]

<u><Personal impact now: IC3.1></u>

<body text>
Inventories, parts, so what! What's this got to do with you? Press the button and see!

<reveals photo of Lechmere>

Have you ever been to a large department store? Computerized inventories were an integral link in bringing all those products to you. [bar code, laser check out...]

<u><Social impact then: IC3.3></u>

<caption>

Jolly good tea, but what's this got to do with computers in the 1950s? Lift and see. <lifting reveals LEO video>

<u><Cultural Impact: IC3.2></u>

<headline>

A double-edged sword

<body text>

The use of computers by business was part of a larger trend: *automation.* Machines that seemed to think and work tirelessly were viewed with both hope and despair. Some claimed this technology would liberate humans from drudgery; others that it would put many people out of work. In 1955, <verify> the potential impact of this emerging trend were even debated in Congress.

New technologies often give rise to such debates, and, indeed, they continue today. How do you react if you hear of new jobs being performed by computers?

View opposing perspectives on the automation debate by selecting with this lever.

<labels over lever>

Friend

Foe

<Display case: the emergence of the industry: EC3.1>

<headline>

The Computer Industry Takes Off!

<body text>

In 195X?, when John Mauchly and J. Presper Eckert started the Eckert-Mauchly Computer Company, few saw any potential for commercial computers. By the end of the decade, however, Remington Rand, the company that bought their fledgling operation, had been joined by many others; IBM, Burroughs, NCR, Sylvania, Raytheon, Packard Bell, Bendix, General Electric, RCA, <non-US examples?> and others all began producing computers. An industry was born.

MILESTONE 4: Trying to Tell It What to DO

<Time tunnel: TT4>

Late 1950s, Early 1960s

[Cold War, Eisenhower, military industrial complex, military as big customer, pushed development of programming languages]

<Intro panel: IP4>

<headline>

Trying To Tell Them What to Do

<body text>

As more organizations purchased computers, a serious problem arose: how to get these computers to go to work. Giving a computer instructions was no easy task and took a long time; it was like learning to speak an utterly foreign language. To make matters worse, no two different computers used the same language. Customers complained that it was taking too long to get results from their expensive computers. Something had to be done. Programming had to be made more efficient.

In the late 1950s, several groups directed their attention to this problem. What they came up with were *programming languages.* These languages allowed computers to obey commands more familiar to people and made it possible for programs written on one computer to run on another. These two qualities made it easier to put computers to work.

Two of the most successful programming languages that emerged during the late 1950s and early 1960s were FORTRAN, used for scientific computing, and COBOL, for business data processing. Both are still widely used today.

<u><Text rail: TR4.1></u>

<body text>
Touch your nose. Stick out you tongue. Did you have to think about it? Probably not, you just did it. That's because your brain automatically translates those phrases and sends instructions to the right muscles to carry out the action required. Computers aren't so smart.

Clear through the 1950s, programmers had to spell everything out for computers in gruelling detail. As if, to touch your nose, you had to tell your arm muscles what your nose was, where it was to be found, and every motion required to get there. As you can imagine, programming a computer was a slow and difficult task.

That's why the development of programming languages was so important.

How do you tell a machine what to do when it can't speak your language? In the early day's of computing, you had to speak the computer's language—an arcane string of numbers and obscure commands. Even worse, no two different computers used the same language! This is what a computer program looked like before programming languages were developed.

<insert sample assembler code>

Can you make any sense of this? This was the only language the UNIVAC I understood. How would you like to have to use this language?

COBOL allowed the computer to understand words and symbols familiar to programmers, such as: ADD, IF, THEN. The key to COBOL and other early programming languages was a special program called a *compiler*. A compiler took the COBOL commands written by the programmer and automatically translated them into the correct series of minute instructions that the computer actually executed.

Programmer writes		Computer Executes
ADD 2, 3	COMPILER	kjnad;cn
		[qdv' efn
		]qdpvok 'fm

As you can see writing a program in COBOL was much less work that having to use the code the computer understood.

Furthermore, a program written in COBOL could be run on any computer for which a COBOL Compiler existed. One of the reason COBOL became so widely used was that the Navy, which had many different types of computers, would not buy machines that did not have a COBOL Compiler. <verify>

<u><text rail: TR4.2></u>

<headline>
The History of COBOL

<body text>
The way COBOL was developed indicates how grave the problem of programming computers had become by the late 1950s. In 1959, a committee of representatives from X computer manufacturers, X government agencies, and X large computer users met to address the need to make programming easier. etc. etc. <verify>

Milestone 5: Computers Mind Your Business

<Time tunnel: TT5>

<Headline>

1960s: Business Goes Global

[suggestions for a better headline?]

<body text>

As the post-War global economy continued to grow, so did corporations. Organized like enormous pyramids, the top managers of large enterprises relied on computers to sift and funnel the information they required to run their far-flung operations. From banks and insurance companies to oil and automobile companies, computers became an integral part of doing big business.

This applied to the public sector as well. Governments, hospitals, and large universities also came to depend upon computers for record-keeping, and NASA could never have put astronauts on the moon without computers.

Through the 1960s, most computers were still mainframes, large, expensive machines to which access was strictly limited. Because of its central role in business and public administration, the computer was suspiciously viewed as a tool of "the Establishment" by the emerging "counter culture" of the period.

<Intro panel: IP5>

<headline>

Big Business Buys the Computer

<body text>

By the 1960s, wherever you found big numbers you were sure to find computers; whether it was performing the vast number of calculations NASA needed to design rockets, or the keeping track of the huge number of insurance policies written by The Travelers Insurance Companies, the computer was the tool for the job. The IBM System/360 contributed to this trend perhaps more than any other of its time.

The Travelers Insurance Company was typical of the companies that came to depend upon computers. At its central *data processing center* in Hartford, Connecticut, the Travelers maintained records on the more than XXXX insurance policies written by its agents nationwide. Enormous "banks," or "libraries," of computer tapes stored information on Travelers's XXX customers.

<text rail: to left of time tunnel: TR5.1>

<headline>

A New Kind of Library

<body text>

When you read a book you are looking at the information stored on its pages; likewise, libraries store lots of information for you to use later. But computers cannot read books; they need a different kind of library.

In the 1960s, machines like the ones in front of you were used to store information for computers to use. To your left <verify> are two tape drives, to your right, a disk drive. Both store and read information magnetically, so a lot of information takes up very little space. Companies, like the Travelers Insurance Companies, created large "libraries" of computer tapes and disks which held information essential to their business. Similar tape and disk drives remain in use today.

So what? Well, during this period, large businesses and governments began to create enormous libraries of data. What sort of data? Oh, you name it: medical records, bank accounts, criminals records, driver's license records, income tax records. Records about you?

<text rail: to left of time tunnel: TR5.2>

<caption: tape drive>

<headline>

Music to a computer's ears.

<body text>

These IBM XXX Tape Drive units are basically large tape recorders built especially for computers. Just as you may use a cassette recorder to record and play music on magnetic cassette tapes, the computer uses these machines to record and "play" data on reels of magnetic tape. And, while you may collect cassette tapes of your favorite groups, computer centers kept huge collections , or "libraries," of tapes of data.

Mainframe computers like the IBM System/360 often had up to XX tape drives connected to them. But it took the human computer operators to retrieve, mount, and store the right computer tapes for a given program to run.

<caption:

<caption: Disk Drive>

<headline>

Automatic Disc Jockey

<text>

You think you're impatient when waiting for a tape to rewind, consider a computer. When you're sampling data to a lightning-fast beat, tape is just too slow. You need something faster, like these IBM XX Disk Drives. These units record information on spinning metal platters coated with magnetic material. An arm driven by a powerful electric motor sweeps across the disks, finding the data the computer needs in no time.

See that round, black plastic "box" on top of the disk drive? That's a *disk pack;* it contains 6 <verify> disk platters. Operators could select from a "library" of disk packs to feed the computer different data or programs.

<caption: magnetic tape>

<headline>

See for Yourself!

<text>

Ordinarily you can't see the information on a computer tape. But here a chemical treatment has revealed the tiny arrangement of binary data magnetically stored on the tape. A dark spot is positive, or a "1," a lighter spot is negative, or a "0." <verify> The computer reads a whole row across the tape simultaneously, 8-bits, 1 *byte* at a time.

<u><text rail: in front of 360 CPU: TR5.3></u>

<headline>

Get in Line and Wait Your Turn

<body text>

Today, when you ask a computer to do something, the computer does it—whether it's a personal computer or an ATM—you expect an immediate response. It's not always been that way. Through the 1960s, most people who used computers never actually saw or touched the machine, and results were often long in coming.

See that cubby hole in the wall to the left? If you had wanted this IBM/360 to do something for you, that's where you would have placed your request and instructions. The computer's operator would have then run your job when there was time available. Between all the different tasks it had to do, which could only be run one at a time, the Travelers kept its IBM/360 busy almost round the clock. Your project would have just been put in line behind all the others already scheduled. Sometimes you might have had to wait days before your results appeared in the cubby hole.

<headline>

In a Room by Itself

<body text>

The Travelers, like most companies employing large mainframe computers during the 1960s, housed its IBM System/360 in its own special installation. Such facilities were constructed to meet the needs of the computer; they were heavily air conditioned and had plenty of space in the floors, ceilings, and walls for cables and wiring. Between the fans in the computers, the disk and tape drives, and the air conditioning, a constant din filled the computer room.

In general, only the computer's operators were allowed to enter the computer room. However, large computer installations were a symbol of power and prestige for many corporations and were many times fitted with glass windows from which visitors could view the array of equipment.

<text rail: TR5.4>

<headline>
Tornado destroys five homes in Illinois town. Flood ravages Mississippi delta. Earthquake damages buildings in California. These people need help fast!

<body text>
Getting money to the victims of disasters is an essential activity of insurance companies and means gathering and responding to lots of data. To process the thousands of claims it received daily the Travelers turned to computers. By the mid-1960s, computer data processing had become a critical part of doing business for the Travelers. The IBM/360 helped make this true of many companies. The computer had found a permanent home at the heart of big business.

<caption: IBM/360>
[The history of the System/360]

<Personal Impact Now: EC5.3>

<headline>

What began then continues today.

<body text>

Today more businesses keep records on computer than ever before. What evidence of this do you see?

<reveals cascade of junk mail>

Businesses use computers to churn out XX tons of mail every year! If you receive such mail, your name and addressed must be stored on a computer somewhere.

<u><Social Impact Then: EC5.2></u>

<headline>

The computer enters people's lives—almost

<body text>

Filling out forms was the way most people interacted with computers during the 1960s. Here students wait to register. Though they never saw it, a computer assigned them to their classes.

Another way people felt the affect of computers was that their phone, gas, and electric bills were generated by a computer. [examples in case?]

Text for Milestone 6: Doing It On the Spot and In Time

<time tunnel: TT6>

<headline>

Small is Beautiful

<body text>

The late 1960s and early 1970s were a period when old ways of doing things were called into question and new ways tried. People seemed to be moving away from the notion that bigger was better. This applied to cars, fashion, and computers.

<intro panel: IP6>

<headline>

Computers have nothing to lose but their chains!

<body text>

During the 1960s, young people around the world raised their voices against "the Establishment." They questioned the centralized "powers that be," and proposed alternative lifestyles and societies where people could live a simpler life, on a smaller scale, closer to the earth.

Simultaneously a similar movement was sweeping the world of computers. Smaller, cheaper components resulted in smaller, cheaper computers that no longer needed special installations. The confines of the central computer center were broken! Computers spread to new, smaller-scale uses.

The PDP-8, by Digital Equipment Corporation, was a leader in this trend. First using transistors, and then smaller integrated circuits, the PDP-8 line of *minicomputers* became so small it was often built right into other pieces of equipment and made its way to places computers had never fit before. Here you'll see it playing an important role in an operating theater and a Broadway show!

<text rail: Operating room: TR6.2>

<headline>
An Electronic "Brain" Helps Save the Real Thing!

<body text>
Can you spot the tumor on the exposed part of this patient's brain? Neither can the surgeon—to the eye, tumor and brain tissue are alike! However, *brain tissue* is connected by nerves to other parts of the body, and nerves carry electricity. So the computer is used to stimulate parts of the body with small electrical pulses and detect where those pulses emerge on the brain. That tissue where the computer detects no signal the surgeon knows to remove.

The PDP-8 was one of the first computers small enough that it could be wheeled into an operating room. It didn't require a special installation.

<caption>

Test a circuit in the body. Press this button. Can you tell what area the surgeon should remove? Press this button for the answer.

<text rail: Chorus Line: TR6.3>

<headline>

A Chorus Line: XX dancers, and one computer

<body text>

Sam controls lights. Hundreds of them—floods and spots in all colors—creating dazzling effects. Little did the audience watching *A Chorus Line* suspect that Sam was a computer! That's him there in front of you—the desk, not the dummy.

Sam, or the LS-8 as he was named by Electronics Diversified, Inc, his manufacturer, relies on a PDP-8a <verify>. The PDP-8a is Sam's brain and memory. It remembers all the many effects and executes them in their proper order. One big advantage to Sam is that the computer can flash lights faster than any engineer could by hand. For *A Chorus Line* that was key. Sam had to keep pace with XX whirling dancers.

<Personal Impact Now: EC6.1>

<body text>

Computers now play a critical role is saving lives.

<reveals CAT scan>

A computer generates this CAT scan image from X-rays to helps doctor identify <verify>

<Social Impact Then: fans cheering at a ball game: IC6.3>

A computer sports fan? Well, by the 1970s, you never knew where you might find a minicomputer!

<Cultural Impact: Impact of Automation: IC6.1>

<headline>

So what happened with Automation?

<body text>

Minicomputers that could be used inside other machines and on factories floors made automation a reality. But did the fears and hopes of people during the 1950s come to pass. The impact of automation depended entirely on your perspective.

Use this program to investigate how computers affected the country and individuals.

<Tech display: IC 6.1>

<headline>

The Disappearing computer

<body text>

Can you spot the computers in these pictures? Even though the computer had emerged from the computer room, it many times disappeared into other machinery. Minicomputers found there way to places you might never have expected.

<Tech. interactive: IC 6.1>

<headline>

The Shrinking Computer

<body text>

As the components from which they were built shrank, so did computers. Compare the size of these

<Text for Milestone 7: Big Science and Supercomputers>

<time tunnel: TT7>

<heading line>

It's a Small World After All

<body text>

Between supersonic jets, satellite communications, space missions, and global markets, the world seemed to get ever smaller but ever more complex. Using computers to help grasp this complicated world sent scientists on a never-ending search for more computer power. The computers built to meet this challenge were dubbed "supercomputers."

<intro panel: IP7>

<headline>

[suggestions?]

<body text>

What will the weather be like next week over the North Atlantic? What is the destructive force of a nuclear warhead? How much oil is under Antarctica? Is the world getting warmer? To answer these and other such questions scientists during the 1970s increasingly turned to huge mathematical models. To create and experiment with such models required vast computer power.

The CRAY-1 computer, when it was introduced in 1976, was by far the fastest computer in the world! <how many times faster?> As such, it played a critical role in changing the way scientists used computers in their research. Churning through vast calculations at lightning speed, the CRAY-1 computer allowed scientists to construct and study mathematical models of objects or events too dangerous, inaccessible, or large to experiment with directly.

Here you will see how the CRAY-1 system was used by the European Centre for Medium Range Weather Forecasts to predict the weather around the world.

<u><Text rail: office: TR7.1></u>

<headline>
[suggestions?]

<body text>
From this room, meteorologists at the European Centre for Medium-range Weather Forecasts study a picture of what they predict the world's weather will look like for ten days. The charts on the wall show the European forecast for June 11-20, 1979 <verify>. At the computer screens in front of you meteorologists examine their weather model in greater detail,

studying how storms and weather conditions evolve in particular areas. (Try it for yourself on the computer to your right.) <verify> The mathematical calculations underlying these charts and computer displays were performed by the CRAY-1 computer behind you.

[Description of weather model?]

<Text rail: Cray-1 room: TR7.4>

<headline>

A Numbers Factory

<body text>

To produce its weather forecasts, the European Centre for Medium-range Weather Forecasts built a computer center the size of a small factory. Housed in this "numbers factory" was an array of computer equipment with a CRAY-1 computer like the one you see in front of you at its heart.

Can you guess why the CRAY-1 computer has no keyboard or screen? Well, the CRAY-1 computer calculated at such a blistering rate that talking to a person would only slow it down, instead other computers were used to feed it data and instructions. In other words, people rarely communicated directly with the CRAY-1 system, but controlled it via other computers.

<body text>

The CRAY-1 computer system was the fastest computer of its day. Such computers are called **supercomputers** and are used for scientific and engineering applications that require vast amounts of calculation to be done quickly.

Who used it and how?

Supercomputers changed the way scientists study the world. Complex mathematical models can simulate objects or events that would be impossible, too expensive, or too dangerous to investigate directly. However, studying such models depends on enormous amounts of calculation–many times more than even mainframes could do in a reasonable length of time. That's when supercomputers are handy.

<headline>

The World's Most Expensive Loveseat

<body text>

The world's fastest computers are not cheap (the CRAY-1 computer system cost $8,000,000 in 1976), but some jobs could not be done without them. For example, defense laboratories use such computers in the design of nuclear weapons. Chemists can study how medicines work before testing them on patients. Aircraft companies use supercomputers to test the design of airplanes before they are built. Oil companies use them to map the interior of the Earth, and the weather forecast is brought to you faster and more accurately thanks to supercomputers like the CRAY-1 system.

What do you see?

This is the CRAY-1/M computer system, a smaller member of the Cray computer family. Seymour Cray's computers have been called "the world's most expensive loveseats." The "seat" houses the equipment that supplies power to the rack of modules above it. A pump circulates Freon (the liquid used in air conditioners) through the cast aluminum racks to keep the computer cool.

Do you see the rows of black squares on the module? Those are **integrated circuits,** or "**chips,**" the innovation in electronics that made computers yet again smaller and faster. Each of these integrated circuits contains 17 transistors. (Today's integrated circuits can contain hundreds of thousands of transistors.) Notice how tightly all the modules are stacked inside the computer. The CRAY-1/M computer has as many transistors as about 1,000 PDP-8s (the machine to your left)! Such dense circuitry generates a lot of heat, which is removed by a built-in cooling system.

You may have noticed that computers got faster as electronic components got smaller. Why is smaller faster? Because even electricity takes time to travel. In fact, the reason the CRAY-1/M system is arranged in a semi-circle and the modules are stacked so tightly is to minimize the distance between different parts of the computer. The CRAY-1/M system is so fast it would have to wait for electrical signals that had to travel too far from one part of the computer to another!

<Personal Impact: EC7.1>

<headline>

So what do supercomputers have to do with you?

<body>

You live on planet Earth right? Well, supercomputers are helping scientists gain a better understanding of our planet's environment and what we're doing to it. For example, computer models are instrumental in investigating global warming.

<u><Social Impact: Then: EC7.2></u>

<headline>

What's the connection between rice farmers and supercomputers?

<body text>

The weather forecasts generated by supercomputers give these rice farmers the advance warning they need to harvest their crop before it is destroyed by a monsoon.

<u><Cultural Impact: ????></u>

<headline>

A picture's worth a hundred thousand numbers

<body text>

Supercomputers only deal with numbers. But the hundreds of thousands of figures that make up a complex mathematical model would be mind-boggling to the human eye. That's why scientists began to use the computer to create visual images of their models, so they could see what was taking place as the computer calculated.

The use of such *computer graphics* soon spread to many non-scientific applications such as entertainment. Many of the computer-generated special effects you see today on television and in movies can be traced back to work first done on supercomputers.

<caption>
Here you see a collection of

<Tech. Display: ????>

<headlines>
Computer Bloopers

<body text>
With computers becoming so powerful, you might even think them infallible. However, we all know that weather forecasting, even when done by computer, is susceptible to inaccuracy. You see, even a supercomputer is only as accurate as the data and program fed to it by its human programmers. And to err is human. So, before we place too

much faith in computers, we should remember that computers are only as reliable as we, their human creators, are.

Just as the computer can magnify human abilities, it can also magnify a trivial error into a minor catastrophe. Here is a collection of such "computer bloopers."

<Tech. Interactive: IC7.3>

<headline>
Just how fast are computers?

<body text>
What's so great about a supercomputer? Why would you need a computer as fast as the CRAY-1 system? Use this program to see.

MILESTONE 8: A Computer on every Desk

<time tunnel: TT8>

<headline>

Early 1980s:

<body text>

De-centralization was the rage during the 1980s. The monolithic federal and corporate bureaucracies constructed during preceding decades were no longer in vogue and were steadily dismantled in favor of organizations where decision-making was broadly distributed. One arena in which the drive toward de-centralization was particularly visible was in computing technology. Personal computers, which flourished during this period, disseminated computing power to individuals. The power and information that for decades had been concentrated in central computing facilities now rested on a desk top.

<intro panel: IP8>

<headline>

Power to the people

<body text>

The invention that set the stage for the personal computer was the microprocessor. [expand....]

<text rail: IBM PC: TR8.2>

<headline>

A tool for business

<body text>

What you see here is the combination of hardware and software that popularized the personal computer. The hardware is the IBM PC, the software Lotus 1-2-3. Together they formed a tool that became an overnight sensation among business people.

The IBM PC was not the first *microcomputer*, or *personal computer* as it came to be called. But soon after its introduction in <month?> 1981, the PC outsold all other computers.

[more to come...]

Computer
Museum

300 Congress Street
Boston, MA 02210
(617) 426-2800

March 22, 1989

Gardner Hendrie
Sigma Partners
P.O. Box 1158
Northboro, MA 01532

Dear Gardner,

Thank you for attending the Advisory Committee meeting last Thursday. Once again we all enjoyed ourselves and consider the meeting to have made substantial concrete progress. The definition of the milestones is an important step in developing the exhibit. As promised, I have compiled minutes of the discussion, which I have enclosed. If you feel I have omitted anything important, please let me know.

To remind you, the next meeting of the committee is scheduled for 9 am Monday, May 15. I will have parking passes awaiting you at the security desk. We will most likely tackle one or two of the milestone vignettes to wrestle with exactly what themes and topics we wish to treat and, more importantly, how we should go about presenting them to best reach our audience. I will circulate an agenda prior the meeting. See you then.

Warm Regards,

Greg

Gregory W. Welch
Exhibit Developer

enclosure

MINUTES

Meeting of the Historical Exhibits Advisory Committee
March 16, 1989

In attendance: Charles Bachman, Gwen Bell, I. Bernard Cohen, Gardner Hendrie, Chris Morgan, Jane Manzelli, Adeline Naiman, Oliver Strimpel, Greg Welch

Discussion:

The committee examined the list of 12 proposed milestones and arrived at a revised list of 9. During the discussion, members of the committee outlined various themes of importance to the history of computing that the exhibit should treat.

The following are the milestones that the committee proposed be included in the exhibit:

1 — **Computing prior to the computer (1930s).** An office from the 1930s illustrating the use of electromechanical calculators and punched card processors. The vignette might center around the Social Security system.

2 — **The stored program (late '40s).** A display centered about the EDSAC that characterizes the early computer projects and explains the importance of the stored program concept.

3 — **The industry emerges (early '50s).** The UNIVAC-1 will serve as the centerpiece to a display of the early commercially-available computers. To what problems were the early "mass-produced" computers applied?

4 — **High-level programming languages (late '50s).** The emergence of FORTRAN and COBOL will illustrate the drive to establish simpler and standard means of expressing instructions for computers.

5 — **Large-scale Business Applications (mid '60s).** Large batch processing operations, the emergence of large computer and storage systems, communication between computers, and databases will be themes revolving around a display of a System/360 in an insurance or banking environment.

6 — **Real-time computing (early '70s).** The advent of minicomputers facilitated the expansion of timesharing, distributed processing and process control. The vignette might focus on a PDP-8 in an industrial control application or an academic environment.

7 — **Personal Computing (early '80s).** With the microchip, computers could be dedicated to the use of an individual.

8 — **Super computing (early '80s).** A display focussed on the Cray-1 will portray the impact computers have had on scientific research. A graphic simulation of an experiment performed by computer would illustrate this trend.

9 — **The Ubiquitous Computer (mid '80s).** Microprocessors have extended the trend of process control begun by the minicomputer to almost every electronic device, from microwaves and toasters, to spacecraft and automobiles.

The natural chronology of the milestones suggested a physical layout of the exhibit that would take visitors through a reasonably well-defined path that would branch in three directions as it approached the present. The committee deemed that the exhibit should not attempt to look into the future, even thought that might be an important mission of the Museum.

Oliver and Gwen introduced a scheme of five themes that should flow throughout the exhibit. These threads would illustrate the hardware, the software, the use, social impact, and "personality" of the various milestones/eras. These themes met with general enthusiasm from the committee. Discussion then expanded this list to a series of trends that might play roles of varying importance in different vignettes. These are the themes the committee felt must be kept in mind:

- Hardware — basic processor and primary memory technology
- Mass storage technology
- Communication and networking
- Time-sharing
- Educational Environments
- Size/Power/Cost of computers
- Personnel requirements for computer centers
- Time required to perform certain jobs
- Availability and accessibility of computers
- Personalities
- "Persona" of era
- Input and Output technologies
- Social impact

Bernard Cohen made the point that, from the perspective of a historian, the development of computers is not *evolutionary*, but rather constitutes a *revolution*. In response, Oliver proposed calling the exhibit *Milestones of a Revolution: [some subtitle to be determined]*. All felt this to be a most appropriate title.

The
Computer
Museum

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AGENDA

Meeting of the Historical Exhibits Advisory Committee
March 16, 1989

Objectives: Determine the 8 milestones that will form the skeleton of the exhibit. Discuss uniting theme that will be its backbone.

Agenda:

- Review proposed Milestones.

- Rank Milestones.

- Reduce list to 8.

- Discuss central theme or perspective that might unite milestones.

Preliminary Set of Milestones for

MILESTONES OF COMPUTING

Please rank the following preliminary milestones according to the following codes:

5 - Must be included
4 - Would personally like to see included.
3 - May be included.
2 - Better left out in my opinion.
1 - Should not be included.

__✓__ 1 -- Calculating and data processing before the computer. (1930s). Social Security

_____ 2 -- An early British machine (EDSAC or Manchester Mark I) with the first 15 pioneers. (Atanasoff to Forrester) (c. 1937-1950) early stored program

__✓__ 3 -- Early commercialization: UNIVAC -1. (c. 1955)

tied

_____ 4 -- FORTRAN and COBOL: standard higher-level languages. (c. 1955-1962)

__✓__ 5 -- SABRE and the IBM 360: Large-scale business applications. (c. 1967)

✓ Minicomputer – process control

__✓__ 6 -- The Microprocessor: the ubiquitous computer (1972-1978)

tied

__✓__ 7 -- Personal Computing: spreadsheet, wordprocessing, hacking (1978-1988)

__✓__ 8 -- Supercomputing: Cray-1: scientific computing (1985)

Networks

_____ 9 -- Standard operating systems: MS-DOS, UNIX (1985--)

_____ 10 -- Database: privacy, security. (1988 --)

_____ 11 -- Computers as International Commodities: , international aptitudes (1988 --)

__~~✓~~__ 12 -- The future: technologies and applications likely to emerge

Please feel free to add suggestions in the space between the milestones.

Descriptions of the Milestones.

1 -- Calculating and data processing before the computer. (1930)

The intent of this milestone is to illustrate to visitors the techniques, such as mechanical adders and punched card processors, that were used to used to satisfy the need to store and manipulate information prior to the advent of the computer. This will give visitors a feel for the demands that led to the development of high-speed computers. The artifact base of this vignette might be a recreation of a clerk's office circa 1930. Among the interactive components, visitors might use a Monroe or an Ordner calculator to solve a problem posed to them.

2 -- An early British computer (EDSAC or Manchester Mark I c. 1948) with the first 15 pioneers. (c. 1937 - 1950)

A recreation of an early pioneering computer project would illustrate the general character of the period. The display would make immediately clear that the earliest computers were not manufactured goods, but experimental projects usually designed by the people faced by the problem computers were designed to solve. This milestone would emphasize that there was no first computer. Rather, the computer was developed independently and in various forms by several efforts in Europe and the United States. A video disc and interactive computer interface with clips from interviews of various pioneers, from Atanasoff to Forrester, would allow visitors to pose questions to and "meet" the people whose work contributed to the evolution of the modern computer. In this way also visitors will understand the motives that drove people to construct computers.

3 -- Early commercialization: UNIVAC - 1

The UNIVAC - 1, to many, signaled the opening of the computer era and the birth of an industry. It was the first computer to be produced in series and receive wide-spread recognition. Who bought it? What tasks did it perform? An artifactual recreation of a UNIVAC installation will answer these questions. Supporting panels will mention the commercial efforts of Zuse and Lyons Catering Ltd.

4 -- FORTRAN and COBOL: higher-level languages and standardization. (1960)

This milestone will introduce the early efforts to address two themes underlying the whole of computer history: the desire to ease programming, and to create standards independent of specific machines and companies. Interviews with key developers of early languages will explain why there were these needs, and how standard languages helped address them. Simple comparisons of machine code, assembler, and algebraic expressions will help visitors appreciate the need to simplify programming. Standardization might be illustrated by an analogy to natural languages: if there was a common international language, translation would be made much easier. The internationality of computer languages will be touched upon by mentions of Pascal and Algol.

5 -- Sabre and the IBM System/360: Large-scale Business applications (c. 1966)

In the mid-1960s, with the introduction of systems such as the IBM System/360, data processing became an integral part of large-scale business enterprises. The SABRE system illustrates this phenomena in a context that visitors can relate to their own experience: making flight reservations. A computer simulation that showed an airplane's seats filling up as reservations were made would illustrate the importance of real-time data processing in such applications. The 1960s were a period of economic expansion. Computers were linked to modernization, modernization to economic growth. As companies grew, they required larger systems. The IBM System/360 was intended to be a family of unified architecture that would allow users to up-grade their equipment without expensive conversion of their software and data. The System/360 was widely-used and established the 8-bit byte.

6 -- The Microprocessor: the ubiquitous computer. (1975-1980s)

The integrated circuit and its outgrowth, the microprocessor, made possible the introduction of the computer as a control component in diverse applications, from factory floor to outerspace, from micro wave ovens to automobiles. Chips make wide-spread automation more feasible. Some raise concerns of the effect on human workers. A vignette that unveiled the computers that pervade our homes and lives would make people aware of how the computer has been incorporated into society to an even greater degree than they perhaps they are aware. The chip will in all likelihood be the base technology of computers through the turn of the century.

7 -- Personal Computing: spreadsheet, wordprocessing, hacking. (1978-1988)

With the application of the microprocessor the cost and size of a computer was reduced to the point where it was feasible for individual home use. One computer serving one person. The spread in computers used by non-computer scientists, programmers or trained personnel increased the importance of easily-used ("user-friendly") applications software. Such programs as spreadsheets and word-processors became the most widely-used.

8 -- Supercomputing: Cray-1 and scientific computing.

Since their genesis, computers generally have been designed to be optimal for either business data processing or scientific calculation. A focus on the Cray-1, the most famous and first "true" super-computer, would illustrate to visitors the technical problems encountered when pushing the state of the art in calculating speed, and the types of tasks it performs. An interactive computer station would help visitors grasp just how fast a computer such as the Cray-1 calculates. Here visitors will understand the notion of time in computing terms.

9 -- Standard Operating Systems: MS-DOS, UNIX (1984--)

The movement toward portability of programs, which has its roots in the early high-level language efforts and system families, spreads to the demand for company-independent operating systems. This trends reflects the increasing influence of the user/customer on the market and is changing the face of the industry. Software becomes as key a driving force as hardware. Software companies begin to be important players.

10 -- Database: Issues of Security and Privacy (1988 --)

Computers have always served society's need to gather and make meaningful use of information, from census statistics and government data, to stock quotes and magazine subscriptions. No citizen is unaffected by this use of computers. The ability to manipulate vast quantities of data is an undeniable asset to society in many applications, but it raises questions of responsibility and appropriate use. How has this technology changed society? Do you receive more junk mail? How do they get your address? Police can keep better track of criminals. How might this affect you? This vignette would invite visitors to reflect upon such issues, by illustrating the extent to which such systems underlie society.

11 -- Computers as International Commodities: national aptitudes (1988 --)

As standards become more universal, the technology of computers becomes more of a utility, a commodity. Computer companies during the 70s spread their operations around the globe. Any computer system may be the product of many nations: architecture from Europe, chips from Asia, assembly in Mexico, software from U.S. Raw components, such as memory chips, have become raw materials fueling a new information age just as coal and steel fueled the industrial age.

12 -- The future: technologies and applications likely to emerge.

The last milestone might look ahead to give visitors a glimpse of the future. What technologies in the experimental phase today might be commonplace in 10 years?

Gregory W. Welch
The Computer Museum
Museum Wharf
300 Congress Street
Boston, MA 02210

<u>Minutes</u>

Lunch Meeting of February 7, 1989

In attendance:

Charles Bachman, Gwen Bell, Oliver Strimpel, Gregory Welch

Discussion focussed upon the *Milestones of Computing* from a software perspective.

Mr. Bachman stressed that, from a programmer's perspective, changes in base technologies do less to change the character of computing than do **architectural innovations** such as the incorporation of address registers, which give programmers **new resources** to exploit.

The **human resistance to innovation** was touched upon as a recurrent theme in the evolution of the technology.

All agreed that the introduction of the **operating systems** was a **fundamental step** in the evolution of modern computing. There were two tacks this development took: batch processing operations such as OS, and time-sharing between users such as the Dartmouth system or CTSS. Both evolved during the mid-1960s.

An early **software development** Mr. Bachman stressed was the creation of "**report generators**" in the mid-50s. The importance of the development of **high-level languages**, such as Fortran and Cobol, was the introduction of a **standard** that allowed application **portability** and **vendor independence**. The concept of the **database** system (exemplified by the IMS system developed by North American Aviation for the Apollo program, and IDS produced by GE for manufacturing control applications) is also central to computing. Transaction software (**human interface**) and **networking** were two other important point discussed. Lastly, the proliferation of application software, and "**fourth generation languages**" is an important story.

Overall trends in software that ought to be touched upon in the exhibit include: the striving toward **standards** and **reliability**, the increasingly **hierarchical structure** of computers.

Minutes

Lunch Meeting of February 13, 1989
at The Computer Museum
300 Congress Street
Boston

In attendance:

Robert Everett, Gwen Bell, Oliver Strimpel, Gregory Welch

Discussion focussed upon the SAGE component of the *Milestones* exhibit and fund-raising efforts.

Everett suggested that the Museum incorporate a simulation of a command center in its display. This could be accomplished with a moderate programming effort and a projection video system. Realistic touches might be appropriate hats for visitors or guides to don, and a light pointer to indicate particular locations on the screen.

Mr. Everett also discussed the appearance of an original operators room. Most striking was the lighting: in-direct, blue flourescent. The screens flashed yellow every 2.5 seconds and then faded green. Though the same base of data was sent to every console, operators could select the region and information they wished displayed.

Mr. Everett agreed that Mitre's gift of $10,000 in 1990 could be dedicated to the SAGE project, a total gift of $20,000. He also agreed to approach individuals with who he is acquainted in the defense industry to match MITRE's gift.

MINUTES

Meeting on *Milestones of Computing*
February 14, 1989

Attending:

Greg Welch, Oliver Strimpel, Gwen Bell

Discussion:

Discussion focussed upon the selection of a set of milestones to propose for the exhibit. The following 12 twelve were agreed upon:

- Calculating and data processing before the computer. (1930s).
- An early British machine (EDSAC or Manchester Mark I) with the first 15 pioneers. (Atanasoff to Forrester) (c. 1937-1950)
- Early commercialization: UNIVAC -1. (c. 1955)
- FORTRAN and COBOL: standard higher-level languages. (c. 1955-1962)
- SABRE and the IBM 360: Large-scale business applications. (c. 1967)
- The Microprocessor: the ubiquitous computer (1972-1978)
- Personal Computing: spreadsheet, wordprocessing, hacking (1978-1988)
- Supercomputing: Cray-1: scientific computing (1985)
- Standard operating systems: MS-DOS, UNIX (1985--)
- Database: privacy, security. (1988 --)
- Computers as International Commodities: , international aptitudes (1988 --)
- The future: technologies and applications likely to emerge

Further discussion concluded that a minimum of eight milestones would be required to do justice to the period we propose to cover. However, all felt that the space dedicated to the exhibit was insufficient for even eight vignettes. Therefore, it was decided to wall off one third of Bay 4, Floor 6 and dedicate this and all of Bay 3, Floor 6 to the exhibit. The remaining two-thirds of Bay 3 would then form the internal lobby area of the Museum. It was estimated that constructing such an expanded version of the exhibit would add $200,000 to the overall cost of the exhibition, for a total of $700,000.

MINUTES

Meeting of the Collections Committee and others
February 16, 1989
to discuss *Milestones of Computing*

Attending:

Oliver Strimpel, Tom Restivo, Allison Stelling, Greg Welch, Ted Johnson, Gwen and Gordon Bell, Jean Sammet, Jon Eklund, Dave Chapman, Anne Russell.

Discussion:

Oliver introduced the exhibit *Milestones of Computing*. It will be The Computer Museum's permanent exhibition dedicated to presenting the history of computing, thereby, fulfilling a fundamental mission of the Museum. To give those attending some perspective on exhibit design considerations, Oliver touched upon how the distractions and diversity of the audience in an exhibit demand an entirely different approach to education than in more traditional educational media. He then continued to explain how, in light of these considerations, the Museum had decided to take the approach of presenting "milestones" in the evolution of computing, rather than say a continuous timeline. Each milestone will be a period vignette off which additional interactive stations or more detailed explanations might be "hung."

A list of the proposed milestones was then circulated to be ranked according to importance and for comments from those attending. Heated discussion ensued as to whether the milestone concept was a valid approach to presenting history. Finally, however, each individual ranked the proposed milestones. At which point, the meeting adjourned for dinner.

After dinner, the proposed milestones were listed according to their ranking, and discussion continued. Finally, after much heated debate an independent list of ten crucial developments in the evolution of computing was drawn up that mirrored the original list with only the addition of the minicomputer and early networks such as the ARPANET. The meeting adjourned.

MINUTES

Meeting of Members of the Board of Directors
to discuss *Milestones of Computing*
February 17, 1989

Attending:

Greg Welch, Jean Sammet, Oliver Strimpel, Robert Lucky, Jonathan Rotenberg, Gardner Hendrie

Discussion:

Discussion focussed upon the proposal for *Milestones of Computing*. While the general approach of structuring the exhibit around milestone vignettes was agreed with, Jonathan, in particular, emphasized the need to establish a central unifying thread to the exhibit. All agreed.

One approach that was considered to create such a "path" was to select a character into whose shoes the visitor could step throughout the exhibit. Who this character might be was the cause of some discussion. Jonathan advocated the case for placing the visitor in the shoes of the innovator, confronting the visitor with the problem or need that led to a particular development. Aside from the technical subtleties involved in many of the innovations that would make them hard to convey to the average visitor, Robert Lucky also expressed concern that such an approach would present a distorted view of the process of innovation. Another proposal was to place the visitor in the shoes of the computer user through time. Some thought this would not be dramatic enough to engage visitors' imaginations. Another perspective considered was that of the general public in different eras.

Other themes discussed during the meeting included: the difficulties of presenting software, the often conflicting drives to innovate and standardize, and the importance of incorporating a dramatic personal touch in the exhibit. One suggestion of a means of conveying the concept of different levels of languages was to invite the visitor to spell their name in bits.

The
Computer
Museum

300 Congress Street
Boston, MA 02210

(617) 426-2800

February 22, 1989

Gardner Hendrie
Sigma Partners
P.O. Box 1158
Northboro, MA 01532

Dear Gardner,

In preparation for the next meeting of the Advisory Committee to Historical Exhibits I have enclosed a list of the milestones we are considering presenting, together with brief descriptions of each. Space will probably limit us to at most ten vignettes, so please rank these according to how important you feel each to be to the story of the evolution of computing. If in your view there are any glaring oversights (such as perhaps minicomputers or networks, as some have suggested) please make note of them. I have also enclosed minutes from other discussions pertaining to the exhibit to stimulate your thinking and keep you abreast of our progress.

I have scheduled the next meeting of the committee for 1:00 p.m. Thursday, March 16 here at the Museum and the subsequent one for May 15 at 9:00 a.m. I hope this amenable with your schedule. Please complete and return the enclosed form and let me know if you shall need me to make parking arrangements for you by Monday the 13th.

The agenda for the up-coming meeting shall be to arrive at the 8-10 milestones that should be included in exhibit and to discuss the theme or interpretive perspective that shall unite the exhibit (refer to the Minutes for 2/17/89).

Thank you very much. I look forward to another fruitful discussion.

Regards,

Greg

Gregory W. Welch
Exhibit Developer

The
Computer
Museum

300 Congress Street
Boston, MA 02210

(617) 426-2800

January 23, 1989

Gardner Hendrie
Sigma Partners
P.O. Box 1158
Northboro, MA 01532

Dear Mr. Hendrie,

Thanks again for agreeing to serve on the Advisory Committee to Historical Exhibits. We look forward to seeing you Thursday, January 26, at 1 pm.

I have enclosed a copy of the exhibit proposal, so that you may get an idea of our goals. In order to stimulate constructive discussion, we are requesting each member of the committee to prepare a brief (one or two sentence) statement of what they feel the exhibit should accomplish; could you please summarize what you feel the average middle-aged professional ought to know about the history of computing?

The tentative agenda for the meeting is as follows:

1:00 - Lunch and introduction of committee members
- Presentation of members' statements
2:00 - Break with tour of exhibit space
2:30 - Discussion of exhibit
3:30 - adjourn

The members of the committee are:

Dr. I.B. Cohen - Harvard University
Dr. Merritt Roe Smith - M.I.T.
Christopher Morgan - Christopher Morgan Rare Books
Gardner Hendrie - Sigma Partners
Jane Manzelli - Brookline High School
Charles Bachman - Bachman Information Systems

See you Thursday!

Regards,

Gregory W. Welch

Gregory W. Welch
Exhibit Developer

MILESTONES OF COMPUTING

Proposal for a New Exhibit on the History of Computing at The Computer Museum, Boston

FILLING A NEED

In only a few decades, computers have assumed a central role in human society. The public has begun to recognize them as indispensable tools upon which the maintenance and growth of modern civilization depend.

To understand the present and prepare for the future, people often look to the past. Thus, along with the growing acceptance of and reliance upon computers, comes an increasing demand for a basic understanding of the history of computers. The nation's schools are beginning to introduce computing into the curriculum, and many school teachers already seek to teach some computer history. The demand from this and all quarters will increase.

The Computer Museum is planning to build a definitive introductory exhibit on the major milestones of the history of computing. The exhibit will focus on the emergence of computer technology (hardware, software, and use), and the ways computers have affected our society. Rapid innovation has added layers of complexity to computer technology. Concepts fundamental to computing are easier to grasp in the context of the environment in which they were developed. Thus, familiarity with the history of computers leads to a better appreciation of the technology. The exhibit will directly address the general public's desire to understand computers by providing a clear and dramatic exposition of the most significant points in their evolution. A semi-popular, widely-distributed book will augment and extend the impact of the exhibit beyond the walls of The Museum.

The Exhibition

The exhibition will consist of two galleries, *Milestones*, and *The World's Largest Computer.* Meant to complement each other, the first will offer a comparative, chronological display of period vignettes; the second will present an awe-inspiring, full-scale recreation of a building-sized computer installation from the past. The exhibit will feature many threads of computer history. One of the most dramatic will illustrate the change in physical size, cost, and performance of computers. The exhibit will also establish connections between the social environment and the technological advances of different periods. For example, what problems were the machines of different eras designed to solve? How did this drive the evolution of the technology? Video segments, photographs, quotations, and other media will engage visitors with key inventors, entrepreneurs, and computer users, imparting a vivid human dimension to the exhibit.

The exhibit will appeal to all levels of the public because it will have many layers. The simplest level will communicate a straight-forward message about the nature and impact of the work performed by computers in each period, and how the technology has evolved. Interactive elements, video and text will offer several deeper layers with information and insights for visitors with greater curiosity.

The exhibit will occupy the Museum's most prominent gallery space: the two entrance bays that all visitors walk through as they enter and leave the Museum. The exhibit will fulfill The Computer Museum's mission to educate and inspire the general public on the history of computing. It will, therefore, occupy this central position on a permanent basis, and will be viewed by more than 100,000 visitors each year.

Milestones

The first section of the exhibit, *Milestones*, will portray important events in the history of computing in the context of society's ever-increasing need to store, manipulate, and retrieve information. It will present computers as tools that allow people to solve both old and radically new information-handling problems. The exhibit will also examine dilemmas presented by the use of computers. The fundamental goal of *Milestones* is to increase the general public's understanding of the social needs that contributed to the development of computers, the evolution of the technology itself, and how its use has affected the way we think about the world.

Milestones will be a series of vignettes, each representing a particular period in computer history. It will combine state-of-the-art exhibition technologies with authentically-detailed recreations in an environment that will animate the past and excite visitors. While focused upon a specific event or technology, each vignette will also capture the broad character of its era. For example, the pioneering work on the ENIAC, considered by many to be the first electronic computer, will be treated within the context of World War II; the work of Charles Babbage, who conceived of a mechanical computer in the mid-1800s, will be considered in the context of the emerging Industrial Revolution.

Throughout its scope, the exhibit will treat all three fundamental aspects of computing — hardware, software, and applications. Often, the centerpiece of a period will be a classic hardware artifact that epitomizes that era; for example, this might be the UNIVAC-1 in the early 1950s, or the IBM System 360 in the mid-1960s. However, presentations of software, including system software, programming languages, and human interfaces, also will be integral parts of the exhibit. These displays will take the form of actual samples of code in various languages, with clear explanations in a variety of media, including hands-on interactive demonstrations, video, and graphics. Developments that will receive particular emphasis will include the birth of high-level programming languages, and the introduction system software, such as operating systems, that allowed the computer to manage its own resources. By accomplishing simplified tasks at interactive stations, visitors will experience the different interfaces computers offered to users and discover typical problems that computers solved. Zealous visitors may even try their hand at programming a simulation of a classic machine. As a whole, the exhibit will transport visitors into the past so that they better appreciate the concerns and problems which computers were designed to solve, the patterns of their development, and the effect they have had on our culture.

The World's Largest Computer

Museum visitors retain the deepest, most enduring impressions from large-scale, enveloping environments that transport them into settings well beyond their experience. The Computer Museum can achieve this impact by creating a highly realistic recreation of the world's largest computer — the SAGE Air Defense computer. With 40,000 pounds of a SAGE system already in its collection, the Museum is uniquely able to do this. Sound effects, photomurals, uniformed manikins, video, and dozens of other realistic effects will combine with the original SAGE artifacts to offer visitors an unforgetable tour through the heart of this giant vacuum tube computer.

The SAGE exhibit is also an ideal environment for understanding the fundamental components of a computer. As visitors walk through the control consoles, the I/O processors, the memory units, the accumulators, and eventually reach the output displays, they will understand that they are following the flow of information through the computer. Comparisons with a modern PC will show that such components are essential to all computers.

MAKING IT HAPPEN

The Computer Museum needs to raise $450,000 to develop these exhibits. A further $150,000 of in-kind gifts will be required in the form of equipment and services. Approximately 20% of the funds and in-kind gifts have already been secured. The exhibits will take approximately one year to develop.

The Exhibit Team

The team developing the exhibit will be led by Curator Dr. Oliver Strimpel (Ph.D., Oxford University). Formerly with the Science Museum in London, Dr. Strimpel has created numerous exhibits related to computers, including *The Computer and the Image*, and *Smart Machines*, at The Computer Museum. Exhibit Developer Gregory Welch (B.A., Harvard University) has returned from studying the science and technology museums of Europe as a Shaw Fellow to oversee fund-raising activities and the creation of the exhibit. He is the creator of several historical exhibits at the Museum, including *Computers in Your Pocket*, now touring the country under the auspices of the Smithsonian Institution. Founding President, Dr. Gwen Bell, will direct the Historical Advisory Committee, and provide consulting services. In June, Richard Fowler will join the team as Exhibit Designer. Mr. Fowler is the designer of England's award-winning National Museum of Photography, Film, and Television.

The exhibit's Historical Advisory Committee to the exhibit will include: Professor Emeritus I.B. Cohen of Harvard University, Christopher Morgan, former editor of *Byte*, Charles Bachman, of Bachman Information Systems, Gordon Bell of Ardent Technologies, Gardner Hendrie of Sigma Partners, and Merrit Roe Smith of MIT.

THE COMPUTER MUSEUM

The Computer Museum was founded in 1982 as a public, non-profit institution dedicated to educating the public about computers and preserving computer history. It possesses the world's most comprehensive collection of computers and related technologies, as well as extensive film, video, and photo archives. Its exhibits fill over 25,000 square feet and range from a three-dimensional time-line of computer history, to displays of state-of-the-art graphics, artificial intelligence and robotics.

The Museum's financial foundation is solid. Over 1500 individual and 150 corporate members from around the world provide 48 percent of the Museum's operating budget. Admissions and revenue from the Museum Store account for a further 32 percent, while government grants and other income provide the remaining 20 percent. The Museum has already achieved its $3.3 million goal for Phase I of its Capital Campaign, and has received pledges for $1.5 million of its $6.75 million Phase II goal.

MILESTONES OF COMPUTING

A Proposal for a New Exhibit on the Evolution of Computing at The Computer Museum, Boston

Executive Summary

The Computer Museum seeks funds to develop a unique and innovative exhibit on the history of computers that will address the public's need to understand the evolution of this vital technology. In only a few decades, computers have assumed a central role in human society. To envision where this technology may take us, it is valuable to understand where it has come from. The resources and experience of The Computer Museum allow it to harness media ranging from historic artifacts to state-of -the-art interactive displays in the creation of an exciting and educational exhibit.

The Museum will open this exhibit in two 4,000-square-foot parts: the first in Fall of 1989, and the second in Spring of 1990. To do this, we must raise $500,000 (of which 25 percent has already been pledged). These funds will pay for the exhibit's development, design, fabrication, educational materials and promotion. In-kind donations totaling $150,000 will also be required.

Milestones of Computing will present the seminal developments and trends in the evolution of computing through displays centered on realistic recreations, and will allow visitors of all ages and backgrounds to explore their own path through history with an advanced computer-controlled interactive video system and database. One striking component of the exhibit will be *SAGE : The World's Largest Computer* which will transport visitors to a top-secret military computer installation of the 1950s. As they walk among the towering components of the machine, the fundamental structure of all computers will be vividly illustrated.

Sponsors of this exhibit will receive widespread recognition. They will be acknowledged on prominent signage in the exhibit itself and in all printed and promotional materials pertaining to the exhibit, including publications such as catalogs, press releases, and educational materials. The publication of a popular book based on the exhibit will bring recognition of the sponsors to an additional nation-wide audience. The sponsor will, thus, be identified as a leading supporter of an innovative program to heighten the public's understanding of a technology that will shape the future.

FILLING A NEED

In only a few decades, computers have assumed a central role in human society. The public has begun to recognize them as indispensable tools upon which the maintenance and growth of modern civilization depend.

To understand the present and prepare for the future, people often look to the past. Thus, along with the growing acceptance of and reliance on computers, comes an increasing demand to understand their history. The nation's schools are beginning to introduce computing into the curriculum, and many instructors already seek to teach some computer history. Similarly, every day more people are employed in computer-related occupations; they, too, seek a perspective that will help them to understand the context of their roles. As the Computer Age continues to unfold, the demand to understand its origins will continue to increase.

To address this need, The Computer Museum is planning to build a distinctive, introductory exhibit on the major milestones in the evolution of computing. The fundamental goal of *Milestones of Computing* is to increase understanding of the social needs that contributed to the development of computers, the evolution of the technology itself (hardware, software, and applications), and how its use has affected the way we think about the world. A secondary goal is to provide a basic introduction to computer hardware and software. By integrating artifacts, working computers, and video displays, the exhibit will accomplish these goals in an exciting and rich interactive environment.

MAKING IT HAPPEN

The Computer Museum needs to raise $500,000 to develop this exhibit, and a further $150,000 worth of equipment and services will be required in the form of in-kind donations. (See attached budget.) Approximately 25 percent of the funds and in-kind gifts have already been secured. The exhibit will take approximately one year to develop, and will open in two phases: the first in the Fall of 1989, the second in the Spring of 1990.

The Exhibit Team

The team developing the exhibit will include Dr. Oliver Strimpel, Gregory Welch, Dr. Gwen Bell, Richard Fowler, and Adeline Naiman. Dr. Strimpel (D. Phil., Oxford University) is the Curator of the Museum. Formerly with the Science Museum in London, he has created numerous exhibits related to computers, including *The Computer and the Image* and *Smart Machines,* at The Computer Museum. Exhibit Developer Gregory Welch (A.B., Harvard University) has rejoined the Museum after studying the science and technology museums of Europe as a Shaw Fellow. He is the creator of several historical exhibits at the Museum, including *Computers in Your Pocket: The History of Pocket Calculators*, now touring the country under the auspices of the Smithsonian Institution. Founding President, Dr. Gwen Bell, is Director of Collections; she has guided development efforts for many of the Museum's exhibits. In June 1989, Richard Fowler will join the team as Exhibit Designer. Mr. Fowler is the designer of England's award-winning National Museum of Photography, Film, and Television. Adeline Naiman, the Museum's Director of Education, is an expert on the use of computers in education and has worked for the National Sciences Resources Center and as a developer of award-winning educational software.

Expert Advice

The exhibit's Advisory Committee is composed of experts in social and technological history, computer hardware and software, and communications and education. The members of the Committee are:

- **Charles W. Bachman**, president of Bachman Information Systems, is a former Vice-President of Cullinet Software and holds many patents for his work in database management systems. Among many honors, he received the ACM's Turing Award.

- **C. Gordon Bell** of Ardent Computer, and formerly Associate Director for Computer and Information Sciences for the National Science Foundation and Senior Vice-President of Engineering at the Digital Equipment Corporation, was the architect of Digital's computers from the establishment of the minicomputer through the VAX series, Encore's multiprocessors, and Ardent's graphics supercomputers. He is the recipient of the ACM's Eckert-Mauchly Award.

- **Professor I. Bernard Cohen**, (emeritus) Harvard University, is one of the foremost authorities on the history of computing. He has long consulted for IBM on the creation of historical exhibits, and has recently published articles on the work of Howard Aiken and Charles Babbage.

- **Gardner Hendrie** is a member of the venture capital group Sigma Partners. Hendrie designed several minicomputers and led the design of Stratus Computers' fault tolerant systems. He is Chairman of the Computer Museum's Board of Directors.

- **Jane A. Manzelli** is the coordinator of computer curriculum for Brookline Public Schools, one of the most respected schools systems in the country.

- **Christopher Morgan**, formerly Editor-in-Chief of *Byte* and *Popular Computing* magazines and a Vice-President of Lotus Development Corporation, now collects and sells rare books related to computing.

- **Professor Merritt Roe Smith**, Massachusetts Institute of Technology, is an award-winning author of books and papers on the history of technology. Among his many advisory roles, he serves on the executive committee of the Council for Understanding Technology in Human Affairs.

THE COMPUTER MUSEUM

The Computer Museum was founded in 1982 as a public, non-profit institution dedicated to educating the public about computers and preserving computer history. It possesses the world's most comprehensive collection of computers and related technologies, as well as extensive film, video, and photo archives. Over 20,000 square-feet of exhibits range from recreations of early computer installations, to displays of state-of-the-art computer graphics, artificial intelligence and robotics. *Milestones of Computing* will be the first phase of a four-year, $3-million project to re-develop 12,000 square-feet of existing exhibit space, and add 5,000 square-feet of new exhibits. This project will ensure that the Museum's exhibits remain on the cutting edge of computer and display technology and that they appeal to an ever-broader audience.

The Museum's financial foundation is solid. Donations and over 1500 individual and 150 corporate memberships from around the world provide half of the Museum's operating budget. Admissions and revenue from the Museum Store account for a further 30 percent, while government grants and other income provide the remaining 20 percent. The Museum has already achieved its $3.3 million goal for Phase I of its Capital Campaign, and has received pledges for $1.5 million of its $6.75 million Phase II goal.

THE EXHIBIT

Milestones of Computing will present important events in the evolution of computing within the context of society's ever-increasing need to store, manipulate, and retrieve information. It will portray computers as tools that allow people to solve both old and radically new information-handling problems, but that have also posed new dilemmas for society. An historical perspective will cast light on how this technology has affected the way we look at the world. *Milestones of Computing* will incorporate the elementary knowledge that every educated member of modern society should have about the history of this vital technology.

Milestones of Computing will be composed of a series of vignettes, each representing a particular period, event, or theme fundamental to computer history. The centerpiece of each vignette will be an authentic, environmental recreation using period artifacts and ephemera. These displays will be enhanced and linked by supporting videos and interactive stations.

The exhibit will feature many threads of computing history. One of the most dramatic will be the change in physical size, cost, and performance of computers. Others will include the push to establish standards and make computers easier to use. The exhibit will also illustrate the connections between the social environment and the technological advances of different periods. For example, what problems and demands existed in society that machines and programs of different eras were designed to solve, and how did this drive the evolution of the technology? Context is important; while focused upon a specific event or technology, each vignette will also capture the broad character of its era. For example, the early mainframe computers would be considered in the context of post-War economic expansion and the business demand for large-scale data processing; the adoption of FORTRAN and COBOL (the first widely-used programming languages) in the late 1950s and early 1960s would be portrayed in light of the emerging profession of programming and the demand for programs that could be executed by different types of computers. A string of video displays will help develop the contextual backdrop of each vignette, and unify the exhibit. Video segments, photographs, sound, and other media will engage visitors with key inventors, entrepreneurs, and computer users, imparting a vivid human dimension to the exhibit. These multiple layers and media will ensure that the exhibit appeals to all levels of the public.

Museum visitors learn best when actively engaged in solving a problem that has personal relevance to them. This exhibit will allow visitors to draw their own picture of history. Experts agree that history is a complex web of diverse and intertwining forces coming together to influence any particular event or development. The computer is an invaluable tool for sifting through and unraveling connections between vast quantities of information. Visitors will be able to explore the past for themselves on easily-used computers throughout the exhibit. These interactive stations will give visitors command of a database of historical facts, images, film clips, and documents, permitting them to piece together, explore and display their own personal perspective on where computers have come from and what influence they have had. No exhibit exists elsewhere that similarly uses the power of the computer to investigate the complex connections that form the web of history.

The *Milestones of Computing* will treat all three fundamental aspects of computing — hardware, software, and applications. Often, the centerpiece of a vignette will be a classic hardware artifact that epitomizes an era; for example, this might be the UNIVAC-1 in the early 1950s, or the IBM System 360 in the mid-1960s. However, the evolution of software, including system software that allows computers to manage their own resources, programming languages that allow people more easily to express instructions for computers, and human interfaces that facilitate the use of computers, will also be an integral part of the exhibit. This is another realm in which interactive computers will be invaluable. By accomplishing simple tasks at interactive stations, visitors will experience some of the different ways users have interacted with computers and discover how computers have been used to solve typical problems.

Museum visitors retain the deepest, most enduring impressions from large-scale, enveloping environments that transport them to settings beyond their experience. Such impact will be incorporated into *Milestones of Computing* by a highly-realistic recreation of the world's largest computer — the *SAGE* air defense computer (40,000 pounds of which are already in the Museum's collection). Sound effects, photomurals, uniformed manikins, video, and dozens of other realistic effects will combine with the original SAGE artifacts to offer visitors an unforgettable tour through the heart of this giant vacuum tube computer.

As a whole, the exhibit will transport visitors into the past so that they better appreciate the concerns and problems which computers were designed to solve, the patterns of their development, and the effect they have had on our culture.

Milestones of Computing will occupy the Museum's most prominent gallery space: the two entrance bays that all visitors walk through as they enter and leave the Museum. It will fulfill The Computer Museum's mission to educate and inspire the general public on the history of computing and, therefore, will occupy this central position on a permanent basis. More than 100,000 visitors a year will view the exhibit. A credit panel listing those whose contributions have made the exhibit possible will be prominently displayed in the galleries.

REACHING THE MARKET

As the opening date approaches, the Museum's Director of Marketing, Mark Hunt, will convene an advisory committee for public relations to create a publicity and promotion campaign for the exhibit. This committee will ensure that the opening and launch of the exhibit achieve maximum media impact. The campaign will make use of the Museum's established relationships with New England print and television media and national magazines and writers on science and technology. All publicity will recognize significant supporters of the exhibit.

Close to 100,000 people visit the Museum each year. Boston hosts over 13 million tourists a year, and half of the Museum's visitors come from outside Massachusetts -- a sizable percentage are foreigners. Overall, the Museum appeals to visitors of all ages, interests, and backgrounds. Studies show a significant portion to be well-educated, and affluent, while forty percent are students. Education and outreach programs are continually expanding the scope of the Museum's audience.

Milestones of Computing

Estimated Budget

ITEM	Cash Cost	In-Kind Donation
Exhibit Development	$45,500	
Exhibit Design	$38,300	
Electronics/Effects	$14,400	$15,000
Programming/Visitor Interface	$14,500	$10,000
Graphic Design and Production	$19,200	$20,000
Fabrication	$260,000	
Video: Design, Editing, Master	$100,000	$50,000
Computer and Video Hardware		$50,500
Educational Materials	$12,000	
TOTAL:	**$503,900**	**$145,500**

Minutes

Meeting of the Advisory Committee to Historical Exhibits
January 26, 1989
1:00 - 3:30 pm.

Compiled by Gregory W. Welch

In attendance:

Gwen Bell, I. Bernard. Cohen, Gardner Hendrie,Jane Manzelli, Christopher Morgan, Adeline Naiman, Merritt Roe Smith, Oliver Strimpel, Gregory Welch.

The purpose of the meeting was to discuss the goals and broad approach of the Museum's historical exhibit, *Milestones of Computing*.

Introduction

Dr. Strimpel opened the meeting with a brief introduction to the Museum, the historical exhibits, and the process of exhibition creation. He stressed the Museum's mission to educate and inspire the public about the world of computers. While historical components will be incorporated into all the Museum's exhibitions, the Milestones and SAGE exhibits will be the only permanent exhibits dedicated to treating the history of computing.

Discussion

Interests of High School Students

Ms. Manzelli launched the committee's discussion by defining aspects of the history of computing that a high school student would wish to learn.

1) Why were computers invented, what problems did they solve?
2) Who were the people involved? The "intrigue" factor.
3) Economics: why are computers a technology that gets cheaper over time?
4) The size story.
5) History for glimpse of future.
6) Computers and responsibility.

Historical Perspective

Dr. Smith then elaborated on how the exhibit should treat history. The exhibit should seek to enhance "public understanding" of computer technology and science and their implications. This could be accomplished, in part, by a display that "mapped" the evolution of computers and helped visitors to situate themselves in this process. The exhibit should seek to illuminate how and why computers were developed and treat the broader implications of this process. However, rather than presenting the development of computers as an "onward march of progress," the exhibit should seek to explicate history as the "frayed web" of connections that it is.

Personal Context
Professor Cohen agreed with Dr. Smith that the state of the market and the social and technological problems that constituted the circumstances in which computers evolved must form an essential element of the exhibit. Space limitations, he felt, however, would preclude a thorough investigation of the implications of computer technology's potential. Nonetheless, this theme might be developed by illustrating the impact of computers over time on one character, an auto mechanical for example. The "hidden computer," the microprocessor, should also be featured in the exhibit.

Dr. Smith added that Video-taped interviews could present not only the "heroes" but also the "foot soldiers" of computer history.

Chris Morgan suggested a component of the exhibit called "How they did it" that would show the operation of computers over time.

Target Age
Professor Smith introduced the issue of what ages the exhibit should target, as he felt that younger children might not be a realistic audience. Dr. Bell clarified the issue by pointing out that the focus of the exhibit was history, and that young children, even though adept at using computers, may be too young to understand or appreciate concepts related to a historical perspective. Ms. Manzelli agreed.

Technological Story
Mr. Hendrie felt that the exhibit must tell the story of the change in computing technology which is"the incredible growth in the power, ease of use, and cheapness of computing" that has occurred in such a compressed span of time. This dramatic quantitative change has affected a qualitative change as well.

Mr. Morgan commented upon how little is generally know about the history of computing, even among the technical community, and that the exhibit should dispel the many myths that still prevail. To do so the exhibit would have to illustrate the multiple, interlocking, complex forces that came into play in the evolution of computing. Developments in a multitude of fields, ranging from economics, to education, from physics, to animation have all affected the direction and character of computing.

Time Period
Dr. Bell introduced the two issues of at what point in time should the exhibit begin, and how international in scope it should be.

All agreed that the exhibit should present a select number of "milestones" of seminal importance, even if such events fell within the same epoch. Professor Cohen argued that the exhibit ought to begin in the late 1930s and not focus on either Charles Babbage or Herman Hollerith. There was some disagreement over the issue of whether Hollerith deserved to be addressed. Cohen contended that Hollerith's invention, just as Babbage's, did not lead directly to the computer; he felt that a more general treatment of pre-computer calculating, including slide rules, tables, adding machines, and card-processing machines, was more appropriate. Dr. Strimpel argued that, nonetheless, Babbage represents an interesting "blind alley" in the historical development of the computer.

Mr. Hendrie asked whether the "milestones" should focus on the seminal inventor/invention, or the wide-spread use of the the innovation. Dr. Smith answered that while the "great inventor" deserves attention, such treatment should be within the context of the overall historical process.

International Coverage

All agreed that the exhibit should be as international as appropriate. The scarcity of foreign artifacts in the Museum's collection was touched upon. Dr. Bell, drawing on Dr. Smith's proposal of a map, suggested the use of a globe that would illustrate the expansion of computer installations and a counter indicating the "population" of computers.

Software

Dr. Strimpel wondered how the exhibit would treat software. Mr. Morgan contended that its was essential that the exhibit cover the introduction of the stored program. Mr. Hendrie felt that visitors would immediately recognize the advantages to expressing a problem in an algorithmic language over binary code. Professor Cohen commented upon the economic shift toward the importance of software with the advent of mass-produced systems. He also stressed the questions: Why is software so expensive? And, why are machines introduced without software? Mr. Welch introduced the idea of examining software through the people who produce it, and how they differ from the producers of hardware. In response to Dr. Strimpel's question as to what level or language the exhibit should use to contact high school students, Ms. Manzelli answered that while some advanced students are familiar with programming languages, the vast majority are unaware of software beyond the application level. The issue was raised as to whether the intention of the exhibit should be to "explain" software, or indeed explain computers at all. It was felt that the visitor should arrive at some general notion as to the distinction between hardware and software.

At this point, several members of the committee had to leave, and discussion turned to administrative issues. It was agreed that minutes should be compiled of the meeting and circulated. It was also suggested that the committee ought to meet at least twice more before June 1.

Presentation Considerations

The remaining members of the committee touched upon two points crucial to the exhibit: that it be streamline, and that it be stimulating and entertaining. After several comments on how the physical composition of the exhibit might reflect non-linear views of the history, and that the idea of displaying a milestone in an exciting manner would somewhat dictate the selection of vignettes, it was agreed that too complex and unstructured an approach might confuse visitors. For that reason it was concluded that a limited number of milestones balanced by more detailed tangential displays was the best approach to take.

COMPUTERS: FROM ABACUS TO AI

A History of Computing from the beginning
and into the future.
Nov. 1988

COMPUTERS: FROM ABACUS TO AI

A History of Computing from the beginning and into the future.

Nov. 1988

Understanding the history of computers helps students appreciate how far we have come in inventing devices that help us function in our society today. This curriculum shows that we are having a technological revolution that is changing our lives in many ways.

The ideas for this curriculum began in 1986 at the Driscoll School. All the activities and materials included in this packet have been used in computer classes for 2 years, and are still being revised each year. It is being used for students in the 7th grade. Seventh grade computer classes meet 3 times a week, for 45 minutes each class.

The curriculum has five units, and each unit contains several activities that explore the development of computers. The units and activities are sequential. The units are:

1. Milestones in Computer History.
2. Generations of Computers.
3. The Technological Revolution.
4. The Computer Museum.
5. The Computer Research Paper.

The first two units are taught in preparation for units 3, 4, and 5 which coordinate with the Social Studies curriculum on Revolutions. (See Appendix III for a description of the Social Studies objectives). In all the Computer History units the activities take advantage of using the computer while studying its development.

These units are outlined as specifically as possible so that other teachers can adapt them to their own needs. Each unit includes a brief objective, as an overview. The activities in each unit are different except that the last activity is always updating the student's scrapbook.

The Student Scrapbook is a notebook made by each 7th grade student over the whole school year. The scrapbook grows to include about 10 chapters on a variety of computer topics. Chapters consist of student notes, handouts, charts, pictures and essays. By the end of the school year it is a personal encyclopedia of computers that contains much of what 7th grade studied throughout the year. The scrapbook is an important feature of the Computer History curriculum, but it covers more than is in this curriculm. (See Appendix I for a list of chapters in a typical 7th grade scrapbook.)

This Computer curriculum includes many readings, worksheets, and assignments that are for teachers to amend, copy and use. Most worksheets are written on Appleworks and are on the Teacher's Computer History Disk. Some materials, like the TimeLiner program, the CrossWord

Magic program, the Computer Museum Slides, the NOVA movie, and the Time-Life Books, may have to be borrowed or purchased. Some teachers may like to visit the library to read more background information on the history of computers.

This Computer History curriculum is interesting to teach and the trip to the Computer Museum is alot of fun. Coordinating this Computer History curriculum with the Social Studies Revolutions curriculum seems to be meaningful for 7th graders. By the time the students begin to work on their independent research projects they have a good knowledge about computers and they understand the process of revolutions, so that they can choose and write fairly sophisticated papers. Each year their papers are compiled in a book, of many chapters, which is a valuable reference for the next year's class.

Good luck and enjoy your journey from the time of the Abacus up until now or the near future!

Ann Koufman,
November 1988.

MILESTONES IN COMPUTER HISTORY
UNIT 1

OBJECTIVE: Students learn about the forerunners of today's electronic digital computers.

Activity I: Students fill out the chart on the Milestones in Computer History as teacher explains the history using props, pictures and slides.

Materials:
1. Milestones Chart
2. abacus
3. pictures 1-11 of various devices and people
4. slides from The Computer Museum Slide Series 2.1-3.4

Time: 2-3 classes

Activity II: Students begin a timeline with the dates and events introduced in the previous classes. Assign the reading "From Pebbles to Gears" with the questions.

Materials:
1. Notes from the previous classes
2. Timeliner program
3. Student's data disks
4. "From Pebbles to Gears" and the questions

Time: 1 or 2 classes, depending on whether the students know how to use Timeliner. (If they don't, then begin to make an historical timeline as a demonstration.)

Activity III: Updating the Scrapbook. Students put a neat copy of their chart and a picture of their choice of one of the devices in their scrapbook. They should write, on the word processor and include, an explanation of the picture. They organize this materail into appropriate chapters.

Materials:
1. completed Milestones Chart
2. picture with written explanation.
3. "From Pebbles to Gears" article and questions

Time: 1 class

ASSIGNMENTS:
1. reading: "From Pebbles to Gears" with answers to the questions.
2. beginning of an historical timeline
3. updated scrapbook

TOTAL TIME: 4-6 classes

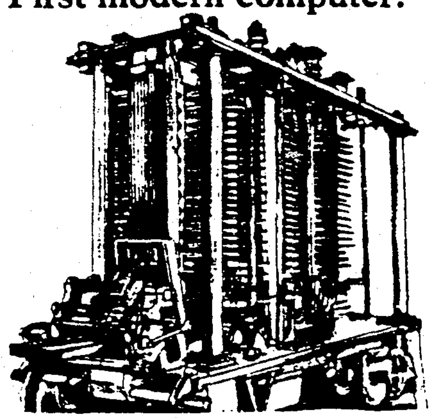
What is a computer?

Put very simply, a computer is a machine which "does things to stuff". In more scientific terms, it is an "information processor". A computer is given information, called "data", instructed to do certain things to it and then show us the results.

The things shown in the pictures below could be called computers. They all receive information which they work on and change to produce new information.

Some people say Stonehenge is a kind of computer. Prehistoric people could work out their calendar from the position of the shadows made by the sun shining on the stones. If you think of the stones as a computer, the sunlight is the input and the calendar is the output.

First modern computer?



This machine might have been the first modern computer – it if had ever worked. It is called the analytical engine and was invented by an English mathematician, Charles Babbage, who lived from 1791 to 1871. Babbage designed the machine to do complicated sums and store the results at each stage in the calculations, and his ideas are the basis for modern computers. The analytical engine never worked, though, because at the time it was not possible to build it accurately enough.

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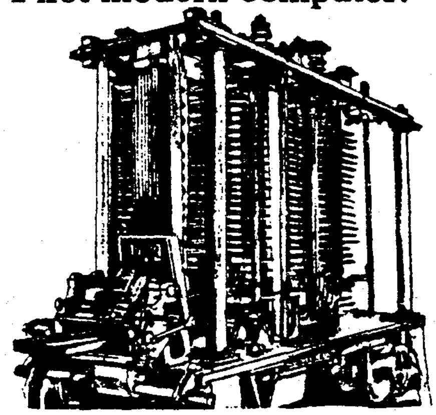

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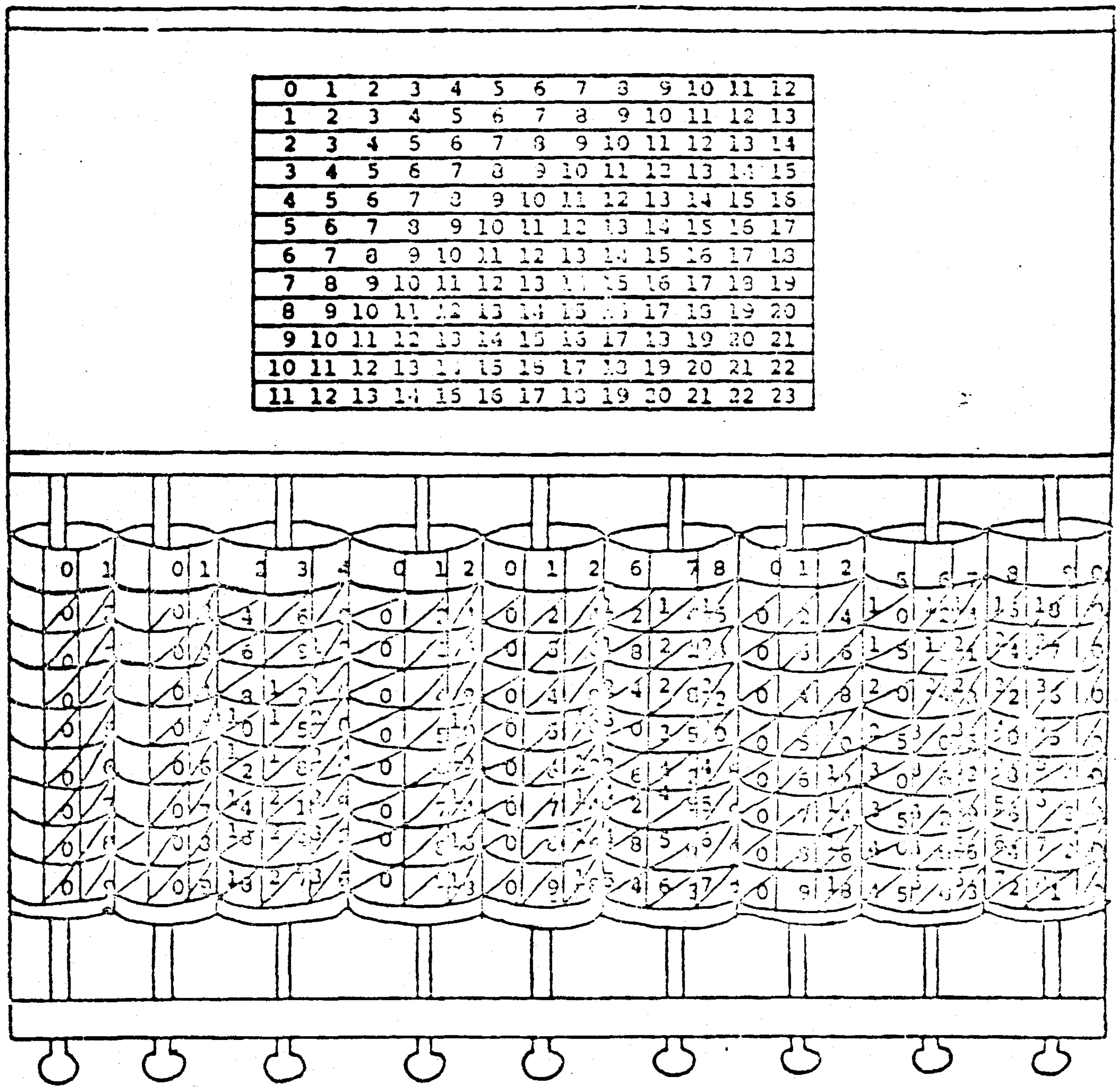
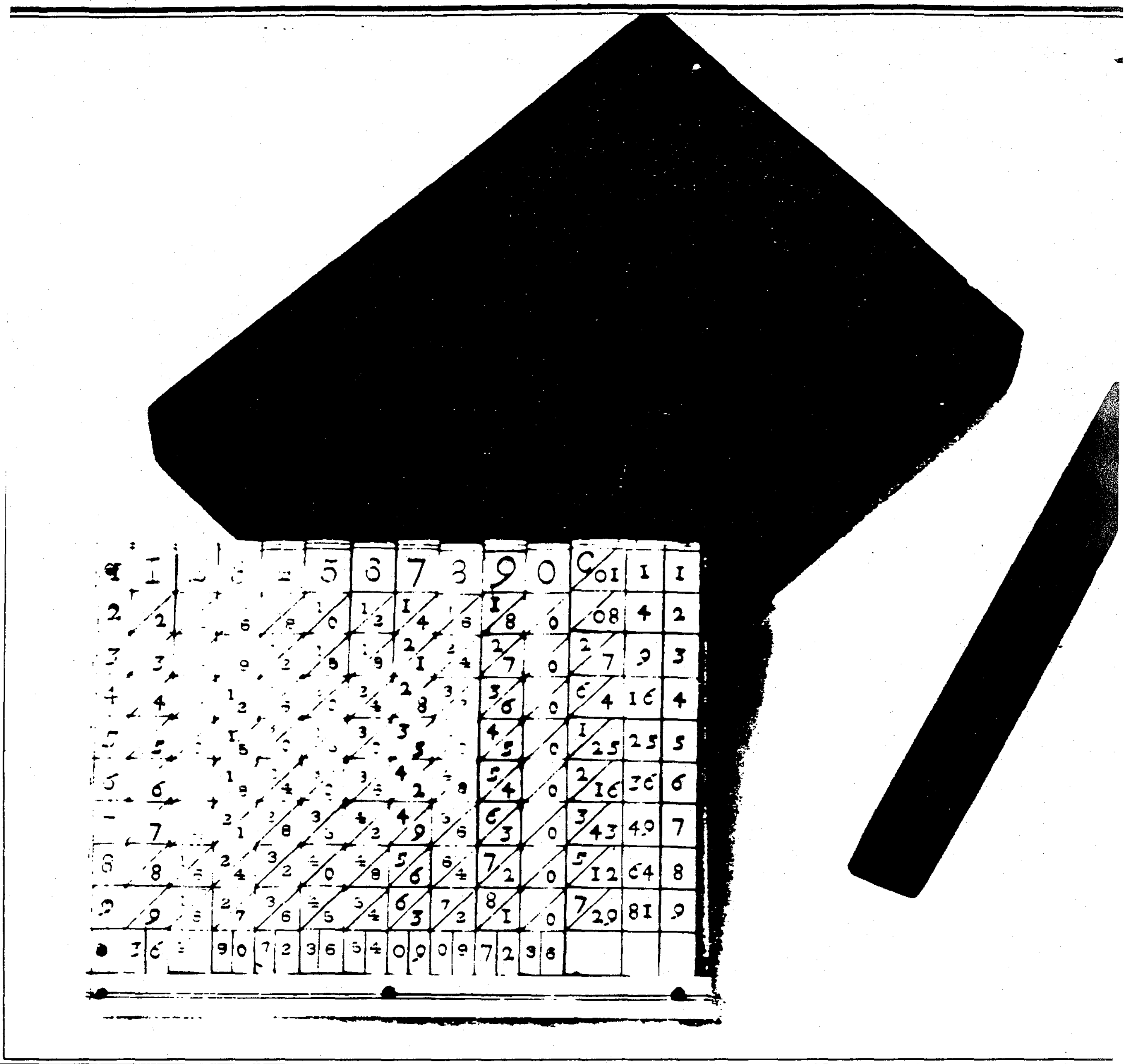
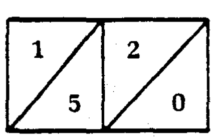
NAPIER'S BONES



0	0	0	0	0	0	0	0	0
9	1/8	2/7	3/6	4/5	5/4	6/3	7/2	8/1
8	1/6	2/4	3/2	4/0	4/8	5/6	6/4	7/2
7	1/4	2/1	2/8	3/5	4/2	4/9	5/6	6/3
6	1/2	1/8	2/4	3/0	3/6	4/2	4/8	5/4
5	1/0	1/5	2/0	2/5	3/0	3/5	4/0	4/5
4	8	1/2	1/6	2/0	2/4	2/8	3/2	3/6
3	6	9	1/2	$\boxed{1/5}$	1/8	2/1	2/4	2/7
2	4	6	8	1/0	1/2	1/4	1/6	1/8
1	2	3	4	5	6	7	8	9
1	2	3	4	5	6	7	8	9

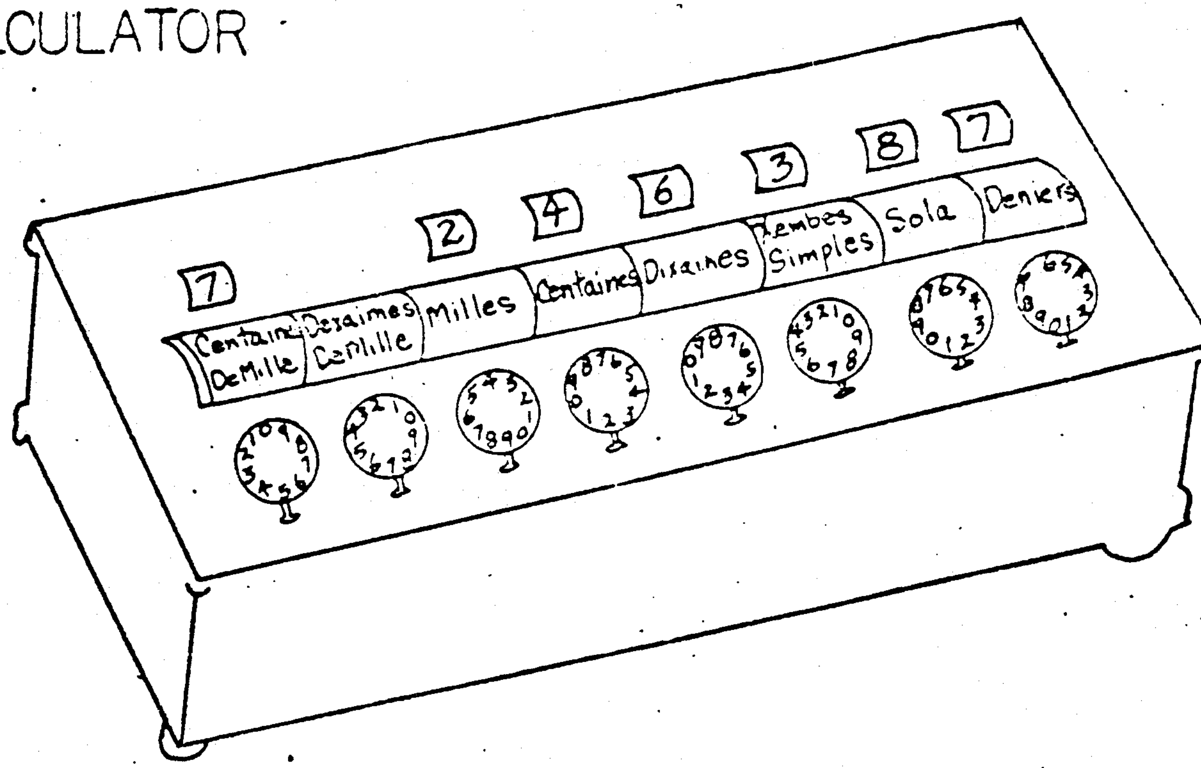


Napier's rods were used to compute multiplication problems quickly and simply. To find the answer to 5 × 3, for instance, look in row 5 on the rod with the 3 at the top. The answer, 15, appears in a box split by a diagonal line: 1/5 . Problems involving numbers with two or more digits are done in almost the same way, except that numbers in adjacent boxes are added along the diagonal. Thus, to find the solution to 5 × 34, look in row 5 on rods 3 and 4:

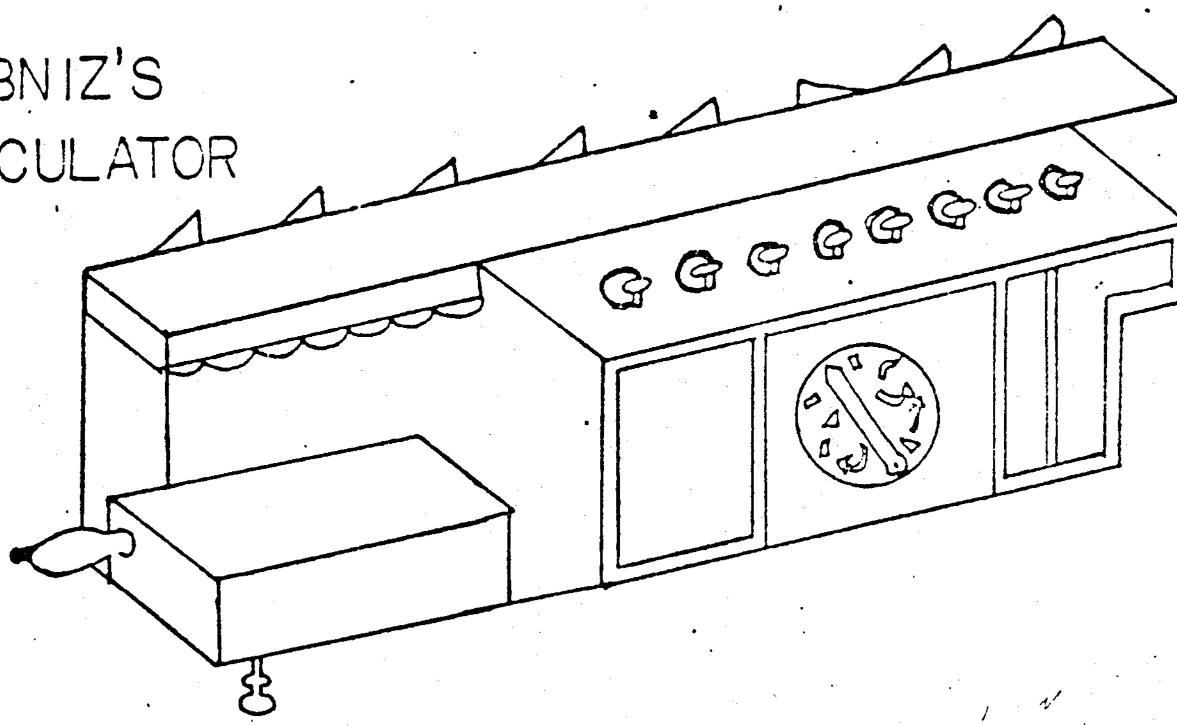


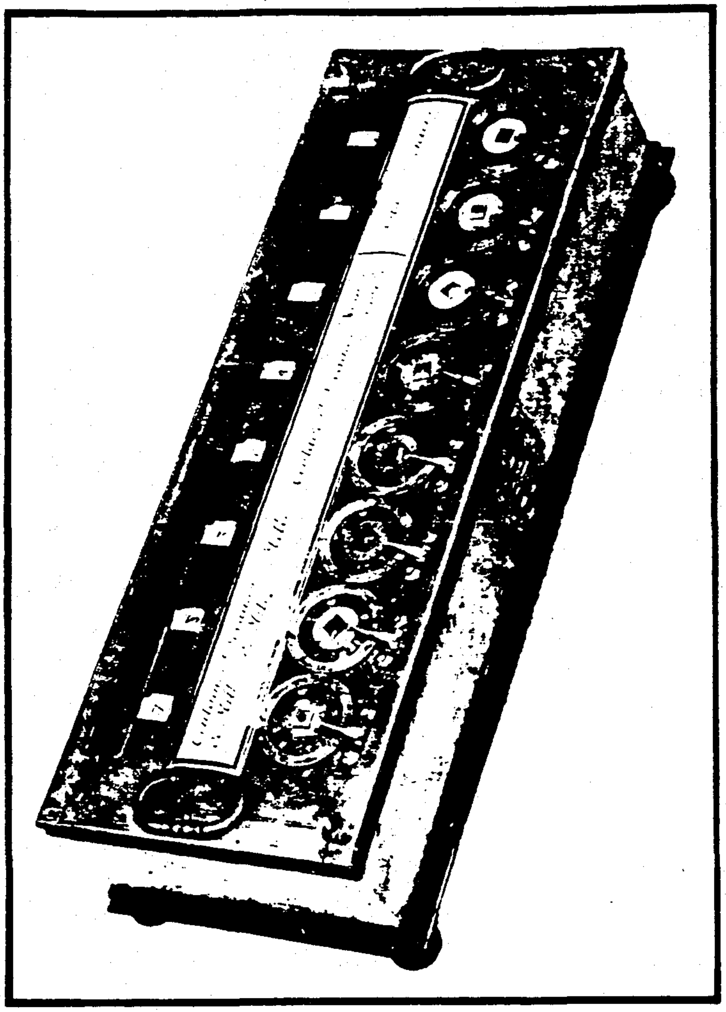
Add the numbers on the diagonal (5 + 2 = 7), then read off the answer: 1/7/0, or 170. (Adding along the diagonal is equivalent to "carrying" in normal multiplication, and on the rods a problem is also usually worked from right to left.) How would you find the answer to 56 × 34? to 5,678 × 34,567? Other sequences of numbers can be multiplied by

PASCAL'S
CALCULATOR



LEIBNIZ'S
CALCULATOR





Pascal's Calculator. Pascal boasted that it was so sturdy it could be taken on long carriage journeys without ill effects. The two dials on the far right, labeled Sols **and** Deniers, **were for money calculations.**

computer, built in the 1940s (see Broadsheet IV). Hollerith-type cards are still a major means of entering data into a computer. The company founded by Hollerith later grew into the giant of the computer industry, IBM.

Patents Collec
The New York Public Libi
Astor, Lenox and Tilden Foundat

8 The Binary System: An example of a bi-literary alphal from Bacon's Of the Advancement of Learning, 1605. The binary code is the language of almost all modern digital computers. In it, all numbers and words to be fed to the computer are expressed in terms of just two symbols. Usual these symbols are a one or a zero, but they can be almost anything: inside the computer they are represented as eithe burst of electricity or the absence of a burst: on a card or paper tape they are represented as a hole or a not-hole.

The first known reference to such a code is found in th 1605 work by Francis Bacon. He used the principle to write coded messages or ciphers. Each letter of the alphabet was represented by a specific combination of the letters *a* and *b* five-letter groups. A message would thus consist of nothing but a long string of *a*'s and *b*'s.

Columbia University Lib

9 Two computer-drawn graphs from a simulation of the future of the world, 1971. This simulation (see Broadsheet V for definition) took into account such factors as populatic growth, use of resources like oil and ores, industrialization (shown as capital investment), and pollution. All these fact were related to each other in complex ways by mathematic expressions.

The graph on the top shows how the world might deve if present trends continue. By the year 2020 (the years appe along the bottom of the graph) population rises to about fiv billion people. Industrialization also reaches a peak at abou the same time. Both then decline because natural resources being depleted.

The graph on the bottom shows a possible pollution disaster brought on by attempts to improve the world condition through increased industrialization. At first population grows, and the quality of life on Earth is high. I around the year 2000 the processes that naturally absorb pollution are suddenly overwhelmed by the world's industi Pollution skyrockets and world population drops by four billion in twenty years.

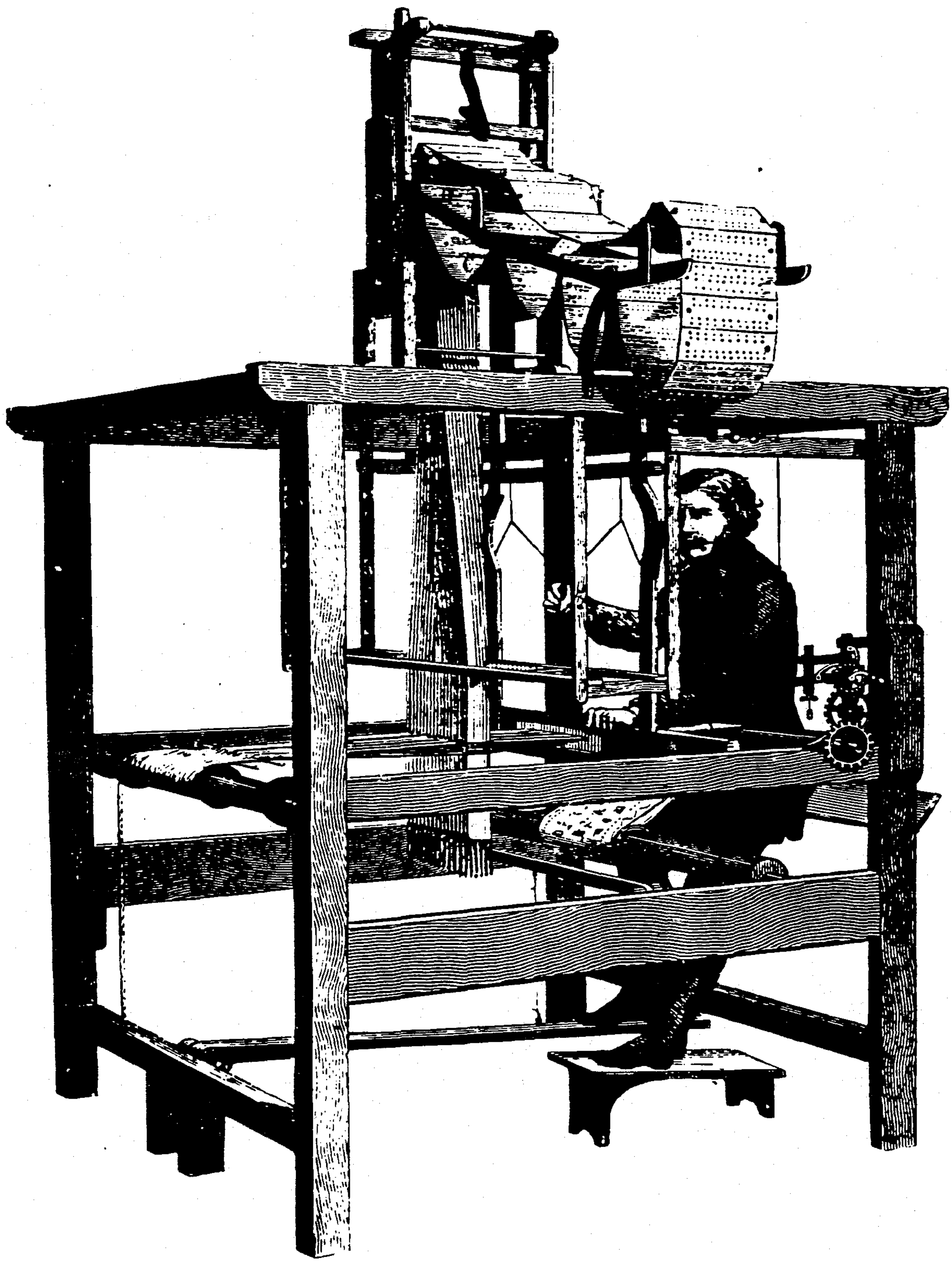
It should be noted that these are not precise prediction They merely act out the assumptions about the world that l behind the simulation. They may be wrong or right, or somewhere in between. This particular study has been the focus of great controversy.

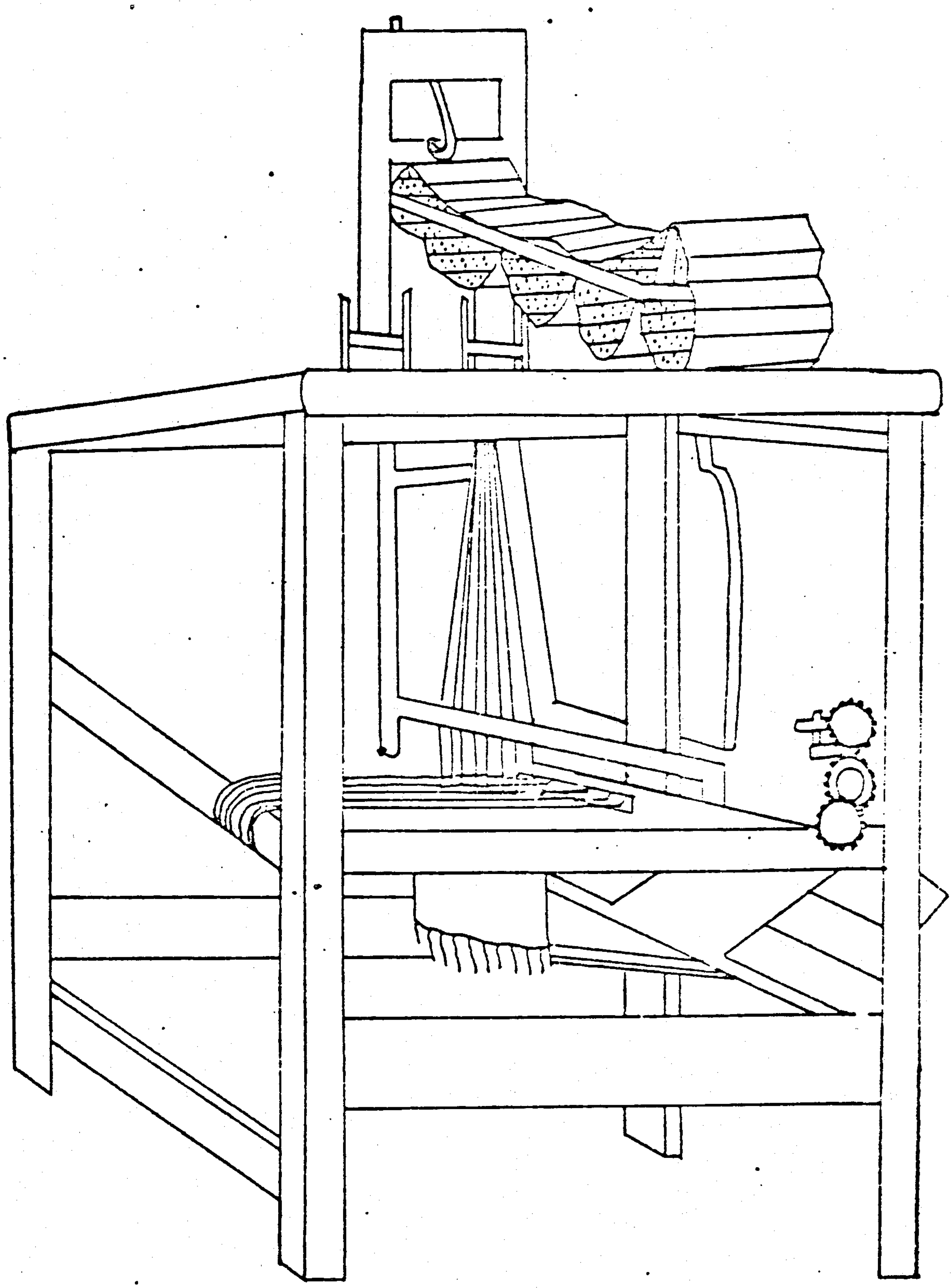
(Reprinted) from Jay W. Forre
World Dynamics. Copyright 197
Wright-Allen Press, Cambridge, Massachu

10 Computer Understanding: A printout of a conversati between a computer and its programmer and pictures dra by the computer to illustrate its actions, 1974. Programmin languages used today are quite cumbersome. They require to learn specialized terminology and permit only a few wor and symbols to be used in programming a problem. This ca make programming an arduous task. One of the main effort Artificial Intelligence Research is to program computers to understand plain English. This would make working with computers easier and less mystifying for most people.

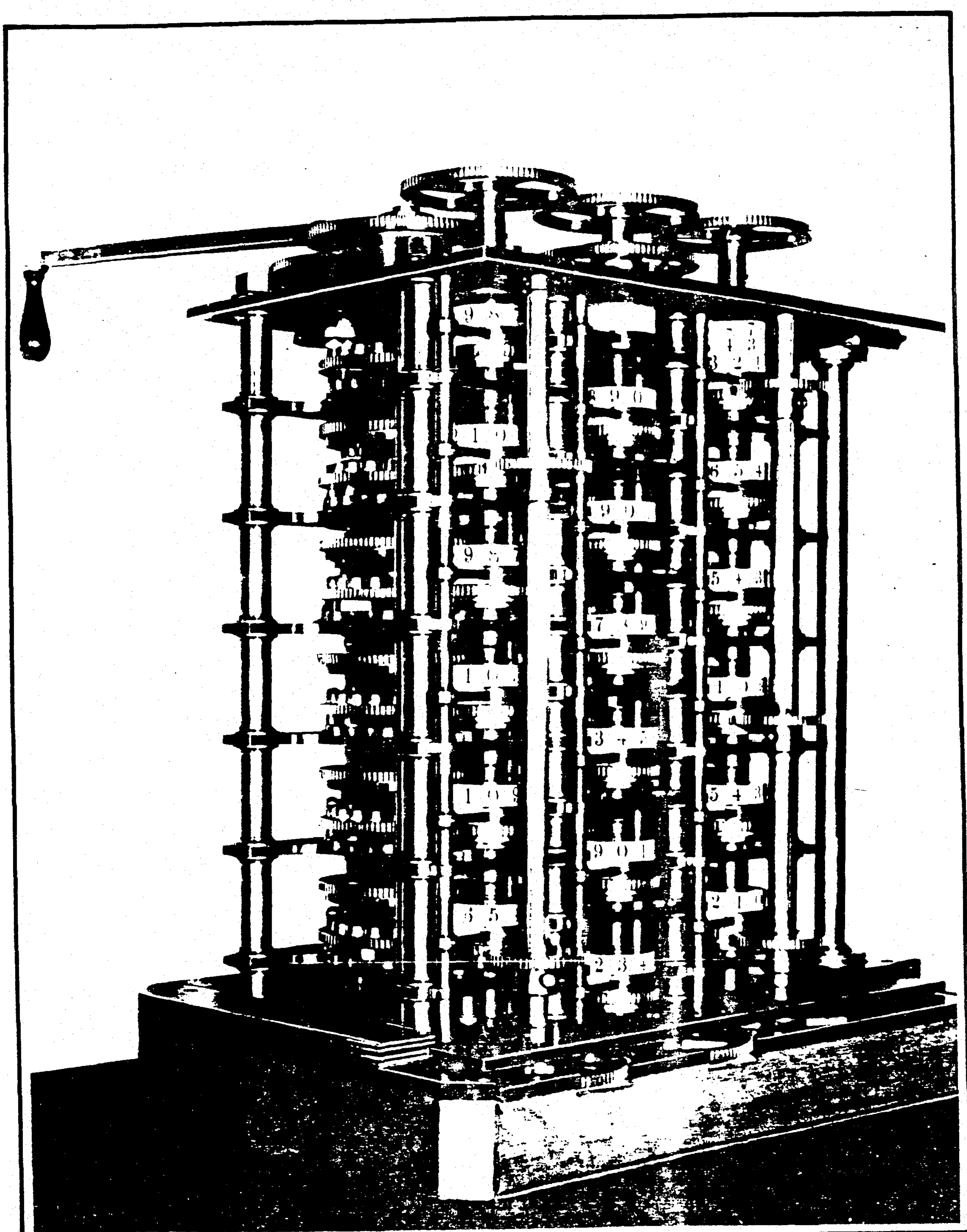
But the task is more difficult than one might think because plain English is less "plain" than it seems at first. Even the most simple sentences can have more than one possible meaning. A person understands which meaning is *really meant* because he or she knows which one makes se in a particular situation. A computer doesn't know this automatically. It must be programmed to know which word can go with other words. It must be able to search for clues

A LA MÉMOIRE DE J. M. JACQUARD.



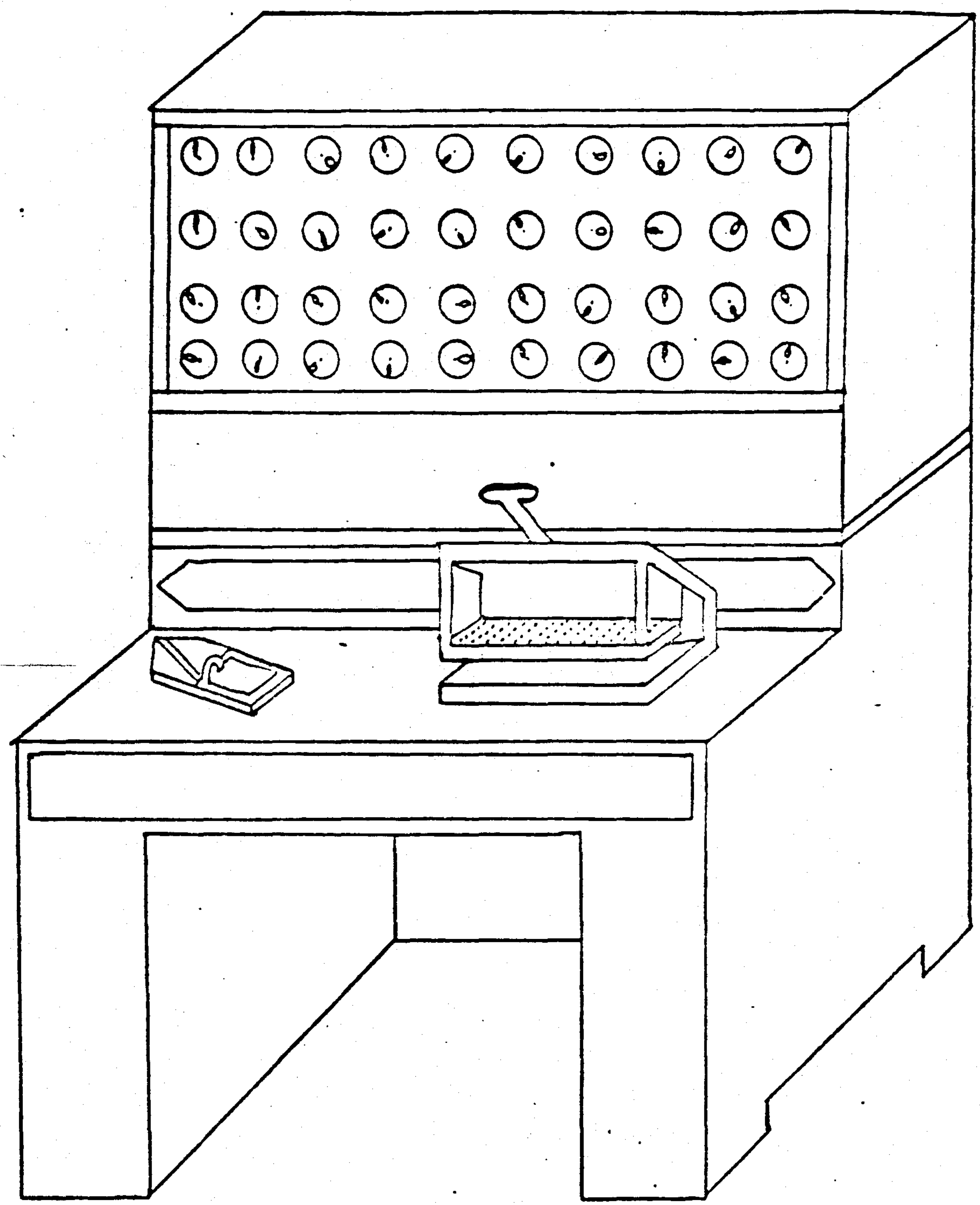


WEAVING LOOM - JACQUARD



The only portion of the Difference Engine that Charles Babbage ever completed. Later and less ambitious machines built by others were smaller and less exact but had the advantage of actually working. One such machine was used for many years to compute

TRANSPARENCY #9



HOLLERITH'S PUNCH

TELEPHONE NUMBER	CC		RB	BO	RAC	DATE OF BILL	AMOUNT DUE
617 266 2339	904		1711	14	6	09 14 80	27 09

PLEASE SEND THIS CARD WITH YOUR PAYMENT

IF YOU PAY IN PERSON, BRING BOTH THIS CARD AND YOUR BILL

New England Telephone

BOSTON, MASS. 02207

PLEASE DO NOT FOLD OR STAPLE THIS CARD

FROM PEBBLES TO GEARS

Although our age is often called the age of the computer, every age since the dawn of civilization has had a computer of some kind. People have always needed devices to help them count and calculate. Through the centuries the amount of counting and calculating that people have had to do in daily life has increased, and their computers have become faster and more complicated in order to keep pace.

One of the earliest computers (1800 B.C.) may have been Stonehenge, on Salisbury Plain in England. It may have been used as an observatory and eclipse predictor for a religion in which eclipses were important events. There is evidence that other cultures—Northwest American Indians, for example—built similar devices on a less monumental scale.

The Ancient Greeks and Chinese constructed small working models of the heavens, as they were then understood, to help in locating celestial objects. These planetariums were sometimes attached to water-driven clock mechanisms (clepsydras) so that they could compute the positions of stars, sun, moon, and planets automatically and continuously. Sometimes the computations were intended to help in correcting calendars. Another motive for building celestial computers was undoubtedly astrological, since they would have shown the positions of heavenly bodies even when the skies were clouded. Of course, the clock mechanisms of early times were rather crude, so the results must have been very approximate. Celestial computers continued to be made in one form or another in every century. The Arab astronomers of the fourteenth century produced very elaborate ones. Even today, similar clocklike mechanisms are used in the mountings of telescopes.

Computers like these, which use some kind of direct physical analogy of the situation they are intended to compute, are called *analog computers*. A slide rule is another analog computer. Computers which use numbers and not measurements in their operation are called *digital computers*. Modern computers are of this type (see Exhibit 4).

The first pocket calculator was undoubtedly the human hand. The second digital computer, invented at least three thousand years ago, was probably the abacus. It must have been a great help to traders in totaling up their costs and profits. Most likely, traders were responsible for spreading the use of the abacus all over the ancient world as they traveled from city to city, buying and selling goods.

Originally an abacus was just a flat slab of stone covered with dust on which markings could be made, like a blackboard in reverse. The Greek and, later, the Roman abacus was a flat tablet cut with parallel grooves along which pebbles, or *calculi*, were moved as counters. Each groove stood for a different denomination: units, tens, hundreds, and so on. Addition and subtraction were easily performed by moving the pebbles in the appropriate rows, and techniques existed for multiplication and division.

The abacus was easily made from materials no further away than the nearest quarry; this made it an excellent computer for the times. Abacuses were used in Europe until the seventeenth century in the form of counting boards. What is today called a "counter" in a shop took its name from these tablelike computers. The Oriental abacus, familiar today with its beads strung on wires or rods, probably came into use in China around the twelfth century. It is still used today in certain parts of China, Japan, and the U.S.S.R.

The abacus was the workhorse of calculation for thousands of years, but it had several defects. During addition, for example, when all ten beads in one row have been moved up, the total must be "carried" by moving up a single bead in the next highest row. This is done manually, so mistakes can occur. A wrong carry from the ones to the tens place might not be serious, but the same mistake going from the thousands to the ten thousands could have been disastrous to a merchant who was doing his accounts. There was no way to get around this problem except to be careful and double-check results.

Then in the seventeenth century the mechanical experience that had been gained in Europe through the building of complicated geared machines, such as clocks, was applied to the problem of calculation. People began to build mechanical calculators that would do arithmetic with the turn of a crank or dial without ever missing a carry.

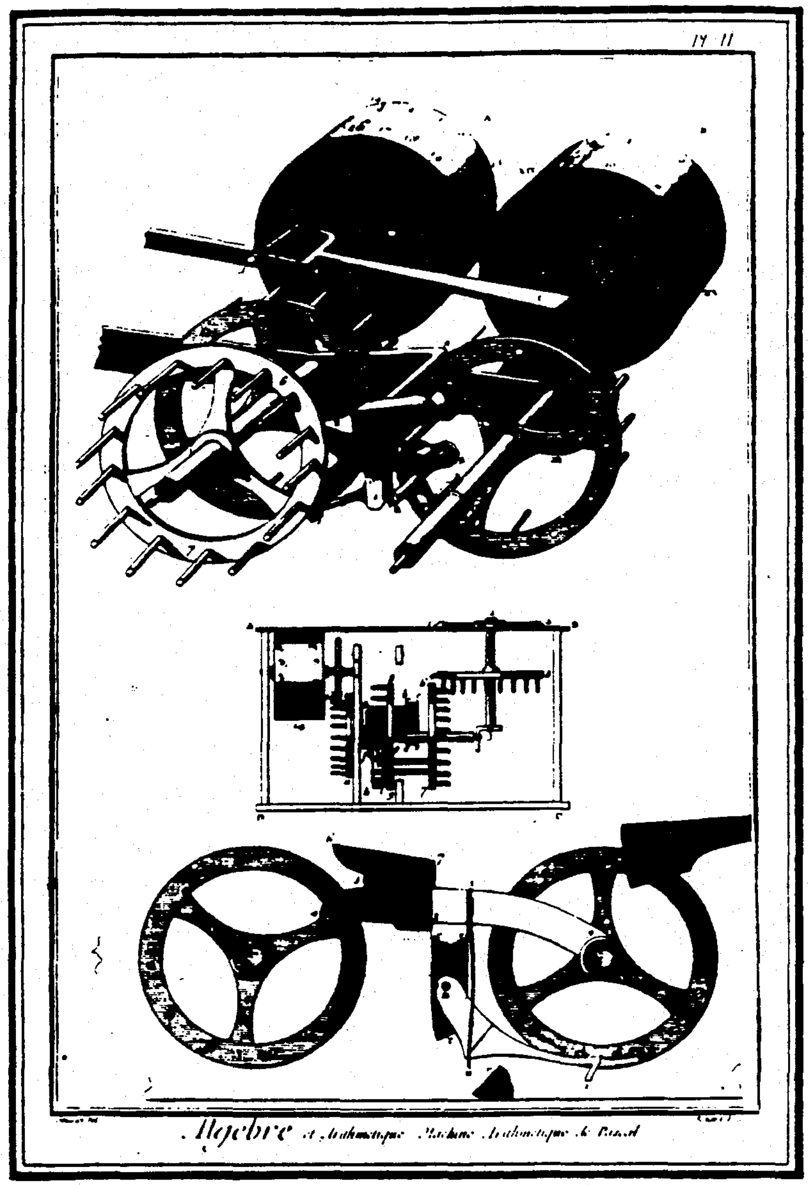
Blaise Pascal, a famous French mathematician, is usually credited with inventing the first mechanical calculator in 1642, when he was twenty years old. It was just one of his many contributions to mathematics. At that time few of even the most educated men could do simple arithmetic, and consequently his machine, which could add and subtract automatically, was thought to be quite marvelous. Supposedly Pascal invented it to help his father, a high tax official, do sums in his office.

Pascal's machine was operated by means of numbered dials that were moved with a stylus. The dials were connected by gears to represent ones, tens, hundreds, and so on. The gears performed the carrying operation: thus when the dial representing tens made one complete revolution and passed from 9 back to 0, the hundreds dial would register another unit. Addition was performed by entering numbers on the dials; as each subsequent number was dialed, it combined with the previous total and a new sum would be displayed in small windows directly above. The same principle is used in small plastic calculators sold today.

Pascal's machine was a brilliant invention as far as it went, but it was not of much use in multiplication or division. To multiply, one had to enter a number on the dials many times over, hardly more convenient than using paper and pencil. An attempt to remedy this situation was made some thirty years later by another famous mathematician, Gottfried Wilhelm von Leibniz, who invented a machine that could multiply as well as add and subtract. Multiplication depended on a special kind of gear, now known as the Leibniz Wheel. The Leibniz Wheel was a pinwheel on which the pins could be moved in and out. Multiplying by a number, say five, involved setting the pinwheel so that five pins protruded from it. When engaged with the calculating mechanism, the pinwheel would cause another gear to turn five notches. Long division could also be speeded up by using this machine to perform the many multiplications necessary in that process. Whereas Pascal's machine was more a curiosity than anything else, Leibniz's machine could in principle have been useful for extended calculations. It was, however, very complicated and expensive. In later years Leibniz's design was modified and improved, and even today the Leibniz Wheel is found in some mechanical desk calculators.

Pascal's calculator, however, was not really the first. In 1623, the year Pascal was born, a German scholar named Wilhelm Schickard wrote a letter to the astronomer Johannes Kepler describing a calculator he had built that would add, subtract, multiply, and divide. From his description the device appears to have been quite ingenious. Only the letter survives, however, for the machine itself was destroyed by fire in Schickard's workshop, and shortly afterward Schickard and his entire family perished of the plague during the chaos of the Thirty Years War.

This sidelight suggests that something deeper was going on than lucky invention. Neither Pascal nor Leibniz knew of Schickard's work, yet they ended up accomplishing the very same thing he had done just a few years earlier. After thousands of years of using pebbles and stone the time was apparently ripe in Europe for the invention of the calculating machine.



An engraving of the mechanism of Pascal's Calculator. The center illustration shows the train of pinwheels and gears that transmitted the motion of the entry dial (marked 2) to the numbered drum beneath the answer window (14). The top illustration shows a front view of the carrying mechanism. Try to trace how a complete revolution of the units gear (on the right) would move the tens gear (on the left) around one digit—a tenth of a revolution.

Photo. Science Museum, London

'Pebbles to Gears' worksheet

Name:______________________________ Date:__________

Answer the following questions on "Pebbles to Gears".

1. What was Stonehenge?

2. Why did the Ancient Greeks and Chinese construct celestial computers?

3. How does an analog computer work?

4. Give an example of an ancient analog computer.

5. Give an example of a more modern analog computer.

6. What was a big problem with the Abacus?

7. How did the mechanical calculator, invented by Blaise Pascal in 1642, improve upon the Abacus?

8. What was the Leibniz wheel? What did it do?

9. Who was Wilhelm Schickard and what was his idea?

10. Schickard, Pascal, and Leibnis were all inventors of calculating machines. What was similar about their devices?

GENERATIONS OF COMPUTERS
UNIT 2

OBJECTIVE: Students learn more about people in computing history and are introduced to the 4 generations of digital computers.

Activity I: As a class, read the handout called Important Names in Computing History. Vies the Computer Museum slides beginning with 1.3 to introduce the idea about memory size and computation speed. Skip to slide 4.1 and present the rest of the packet.

Materials:
1. 10 Important Names in Computing History
2. museum slides 1.3 and 4.1-12.4

Time: 1 to 2 classes, depending on how detailed you are about each slide and on how long the students seem interested in the slides.

Activity II: Discus the generations of computers using the handouts called Computer Firsts and the Early Development of Computers. Students fill in the Age of Modern Computing chart.

Materials:
1. Computer Firsts
2. Early Development of Computers
3. Age of Modern Computing chart

Time: 1 class

Activity III: As a class read about women in Computing History and students review by reading the SRA handouts, doing the SRA worksheet, and filling in the timeline.

Materials:
1. handouts on Lovelace and Hopper
2. notes from SRA History unit with worksheet on matching names with inventions or ideas
3. TimeLiner program
4. Student's data disks

Time: 2 classes

Activity IV: Discus the history of software devices, as students fill in the Software Devices chart. Demonstrate a nanosecond. Students add final touches to their timelines. By this time they have studyied inventions in Social Studies and can add other non-computer inventions to their timelines. Assign the reading "Modern Computers" with the questions.

Materials:
1. Software Devices chart
2. Nanosecond article and a piece of wire 11.8" long
3. Timeliner worksheet
4. Social Studies notes on inventions with their dates
5. "Modern Computers" and questions

Time: 1 class

Activity V: Students make or do a crossword puzzle using the handouts from this Unit.

Materials:
1. CrossWord Magic program
2. CrossWord Magic worksheet
3. necessary handouts
4. student's data disks

Time: 1, 2 or 3 classes, depending on whether the teacher makes the puzzle for the students to do in class, or the students make their own puzzles and know how to use CrossWord Magic. (If students do not know how to use this program, then begin a puzzle as a demonstration.)

Activity VI: Updating the Scrapbook. Students put all handouts, charts, notes into their scrapbook. They make a title/contents page for this chapter.

Materials:
1. 10 Important Names in Computing History
2. Computer Firsts
3. Age of Modern Computers chart
4. Early Development of Computers
5. Women in Computing History
6. SRA History list
7. Software Devices chart
8. Nanosecond article
9. "Modern Computers" article with the questions

Time: 1 class

ASSIGNMENTS:
1. reading: Modern Computers with answers to the questions.
2. completed SRA worksheet
3. completed timeline
4. completed crossword puzzle
5. updated scrapbook

See Appendix II for a TEST on Computer History that takes 1 class period.

TOTAL TIME: 7-9 classes (including the TEST)

10 Important Names in Computing History

BLAISE PASCAL was a Frenchman who invented a method of adding numbers mechanically. In 1642 he invented the Arithmetic Machine, which was a calculator run by gears. He invented it to help tax accountants; his father was one.

JOSEPH JACQUARD was a loom maker in the early 1800s who developed the punched card loom. Punched cards were one of the beginning major tools for storing information. Each 3 X 7 inch card was made of stiff paper and was punched with holes. Where the holes were, determined the pattern woven into the fabric. So, the cards stored information that told the loom what pattern to weave.

CHARLES BABBAGE is called the "father of modern computing" because in 1835 he conceived of a machine that would be a precursor to the computers we use today. His machine, called the Analvtical Engine, had input, output, memory, and CPU; the four components of modern-day computers. Most people could not understand Babbage's new and unusual ideas. They thought he was eccentric, and his machine was never built during his lifetime.

ADA AUGUSTA LOVELACE was a gifted mathmetician who saw the importance of Babbage's idea for the Analytical Engine. She wrote about Babbage's ideas in a way so that other people could understand them. Also, she convinced Babbage to use the binary number system for the Analytical Engine because that would make it work more efficiently.

HERMAN HOLLERITH used Jacquard's idea of punched cards to help count and record information from the U.S. census. The holes in Hollerith's cards represented answers people could give to the census questions. Using Hollerith's cards, the Bureau completed the 1890 census in 2 and 1/2 years, instead of 10 years as it was for the 1880 census. Hollerith formed the Tabulating Machine Corporation which later became part of the International Business Machines Corporation, known as IBM.

HOWARD AIKEN and his co-workers at Harvard University in 1939 finally built a machine like Babbage's Analvtical Engine. It was called the MARK I or the Automatic Sequence Controlled Calculator. The MARK I could add or subtract two numbers in about 3 seconds, and it could multiply two numbers in about 6 seconds. This was very fast compared to earlier machines.

(over)

JOHN W. MAUCHLY & J. PRESPER ECKERT contributed to the next major advance after the MARK I. They used vacuum tubes in a computer called the ENIAC (Electronic Numerical Integrator and Calculator). It was much faster than earlier calculating machines but it was as large as many houses (1500 square feet) and weighed 30 tons. Its 18,000 vacuum tubes and hundreds of thousands of electrical parts used 200 kilowatts of electicity, which is as much electricity as a dozen or more average homes use. It is hard to believe that the giant ENIAC had less memory and was slower than some of today's hand-held calculators. ENIAC, however, was the starting point for many interesting changes in computers.

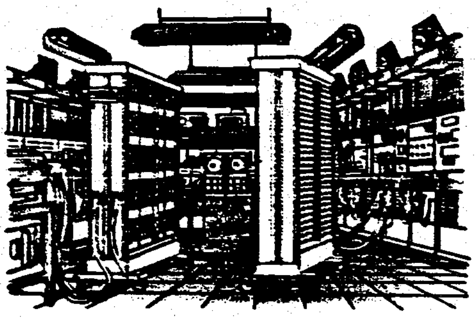
JOHN VON NEUMAN was a Princeton University professor who made two important suggestions towards improving the ENIAC. He first showed that binary numbers would be better than decimal numbers for use in computers. He also suggested that the computer's memory should not just store numbers but also instructions that tell the computer what calculation to do. These instructions are called programs.

GRACE HOPPER was the first woman programmer. She developed the computer language called COBOL. During the 1950s people realized that programing would be much simpler if computer manufacturers would agree on a simple language for all business uses. The result was Hopper's COmmon Business Oriented Language and it continues to be used today.

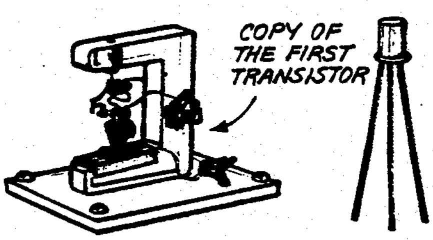
Computer firsts

Computers, 1981

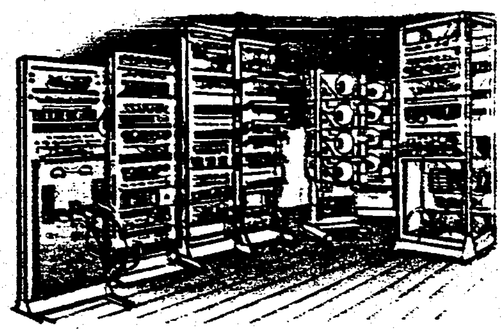
The development of computers can be divided into three main stages, or generations. The first generation was the large mainframes built with valves. The smaller more reliable computers built with transistors are called the second generation, and computers made with silicon ch are the third generation. Here is a list of the main dates the history of computers.



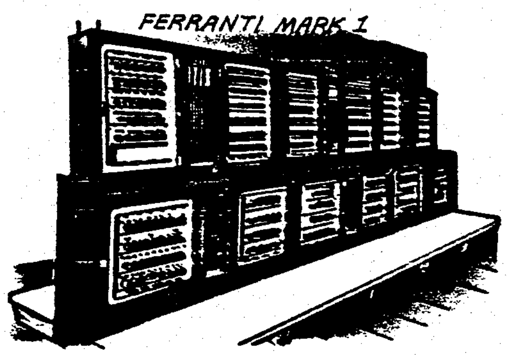
1945 ENIAC, the first all-electronic machine, was built. It was more like a calculator than a present-day computer, though, as it could not store data or programs. ENIAC stands for Electronic Numerical Integrator and Calculator.



1947 A new kind of electronic component, called the transistor, was invented. Transistors were first used in computers in about 1953.



1948 The Manchester University Mark I, the first real computer (that is, one which could store a program of instructions), ran for 52 minutes on June 21.



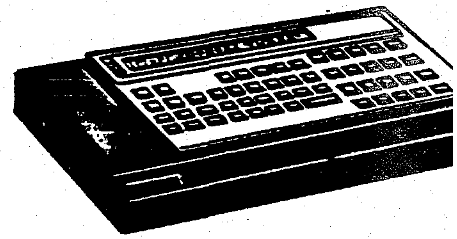
1950 The Ferranti Mark I, based on the Manchester Mark I, was sold commercially in Europe.

1958 The first working integrated circuit was developed.

1960 The first "chips" – integrate circuits on chips of silicon – were produced.

1964 The first computers built wi integrated circuits were produced f the general market.

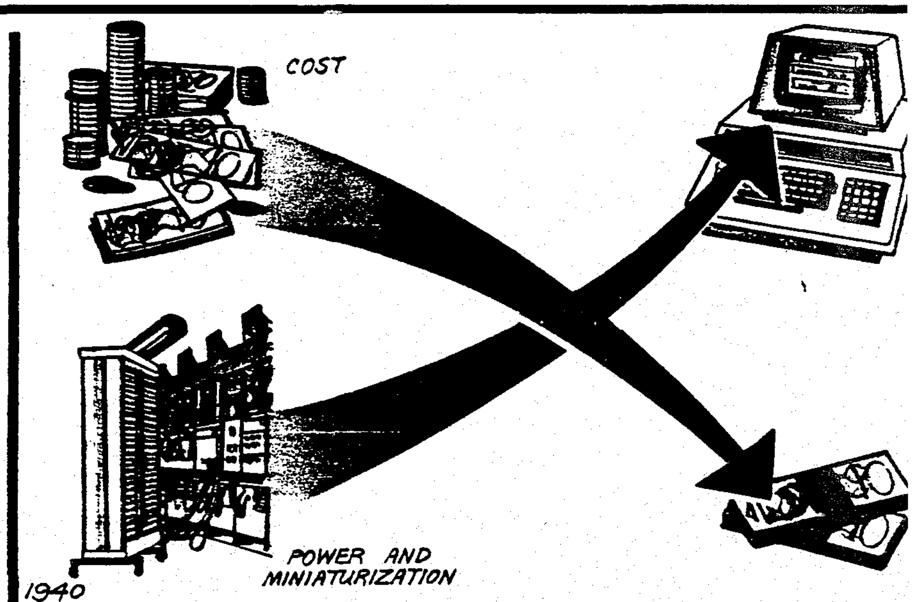
1975/6 The first small "home" computer, the "Altair", was on sal



1980 The first pocket computer, Japanese Sharp PC1211 was sold.

The future

This graph shows how dramatically computers have developed over the last 40 years, becoming smaller, cheaper and more and more powerful. The first computers could do relatively few calculations a second whereas a 1980 mainframe can carry out millions of instructions each second. These trends will probably continue and perhaps the only restrictions on the future of computers will be the cost of new inventions and whether we really want such machines. If cars had developed at the same rate as computers we would now be able to travel at thousands of kilometres an hour in tiny vehicles which would use hardly any fuel and be relatively cheap to buy.



EARLY DEVELOPMENT OF COMPUTERS

MARK I 1944

.....51 feet long, weighed 5 tons

.....500 miles of wire

.....add and subtract in 3 seconds

.....multiply in 6 seconds

ENIAC 1946

.....18,000 vacuum tubes

.....weighed 30 tons

.....500 additions in 1 second

.....300 multiplications in 1 second

.....could store only 20 ten digit numbers

EDSAC 1949

.....5900 vacuum tubes

.....stored in binary

.....addition in 864 microseconds

.....multiplication in 2.9 milliseconds

.....could store instructions and data

UNIVAC I 1951

.....first commercial computer

1st

Generation

1954-1959

.....vacuum tubes

.....slow.....milliseconds

.....machine language

.....small storage.....40,000 characters

.....physically large

2nd

Generation

1959-1964

.....transistors

.....faster.....microseconds

.....fortran language

.....larger storage.....100,000 characters

.....physically smaller

.....lower cost

3rd

Generation

1964-1975?

.....faster.....nanoseconds

.....many programming languages

.....smaller in size

.....lower cost

.....time sharing

4th

Generation

1975-????

.....even faster.....picoseconds

.....natural languages

.....even more storage

.....hand-held machines

.....even lower cost

.....networking

AGE OF MODERN COMPUTING

		FIRST GENERATION	SECOND GENERATION	THIRD GENERATION	FOURTH GENERATION	. . .
ECTRICAL DEVICES						. . .
LCULATIONS PER SECOND						. . .
OTES						

AGE OF MODERN COMPUTING

	1940's	FIRST GENERATION 1950's	SECOND GENERATION 1960's	THIRD GENERATION 1970's	FOURTH GENERATION 1980's	
LECTRICAL DEVICES	Vacuum Tubes	Vacuum Tubes	Transistors	Silicon Chips	Micro processor	...
ALCULATIONS PER SECOND		1,000	10,000	1,000,000	10,000,000	...
OTES	MIT -1940 Whirlwind $ 5 million entire building	SAGE -1958 Univac I- predicts 192- election $13 million 4 story building	1960 IBM 1401 for business Used punched cards $150,000 1 office	refridgerator		...

The First Woman Programmer by Esther Lakritz

If Ada, the Countess of Lovelace, were alive today, she'd be pleased that her memory lingers on. Beginning in 1983, Ada will be the only computer programming language used by the Department of Defense for materials handling and the control of weapons, space, tactical, and strategic systems. Touted as simple and straightforward, Ada is slated to become the single most important language for government work.

This language is named for Ada, the Countess of Lovelace, a fascinating figure who lived in the first half of the nineteenth century. Her father was the celebrated poet Lord Byron. Even though her parents separated when she was a month old and she never saw her father again, he immortalized her in the third canto of "Childe Harold."

Ada was a very gifted child. She became a linguist and a talented musician, playing the violin, guitar, and harp. But her true genius lay in mathematics. By the age of fifteen, she had mastered geometry. She wanted to continue in this field but was discouraged from doing so. Her math tutor, although recognizing her genius, believed that mathematics demanded a fierce concentration and unremitting strength of intellect that was beyond the stamina of a female. He thought she should not be encouraged, for fear of impairing her health.

But she did continue. Her career began in earnest when she met the inventor of the *difference engine*, Charles Babbage. His machine used the "difference method" to produce computed tables. Babbage, amazed at her comprehension of the machine, urged her to continue in mathematics.

Later on, Babbage developed the *analytical engine*. This machine gave mathematical solutions to problems through direct processes of arithmetic. While Ada was translating an Italian account of the analytical engine, Babbage suggested she include her own comments. The phrases she used are straight out of modern computer terminology.

Ada's husband, the Earl of Lovelace, believed she should receive proper credit for her work. However, as a woman, only her initials could appear at the end of the translation. Since Ada not only understood Babbage's machine, but could also explain it clearly and graphically, the work caused quite a stir. Yet, her identity remained a secret.

After that, things began to go downhill. Ada's math career stalled because of a lack of educational opportunities. She began to lose interest in her family. She and Babbage started to bet on horse races to raise money for his inventions. Despite the use of a mathematical no-fail system, they lost heavily. Ada became more depressed and withdrawn. Afflicted with cancer, Ada died at 36, the same age her father died. She is buried next to him. □

THE WORLD'S SECOND PROGRAMMER Grace Murray Hopper

After the death of Ada Lovelace, it would be a hundred years before women became involved in computers again. By that time, technology had progressed beyond gear-driven calculators to devices using electricity, vacuum tubes, and relays.

Babbage's machine was reborn at Harvard in 1944 as a machine called the MARK I, or Automatic Sequence Controlled Calculator. The MARK I was designed by Howard Aiken. However, it was a woman - Grace Murray Hopper - who saved the MARK I project. "She tamed the beast", said one member of the project team, "by writing complex instructions that made it work". She put into practice many of Ada Lovelace's ideas about loops and subroutines, as she programmed this computer.

Hopper graduated Phi Beta Kappa from Vassar College in 1928. In 1930 she married Vincent Hopper. In 1943 she joined the Navy and was commissioned a lieutenant in 1945. Her first assignment was the joint Harvard-Navy MARK I project. At Harvard she developed programs for the MARK I. "It was all so obvious. Why start from scratch with every single program you write? This planted the seeds for COBOL (Common Business Oriented Language), a programming language still widely used today.

While Grace Hopper was at Harvard, the term "debug" came into being. According to Hopper, "In 1945 while working in a World War I-vintage non-air-conditioned building on a hot humid summer day, the computer stopped. We searched for the problem and found a failing relay - one of the big signal relays. Inside we found a moth that had been beaten to death. We pulled it out with tweezers and taped it to the log book. From then on, when the officer came in to ask if we were accomplishing anything, we told him we were "debugging" the computer".

Grace Murray was born in 1906 and is still going strong at age 83 today! She viewed Halley's Comet in 1910 and she saw it again in 1986! She is currently a captain in the Naval Reserve, and travels worldwide giving speeches, except for "every Friday night, when I wash my white top, white shirt, and white hair!"

SR A.3
(History)

Historical Overview

Early means of counting: pebbles, sticks, etc.

Abacus: 3,000 B.C.

John Napier (1550-1617)
Naiper's Bones (1617): This device aided multiplication calculations.

William Oughtred (1575-1660)
This English clergyman and teacher arranged two of Napier's logarithms along an ordered scale and invented the first slide rule. The slide rule manipulated lengths of numbers and their proportions in a manner similar to today's analog devices.

Blaise Pascal (1623-)
Pascal developed an adding machine in 1642.

Gottfried Wilhelm Leibniz (1646-1716)
Leibniz invented components called "stepped-pinions" which allowed repeated addition of the same entry without resetting it. Early variation of the calculator.

Charles Babbage (1791-1871)
In the 1820's, Babbage began trying to build a general purpose computer. He proposed, but never completed, an automatic calculator called the Analytical Engine.

Augusta Ada Lovelace (Lady Byron)
Lord Byron's daughter was an admirer of Charles Babbage; she wrote several of the operating instructions for his machines as well as providing financial aid. Her mathematical contributions helped clarify and improve several of the internal operations of the machines.

J. M. Jacquard (1752-1834)
Jacquard developed the Jacquard Loom through which a woven pattern was controlled by punched cards.

George Boole (1815-1864)
Boole was an Irish logician and mathematician. He developed the algebraic logic that was to be used in computing machinery, a logic that is known today as 'Boolean algebra'. It was a system of formulating logical statements symbolically so that they could be written and proven in a manner similar used in ordinary algebra.

Herman Hollerith (1860-1929)
Developed a method to mechanize the 1890 U. S. Census by using punched cards.

Vannevar Bush (1890-1929)

In 1930, he developed the first analog computer which was used in Word War II to help aim guns.

Howard Aiken

In 1944, he developed the first digital computer called the MARK I. This machine did what Babbage envisioned, but was quite slow; requiring several seconds to complete a single arithmetic operation.

J. Eckert and J. Mauchly

These two engineers built the first digital computer that was controlled by parts called vacuum tubes. This first general purpose electronic computer, called the ENIAC, was developed in 1946. These two inventors also created the UNIVAC I in 1951 which was the first computer made in large numbers, the first commercially available general purpose computer.

John von Neumann (1903-1957)

Von Neumann developed the idea of keeping instructions for the computer's memory. He did this in 1947. His work influenced the EDVAC, which was the first stored-program computer.

Grace Murray Hopper

Hopper invented the first practical computer, and was part of the team that created COBOL. At 76 (1983), she is the Navy's oldest officer on active duty; she was retired in 1976, but recalled seven months later to standardize the Navy's computer programs and languages, and has been elevated to Captain by a special act of Congress.

The First Generation

The word generations stands for a way to talk about the history of computers. The first generation of computers began in the 1940's and lasted through the 1950's. They used vacuum tubes for calculation, control, and sometimes for memory also.

The Second Generation

In the late 1950's and early 1960's, the transistor became available to replace vacuum tubes and signaled the beginning of the second generation. Not only did this allow computers to become smaller, but transistors also enabled computers to process information much quicker.

The Third Generation

In the mid 1960's, the integrated circuit, which made microcomputers possible, was introduced.

The Fourth Generation

The chip, or large-scale integrated circuits, are generally associated with this period. They made microprocessors and microcomputers possible in the 1970's. Some people do not regard this as a new "generation", while others proclaim we are currently part of the fifth generation.

SA A.3
(History)

NAME ______________________________

DATE ____________________

Listed below are names of people who contributed to the development of computers. Match a description in Column 2 with a name in Column 1.

____1. Augusta Ada Byron	a. inventor of "adding wheel"
____2. George Boole	b. marked ivory pieces for multiplicatio
____3. Joseph Jacquard	c. the slide rule
____4. Grace Murray Hopper	d. father of modern computing
____5. Blaise Pascal	e. developed first digital computer - (Mark I)
____6. Charles Babbage	f. mathematician who worked on the Difference Engine
____7. William Oughtred	g. algebraic logic
____8. Howard Aiken	h. author of COBOL
____9. Napier Bones or Rods	i. punched card machine inventor for census
____10. Herman Hollerith	j. weaving loom inventor

COPY

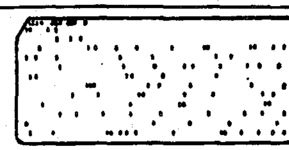
INTERMEDIATE

WORKSHEET TO COPY AND USE WITH THIS MONTH'S POSTER

NAME: ______________________________

HISTORY OF SOFTWARE DEVICES

DIRECTIONS: Below is a list of some of the devices that store software. Use references to complete the information categories on each device. The first is done for you.

SOFTWARE DEVICE	APPROX. DATE INVENTED	A COMPUTER THAT HAS USED IT	PICTURE
PUNCHED CARD	1800s	Jacquard's Loom	
PAPER TAPE	1900s	MARK I	
MAGNETIC TAPE REEL	1950s	UNIVAC	
CASSETTE TAPE	1950s	Atari	
HARD DISK	1960s	(most large-capacity computers) IBM System 36	
FLOPPY DISK	1970s	(most personal computers) Apple II, IBM PC, Commodore 64	
LASER VIDEODISC	1980s	(some personal computers) Apple II	

punched card

magnetic tape

cassette tape

OPY

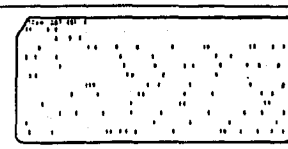
INTERMEDIATE

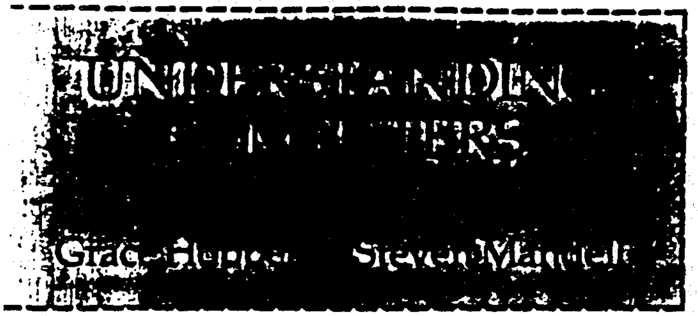
WORKSHEET TO COPY AND USE WITH THIS MONTH'S POSTER

NAME: ______________________

HISTORY OF SOFTWARE DEVICES

DIRECTIONS: Below is a list of some of the devices that store software. Use references to complete the information categories on each device. The first is done for you.

SOFTWARE DEVICE	APPROX. DATE INVENTED	A COMPUTER THAT HAS USED IT	PICTURE
PUNCHED CARD	1800s	Jacquard's Loom	
PAPER TAPE			
MAGNETIC TAPE REEL			
CASSETTE TAPE			
HARD DISK			
FLOPPY DISK			
LASER VIDEODISC			



You've waited long enough to receive your copy of **Understanding Computers** by Grace Hopper and Steven Mandell. Now that you have a copy (we sent one to you a few weeks ago) we invite you to take a moment to consider it.

In addition to the solid topical coverage of hardware, software, computer programming, and systems analysis, the authors take care to address the critical issues that have emerged as a result of our computerized society. This concern is developed generally throughout the text and specifically in these two chapter features –

A chapter opening ARTICLE from such periodicals as *Omni, Time, Newsweek*, or *Computerworld* introduce the relationship between the ever changing computer field and the chapter concepts ahead. These motivating articles raise student interest in the chapter topics. For examples, please see the ARTICLES listed below.
"Welcome to the Hotel Interactive" (p. 206)
"Cal Tech at it Again" (p. 316)

A chapter closing ISSUE explores a topic related to the chapter concepts. These issues touch on subjects of great importance to everyone and are designed to promote stimulating and thoughtful class discussion. For example, please take a look at the ISSUES below
"Industrial Robots: Improving Work or Eliminating Workers?" (p.286)
"Computer Mistakes: Who is Responsible?" (p.310)
"Privacy and the Computer: The Demise of Confidentiality" (p.356)

And, if you teach BASIC in your course, a 65 page BASIC Programming Supplement is included at the end of the text.

Software and Supplements provide you a complete teaching resource.
- Software – "Your First Computer Experience"©
- Instructor's Manual
- Videotape of Commodore Grace Murray Hopper
- Computerized Testing available to qualified adopters
- Student Study Guide
- Audio Study/Review Cassette

If you have any questions, or if you did not receive your examination copy, please call us toll free 800-328-9424 or write West Publishing Co./50 W. Kellogg Blvd./P.O. Box 43526/St. Paul, MN 55164.

UNDERSTANDING COMPUTERS
Captain Grace Murray Hopper
Steven L. Mandell

NANOSECOND RULER
Nanosecond billionth of a second
Maximum distance electricity can travel ...

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The Nanosecond Story

as told by Grace Hopper

The following is an excerpt from the videotape of Grace Hopper which accompanies the text. The tape is available to all adopters in either ¾", VHS, or Beta formats.

"I'm an extremely annoying employee. I normally drive all of my bosses totally nuts because I won't do anything until I understand what I've been told to do. So when you tell me to do something I start asking questions.

"They told me that the computer was adding in milliseconds, so naturally I said, 'What's a millisecond?' All they told me was a thousandth of a second. Well, I could see a second go by on the clock, by darned if I could see a thousandth of it. So I said, 'Please show me a millisecond.' Nobody but nobody would show me a millisecond....

"Finally a couple of years later somebody looked at one of my programs and said, 'Hey, you wasted five microseconds.' I said, 'So what, what's a microsecond?' Well, they very cheerfully told me that it was a millionth of a second. And I promptly had a problem....

"Pretty soon over the engineering building they started talking about billionths of a second–nanoseconds. Finally one day, in total desperation, I called over to the engineering building and I said, 'Please cut off a nanosecond and send it over to me.' Now what I wanted when I asked for a nanosecond was a piece of wire which would represent the maximum distance that electricity can travel in a billionth of a second. Of course it wouldn't really be through wire, it would be out in space at the velocity of light. So if you start with the velocity of light and use your friendly computer you'll discover that a nanosecond is 11.8 inches long.

"Boy, I was happy with my nanosecond and I looked at it from all angles. I thought about it very seriously. I looked at wall switches and counted the distance to various lights....And you may get yourself in a spot where you have to explain why two pieces of equipment have to be close together. I got in a worse once. I had to explain to the admiral why it took so long to send a message by satellite. And I had to point out to him that between here and the satellite there were a very large number of nanoseconds.

"They work very well to help explain things, so I hope you'll get some of these..."

Please accept this Nanosecond Ruler with the compliments of West Publishing Company.

TimeLiner Worksheet

Directions: Add the following EVENTS and DATES to your timeline. Add atleast 10 non-computer inventions to the timeline. Add yourself (when you were born) to the timeline. Save this updated timeline on your data disk.

EVENT	DATE	
Whirlwind	1948	
UNIVAC	1952	
SAGE	1958	
IBM 1401	1960	
transistor	1958	
vacuum tubes	1940	
silicon chips	1970	
Ada Agusta Lovelace	1820	(birth year)
Grace Hopper	1906	(birth year)
MARK 1	1944	
ENIAC	1943	
EDVAC	1950	

MODERN COMPUTERS

The story of the modern computer is in many ways the story of old computers told anew. The plot is the same—the invention of faster and more powerful devices to help with bigger calculations—but the characters are different, and the story is told in the new language of electronics. One chapter of it begins in 1937 with Howard Aiken, a graduate student in physics at Harvard University. In his work Aiken had to solve many complicated mathematical equations, involving long, arduous calculations. Since the time of Babbage, the main improvement that had been made in calculating aids was in desk calculators. These machines increased the amount of calculating a person could do, and they cut down on errors, but they had one drawback: the operator still had to punch the keys—he, or more often she, had to do the problem "in person." After working with desk calculators for some time, Aiken became exasperated. He began to think of ways to get a machine to do all the tedious work for him.

In 1939, with support from the IBM Corporation, Aiken began work on a computer called the Automatic Sequence Controlled Calculator, or Mark I, which was completed in 1944. The Mark I was a hybrid of the mechanical calculators of the past and the electronic computers soon to come. Calculation was accomplished electronically, but the machine still had many moving parts, including counters of the type invented by Dr. Herman Hollerith some fifty years before (see Exhibit 7). According to one observer, when the Mark I was in operation, the sound of its three thousand relays* opening and closing was "like a roomful of ladies knitting."

The Mark I was similar in principle to Babbage's Analytical Engine. It too was designed to calculate automatically, without human attention, by following a series of instructions laid down by the programmer. The Analytical Engine was to have been programmed with punched cards: Mark I received instructions in a similar fashion, from holes punch-coded in a long paper tape.

Aiken succeeded with his machine where Babbage had failed because he had the benefits of modern mass-production methods and electronic technology behind him. Yet when Aiken came across a description of the Analytical Engine three years after beginning the Mark I, he remarked, "If Babbage had lived seventy-five years later, I would have been out of a job."

By this time World War II was under way, and the fighting brought demands for calculations to an unprecedented scale. One crucial problem—like that of navigation in earlier times—was the preparation of tables showing how far artillery shells would travel when fired at different angles. At the University of Pennsylvania, where this work was done, the computation of firing tables for the Army had been keeping nearly two hundred women busy full time on desk calculators, aided by an analog-type computer called a Differential Analyzer. Three months' work would produce a single firing table of about three thousand trajectories.

Even these efforts obviously could not keep up with the demand for tables, and in 1943 two scientists, J. P. Eckert and John Mauchly, began to build a computer called ENIAC, short for "Electronic Numerical Integrator and Calculator." (They couldn't use the Mark I, since it was already being used by the Navy for their own firing tables.) Although ENIAC was not completed until 1946, after the war, the military still found constant use for it in improving weapons systems. Because ENIAC was completely electronic—using vacuum tubes that could do millions of operations per second—it was much faster than the Mark I. Where an artillery table might once have taken human computers several months to prepare, ENIAC could do the job in two or three days.

the Manhattan Project, where [illegible]
mathematicians of this century, was in charge of finding ways to perform the huge calculations needed to design the atomic bomb. Von Neumann once estimated that the bomb project would involve more arithmetic than all the computations ever done in the entire history of man! Von Neumann's interest in speeding up such calculations was sparked when he heard about ENIAC during a chance encounter on a train platform with H. H. Goldstine, the head of the ENIAC project. In collaboration with Goldstine and the ENIAC group, von Neumann developed an important improvement known as the stored program.

ENIAC, like earlier computers, could store numbers but not the instructions for using them. ENIAC's instructions took the form of electrical connections. This meant that every time a new problem was to be tackled many connections had to be rearranged to correspond to the new set of instructions. The process was similar to plugging jacks into a telephone switchboard, only much more complex. Hundreds of people might spend several days preparing ENIAC for a big problem.

Von Neumann had a better idea, which was incorporated in a new machine called EDVAC, in 1950. Only the basic logical and arithmetical operations, such as addition and multiplication, were built into the circuits of the machine. Each function was assigned a special number, and the machine was arranged to perform the operation from memory whenever that number was called. Thus the entire sequence of operations needed for a problem could be stored in memory, just like other numbers; in going through them one by one EDVAC would automatically perform them.

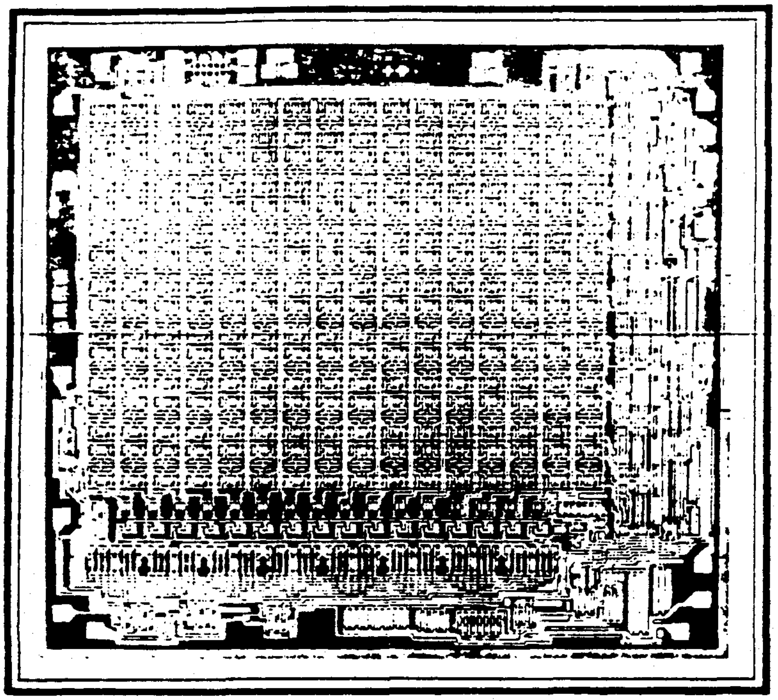
One advantage of this scheme was that it required no changes in wiring. To program a new problem, the user had only to enter the correct series of numbers. More important, since the instructions were numbers, not wires, the computer had the ability to change them to other numbers, and hence to other instructions. In other words, if the programmer wished to, he or she could program the computer to modify its own instructions midway through a calculation, depending upon the results that had been obtained so far. This feature gave the programmer more freedom, since many of the decisions in solving a problem could now be left to the machine.

Another improvement suggested by von Neumann was the use of the binary number system. The binary system expresses all numbers, and letters too, as different sequences of 1's and 0's, much as the Morse Code uses dots and dashes (see Exhibit 8). Although it is clumsy for human use because numbers are very long in it (the number 9, for instance, is 1001), binary is perfect for computers. The circuits from which computers are built can only be on or off at any given time. These on-off states correspond exactly to the 1 and 0 digits of the binary system. Basic operations like addition and multiplication and storage of numbers in memory are much more efficient when the binary system is used, as it has been in almost all computers after ENIAC.

By 1950, with the success of the stored-program concept and the transition to all-electronic operation, the computer had taken on the basic outlines it has today. A major improvement came in the mid-1950s, when the small, cheap, fast, and reliable transistor, invented several years earlier, replaced the bulky and expensive vacuum tube as the basic element of computer circuitry. Since around 1960, ways have been developed to print ever-increasing numbers of circuit elements on tiny chips of silicon. Such circuits can perform the basic operations such as addition or the retrieval of a number from memory in a few billionths of a second—tens or hundreds of times faster than was possible with transistors or vacuum tubes. They are also very compact and cheap. All of this has led to the use of small computers in many applications where the large computers of just a few years ago would have been uneconomical. The most obvious example of this trend is the electronic pocket calculator, which puts at the disposal of a single person more calculating power than could have been had a few decades ago with a roomful of equipment.

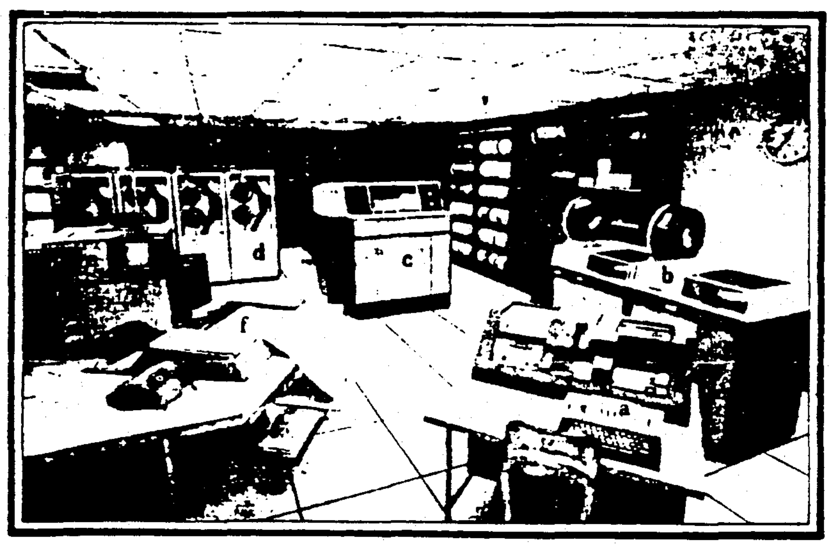
*A relay is an electromechanical device that turns one circuit on or off in response to the amount of current in another controlling circuit.

A disc operating system, in v stored on discs, supplemente tapes. Data is punched onto reader (e) into computer mer discs (stored at b) or magnet retrieve information, the pro entered on the system consol printed out on the printer (c standard and are tailored to



A photograph taken through a microscope of an integrated circuit used in a modern computer. Though no more than a sixth of an inch on a side, such a circuit can do the job of thousands of transistors or bulky vacuum tubes, such as were used in earlier computers. Miniature circuits make possible the pocket-sized calculators sold today, some of which can even be programmed.

Courtesy of RCA Solid State Division, Somerville, New Jersey



A disc operating system, in which programs and data are stored on discs, supplemented in this case by magnetic tapes. Data is punched onto cards at *a*, fed through the card reader (*e*) into computer memory, then transferred to either discs (stored at *b*) or magnetic tapes (mounted in *d*). To retrieve information, the program and/or job numbers are entered on the system console (*f*), and the information is printed out on the printer (*c*). Most computer systems are standard and are tailored to a user's individual needs.

Photo by Dudley Gray

"Modern Computers" worksheet

Name:______________________________ Date:__________

Answer the following questions on "Modern Computers".

1. What was the one drawback with desk calculators?

2. Who constructed the Mark I and how did it work?

3. What does ENIAC stand for and what was it used for?

4. Which new machine stored operations like addition and multiplication?

5. Which numbers does the binary system use?

6. What did the transistor replace?

7. Give an example of a small computer that has replaced a large one.

Crossword Puzzle worksheet

Directions: Make a crossword puzzle using the Crossword Magic program. Use as many names of important people in computing history, names of computers, and names of software devices as you can. Make up the clues. You may work with a partner. Save your puzzle on your data disk.

Helpful handouts you might want to use as reference:

10 Important Names in Computing History

Computer Firsts

Age of Modern Compuers chart

Software Devices chart

SRA History list

Early Development of Computers

THE TECHNOLOGICAL REVOLUTION
UNIT 3

OBJECTIVE: Units 3, 4, and 5 coordinate with the Social Studies curriculum on Revolutions. In Social Studies and Computers students study about various computer applications and how they affect our lives everyday. (See Appendix III for Social Studies objectives). In Computers, students also learn about computer careers, Artificial Intelligence and Robotics.

<u>Activity I:</u> Discus and read about how computers affect our lives everyday, using the handout on "Things Computers Do". On the board make a list of the ways computers are involved in student's lives. Students make their own lists, and word process them. Assign the reading "Computers are Everywhere" with the questions.

Materials:
1. "Things Computers Do"
2. Computers in Your Life worksheet
3. "Computers are Everywhere" with questions
4. student's data disks

Time: 1 to 2 classes, depending on whether you use the reading as an in class assignment or homework.

Activity II: Discus computer careers and students take notes on the Computer Careers worksheet, which they word process.

Materials:
1. Computer Careers worksheet
2. student"s data disks

Time: 1 class

<u>Activity III:</u> Explore A.I. through discussion of the opinions and questions on the handout. Students use Eliza with the Eliza worksheet.

Materials:
1. A.I.
2. Eliza program
3. Eliza worksheet

Time: 2 classes

Activity IV: Introduction to Robots and the Technological Revolution. View the NOVA movie, and answer the questions on the NOVA worksheet.

Materials:
1. "NOVA: The Robot Revolution" movie
2. NOVA worksheet

Time: 2 classes

Activity V: Update the scrapbook. Students organize their notes and handouts into appropriate chapters in their scrapbook.

Materials:
1. "Things Computers Do" sheet
2. word processed Computers in Your Life list
3. word processed Computer career notes
4. A.I. sheet

Time: 1 class

Assignments:
1. word processed Computers in Your Life list
2. answers to "Computers are Everywhere" questions
3. word processed Computer career notes
4. answers to Eliza questions
5. answers to NOVA movie questions

See Appendix II for a TEST on Computers in Our Lives and in the Future, that takes less than 1 class.

Total Time: 7 to 9 classes (including the TEST)

Things computers do

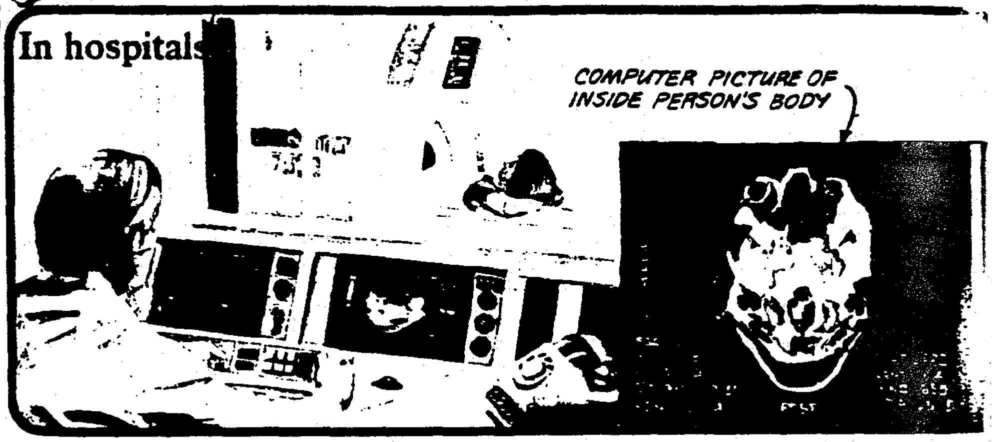
The great speed with which computers can work through vast amounts of information makes them good for calculating millions of telephone bills, keeping business records of sales and payments, for scientific calculations, and so on. Here, though, are some other things computers can do.

Teaching in schools

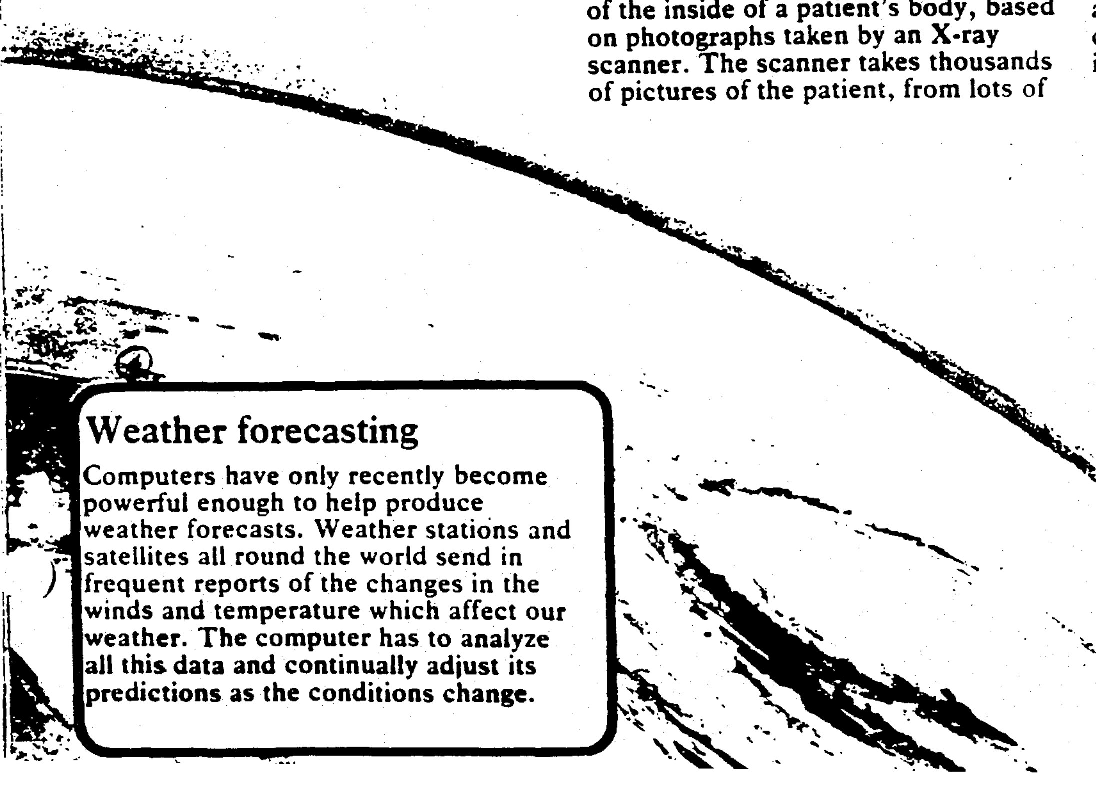
These children are using a computer to help them learn to read and write. The children answer the computer's questions by touching a sensitive board near the word or picture they think is correct.

This model train control unit contains a microprocessor chip which works like a tiny computer and can control four trains at once. Instructions about the speed and direction of the trains are stored in the chip's memory circuits, and sent as pulses along the tracks to the trains. Chips in the trains decode the instructions and control the trains.

In hospitals



A computer can show detailed pictures of the inside of a patient's body, based on photographs taken by an X-ray scanner. The scanner takes thousands of pictures of the patient, from lots of different angles. The pictures are sorte and processed by the computer, and th doctor can then ask it to show an orgar in the body from any angle.



Weather forecasting

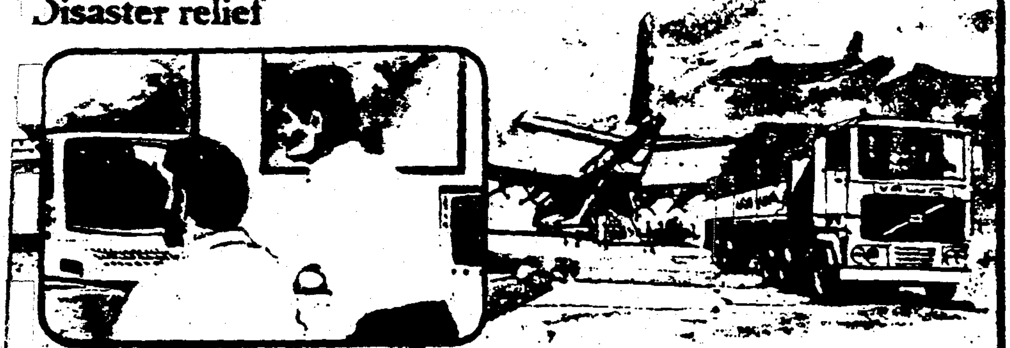
Computers have only recently become powerful enough to help produce weather forecasts. Weather stations and satellites all round the world send in frequent reports of the changes in the winds and temperature which affect our weather. The computer has to analyze all this data and continually adjust its predictions as the conditions change.

Helping the handicapped

Severely handicapped people can use computers to communicate with other people, "talking" to them via the computer screen. In the system shown above, the person controls the computer by sucking and blowing down a tube, telling it which letters to select to spell out words.

6

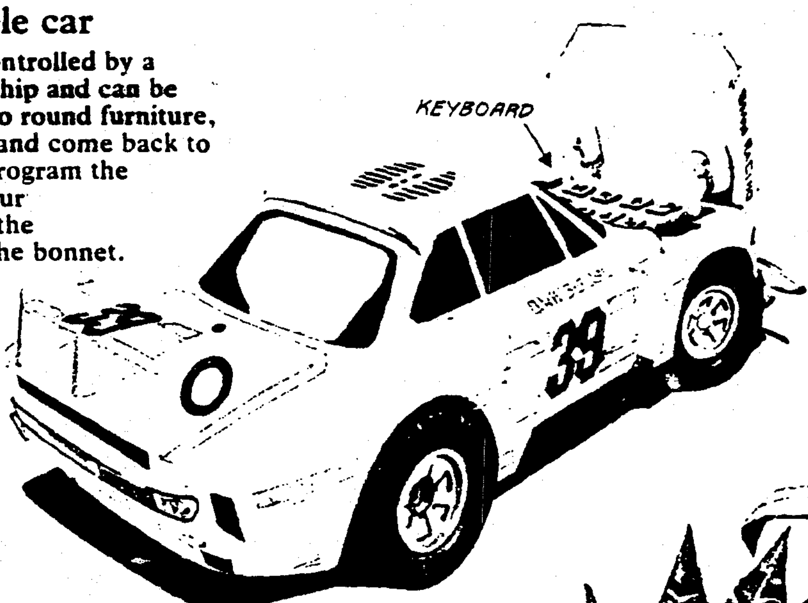
Disaster relief



Computers help organize the sending of aid to the victims of earthquakes or famines. The computer can sort through all the information about the disaster area, and record what goods have been sent. It can then show, for instance, that more food rather than blankets is needed, and that several small planes should be sent instead of one big one as the area has only a small airport.

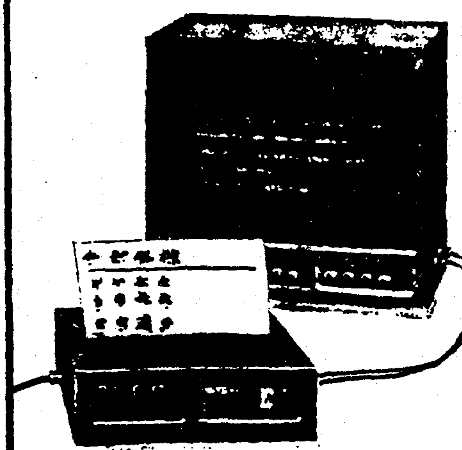
Programmable car

his toy car is controlled by a icroprocessor chip and can be programmed to go round furniture, out of the room, and come back to ou again. You program the r by tapping your instructions into the keyboard under the bonnet.



7

For translation



It is very difficult for computers to translate from one language to another, as words can have different meanings in different sentences. For instance, the computer needs to be given a lot of information before it can recognize the difference between "I feel like a cup of tea" and "I feel like an idiot". Computers which can translate are being developed, though, using scanning devices as shown above, to "read" foreign scripts.

9

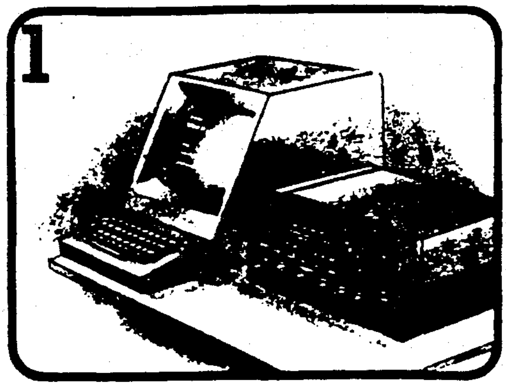
Making music

An artist, John Lifton, has used a computer to make music from plants. All plants contain tiny charges of electricity, and changes in these charges were recorded by the computer. The computer then sent messages to a sound synthesizer which made different sounds depending on the changes in the plants. People even brought their own plants to test on the computer to see what sounds they made.

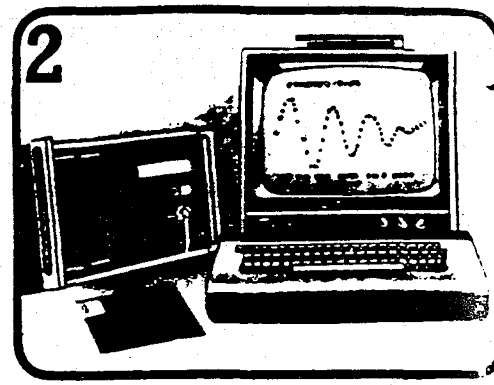
Home computers

In the past, only highly trained computer experts were able to use computers, but as they become cheaper, smaller and easier to operate, many people such as doctors, teachers, librarians, architects and artists are finding that a computer can help them.

There are lots of uses, too, for a computer at home – to look after home finances, store useful information such as addresses and timetables and play games with. You can already buy a pocket-sized computer quite cheaply, and learn to use it in a few hours. Computer enthusiasts can even build their own computer from a kit.



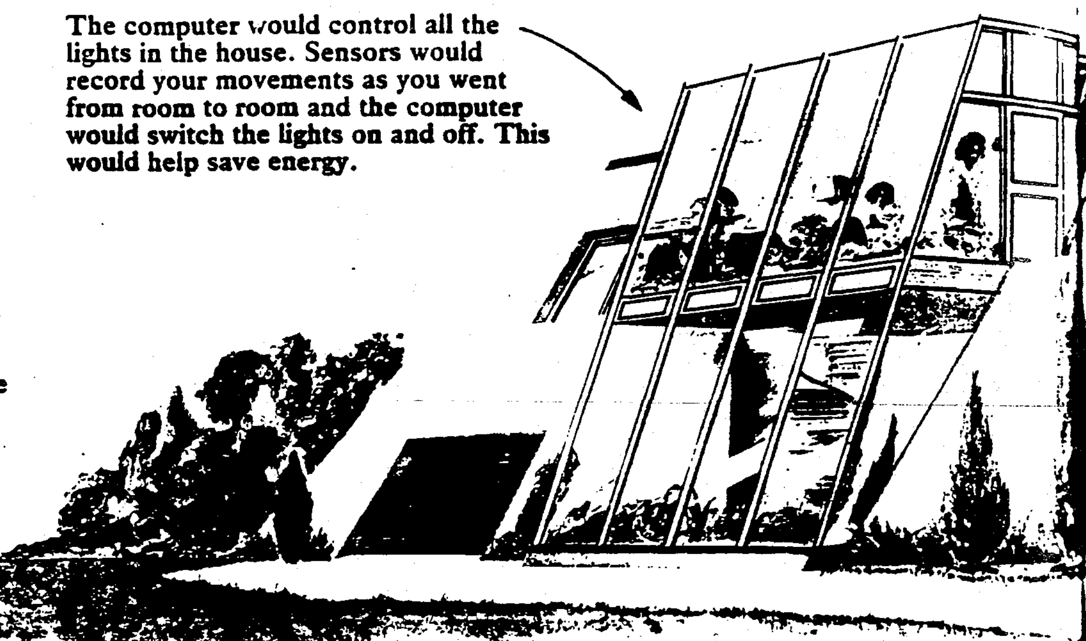
This is an American "Altair", one of the first small "home" computers which was on sale in 1976. It could be built from a kit, but it was quite complicated to use and had lots of switches and flashing lights.



Within a few years, though, home computers have become much easier to use. They have very few buttons and switches and all the operating instructions and information are shown on the computer screen.

Computerized homes

Sometime in the future, houses will probably have built-in computers which control everything from paying the bills to opening the doors. An experimental house like this has already been built in Arizona, USA. This picture shows some of the things such a home computer could do.

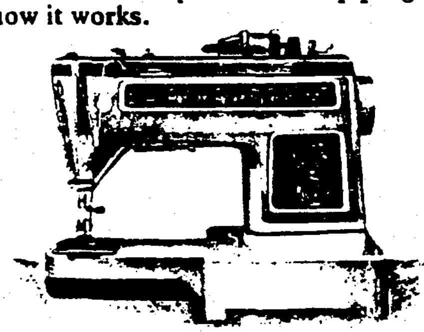


The computer would control all the lights in the house. Sensors would record your movements as you went from room to room and the computer would switch the lights on and off. This would help save energy.

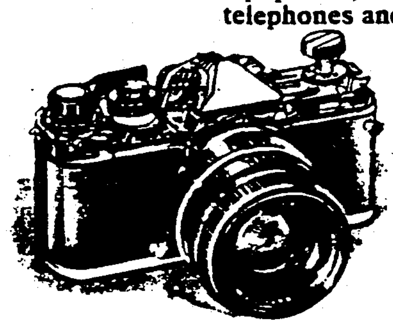
Hidden computers

Each of these things has a small computer inside, in the form of a microprocessor chip programmed to control how it works.

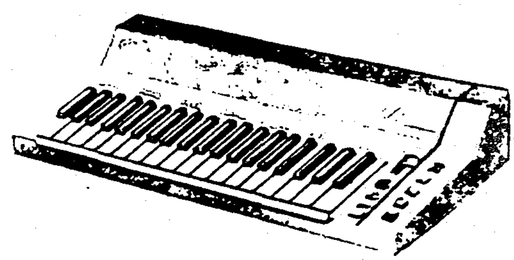
Microprocessors are used in many other kinds of equipment, such as washing machines, cookers, telephones and electronic games.



This sewing machine has a chip programmed to do lots of different embroidery stitches. To change the stitch you press a button and the chip sends instructions to the mechanical stitching parts of the machine.

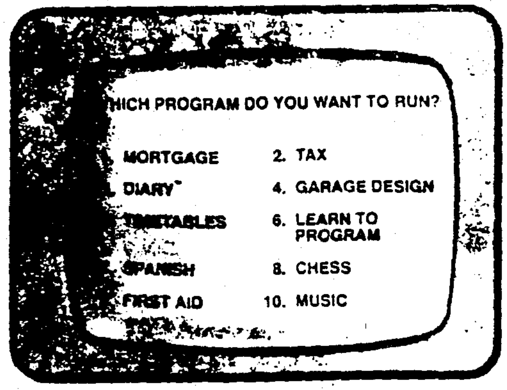


The aperture and shutter speed of this camera are controlled by a microprocessor. Light sensors register how bright the light is, and the chip selects the correct aperture size and shutter speed.

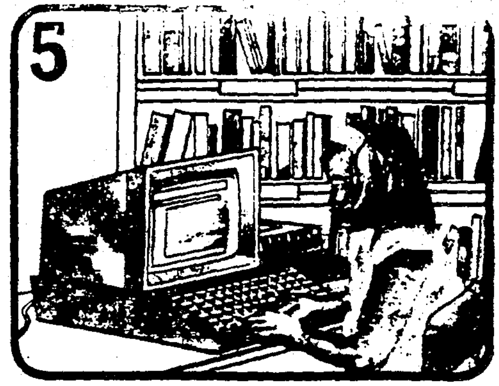


This electronic keyboard can make the sounds of 29 musical instruments. It contains information about the sounds of the instruments in the memory of its chips. When you play on the keyboard it makes the sound of the instrument of your choice.

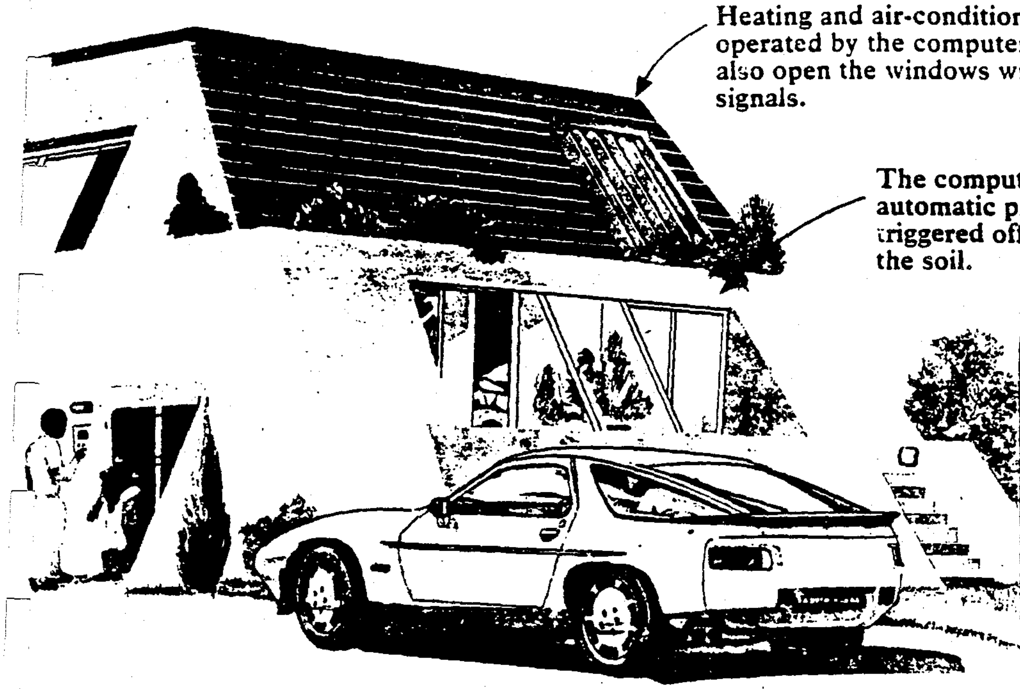
v that computers are easy to use, ..ple can experiment with a computer ıd do their own programming. A few ..rs ago, only computer experts had ess to the computers, and they ..trolled how they worked.



You can also buy pre-recorded computer programs on discs and cassettes. There are programs for computer games and for calculating bills, and also to help you learn a new language, or design a do-it-yourself project.



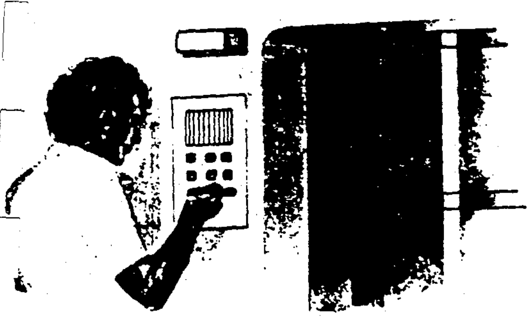
Microcomputers in schools and public libraries give lots of people the chance to use a computer. In the future, though, owning a computer will probably be as common as owning a wristwatch.



Heating and air-conditioning would be operated by the computer, and it could also open the windows with electronic signals.

The computer would switch on an automatic plant watering system, triggered off by humidity sensors in the soil.

Entry control



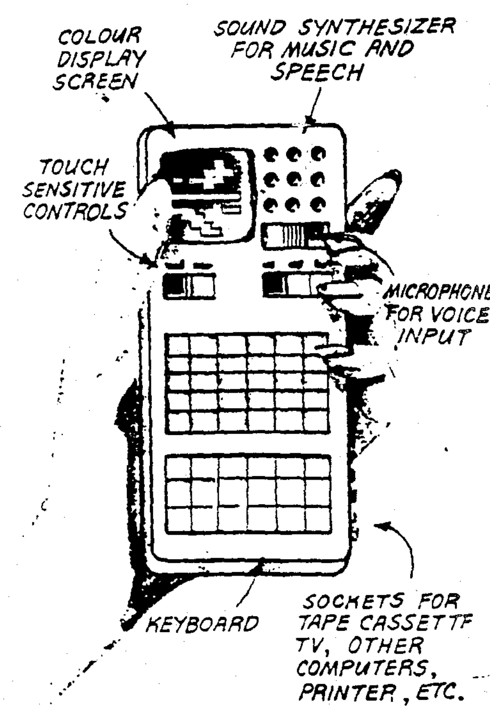
To enter the house you would punch your personal code into a keyboard on the door. The computer could be programmed to let in certain people only, and could take messages and reply in a human-like voice, using a speech synthesizer.

The computer terminal

The computer itself could also be used for many other purposes: for storing information, paying bills, playing games, in fact, for anything you programmed it to do.

Pocket computer

In the very near future you will probably be able to buy, quite cheaply, a pocket computer with all the features shown below. See if you can think of things you would do with a pocket computer if you had one.



NAME:______________________________

COMPUTERS IN YOUR LIFE

List every way you can think of that computers are involved in your life:

Exerpts From: ~~SPOTLIGHT ON COMPUTER LITERACY~~, by Ellen Richman
Random House, 1985.

COMPUTERS ARE EVERYWHERE

Computers affect our lives every day in many ways. How? Where are they used? Let's take a look.

Computers in Government

The United States government was one of the first computer users. During World War II, the government designed computers to crack the enemy's secret military codes. Today the military forces use computers for tasks such as tracking and guiding aircraft, ocean vessels, and tanks, and for planning defense strategies. They also use computers to keep records of people that are in the military—their rank, jobs, pay, and other important information.

Do you remember when the Census Bureau used Hollerith's punched cards and Tabulating Machine?

The Census Bureau is a government agency. It uses computers to sort the information it receives every ten years on every person in the United States. The 1980 census had over three billion answers to questions. It would have taken thousands of people more than 10 years to sort all that data. Computers did the job in less than a year.

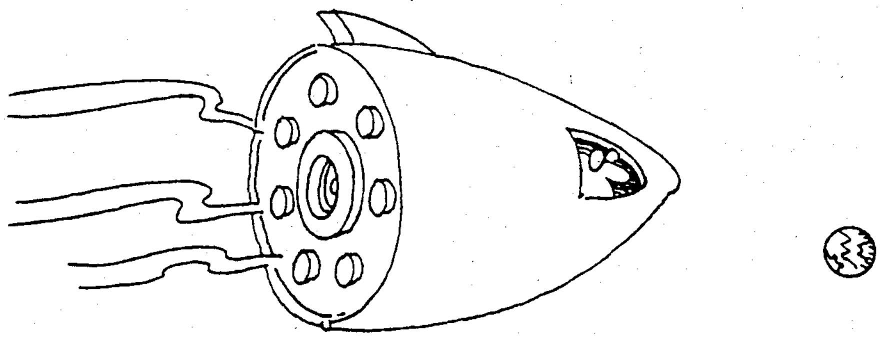
There are hundreds of other agencies that use computers for all kinds of jobs.

The Internal Revenue Service is the government agency that collects taxes. Computers keep records of tax forms and check them for errors. Computers print out checks for people who get refunds. Computers also print out notices to people who still owe taxes.

State and local governments also rely on computers to get jobs done. For example, states keep records of all cars, trucks, and other vehicles owned by people. A city might have its traffic lights timed by a computer.

Computers in the Space Program

Spaceships wouldn't get off the ground if it weren't for computers. From the launching of the first spaceship in 1959, computers have been used for space flights. They have helped plan the path of spaceships. They have been used to keep the ships on course and plan their landing.



Computerized equipment found the oxygen leak.

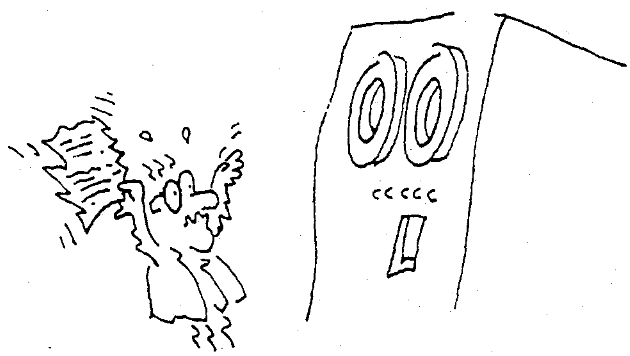
Computers have proved to be very important in emergencies. Several years ago a leak was found in the oxygen tank of the command module of the Apollo 13. There was only a small amount of oxygen left for emergency use. It was important to get the astronauts back to earth as soon as possible. Scientists, programmers, and computer operators at the Manned Spacecraft Center in Houston, Texas, worked non-stop. They gave the computers information to use to plan a new flight path. With each new plan, the computers listed important data. They told how long the return flight would take. They told how much fuel and oxygen would be used. They gave the time and place of the splashdown. Thousands of factors had to be considered. There was not enough time for the control center staff to work out all the calculations by themselves. By using computers, they were able to plan a new course for the Apollo's return. The astronauts were brought safely back to earth.

1. Why is it better to use a computer instead of people to do certain jobs when planning a space flight?
   - **a.** The computer knows the correct speeds, path, and landing site without instructions from a human.
   - **b.** The computer can do calculations faster and more accurately.
   - **c.** The computer can tell which day will have the best weather for takeoff.

Computers in Offices

Look at a bill from a department store or a credit company. Was the bill written by a person or printed by a machine? Large companies use computers to keep track of customers' accounts and prepare their bills. It would take many people to do the work of one computer. Computers not only work faster, they are more accurate.

Does that mean that computerized bills never have mistakes? No! Computerized bills cause some very upsetting problems. For example, Mr. Rossi received a bill from a department store for $0.00. So, he ignored the bill. The next month he got a "friendly" reminder (printed by a computer) that he still owed the store $0.00. He wrote a letter to the store asking it to correct the mistake. Before anyone acted on his request, he got another letter (printed by the computer). It told him that if he didn't pay his bill, the store would close his charge account. Before the problem was finally cleared up, Mr. Rossi was very angry—with the computer!



The mistake, of course, was not the computer's fault. In this case it was a programming error. The programmer didn't instruct the computer to stop sending bills when the balance was down to zero. But it was easier for Mr. Rossi to blame the computer.

Computer "mistakes" are not always the fault of the programmer. Sometimes mistakes are made when an office worker accidentally types the wrong information into the computer. Suppose a customer sends a check for $10.50 but the typist enters $1.50. The balance on the next bill will be wrong!

Sometimes the computers themselves cause errors through mechanical or electrical breakdowns. But, these situations are so rare, that "computer errors" are almost always "human errors."

Most large companies use computers to handle many chores. Computers prepare paychecks and keep payroll records. They keep track of inventory and accounts. Computers also process data to give estimates of how much money a company might make at a future date. Why do companies rely so much on computers? Computers can do some work so much faster and more accurately than people. When computers take over boring and tedious tasks, people are free to use their time and skills to reason and make judgments. Computers can do work that requires no thinking, planning, reasoning, or judging 24 hours a day. They can work every day of the year without taking breaks or going on vacation—and they never get tired!

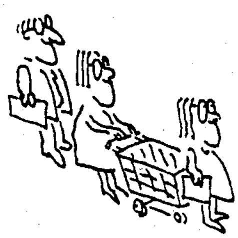
Inventory is the merchandise in a store, factory, or warehouse. An **account** is a record of goods or services bought or sold.

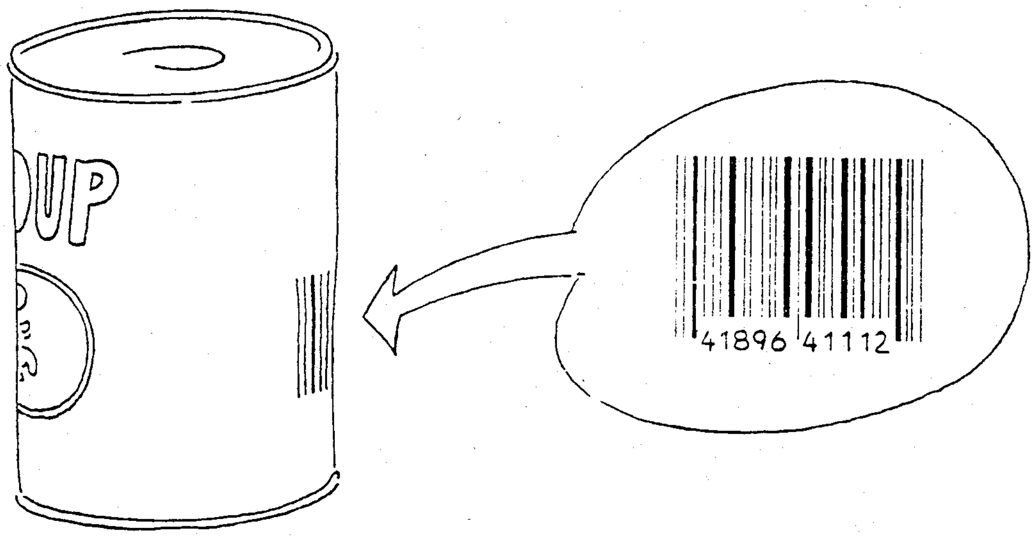
Computers in Supermarkets

A **scanner** is an input device in a computer system.

When the Thompsons go grocery shopping, they dislike waiting in the checkout lines. Often, there are delays while the cashier looks for the price on each item and rings it up on the register. But, one day, they noticed that the checkout lines were moving very quickly. When it was their turn to check out, they found out why. The cashier did not even look for the prices or ring them up on the register. The cashier passed each item over a "window," called a **scanner,** on the checkout counter. The correct price was automatically printed on the register tape. How did that happen?

The supermarket installed a Universal Product Code computer system. Today, almost all packaged products are marked with a set of black and white bars and numbers. This symbol is called the **Universal Product Code,** or UPC.





The first few bars and numbers in the UPC usually represent the name of the manufacturer and the product. The remaining bars represent the size of the product.

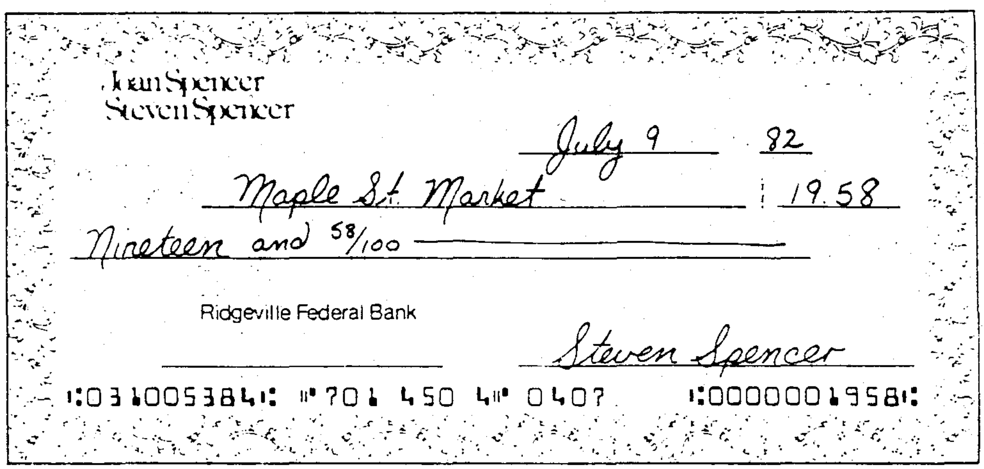
Computers in Banks

The Spencer family decides to go to a movie on a Sunday. They don't have enough cash at home and the banks are closed. That isn't a problem. On the way to the show, they stop at the bank. Mrs. Spencer inserts a plastic bank card in the 24-hour automatic teller. She punches in her bank code and pushes a button to get cash. The automatic teller gives her the money. All across the country, banks are installing computerized automatic tellers. They allow customers to withdraw cash, make deposits, and pay bills any time of the day or night.

An automatic teller has a special keyboard.

A **deposit** is money put into an account.

Banks also use computers to keep track of checking and savings accounts. In Chapter 4, you read that bank checks have account numbers printed on them in magnetic ink. An input device called a Magnetic Ink Character Reader reads the numbers on the check.


Joan Spencer
Steven Spencer
July 9 82
Maple St. Market 19.58
Nineteen and 58/100
Ridgeville Federal Bank
Steven Spencer
⑆0311005384⑆ ⑈701 450 4⑈ 0407 ⑆0000001958⑆

When the bank cashes this check, a clerk types the amount in the lower right hand corner. These are magnetic characters also. The banks computer "reads" the Spencers' account number and the total. It subtracts $19.58 from their account. Each month, the computer prints a list of checks cashed, deposits made, and the balance. This list, or *statement,* is mailed to the Spencers.

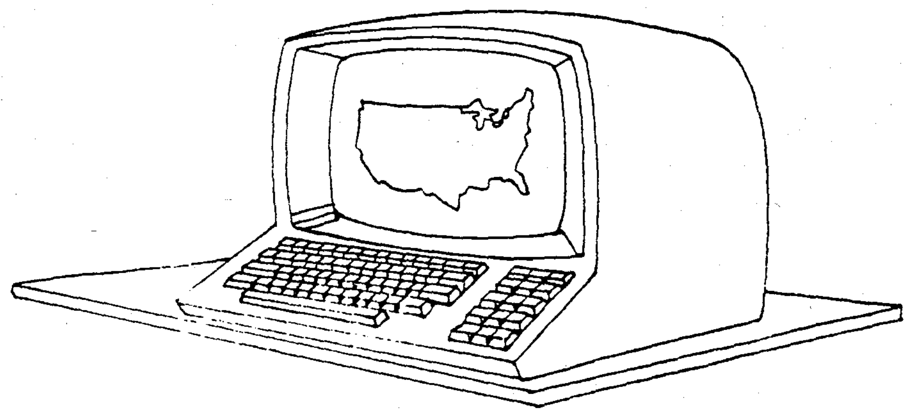
The **balance** is the total amount left in the account.

Banks use computers for many other things, too. They compute interest on loans and savings accounts. They keep track of how much money a bank is able to lend. They also compute how much money a bank may have at a given moment. There is so much activity in a bank that it would be impossible to keep records without computers.

Interest is the extra money you pay back on a loan. For example, you borrow $100. You must pay back $115. The $15 is interest. If you "lend" the bank money by putting it in a savings account, the bank will pay you interest.

Computers in Schools

It's time for social studies. Joanne is working on map skills. She gets to the classroom computer and loads a program. An outline map of the United States that shows major rivers appears on the screen. The computer prints a question under the map: WHAT RIVER MARKS THE BOUNDARY BETWEEN THE UNITED STATES AND MEXICO? Joanne looks at the map and types in RIO GRANDE. The computer responds with RIGHT. JOANNE! Then it asks another question. Mountain ranges, states, and major cities appear and disappear on the screen as needed.



Is this a special school or a classroom of the future? No. Many classrooms have computers which can help students in many subjects. Using computers to help students learn is called **Computer Assisted Instruction,** or **CAI.**

ımputer Assisted :truction is ıetimes referred to Computer Based ucation.

Why use a computer? A computer is very patient. It will not yawn or get bored, upset, or angry if you take a long time to answer a question. Also, when you type in your answer, the computer will tell you immediately if it is correct or not. No waiting until the next day to get your score.

However, a computer can't take over the role of a teacher. It doesn't explain things in different ways. You can't ask it *any* question. Also, it has no feelings. It won't sympathize with you if you've been home for a week with the flu. A computer is a very precise machine. Your answer must be exactly right, or the computer will count it wrong. And, of course, a computer can't give you a real smile or a pat on the back.

ɔpose you typed) GRAN instead of RIO ANDE. Your teacher ɡht know what you ɪan, but the computer n't.

Computers are also used to teach programming skills, such as those in Unit 3 of this book. There may be computers in your school that do other things. A computer in the office might store student records and keep track of attendance. It might also print out class schedules and report cards.

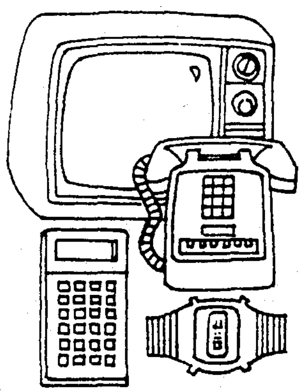
Computers in Your Home

Some people have computers in their homes. They may use them to keep family records such as taxes and bank accounts. They may use them to store records such as important dates or recipes. Many people use their home computers to play games or to learn how to write programs.

Some day computers might be as common as televisions in homes. They will be used to store information such as phone numbers, addresses, appointments, and bank accounts. They will probably be connected to mainframe computers outside the home. This will let people communicate with stores, banks, and news services. For example, you would be able to look at a store catalog on the screen. Then, you could order items by using your keyboard. To pay for the items, you would transfer money from your bank account to the store's account. You would do all of this at home, using your computer.

Is there a computer in your house? Think, for a moment, what a computer is. It's a machine that can accept, store, process, and give out information. Remember, the memory stores information. The central processing unit processes the information. The memory and CPU are **integrated circuit chips.** Do you think you have any of these chips in your house? You probably do. Do you have a digital clock or watch? An electronic game? A microwave oven with a "memory"? A new color television? A new car? A sewing machine that can be programmed? A push-button telephone? A calculator? All of these items contain computer chips. They usually have a memory chip and a CPU chip. The input units are the buttons, dials, and switches you use to operate these appliances. The output units are display screens such as the numbers on your digital watch. They are also electronic signals such as the telephone connection you make with your friend in another city.

Remember, integrated circuit chips are smaller than your fingernail.



You probably do have some of these computers in your home. The difference between these computers and "personal" or microcomputers is that the computers in your home are built into other appliances. They are designed to perform specific tasks rather than a wide variety of tasks. Now ask yourself again, is there a computer in your home?

1. Name two things that people use microcomputers for at home.
2. Name three items in your home that probably have integrated circuit chips in them.

Name: ______________________________

Computers are Everywhere
Spotlight on Computer Literacy

Answer the questions on this worksheet.

1. Computers in Government:

    1. a.______ b.______ c.______ d.______

    2.

    3. a.______ b.______ c.______ d.______

2. Computers in the Space Program:

    1. a. b. c.

3. Computers in Hospitals:

    1.

    2.

4 . Computers in Offices:

    1. a.______ b.______ c.______ d.______

    2. benefit:

       problem:

5. Computers in Supermarkets:

    1. 1.

       2.

    2.

    3.

6. Computers in Banks:

    1. a. b. c. d.

    2.

(over)

7. Computers in Schools:

1.

2. a. b. c. d. e. f.

8. Computers in your Home:

1. 1.

   2.

2 1.

   2.

   3.

9. Computers as Robots:

1.

2. a. b. c.

Computer Careers

Computers affect us in some way everyday. Some people have decided to be more involved with computers and have chosen computer careers. There are many kinds of jobs that deal with computers. Some jobs involve working with hardware and some involve working with software. Some computer careers involve working closely with a computer while others invove working more closely with people. Take notes about the following careers as we discus them in class.

Programmer:

Software Designer:

Data Entry Person:

Software Librarian:

Systems Analyst:

Computer Engineer:

Computer Technician:

Computer Operator:

Data Processing Manager:

Sales Representative:

Public Relations and Advertising:

Technical Writers:

Computer Teachers:

(For reference see Spotlight on Computer Literacy, pp.76-79.)

ARTIFICIAL INTELLIGENCE (AI)

Definition: Artificial Intelligence is a branch of computer science devoted to programming computers to carry out tasks that would require intelligence if carried out by humans.

Questions to think about:

1. What is thinking?

2. Can computers think?

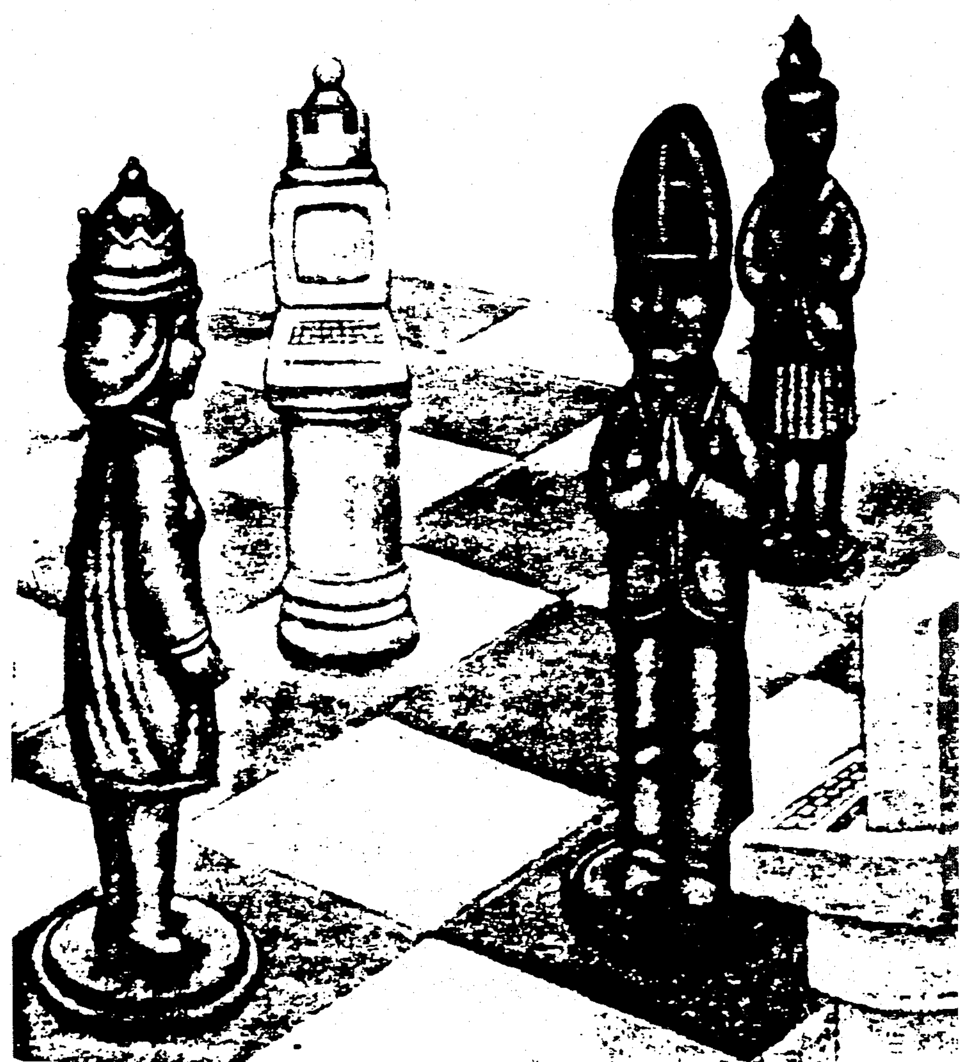
3. Researchers are teaching computers to see, to understand everyday speech, to use common sense: but how close are they to human intelligence?

4. Can a computer comment on a poem, story, or work of art?

ELIZA is a famous AI program. It was developed in 1966 by Joseph Wiezenbaum of M.I.T. as a joke!

Play ELIZA, and see what you think.

Intelligence is more than lots of knowledge. It is also intuition, insight, inspiration.



Eliza worksheet

Eliza is a program that will talk with you about a problem you may be having. Find out if she can help you.

Write down the problem you plan to discus with Eliza:

Play Eliza.

What does Eliza say if she does not understand you?

What does Eliza say when you ask her a question?

Make a list of about five things Eliza says to you that seem strange or make you frustrated with her.

Is Eliza helpful? Why or why not.

Is Eliza smart? Why or why not.

NOVA: THE ROBOT REVOLUTION?

NAME: ____________

Directions: As you watch the movie called "The ROBOT Revolution and the Future of the American Workplace" answer the following 12 questions. When the movie is over, answer the last two questions on the back of this sheet.

1. How is foreign productivity challenging American productivity?

2. In the early 1970s, how were computers used in business?

3. When the microprocessor was developed, how did computer power change industry? Give two examples from the movie.

4. Define ROBOT:

5. What are two benefits of using ROBOTS?

6. How are computers used at the Stock Exchange?

7. How are computers used at offices?

8. Define MAINFRAME COMPUTER:

9. What does CIM stand for and what does it mean?

10. What does CAD stand for and what does it mean?

11. Define EXPERT SYSTEM:

12. What are two drawbacks of using ROBOTS?

OVER

When the movie is over, answer these two questions:

13. Can a Robot think? Support your answer with atleast two reasons.

14. How is the future of manufacturing going to be changed by Robots and by computers in general?

THE COMPUTER MUSEUM
UNIT 4

Objective: Students get a hands-on experience of all the previous units.

Activity I: Get ready to go to the museum with an introduction to the museum exhibits and an explanation of how the museum is organized. Explain the Museusm's rules. Students get the permission letter to bring home. Discus the assignment they will do at the museum. Discus the fact that they will be writing a research paper that might develop out of a special interest they make at the museum. More details on that project are explained after the trip.

Materials:
1. The Computer Museum Exhibits handout
2. permission letter
3. Museum Assignment

Time: 1 class

Activity II: Go to the Museum

Materials:
1. museum trip schedule
2. extra Museum assignment sheets

Time: 1 day

Assignments:
1. return permission slip
2. completed Museum Assignment worksheet

Total time: 1 class and 1 day

The Computer Museum Exhibits

OVERVIEW

The Computer Museum traces the history of computers from the mid-1940's to the present and charts the development of computer technology from vacuum tubes to transistors to integrated circuits. You will see the remarkable changes in the size, price, speed, and capability of computers during their short 40 year history.

At the Museum, your group will be given a brief, guided tour of the historical exhibits. Then, you will be free to explore the remaining two galleries at your own pace. You will have the opportunity to use personal computers as well as state-of-the-art graphics equipment.

VACUUM TUBE ERA

Vacuum tubes were used in the earliest electronic computers to perform mathematical calculations. These tubes, the "brains" of the early computers, acted as switches that controlled the flow of information.

The Whirlwind was the first real-time, stored-program computer. Built at MIT during the 1940's, the Whirlwind cost $5 million and occupied an entire building. At the Computer Museum, a $2000 personal computer sits next to the Whirlwind and solves the same problems that the Whirlwind did on television in 1953.

The AN/FS Q-7, or SAGE system, was the largest computer ever built. It was used by the Air Force from 1958 to 1983 to monitor U.S. airspace for enemy aircraft. Each SAGE system was housed in a four-story building and cost $13 million. You will walk through the AN/FS Q-7 and explore the parts common to all computers: the arithmetic unit, the central processing unit, different types of memory, and input and output devices.

The Univac I was the first commercial computer. Among other things, it was used to predict the 1952 presidential election. CBS covered the event, which was the first time that many people had ever seen a computer.

TRANSISTOR ERA

Transistors perform the same function as vacuum tubes. They eventually replaced vacuum tubes because they were smaller, cheaper, and more reliable. Because of their smaller size and lower cost, many businesses bought "transistorized" computers during the 1960's.

The IBM 1401 is a typical business computer from the 1960's. It cost $150,000 and was housed in an office. Most companies had only one computer which was used by one person at a time.

Programmers rarely had direct access to the computer. They sat in separate offices and wrote their programs by hand. A card punch operator typed the program onto punch cards. These cards were then fed into the computer which ran the program.

The Univac I computer as it appears at the Computer Museum.

COMPUTER RESOURCES FOR SCHOOLS

NOTES FOR TEACHERS AND STUDENTS

A History of Electronic Computers

"To compute" is used to describe adding, subtracting, and other ways of dealing with numbers. In adding or subtracting you count, or compute to get an answer.

Tools for counting and calculating numbers, such as the abacus, the slide rule, or even multiplication tables, have existed for hundreds of years. Most of these instruments performed simple arithmetic and were operated manually, such as Pascal's adding machine (1640). Hollerith's tabulating machine for the 1890 census used punched cards to hold information about people -- demonstrating the improved the ability of machines to store information and add totals.

But why not create a machine that could manage numbers in all sorts of ways and solve any kind of problem? This idea was quite challenging for many scientists. However, it wasn't until the 1940s that they finally invented the machine we know today as the computer. It was a device that was complicated enough to perform logical operations automatically, that had a memory in which to store numbers (data) and programs, and that had a way of displaying an answer. The "stored program" or a machine with internal "memory" (storage) was an innovation that transformed calculators into genuine computers.

Illustrations by Stuart Goldenberg

The Whirlwind was one of the first computers with internal memory. In the late 1940s at the Massachusetts Institute of Technology (MIT), the Whirlwind project was funded by the U.S. Navy and developed as a flight simulator to train naval bomber crews. It took five years to design and build and cost $5,000,000. The Whirlwind occupied an entire building at MIT and was used from 1950-1959 for scientific and engineering purposes.

From the late 1940s to the early 1950s, computers were very large -- similar in size to the Whirlwind. The UNIVAC (Universal Automatic Computer), built in 1951, was one of the first commercial computers produced in the United States. All previous computers were developed by scholarly institutions and were very large and expensive. They also used a lot of energy (often enough electricity to light up a small city!).

Photograph © Lou Jones

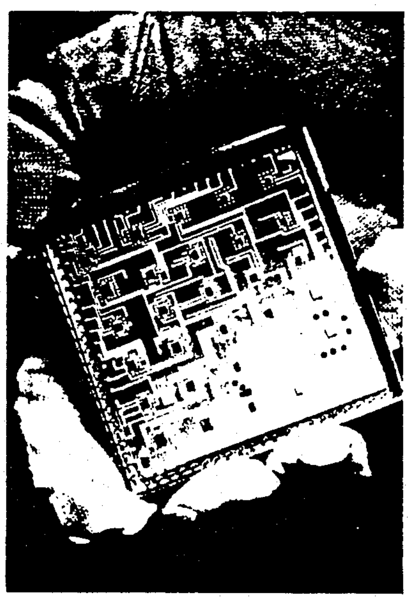
Glass vacuum tubes were used on the earliest electronic computers.

Size and cost were not the only problems with these *first generation* computers. They were built with thousands of glass vacuum tubes -- much like the light bulbs we use in our homes. Vacuum tubes allowed the machines to compute numbers quickly because, unlike earlier inventions, they were electronic. "Electrons" (particles of matter with an electric charge) moved around inside of the computer as information and were not slowed down by mechanical moving parts.

But vacuum tubes were not altogether reliable. In 1948, scientists at Bell Laboratories invented what would eventually become a substitute for the vacuum tube: the transistor. Like the vacuum tube, a transistor acted as an electronic conductor of information to calculate numbers.

Transistors used very little electricity, were small in size, and could be produced in large quantities at a low cost. They were much more reliable than the vacuum tubes.

This *second generation* of computers, built with transistors, was much less expensive than either the Whirlwind or UNIVAC. And they could be housed in a single room, rather than in an entire building. By the 1960s, transistors had replaced vacuum tubes in computers. Transistors also replaced vacuum tubes in other electronic appliances such as radios and televisions.



Photograph © Lou Jones

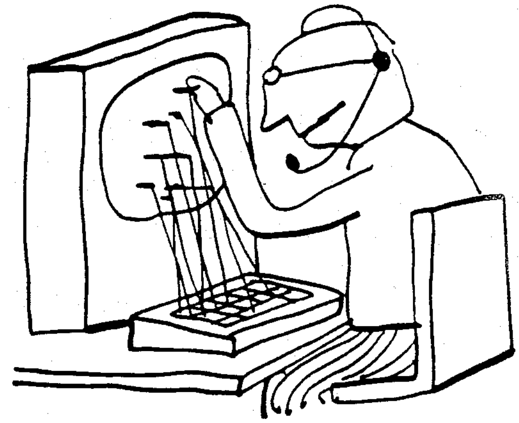
Small printed circuit board.

However, transistors weren't all there was to a computer. Every transistor had to be connected with wires to many other parts of the computer. The large number of wire connections meant that computers were still somewhat unreliable. They required frequent preventative maintenance just to ensure that all the connections were sound. And, although computers in the 1960s were much smaller than earlier machines, the size of the various parts kept computers from getting even smaller still.

In the 1960s, scientists learned how to put transistors and the other parts of a computer onto small, thin pieces of silicon. Silicon is a common organic substance that can be obtained from any rocky material. Each "miniaturized" part of the computer was linked on a slice of silicon, becoming an "integrated circuit." Scientists were

Microcomputer applications range from timing a microwave oven to controlling traffic lights to functioning as the central processing unit (CPU) in a home computer.

able to engrave all the parts of a computer onto a single "chip" of silicon. These new machines, built with silicon chips, represented the *third generation* of computers -- they were no longer the size of buildings or rooms, but instead were about as big as the refrigerator in your own home. The tiny silicon chips were able to do the same jobs as the fragile vacuum tubes or the individually-wired transistors in older computers.



By the 1970s, scientists had learned how to make the chips even smaller. They squeezed more and more circuits onto the surface area of the silicon chip -- creating what we know today as the "microprocessor."

The microprocessor made it possible to reduce the size and cost of computers even further. Today, these *fourth generation* computers are quite small, and yet they are able to do much more than the Whirlwind ever could in much less time! Microcomputer applications range from timing a microwave oven to controlling traffic lights to functioning as the central processing unit (CPU) in a home computer. Because of the significant decrease in price, computers now are used by a wide variety of people in many different ways.

7th Grade
Museum Permission Letter

April 4, 1988

Dear 7th Grade Parents,

On Thursday, April 14th, the 7th Grade will go on a field trip to the Computer Museum, Museum Wharf, Boston. We will be leaving Driscoll after first period, at 9am, and will be returning to the school by 2pm.

We will be exploring the past and the present of computer developments. We will be going on a planned tour, viewing two short films, and trying out the many hands-on microcomputer activities. This trip combines studies from the Computer and the Social Studies curricula. The students will be collecting information for an individualized Computer-Social Studies research project.

The cost of the trip is $3.00 per student to help to cover the cost of the bus ride and museum admission. All 7th graders are expected to go on this field trip and if the fee is a problem, let us know in the tear-off below. Please send in the tear-off with the fee by, Thursday, April 7th.

We will be going to the McDonalds or the Milk Bottle for lunch: however, students can still bring a bag lunch if that's what they prefer. On the day of the trip, students will only need money for their lunch ($3.00) and the Museum store if they want to make a pruchase.

If you have any questions about this field trip, do not hesitate to contact either of us at Driscoll.

Sincerely,

Ann Koufman, Computers
and
Michael Breshnahan, Social Studies

Parents:

Please fill out this tear-off and send it with $3.00 by Thursday, April 7th. Check here if the fee is a problem________.

(Student's name)________________________ has my permission to go on the Computer Museum field trip on April 14, 1988.

____
Parent's Signature

NAME:

COMPUTER MUSEUM ASSIGNMENT

DIRECTIONS: Make sure you have this worksheet with you when you are at the Museum.

There are 3 main exhibits at the Computer Museum. The exhibits are History of Computers, The computer and the Image, and Smart Machines. You will have the opportunity to see all the exhibits. **Answer all the following questions as you are at the Museum and complete this worksheet for homework. It is due on Friday, in Computer class.**

Be thinking about what you want to write your research paper on when you are in the exhibits. Possible topics are typed in all CAPS.

The History of Computers

Go on the guided tour of this exhibit. Possible research topics include: SAGE, BIOGRAPHY OF SEYMORE CLAY, WOMEN IN COMPUTING HISTORY.

There is no question to answer in this section, but if you are interested in doing your research paper on a topic in this exhibit, make sure you view the filmstrip on Computing History.

The computer and the Image

Examine how computers are used to create, enhance and transform visual images. For example you will see how computers aid in the design of an object like a sneaker or the creation of animation for a T.V. commercial. Play with as many activities as you have time for. The possible research topics in this exhibit include:

HISTORY OF PERSONAL COMPUTERS
ANIMATION
HOLOGRAMS
COMPUTER AIDED DESIGN
SIMULATIONS
DEVELOPMENT OF ARCADE GAMES

Choose any hands-on activity and play with it long enough for you to be able to learn what it is all about. Think about how it works and describe it in the space below.

(over)

Smart Machines

Meet as many of the "Smart Machines" as you have time for.

Choose one exhibit and use it as an example to argue about how a computer thinks. Write your argument in the space below.

What do you think the Smart Machines of the future will be like? Write or draw your vision in the space below.

Computer Museum Trip: Grade 7

Thursday, April 14, 1988

9am	bus leaves Driscoll
9:45am	arrive at Museum Everyone spits out their gum before getting off the bus!! In the Museum lobby we split up into two groups, with 2 teachers per group of 25 students.
10-10:30am	Guided tour for Group 1
10:10-10:40am	Guided tour for Group 2
10:30-11:15	Group 1 is in "Smart Machines"
10:40-11:15	Group 2 is in "The Computer and the Image"
11:15-noon	Groups switch locations Group 1 is in "The computer and the Image" Group 2 is in "Smart Machines"
12-1pm	Groups meet for lunch at McDonalds and the Milk Bottle. It is possible for some students to visit the Museum store, with a teacher.
1pm	bus leaves the Museum for Driscoll

THE COMPUTER RESEARCH PAPER
UNIT 5

OBJECTIVE: Each student researches, writes and word processes a specific computer topic of thier choice from a list of possibilities.

Activities: See schedule of essay dates.

Materials:
1. Computer Research Paper Topic list
2. library resources
3. Social Studies resource packets
4. Computer Time Life Book Series
5. student's data disks
6. Pin Point Spelling Checker

Total Time: about 3 weeks

SCHEDULE OF ESSAY DATES

Friday, April 15th:	Essay Topic should be chosen.
Thursday, April 28th:	Notes graded in Soc. Studies class.
Friday, April 29th:	First draft of essay written in Soc. Studies class.
Tuesday, May 3rd:	Word Process first draft of essay in Computer class.
Wednesday, May 4th:	First draft due in Soc. Studies.
Thursday, May 5th:	Work on papers in classes.
Friday, May 6th:	No Classes. Have fun!!!
Tuesday, May 10th:	Work on final revisions of essay in Computers.
Thursday, May 12th:	Papers due in Computer class.

Note: After School Computers on Tuesdays and Wednesdays from 2-3pm is a great time to come for extra help and extra computer time. Take advantage of it!!

Computer Research Paper Topics

Directions: Choose a topic for about a 2 page essay on computers. This is a joint project between Computers and Social Studies. You will research, take notes, and write in Social Studies classes and you will write, edit, and word process in Computer classes.

You will earn a letter grade for content and a check grade for word processing. Papers will be graded together by Ms. K. and Mr. B. and your grade will count for both Computers and Social Studies.

Section I of the list are topics that Mr. B. has readings on. Section II are topics that you found out about at the Computer Museum, and can read about in the Computer Time Life Book Series in the library. On the other side of this list are the due dates for the various parts of the project.

SECTION I

1. Computers of the Future
2. Computers and Health
3. Computers and the Home
4. Computers and Art
5. Computers and Business
6. Computers and Satellites
7. Computers and Manufacturing
8. Computers and the Handicapped
9. Computers and Crime
10. Computers and Sailing

SECTION II

12. SAGE
13. Biography of Seymore Clay
14. Women in Computing History
15. History of Personal Computers
16. Animation
17. Holograms
18. Computer Aided Design
19. Simulations
20. Development of Arcade Games
21. Robots
22. Topic of your choice, with approval from Ms. K.

Appenix I

The Computer Scrapbook:

1. Typical Chapters
2. First 2 Assignments

The Computer Scrapbook

Chapter 1: Computer Components
- Hardware
- CPU, Input, Output, Memory

Chapter 2: Kinds of Software

Chapter 3: The Computer as a Tool
- Word Processing

Chapter 4: Milestones in Computing History

Chapter 5: Important Names in Computing History
Women in Computing History

Chapter 6: Generations of Computers

Chapter 7: Artificial Intelligence

Chapter 8: Robots: Smart Machines?

Chapter 9: Computer Research Paper

Chapter 10: The Computer as a Tool
- Databases

Chapter 11: Computers and Ethics

SCRAPBOOK ASSIGNMENT #1 and #2

INTRODUCTION TO THE COMPUTER SCRAPBOOK

As a seventh grader you will make a computer scrapbook during the whole school year. It will be finished when you are finished with the seventh grade. This will be a book by you and for you. It will contain a wide varity of items, articles, and notes about computers in our everyday lives. It will be your own personal Computer Encyclopedia.

GRADING CRITERIA

Your Computer Scrapbook should be organized and neat. You will make it in a floppy, three-ringed binder. Pages should be hole-punched and put into the binder neatly. They should be numbered and in a logical order. Each page should have an explanation of what it is about.

Your scrapbook will be organized into chapters. Each chapter will involve several assignments. Each chapter should have a cover page that introduces its topic.

ASSIGNMENT #1 Due date: ____________________

Get yourself a floopy, 3 ringed-binder. Begin making your Scrapbook by making a cover page. This page should just say "Computer Scrapbook," who it is by, and what section you are in.

ASSIGNMENT #2 Due date: ____________________

Make a "Hardware Page". This page should have a picture of a computer with all its parts. Please include the CPU, the monitor, one or two disk drives, and a printer. If you want to, you could include a mouse, a modem, or any other peripherals. You can draw these pictures or cut them out of a magazine. Label each part. Title this page "Computer Hardware".

Appenix II

Computer History Tests:

1. Computer History
2. Computers in our Lives
   and in the Future

COMPUTER HISTORY TEST

NAME:____________________ DATE:____________________

PART 1

DIRECTIONS: Listed below are names of people who contributed to the development of computers. Match a name in column 1 with a description in column 2.

column 1	column 2
______1. Charles Babbage	a. Weaving loom inventor from France.
______2. Gottfried Leibniz	b. Author of Cobol
______3. John Napier	c. Developed the Arithmetic Machine in 1642
______4. Ada Lovelace	d. Invented the Tabulating Machine for the 1890 census
______5. Joseph Jacquard	e. Inventor of the first machine to +,-,x,/
______6. Howard Aiken	f. Developed the Mark I, the first digital computer
______7. Grace Murray Hopper	g. Father of modern computing
______8. Herman Hollerith	h. Developed rods to do multiplication
______9. Blaise Pascal	i. The first math device
______10. Abacus	j. First woman programmer

Part 2

Directions: Complete the following exercises.

1. Match the electrical device with the computer generation.

a.	integrated circuit	1.	first generation
b.	vacuum tube	2.	second generation
c.	integrated circuit chip	3.	third generation
d.	transistor	4.	fourth generation

2. As each generation of computers changed, computers became

   a. larger and more expensive

   b. smaller and less powerful

   c. smaller and less expensive

   d. larger and more powerful

3. What was the importance of integrated circuit chips?

4. What is a Nanosecond?

Part 3

Imagine that Ada Agusta Lovelace could come back in time and visit today with Grace Murray Hopper. Write a conversation or dialogue between these two important women in computing history. Have them discus such things as how computers are being used, advances in programming, what women are doing in computers now, what it is/was like to be an influential women in a male-dominated field of work, and any other ideas you think these two women might discus.

TEST 2   COMPUTERS IN OUR LIVES AND IN THE FUTURE

NAME: ____________

DATE: ____________

Part **1**: Choose the best answer for each.

1. Writing and devising a letter to your pen pal can be done with

   a. a word processing program.
   b. a data-base management program.
   c. an electronic spreadsheet.

2. Which job would not be suitable for a computer in a department store?

   a. Calculate a customer's bill.
   b. Process paychecks.
   c. Handle customers' complaints.

3. If your computerized bill has an error, it was probably

   a. a mistake made by a computer.
   b. a mistake made by a person.
   c. a poor electrical connection.

4. A person who writes computer programmers is a

   a. data entry person.
   b. computer operator.
   c. programmer.

5. A person who services and repairs computers is a

   a. sales representative.
   b. computer technician.
   c. software librarian.

Part 2: Answer the following questions in complete sentences.

1. Describe 2 ways in which computers are used in hospitals.

2. What is a "universal product code"? Tell what is so good about it; say what could be a problem with it..

3. Describe 3 ways in which computers are used in schools. Give <u>examples</u> of how they are used in your school.

4. What is a Robot? What can they do to help us?

Part 3

Computers in the Future

Pretend that it is the year 2018; that is thirty years from now. Write a paragrah that tells how computers might affect your life. Use your imagination!! What might your home be like because of computers? How might your job be affected because of computers? Say how computers might affect how you spend your free time?

Appenix III

Social Studies Objectives for Computer Revolution curriculum

Social Studies: Computer Applications

Computers **effect** our lives in many ways. In what **areas** and how do they **change** life? In Social Studies classes, students study this outline in great detail.

The following is a list of **areas** where computers have made a big change in the way people work and live:

Sports	Business	Space
Medicine	Banking	The Handicapped
Agriculture	The Office	Music
Government	Communications	Art
Military	Factories	Crime
Education	Architecture	Writing
Entertainment	Transportation	Sales
The Home	Clothing	

Each of the following categories of **changes** are ways in which computers have changed our lives in all of the above areas:

1. Specialization changes: new jobs that are created by computers.

2. Skill Learning changes: ways people learn because of computers.

3. Living Pattern Changes: ways in which people get food, clothing, shelter, transportation, health care, safety, and entertainment because of computers.

4. Community and Family Ties changes: ways in which computers effect human groupings and peoples' feelings towards their neighbors and family.

5. International Ties Growth changes: how computers bring people of different countries closer together.

Appenix IV

Appleworks files on the

Teacher's Computer History Disk

Teacher's History Disk
CATALOG

The following is a catalog of the the AppleWorks files on the Teacher's History Disk. The names of the files should be clear enougr to match with the materials in the curriculum packet.

Main Menu

Other Activities

List All Files

Disk volume /HISTORY has 82K available

Name	Type of file	Size	Date	Time
AI	Word Processor	1K	6/16/86	
Careers WkSh	Word Processor	2K	6/16/86	
Comp.Everywhere	Word Processor	2K	6/16/86	
Computer Applic	Word Processor	2K	6/16/86	
CrossWord WkSh	Word Processor	1K	6/16/86	
Early Developme	Word Processor	2K	6/16/86	
Eliza WkSh	Word Processor	1K	6/16/86	
Essay.dates	Word Processor	2K	6/16/86	
Important Names	Word Processor	5K	6/16/86	
Intro to SBook	Word Processor	3K	6/16/86	
Life List	Word Processor	1K	6/16/86	
ModernComputers	Word Processor	1K	6/16/86	
Museum Assignme	Word Processor	3K	6/16/86	
Museum Permissi	Word Processor	3K	6/16/86	
Museum Schedule	Word Processor	2K	6/16/86	
NOVA	Word Processor	2K	6/16/86	
Pebbles to Gear	Word Processor	2K	6/16/86	
Research Topics	Word Processor	2K	6/16/86	
Test 1.1	Word Processor	2K	6/16/86	
Test 1.2	Word Processor	2K	6/16/86	
Test 1.3	Word Processor	1K	6/16/86	
Test 2.1	Word Processor	2K	6/16/86	
Test 2.2	Word Processor	1K	6/16/86	
Test 2.3	Word Processor	1K	6/16/86	
TimeLiner	Word Processor	2K	6/16/86	

down arrows to move through list 1141K Avai

MINUTES

Meeting of the Historical Exhibits Advisory Committee
March 16, 1989

In attendance: Charles Bachman, Gwen Bell, I. Bernard Cohen, Gardner Hendrie, Chris Morgan, Jane Manzelli, Adeline Naiman, Oliver Strimpel, Greg Welch

Discussion:

The committee examined the list of 12 proposed milestones and arrived at a revised list of 9. During the discussion, members of the committee outlined various themes of importance to the history of computing that the exhibit should treat.

The following are the milestones that the committee proposed be included in the exhibit:

1 — **Computing prior to the computer (1930s).** An office from the 1930s illustrating the use of electromechanical calculators and punched card processors. The vignette might center around the Social Security system.

2 — **The stored program (late '40s).** A display centered about the EDSAC that characterizes the early computer projects and explains the importance of the stored program concept.

3 — **The industry emerges (early '50s).** The UNIVAC-1 will serve as the centerpiece to a display of the early commercially-available computers. To what problems were the early "mass-produced" computers applied?

4 — **High-level programming languages (late '50s).** The emergence of FORTRAN and COBOL will illustrate the drive to establish simpler and standard means of expressing instructions for computers.

5 — **Large-scale Business Applications (mid '60s).** Large batch processing operations, the emergence of large computer and storage systems, communication between computers, and databases will be themes revolving around a display of a System/360 in an insurance or banking environment.

6 — **Real-time computing (early '70s).** The advent of minicomputers facilitated the expansion of timesharing, distributed processing and process control. The vignette might focus on a PDP-8 in an industrial control application or an academic environment.

7 — **Personal Computing (early '80s).** With the microchip, computers could be dedicated to the use of an individual.

8 — **Super computing (early '80s).** A display focussed on the Cray-1 will portray the impact computers have had on scientific research. A graphic simulation of an experiment performed by computer would illustrate this trend.

9 — **The Ubiquitous Computer (mid '80s).** Microprocessors have extended the trend of process control begun by the minicomputer to almost every electronic device, from microwaves and toasters, to spacecraft and automobiles.

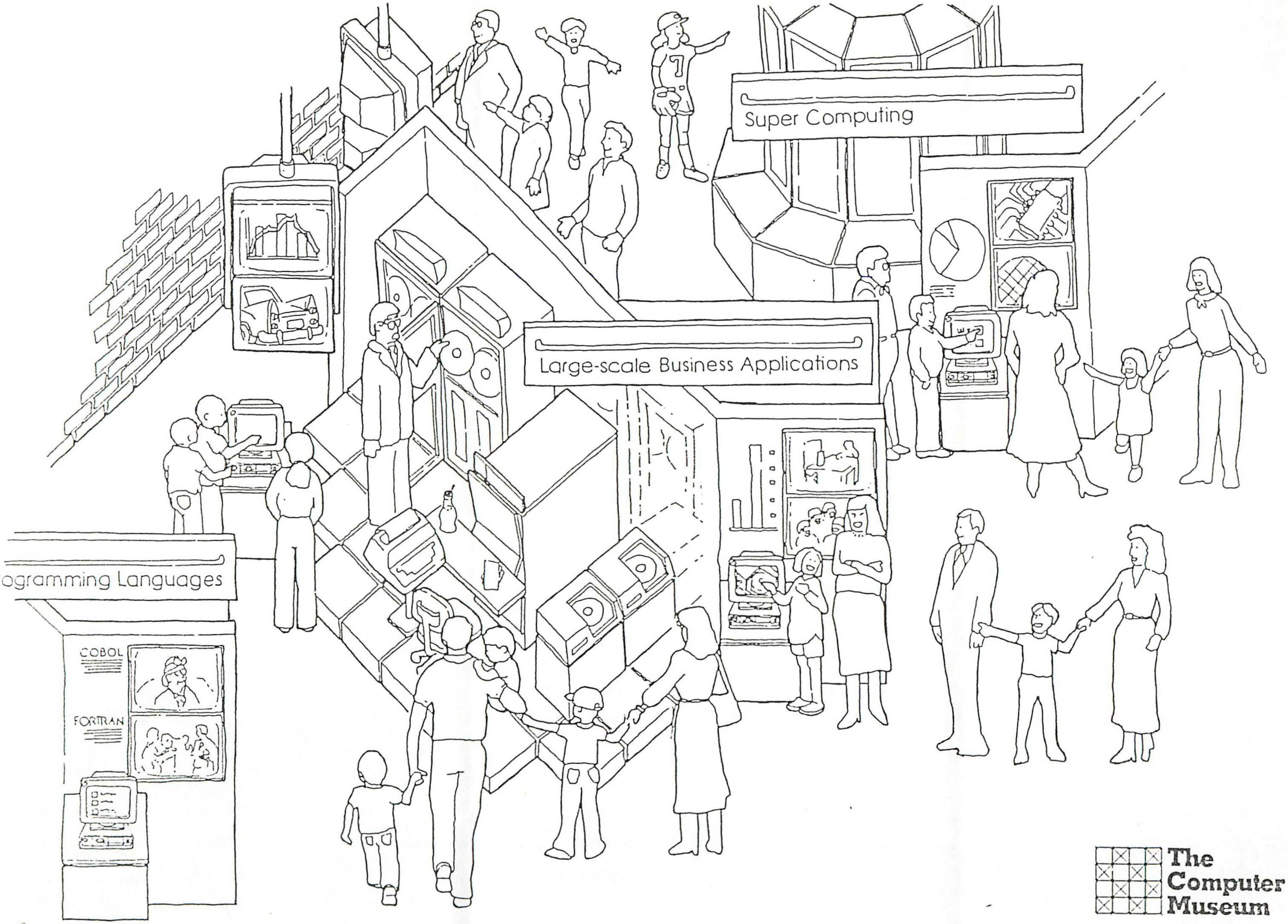
The natural chronology of the milestones suggested a physical layout of the exhibit that would take visitors through a reasonably well-defined path that would branch in three directions as it approached the present. The committee deemed that the exhibit should not attempt to look into the future, even thought that might be an important mission of the Museum.

Oliver and Gwen introduced a scheme of five themes that should flow throughout the exhibit. These threads would illustrate the hardware, the software, the use, social impact, and "personality" of the various milestones/eras. These themes met with general enthusiasm from the committee. Discussion then expanded this list to a series of trends that might play roles of varying importance in different vignettes. These are the themes the committee felt must be kept in mind:

- Hardware — basic processor and primary memory technology
- Mass storage technology
- Communication and networking
- Time-sharing
- Educational Environments
- Size/Power/Cost of computers
- Personnel requirements for computer centers
- Time required to perform certain jobs
- Availability and accessibility of computers
- Personalities
- "Persona" of era
- Input and Output technologies
- Social impact

Bernard Cohen made the point that, from the perspective of a historian, the development of computers is not *evolutionary*, but rather constitutes a *revolution*. In response, Oliver proposed calling the exhibit *Milestones of a Revolution: [some subtitle to be determined]*. All felt this to be a most appropriate title.

The Computer Museum



Super Computing
Large-scale Business Applications
ogramming Languages
COBOL
FORTRAN
The Computer Museum

Milestone Themes Worksheet

	Computing Before Computers	The Stored Program	The Industry Emerges	Programming Languages	Large-scale Business Applications
Hardware	X	X	X		X
Software		X		X	X
Need	X	X		X	
Use	X	X	X	X	X
Tech. Impact		X		X	
Soc. Impact	X		X		X
Personality		X			
Communication					X
Mass Storage					X
Time-sharing					
Education					
Size/Power/$	X	X	X		X
Personnel	X		X		X
Time for job	X	X	X	X	X
Availability			X	X	X
People		X			
Char. of Era	X	X			X
Input/Output	X				X
Visitor's Questions					

Milestone Themes Worksheet

	Real-time Computing	Personal Computing	Supercomputing	The Ubiquitous Computer
Hardware	X	X	X	X
Software		X		
Need				
Use	X	X	X	X
Tech. Impact	X		X	X
Soc. Impact		X		X
Personality		X	X	
Communication	X	X		
Mass Storage			X	
Time-sharing	X			
Education	X	X		
Size/Power/$	X	X	X	X
Personnel				
Time for job			X	X
Availability	X	X	X	X
People			X	
Char. of Era	X	X		
Input/Output	X	X		
Visitor's Questions				

PROJECT SUMMARY

As computers change our world, people feel a need to know how this vital technology evolved. It is to meet this demand that The Computer Museum is developing the exhibit, *Milestones of a Revolution: Computing from the 1930s to Today.*

The Computer Museum is in a unique position to create a definitive and innovative exhibit on the history of computing. Not only does it possess the world's most complete collection of computer artifacts, but it has extensive experience in the dynamic use of computers in interactive exhibits. The exhibit will draw on both.

The effective presentation of such a complex topic as history to a diverse audience demands the most creative use of computers and hypermedia techniques. Through an Apple Macintosh-implemented *Interactive History Navigator,* visitors to the Museum will experience history as never before. This special software environment will enable visitors to explore the past through flexible access to a rich database of photos, video, participatory presentations, and historical information. So empowering will the *Interactive History Navigator* be that, short of a literal return in time, or months of research, no other experience could bring the past alive so meaningfully to a broad audience.

To implement this system, The Computer Museum requests the "Explorations" program of Apple Computer, Inc. to provide 22 Apple Macintosh computer systems. Other vendors are being asked for donations of the additional equipment necessary for the project. To create the content of the exhibit, the Museum will draw on its own archives and collections.

The exhibit will open in the fall of 1990 and will require support of $770,000 in cash and $356,000 worth of donated services and equipment. A significant portion has already been raised. The Museum will develop the exhibit and software using in-house resources and will provide for the maintenance and support of the exhibit once it is in operation.

The
Computer
Museum

300 Congress Street
Boston, MA 02210
(617) 426-2800

May 5, 1989

Gardner Hendrie
Sigma Partners
P.O. Box 1158
Northboro, MA 01532

Dear Gardner,

As you may recall, at the last meeting of the Advisory Committee, we defined the nine vignettes that will form the backbone of *Milestones of a Revolution*. (For your reference, I have enclosed the minutes of the last meeting and renderings of how the exhibit might appear.) Toward the end of the meeting, we discussed a series of themes of varying importance that might run throughout the exhibit, some treated at nearly every milestone, others only at a few points in the exhibit. What we would like to do at the up-coming meeting (Monday, May 15, at 9:00 am) is run through the list of milestones, discussing which themes should be treated where. I have enclosed a worksheet that reflects my ideas along these lines and to help you focus your thinking.

After that, we think it would be a good idea to focus our attention on one particular milestone, "Large-scale Business Applications," and discuss exactly how we will convey the themes we think ought to be presented at this point in the exhibit. I think we should pay particular attention to the techniques we will use to reach our less sophisticated visitors.

Last week, I submitted a proposal to Apple Computer, Inc. to provide equipment for the creation of an interactive video/database system for *Milestones*. We are calling this element of the exhibit the *Interactive History Navigator*. I have enclosed a copy of the project summary from the proposal sent to Apple. Other fund-raising continues apace.

See you on the 15th. Parking will be arranged as usual. If you have any questions, please call me.

Regards,

Greg

Gregory W. Welch
Exhibit Developer

cc: Oliver Strimpel
Adeline Naiman
Gwen Bell

enclosures

The
Computer
Museum

300 Congress Street
Boston, MA 02210
(617) 426-2800

February 5, 1990

Gardner Hendrie
Sigma Partners
P.O. Box 1158
Northboro, MA 01532

Dear Gardner,

As you know, the *Milestones of a Revolution* exhibit will chronicle the evolution of computing technology and techniques and the impact they have had upon the way we live, work, and think. It must be a definitive display, accessible and provocative to all museum visitors, from the least sophisticated to the best informed.

To provide you with some context for our discussion on February 15, I have enclosed materials that describe the general content of the exhibit and the course of the project's development. (You may have seen some or all of it before.)

We are confident that the milestones structure establishes a solid foundation upon which to erect our presentation. Through nine distinct vignettes, it lays down the most important changes in technology and computing techniques that have occurred over the past fifty years. Our challenge is now to build upon this base an interpretation that will help visitors understand the social context and implications of computer technology.

To serve as a departure point for discussion, I am asking each consultant to reflect upon what one or two points, *from his or her perspective*, would be essential to an understanding of how the evolution of computing has effected our culture, economy, way of thinking, etc., and, in turn, has been directed by the values and institutions of society. In considering these themes, please weigh how they could be illustrated in an exhibit. Can they be associated with specific objects, events, or statistics?

I look forward to seeing you at 2:30 on the 15th and expect that we will have a fruitful and enjoyable meeting. If you have any questions, please do not hesitate to call me at 617/426-2800 x337.

Sincerely,

Greg

Gregory W. Welch

MINUTES

Meeting of the Historical Exhibits Advisory Committee
January 26, 1989

In attendance: Gwen Bell, I. Bernard. Cohen, Gardner Hendrie,Jane Manzelli, Christopher Morgan, Adeline Naiman, Merritt Roe Smith, Oliver Strimpel, Gregory Welch.

Purpose:

The purpose of the meeting was to discuss the goals and broad approach of the Museum's historical exhibit, *Milestones of Computing*.

Introduction

Dr. Strimpel opened the meeting with a brief introduction to the Museum, the historical exhibits, and the process of exhibition creation. He stressed the Museum's mission to educate and inspire the public about the world of computers. While historical components will be incorporated into all the Museum's exhibitions, the Milestones and SAGE exhibits will be the only permanent exhibits dedicated to treating the history of computing.

Discussion

Interests of High School Students
Ms. Manzelli launched the committee's discussion by defining aspects of the history of computing that a high school student would wish to learn.

1) Why were computers invented, what problems did they solve?
2) Who were the people involved? The "intrigue" factor.
3) Economics: why are computers a technology that gets cheaper over time?
4) The size story.
5) History for glimpse of future.
6) Computers and responsibility.

Historical Perspective
Dr. Smith then elaborated on how the exhibit should treat history. The exhibit should seek to enhance "public understanding" of computer technology and science and their implications. This could be accomplished, in part, by a display that "mapped" the evolution of computers and helped visitors to situate themselves in this process. The exhibit should seek to illuminate how and why computers were developed and treat the broader implications of this process. However, rather than presenting the development of computers as an "onward march of progress," the exhibit should seek to explicate history as the "frayed web" of connections that it is.

Personal Context
Professor Cohen agreed with Dr. Smith that the state of the market and the social and technological problems that constituted the circumstances in which computers evolved must form an essential element of the exhibit. Space limitations, he felt, however, would preclude a thorough investigation of the implications of computer technology's potential. Nonetheless, this theme might be developed by illustrating the impact of computers over time on one character, an auto mechanical for example. The "hidden computer," the microprocessor, should also be featured in the exhibit.

Dr. Smith added that Video-taped interviews could present not only the "heroes" but also the "foot soldiers" of computer history.

Chris Morgan suggested a component of the exhibit called "How they did it" that would show the operation of computers over time.

Target Age
Professor Smith introduced the issue of what ages the exhibit should target, as he felt that younger children might not be a realistic audience. Dr. Bell clarified the issue by pointing out that the focus of the exhibit was history, and that young children, even though adept at using computers, may be too young to understand or appreciate concepts related to a historical perspective. Ms. Manzelli agreed.

Technological Story
Mr. Hendrie felt that the exhibit must tell the story of the change in computing technology which is"the incredible growth in the power, ease of use, and cheapness of computing" that has occurred in such a compressed span of time. This dramatic quantitative change has affected a qualitative change as well.

Mr. Morgan commented upon how little is generally know about the history of computing, even among the technical community, and that the exhibit should dispel the many myths that still prevail. To do so the exhibit would have to illustrate the multiple, interlocking, complex forces that came into play in the evolution of computing. Developments in a multitude of fields, ranging from economics, to education, from physics, to animation have all affected the direction and character of computing.

Time Period
Dr. Bell introduced the two issues of at what point in time should the exhibit begin, and how international in scope it should be.

All agreed that the exhibit should present a select number of "milestones" of seminal importance, even if such events fell within the same epoch. Professor Cohen argued that the exhibit ought to begin in the late 1930s and not focus on either Charles Babbage or Herman Hollerith. There was some disagreement over the issue of whether Hollerith deserved to be addressed. Cohen contended that Hollerith's invention, just as Babbage's, did not lead directly to the computer; he felt that a more general treatment of pre-computer calculating, including slide rules, tables, adding machines, and card-processing machines, was more appropriate. Dr. Strimpel argued that, nonetheless, Babbage represents an interesting "blind alley" in the historical development of the computer.

Mr. Hendrie asked whether the "milestones" should focus on the seminal inventor/invention, or the wide-spread use of the the innovation. Dr. Smith answered that while the "great inventor" deserves attention, such treatment should be within the context of the overall historical process.

International Coverage
All agreed that the exhibit should be as international as appropriate. The scarcity of foreign artifacts in the Museum's collection was touched upon. Dr. Bell, drawing on Dr. Smith's proposal of a map, suggested the use of a globe that would illustrate the expansion of computer installations and a counter indicating the "population" of computers.

Software
Dr. Strimpel wondered how the exhibit would treat software. Mr. Morgan contended that its was essential that the exhibit cover the introduction of the stored program. Mr. Hendrie felt that visitors would immediately recognize the advantages to expressing a problem in an algorithmic language over binary code. Professor Cohen commented upon the economic shift toward the importance of software with the advent of mass-produced systems. He also stressed the questions: Why is software so expensive? And, why are machines introduced without software? Mr. Welch introduced the idea of examining software through the people who produce it, and how they differ from the producers of hardware. In response to Dr. Strimpel's question as to what level or language the exhibit should use to contact high school students, Ms. Manzelli answered that while some advanced students are familiar with programming languages, the vast majority are unaware of software beyond the application level. The issue was raised as to whether the intention of the exhibit should be to "explain" software, or indeed explain computers at all. It was felt that the visitor should arrive at some general notion as to the distinction between hardware and software.

At this point, several members of the committee had to leave, and discussion turned to administrative issues. It was agreed that minutes should be compiled of the meeting and circulated. It was also suggested that the committee ought to meet at least twice more before June 1.

Presentation Considerations
The remaining members of the committee touched upon two points crucial to the exhibit: that it be streamline, and that it be stimulating and entertaining. After several comments on how the physical composition of the exhibit might reflect non-linear views of the history, and that the idea of displaying a milestone in an exciting manner would somewhat dictate the selection of vignettes, it was agreed that too complex and unstructured an approach might confuse visitors. For that reason it was concluded that a limited number of milestones balanced by more detailed tangential displays was the best approach to take.

MINUTES

Meeting on *Milestones of Computing*
February 14, 1989

Attending:

Greg Welch, Oliver Strimpel, Gwen Bell

Discussion:

Discussion focussed upon the selection of a set of milestones to propose for the exhibit. The following 12 twelve were agreed upon:

- Calculating and data processing before the computer. (1930s).
- An early British machine (EDSAC or Manchester Mark I) with the first 15 pioneers. (Atanasoff to Forrester) (c. 1937-1950)
- Early commercialization: UNIVAC -1. (c. 1955)
- FORTRAN and COBOL: standard higher-level languages. (c. 1955-1962)
- SABRE and the IBM 360: Large-scale business applications. (c. 1967)
- The Microprocessor: the ubiquitous computer (1972-1978)
- Personal Computing: spreadsheet, wordprocessing, hacking (1978-1988)
- Supercomputing: Cray-1: scientific computing (1985)
- Standard operating systems: MS-DOS, UNIX (1985--)
- Database: privacy, security. (1988 --)
- Computers as International Commodities: , international aptitudes (1988 --)
- The future: technologies and applications likely to emerge

Further discussion concluded that a minimum of eight milestones would be required to do justice to the period we propose to cover. However, all felt that the space dedicated to the exhibit was insufficient for even eight vignettes. Therefore, it was decided to wall off one third of Bay 4, Floor 6 and dedicate this and all of Bay 3, Floor 6 to the exhibit. The remaining two-thirds of Bay 3 would then form the internal lobby area of the Museum. It was estimated that constructing such an expanded version of the exhibit would add $200,000 to the overall cost of the exhibition, for a total of $700,000.

MINUTES

Meeting of the Collections Committee and others
February 16, 1989
to discuss *Milestones of Computing*

Attending:

Oliver Strimpel, Tom Restivo, Allison Stelling, Greg Welch, Ted Johnson, Gwen and Gordon Bell, Jean Sammet, Jon Eklund, Dave Chapman, Anne Russell.

Discussion:

Oliver introduced the exhibit *Milestones of Computing*. It will be The Computer Museum's permanent exhibition dedicated to presenting the history of computing, thereby, fulfilling a fundamental mission of the Museum. To give those attending some perspective on exhibit design considerations, Oliver touched upon how the distractions and diversity of the audience in an exhibit demand an entirely different approach to education than in more traditional educational media. He then continued to explain how, in light of these considerations, the Museum had decided to take the approach of presenting "milestones" in the evolution of computing, rather than say a continuous timeline. Each milestone will be a period vignette off which additional interactive stations or more detailed explanations might be "hung."

A list of the proposed milestones was then circulated to be ranked according to importance and for comments from those attending. Heated discussion ensued as to whether the milestone concept was a valid approach to presenting history. Finally, however, each individual ranked the proposed milestones. At which point, the meeting adjourned for dinner.

After dinner, the proposed milestones were listed according to their ranking, and discussion continued. Finally, after much heated debate an independent list of ten crucial developments in the evolution of computing was drawn up that mirrored the original list with only the addition of the minicomputer and early networks such as the ARPANET. The meeting adjourned.

MINUTES

Meeting of Members of the Board of Directors
to discuss *Milestones of Computing*
February 17, 1989

Attending:

Greg Welch, Jean Sammet, Oliver Strimpel, Robert Lucky, Jonathan Rotenberg, Gardner Hendrie

Discussion:

Discussion focussed upon the proposal for *Milestones of Computing.* While the general approach of structuring the exhibit around milestone vignettes was agreed with, Jonathan, in particular, emphasized the need to establish a central unifying thread to the exhibit. All agreed.

One approach that was considered to create such a "path" was to select a character into whose shoes the visitor could step throughout the exhibit. Who this character might be was the cause of some discussion. Jonathan advocated the case for placing the visitor in the shoes of the innovator, confronting the visitor with the problem or need that led to a particular development. Aside from the technical subtleties involved in many of the innovations that would make them hard to convey to the average visitor, Robert Lucky also expressed concern that such an approach would present a distorted view of the process of innovation. Another proposal was to place the visitor in the shoes of the computer user through time. Some thought this would not be dramatic enough to engage visitors' imaginations. Another perspective considered was that of the general public in different eras.

Other themes discussed during the meeting included: the difficulties of presenting software, the often conflicting drives to innovate and standardize, and the importance of incorporating a dramatic personal touch in the exhibit. One suggestion of a means of conveying the concept of different levels of languages was to invite the visitor to spell their name in bits.

MINUTES

Meeting of the Historical Exhibits Advisory Committee
March 16, 1989

In attendance: Charles Bachman, Gwen Bell, I. Bernard Cohen, Gardner Hendrie, Chris Morgan, Jane Manzelli, Adeline Naiman, Oliver Strimpel, Greg Welch

Discussion:

The committee examined the list of 12 proposed milestones and arrived at a revised list of 9. During the discussion, members of the committee outlined various themes of importance to the history of computing that the exhibit should treat.

The following are the milestones that the committee proposed be included in the exhibit:

1 — **Computing prior to the computer (1930s).** An office from the 1930s illustrating the use of electromechanical calculators and punched card processors. The vignette might center around the Social Security system.

2 — **The stored program (late '40s).** A display centered about the EDSAC that characterizes the early computer projects and explains the importance of the stored program concept.

3 — **The industry emerges (early '50s).** The UNIVAC-1 will serve as the centerpiece to a display of the early commercially-available computers. To what problems were the early "mass-produced" computers applied?

4 — **High-level programming languages (late '50s).** The emergence of FORTRAN and COBOL will illustrate the drive to establish simpler and standard means of expressing instructions for computers.

5 — **Large-scale Business Applications (mid '60s).** Large batch processing operations, the emergence of large computer and storage systems, communication between computers, and databases will be themes revolving around a display of a System/360 in an insurance or banking environment.

6 — **Real-time computing (early '70s).** The advent of minicomputers facilitated the expansion of timesharing, distributed processing and process control. The vignette might focus on a PDP-8 in an industrial control application or an academic environment.

7 — **Personal Computing (early '80s).** With the microchip, computers could be dedicated to the use of an individual.

8 — **Super computing (early '80s).** A display focussed on the Cray-1 will portray the impact computers have had on scientific research. A graphic simulation of an experiment performed by computer would illustrate this trend.

9 — **The Ubiquitous Computer (mid '80s).** Microprocessors have extended the trend of process control begun by the minicomputer to almost every electronic device, from microwaves and toasters, to spacecraft and automobiles.

The natural chronology of the milestones suggested a physical layout of the exhibit that would take visitors through a reasonably well-defined path that would branch in three directions as it approached the present. The committee deemed that the exhibit should not attempt to look into the future, even thought that might be an important mission of the Museum.

Oliver and Gwen introduced a scheme of five themes that should flow throughout the exhibit. These threads would illustrate the hardware, the software, the use, social impact, and "personality" of the various milestones/eras. These themes met with general enthusiasm from the committee. Discussion then expanded this list to a series of trends that might play roles of varying importance in different vignettes. These are the themes the committee felt *must be* kept in mind:

- Hardware — basic processor and primary memory technology
- Mass storage technology
- Communication and networking
- Time-sharing
- Educational Environments
- Size/Power/Cost of computers
- Personnel requirements for computer centers
- Time required to perform certain jobs
- Availability and accessibility of computers
- Personalities
- "Persona" of era
- Input and Output technologies
- Social impact

Bernard Cohen made the point that, from the perspective of a historian, the development of computers is not *evolutionary,* but rather constitutes a *revolution.* In response, Oliver proposed calling the exhibit *Milestones of a Revolution: [some subtitle to be determined].* All felt this to be a most appropriate title.

MILESTONES OF A REVOLUTION: PEOPLE AND COMPUTERS

A Proposal for a New Exhibit at

The Computer Museum
300 Congress Street
Boston, MA 02210

January 11, 1990

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SUMMARY

The Computer Museum seeks sponsors for a unique and innovative exhibit on the historical impact of computers. The multi-media exhibit, *Milestones of a Revolution: People and Computers*, will help the general public better understand the changes wrought by the use of computers over the past fifty years. The Museum will open this 5,000-square-foot exhibit in the Spring of 1991. The project will cost $782,000 (of which $410,000 has already been committed). These funds will pay for the exhibit's development, design, fabrication, educational materials and promotion. In-kind donations of equipment and services valued at $235,000 will also be required.

Sponsors of the project currently include:

$100,000 or more:	Digital Equipment Corporation
	International Business Machines Corporation
$25,000-$74,999	The National Endowment for the Humanities
	The Travelers Companies
under $25,000	The MITRE Corporation
	Unisys Corporation

(A list of the individual contributors is available upon request.)

In only a few decades, the computer has assumed a central role in human society and changed the way we live, work, and think. *Milestones of a Revolution* will present the seminal developments and broad trends in computing through a series of realistic vignettes that illustrate how computers have been used over the years. These vivid displays will be enhanced by audio effects, films, videotapes, and interactive computer stations that add deeper layers of interpretation to the exhibit. The singular resources and experience of The Computer Museum allow it to blend historic artifacts with state-of-the-art interactive displays to create exciting and educational exhibits. Visitors of all ages and backgrounds will be able to explore and to appreciate this rich, multi-media presentation chronicling the revolutionary impact of the computer. To envision where this revolution may lead, it is valuable for the public to be familiar with its past.

Sponsors of this exhibit will receive widespread recognition. They will be acknowledged on prominent signage in the exhibit itself and in all printed and promotional materials pertaining to the exhibit, including publications such as catalogs and educational materials. An estimated 250,000 people will visit the exhibit each year. The sponsors, thus, will be identified as a supporter of a unique program to heighten the public's understanding of a technology that has had a profound effect upon our society and that will play an even larger role in shaping our future.

FILLING A NEED

In only a few decades, computers have assumed a pivotal role in human society, and the public has begun to recognize them as indispensable tools upon which the maintenance and growth of modern civilization depend. Just as the steam engine powered the Industrial Revolution, the computer is the engine of a new movement transforming our world: the Information Revolution.

To understand the present and prepare for the future, people often look to the past. Thus, along with the growing acceptance of and reliance on computers, comes an increasing demand to understand their history. Schools already teach computing, and to provide their students with a perspective on the transformation in which they are taking part, many instructors include computer history in their curricula. In a similar vein, the daily-increasing numbers of people employed in computer-related occupations seek insights into the broader context of their work. As the Information Revolution continues to unfold, the demand to understand its past continues to increase.

Milestones of a Revolution will meet this need. It will contribute to the increased public awareness of the social needs that contributed to the development of computers, the evolution of the technology (hardware, software, *and* applications), and how its use has affected the way we live, work, and think. By integrating artifacts, working computers, and video displays, the exhibit will accomplish these goals in an exciting and rich interactive environment accessible to all. *Milestones of a Revolution* will present the elementary knowledge that every educated member of modern society should have about the history of computer technology.

THE EXHIBIT

Milestones of a Revolution will present important events in the evolution of computing within the context of society's ever-increasing need to store, manipulate, and retrieve information. It will portray computers as tools that allow people to solve both old and radically new information-handling problems. It will not ignore, however, that the use of computers has also posed new dilemmas for society. The exhibit's historical perspective will cast light on how this technology has affected the world around us.

Milestones of a Revolution will consist of a series of displays, each representing a particular period, event, or theme fundamental to computer history. The centerpiece of each display will be an authentic, environmental re-creation using period artifacts and ephemera. These vignettes will be enhanced and linked by supporting videos and interactive stations. Though valuable artifacts will be protected, visitors will be encouraged to touch and explore, to give free reign to their curiosity. Phones may have recorded conversations on which visitors can eavesdrop and panels may reveal hidden viewing points or artifacts. Stylistic and design elements will reinforce the vintage appearance of each vignette, while uniting the whole exhibit.

A Brief Description

When visitors enter the Museum, they will be immediately drawn to the *Milestones of a Revolution* by a large bank of videc screens arrayed as a gateway to the exhibit.

Across the screens in small letters stream a myriad questions: "$1,000 at 15% compounded daily for 5 years, what'll I have?" "A load of 30 tons across a 40-foot beam. Is it strong enough?" "At 300,000 mph, how long to Jupiter?" "How much is 47 lbs. at $1.75 each?" Over these pass in large letters: "How many?" "How much?" "How often?" "How big?" The narrator's voice explains how people have always needed answers to such questions, and have always built tools to aid the human mind in arriving at answers.

The screens display a giant image of an abacus. Against this background, individual screens flash pictures of ancient calculating devices, Napier's Bones, astrolabes, and early slide rules. "As our questions became more complex, so did our tools," continues the narrator. Ornate and intricate mechanical calculators begin to appear on individual screens, the Pascaline, the Sheutz Difference Engine, and the Bush Differential Analyzer.

"The computer, the modern decedent of all these tools, emerged during the 1940s." The background cuts to a stylized map of the world; a clock counting the years appears in the center. The clock reads 1937. Lights begin to glow in Boston, Iowa, New York, and Germany. Pictures of Aiken, Atanasoff, Stibitz, and Zuse appear, then their machines. The clock speeds up. As the years tick by ever faster, flashes of light on the map indicate were computers are coming into use. Lights come on in England, Philadelphia, Minneapolis, and California. Pictures of engineers, inventors, and programmers accompany the new lights. The years pass ever faster. Lights begin to spread throughout the U.S. and Europe and to appear in Japan.

"In the past decades, computers have become smaller, more powerful, less expensive, and used by ever more people." Now computers and people flash all over the globe with ever greater rapidity, computers in banks, in schools, in space, in clock radios. As the clock reaches the 1990s, the images freeze, and across the monitors stream questions in small text: "What bank was the first to use a computer?" "Who invented the floppy disk?" "When was the first computer used in a factory?" "Where was the PC invented?" Above these, in large letters scroll: "Who?" "How?" "Where?" "When?" and "WHY?" The narrator concludes: "How did this explosive growth in computing come about and how has it changed our world? Come explore the past and see. Come explore the *Milestones of a Revolution*."

The First Milestone

The following description of the first milestone gives an impression of what visitors will experience and learn in the exhibit.

Visitors enter the exhibit to find themselves in a U.S. government office circa 1935. Every detail conveys the atmosphere of the time: the wooden chairs and desks, the New Deal posters on the walls, the vintage telephone. A slapping, whirring and clicking fills the office. Everywhere are stacks of punch cards. Dominating the office are two large metal machines. It is from these that the noise emanates. Through the noise of the machines, visitors make out a conversation.

"Have you processed the payments to Massachusetts residents yet?"
"Not yet, that's their stack on the table. The records for Louisiana are in the tabulator now."
"Okay, we have some new recipients to add, and I want to make sure they get their first Social Security check this month."
"It's going to set us a bit behind, but when their cards are punched, I'll run the stack through the sorter. Oh, by the way, has Johnny finished wiring up that plugboard so the tabulator'll keep a running total of payments made for the month?"
"I'm not sure." (The conversation fades.)

To either side of the vignette are text and photos, additional artifacts, and interactive computers that explain what visitors have seen and overheard and expand upon the presentation.

The text will pose a problem to visitors: "You have to process 1 million Social Security checks a month. How are you going to do it?" It goes on to explain that punched card machines performed the large-scale information processing essential to administering programs such as Social Security. A photograph of Roosevelt delivering the first Social Security payment and headlines announcing the event emphasize the social and personal impact of such information handling capabilities. Visitors who discover the hidden panel will reveal a vintage radio playing period music and then one of FDR's Fireside Chats.

Adjacent to this presentation sits a touchscreen computer that gives visitors access to a laser disk full of film and video clips related to the vignette. The program is structured in such a way that visitors can investigate the general intellectual, economic, and cultural climate of the period. For example, by touching the "button" on the screen marked "economic background" the visitor could view a newsreel clip showing the plight of people during the Depression and the building of large government as part of the New Deal to rebuild the economy.

The history of computers is a story about people. At the 1930s vignette, for example, touching the "button" marked "People" on the interactive video system will display a film clip of Thomas J. Watson Sr., President and founder of IBM. Watson expounding his "THINK" philosophy will give visitors insights into his unique character and the type of thinking that spread the automation of information processing. It expands the human interest appeal of the exhibit.

At the opposite side of the vignette, a second display describes how the electromechanical processing of information takes place. Samples of punched cards and components of the machines that visitors can view close up reinforce this description. An interactive computer allows visitors to enter their names and examine what they would look like punched on a card. Encoding information, the program explains, is fundamental to computing. Ambitious visitors can then process a job simulated on the computer. Here they learn that the tabulating machines can perform only specific operations and that people must coordinate all their actions. At the next vignette, this will be contrasted with the programmability of computers.

Live actors will periodically inhabit the vignette playing the roles of actual clerks from the time. They may also give presentations on vintage card punch machines, explaining how they work, and giving visitors souvenir cards punched with their names. Such live presentations will add new dimensions to many of the exhibit's nine vignettes.

<u>The Nine Milestones</u>

The first milestone, as just described, will set the stage for the changes that visitors will witness as they pass through the years. The next three illustrate the first steps, the ground work, that proceeded and established the environment for the explosion in the use of computers. The final five milestones demonstrate the fantastic proliferation in computers from the mid-1960s to the present and the course of their development. Since the final three vignettes treat trends which continue to unfold today, at the end of the exhibit visitors will be invited to reflect upon the implications of the development of computers for tomorrow.

In chronological order, the nine milestones are as follows:

- **What we did before computers (1930s).** The need for computing and data processing predates what today we think of as a computer. Government and commerce have always required the recording and manipulation of information, and society has always developed tools to help meet this need. The vignette will focus upon the Social Security system and how punched-card data-processing equipment was employed in large-scale record-keeping operations.

  The broader social context of the Depression, the New Deal, and the rise of big government that all had an impact on the use of such information-processing equipment will be conveyed through supporting photographs and film footage. Music from the period will also help set the context of this vignette, to locate the starting point of the visitor's journey through time.

- **Computers emerge (late 1940s).** The modern computer emerged with the application of electronic technology and the implementation of the stored program and was a direct outgrowth of computing projects undertaken during World War II. The stored program allowed a computer to follow a set of instructions, and more importantly, modify those instructions itself. This property distinguished the computer from any tool previously built by mankind and captivated the public imagination by inciting speculation about an age of "thinking machines."

  A display centered upon the Manchester University Mark I, the first machine to execute a program stored in its memory, will illustrate the character of the early experimental computer projects and that the development of the computer is not a distinction that belongs to any one country or project. The "mad scientist" maze of wires, tubes, and engineer's tools scattered about in a dingy room lit by bare bulbs will clearly convey that the early computers were far from the slickly packaged devices we recognize today. These early machines were designed and built by their users.

The pioneers of computing represent some of the most interesting characters in the history of the technology. Straight from the source, visitors will learn of the frustration many astronomers, physicists, and mathematicians faced when they encountered problems whose solution was utterly impractical by human and mechanical calculators of the time. To branch into new areas of study, they needed new tools and techniques. The impetus provided by World War II to their efforts will be one of the central themes of this vignette.

- **Computers go to market (early 1950s).** The Univac I will be the centerpiece of a display that treats the early commercially available computers. An outgrowth of the immediate post-War projects, and still far from becoming the commodity they are today, the Univac I and other early computers available for purchase broke the barrier between the government or university laboratory and the marketplace, between scientific applications and business applications. It represented a critical step from the one-of-a-kind computer to the mass-produced. The Univac I will be installed in a recreation of one of its actual early applications.

- **Telling computers what to do (late 1950s).** Though the underlying technology of the computer had been refined, and a market for the machine opened, the computer remained a comparatively unproductive technology. Why? They were dreadfully difficult to use. In the later 1950s and early 1960s many people turned their efforts to solving this problem. The approach they took was to create a more flexible and natural method of expressing the instructions for a computer to follow and to use the computer's own abilities to facilitate this. The result was a plethora of programming languages; the two most influential and long-lasting from this period were FORTRAN and COBOL, the former for scientific problems, the latter for business.

So that visitors better understand the issues at stake during this period in the evolution of computing, this vignette will put them in the shoes of a programmer from that period. This will help convey the environment in which programmers worked and the emerging "programmer culture." An interactive computer station will help introduce visitors to the difficulties posed by giving instructions to computers and the value of programming languages. The interactive video station will introduce visitors to the people who made up this new breed, the people whose focus was software, the programmers, the hackers.

After these developments, the stage was set for the monumental proliferation of computers. The catalyst came with the application of the transistor.

- **Business buys computers (mid-1960s)**. In the 1960s, in the context of the post-War economic boom, big business embraced the computer. Aside from the productivity improvements fostered by the development of programming languages, this was in large part attributable to the use of transistors. The transistors dramatically reduced the cost of manufacturing and operating computer hardware. The character of large-scale business computing organizations, the emergence of large computers and storage systems, communication between computers, databases and the issues these developments raised will be themes revolving around a display of an IBM System/360, the largest selling family of computers of its day, in an insurance company computing environment. The very style of the installation will convey the pride corporations took in having large dataprocessing department. This was the heyday of scientific management, and the computer was the visible tool of the visible hand.

- **Computers Uncaged (early 1970s)**. The advent of minicomputers facilitated the expansion of timesharing, distributed processing, process control, and communication between computers. The vignette will focus on a DEC PDP-8 in an industrial control application. The minicomputer brought computing outside the doors of installations in large institutions. For the first time, smaller businesses and schools were able to purchase computers. It marked the beginning of the popularization of the computer. The proliferation of computers meant that many organizations employed more than one. The need to link these disparate resources helped drive the emergence of networks that allowed computers to communicate over distances. The vignette will investigate the links between the increasingly anti-Establishment atmosphere in society at large, and the de-centralization of computing power that occurred during this period.

The final three vignettes treat incipient trends that have still to reach maturity.

- **Creating new possibilities (early 1980s).** A display focused on a Cray-1 will portray the impact computers have had on scientific research. In the early 1980s, the emergence of very powerful computers, so-called "supercomputers," meant that, in many cases, experiments could be simulated on computer more easily than they could be performed in real life. The supercomputer has opened up whole new domains in numerical experimentation and scientific visualization and, as a result, is changing the very nature of scientific investigation. The power of the supercomputer to create and manipulate intricate life-like images is effecting our understanding of reality. Government initiatives have had a significant impact on the development and use of supercomputers; the Cray-1 will be "installed" at Lawrence Livermore Laboratories.

- **More people get in on the act (mid-1980s).** With the microprocessor, computers became inexpensive enough that they could be dedicated to the use of an individual. The personal computer affected many professions. As more people were able and had need to use computers, new ways of using the computer came into being. More important than individual use is the way the personal computer has affected the organization of larger enterprises. Whereas in the 1960s computing power was centralized and inaccessible, the personal computer is decentralizing the access to information and computing power. This technical phenomenon has affected and in turn been shaped by the organizational of the work environment. While the focal point of the vignette will be an IBM PC, the milestone will also present many of the need breed of entrepreneurs, the renegades who nurtured the first personal computers in their garages.

- **Computer pervasion (mid-1980s).** Microprocessors have extended the trend of process control begun by the minicomputer to almost every electronic device, from microwaves and toasters to spacecraft and automobiles. How many computers do you have in your house?...probably ten times more than you think. This display will unveil the imbedded computers that surround us. A pile of everyday objects containing microprocessors will be the focal point of the milestone.

<u>Content</u>

Several ideas will be investigated throughout the length of the exhibit. One of the most dramatic will be the change in physical size, cost, and performance of computers. The evolution of software, including system software that allows computers to manage their own resources, programming languages that allow people more easily to express instructions for computers, and human interfaces that facilitate the use of computers, will also be an integral part of the exhibit. Others will include the push to establish standards and the connections between the social environment and the technological advances of different periods. For example, what problems and demands existed in society that machines and programs of different eras were designed to solve, and how did this drive the evolution of the technology? Context is important; while focused upon a specific event or technology, each vignette will also capture the broad character of its era. These multiple layers and media will ensure that the exhibit appeals to all levels of the public.

As a whole, the exhibit will transport visitors into the past so that they better appreciate the concerns and problems which computers were designed to solve, the patterns of their development, and the effect they have had on our culture.

Milestones of a Revolution will occupy over 5,000 square feet of the Museum's gallery space. Most visitors will begin their visit to the Museum in this exhibit. *Milestones of a Revolution* will fulfill The Computer Museum's mission to educate and inspire the general public on the history of computing and, therefore, will occupy this central position on a permanent basis. A credit panel listing those whose contributions have made the exhibit possible will be prominently displayed in the gallery.

MAKING IT HAPPEN

The Computer Museum needs to raise $782,000 to develop this exhibit, and a further $235,000 worth of equipment and services in the form of in-kind donations. Over 50 percent of the funds have already been committed. The exhibit will take approximately one-and-a-half years to develop, and will open in the Spring of 1991.

Staff

The following Museum staff will be involved in the project. Two additional research assistants will also be hired for this project.

- **Dr. Oliver Strimpel** (D. Phil., Oxford University) has been the Curator of The Computer Museum since 1984. He will direct the project, which will require 20 percent of his time over its course. Formerly with the Science Museum in London, Dr. Strimpel has created numerous exhibits related to computers, including *The Computer and the Image* and *Smart Machines,* at The Computer Museum.

- **Gregory Welch,** Exhibit Developer, (A.B., History of Science, Harvard University) has rejoined the Museum after studying the science and technology museums of Europe as a Shaw Fellow. He is the creator of several historical exhibits at the Museum, including *Computers in Your Pocket: The History of Pocket Calculators,* now touring the country under the auspices of the Smithsonian Institution. He will dedicate 100 percent of his time to the *Milestones* project.

- **Dr. Gwen Bell,** the Museum's Founding President and Director of Collections, has guided development efforts for many of the Museum's exhibits. She has consulted extensively on the history of computers, including working with the *Annals of the History of Computing,* the SIGGRAPH Graphics History Project, and Time-Life Books. She will administer collections aspects of the project. This will require 10 percent of her time.

- **Richard Fowler ,** Exhibit Designer is the Design Director of England's award-winning National Museum of Photography, Film, and Television. Mr. Fowler will spend one year at the Museum; 25 percent of this time will be dedicated to this project.

- **Adeline Naiman,** (A.B., History and Literature, Radcliffe) the Museum's Director of Education, is an expert on the use of computers in education and has been Director of HRM Software and of Technical Education Research Centers. Author of books and columns on the use of computers in education, she is vice-chair of the Massachusetts Educational Technology Council. She will oversee the creation of educational materials and programs to accompany the exhibit.

- **Daniel Griscom,** the Museum's Exhibits Engineer (B.S. Computer Science, Massachusetts Institute of Technology) will work closely with the software developer in the implementation of the *Interactive History Navigator.* This will account for 10 percent of his time.

<u>Consultants</u>

The Computer Museum has succeeded in drawing together a distinguished committee of consultants to investigate and elaborate the central themes and content of the exhibition. These include scholars of the history of science, the history of technology, and cultural history.

- **Dr. Daniel Bell,** American Academy of Arts and Sciences and professor emeritus of Harvard University, is a renown sociologist who has studied the impact of technology on social structures. His 1973 work, *The Coming of Post-Industrial Society,* has become a classic. Among his many advisory roles Dr. Bell has served on the President's Committee on Technology, Automation and Economic Progress and as the U.S. representative to the OECD Interfutures Project. Dr. Bell is also a member of the editorial board of *Daedalus* and is a Trustee of the Institute for Advance Studies.

- **Dr. I. Bernard Cohen**, (emeritus) Harvard University, is a distinguished figure in the study of the history of science. He is an expert on Sir Isaac Newton and is author of, among many publications, *Revolution in Science*. He has long had an interest in and is one of the foremost authorities on the history of computing. He has worked with the office of Charles and Ray Eames and consulted for IBM on the creation of historical exhibits. He recently published articles on the work of Howard Aiken and Charles Babbage and is in the processes of writing Aiken's biography. He has provided input during the preliminary phase of project planning.

- **Dr. Ruth Schwartz Cowan**, SUNY Stony Brook, has written extensively on the impact of technology on women and social institutions. Her book, *More Work for Mother: The Ironies of Household Technology from the Open Hearth to the Microwave*, was awarded the 1984 Dexter Prize for the best book in the history of technology. She has taught courses on social studies of science and the history of technology and will bring an appreciation of the interaction of technology and social values to the *Milestones* exhibit.

- **Dr. David S. Landes**, professor emeritus of Harvard University, is an eminent economic historian who has examined links between economic and technological change. His 1968 work, *The Unbound Prometheus*, is widely considered a seminal work in the field. His appreciation for the connections between technology and culture is also evident in his book, *Revolution in Time: The Clock and the Making of the Modern World*. Dr. Landes is a member of the editorial board of *Technology and History*.

- **Dr. David Marc**, Annenberg School of Communications, University of Southern California, has written extensively on the social impact of television. His books *Comic Visions: Television Comedy and American Culture* and *Demographic Vistas: Television in American Culture* have been widely acclaimed. He will bring to the project the insights of a cultural historian.

- **Dr. Merritt Roe Smith**, Massachusetts Institute of Technology, is an award-winning author of books and papers on the history of technology. Among his many advisory roles, he serves on the executive committee of the Council for Understanding Technology in Human Affairs. He is also President of the Society for the History of Technology. Dr. Smith's broad vision of technology in American society will place the role of the computer in context.

Advisors

The Museum depends on the efforts and expertise of many volunteers. To ensure technical accuracy and well-formulated interpretation in the exhibit, we have drawn together a group of experts in computer hardware and software, communications, and education. These advisors include.

- **Charles W. Bachman**, president of Bachman Information Systems. He is a former Vice-president of Cullinet Software and holds many patents for his work in database management systems. Among many honors, he received the prestigious Association for Computing Machinery (ACM) Alan M. Turing Award.

- **C. Gordon Bell** of Ardent Computer, formerly Associate Director for Computer and Information Sciences for the National Science Foundation and Senior Vice-president of Engineering at the Digital Equipment Corporation, was the architect of Digital's computers from the establishment of the minicomputer through the VAX series, Encore's multiprocessors, and Ardent's graphics supercomputers. He is the recipient of the ACM's Eckert-Mauchly Award.

- **John Diebold**, Chairman of The Diebold Group, Inc., is an internationally acknowledged leader in the fields of management and technology. His first book, *Automation*, coined the term and is a classic in technology management. His consulting firm advises major corporations and governments around the world and over the past 35 years has had a significant impact on the the computer and communications revolution. Mr. Diebold served as an advisor to the Deutsches Museum on the creation of its computer exhibit.

- **Gardner Hendrie** is a member of the venture capital group Sigma Partners. Hendrie designed several minicomputers and led the design of Stratus Computers' fault tolerant systems. He is Chairman of the Computer Museum's Board of Directors.

- **Jane A. Manzelli** is the coordinator of computer curriculum for the Brookline, Massachusetts, Public Schools, one of the most respected school systems in the country. She has prepared a curriculum on computer history for middle school and high school students and is very knowledgeable about young students' understanding, what they will bring to the exhibit, and what they will be able to assimilate.

- **Christopher Morgan**, formerly Editor-in-chief of *BYTE* and *Popular Computing* magazines and a Vice-president of Lotus Development Corporation, now collects and sells rare books related to computing. His technical background includes a post as Senior Design Engineer with Pratt and Whitney.

- **Jonathan Rotenberg** is Founder and President of the Boston Computer Society, an organization that unites over 30,000 computer users across the country and disseminates information on the use of personal computers.

THE COMPUTER MUSEUM

The Computer Museum was founded in 1982 as a public, non-profit institution dedicated to educating the public about computers and preserving computer history. It possesses the world's most comprehensive collection of computers and related technologies, as well as extensive film, video, and photo archives. Its over 20,000 square-feet of exhibits range from re-creations of early computer installations, to displays of state-of-the-art computer graphics, artificial intelligence and robotics. *Milestones of a Revolution* will be part of the first phase of a four-year, $3-million project to re-develop 12,000 square-feet of existing exhibit space, and add 5,000 square-feet of new exhibits. This project will ensure that the Museum's exhibits remain on the cutting edge of computer and display technology and that they appeal to an ever-broader audience.

The Museum's financial foundation is solid. Donations and over 1500 individual and 150 corporate memberships from around the world provide half of the Museum's operating budget. Admissions and revenue from the Museum Store account for a further 30 percent, while government grants and other income provide the remaining 20 percent. The Museum has already achieved its $3.3 million goal for Phase I of its Capital Campaign, and has received pledges for $1.5 million of its $6.75 million Phase II goal.

REACHING THE MARKET

As the opening date approaches, the Museum's Director of Marketing will convene an advisory committee for public relations to create a publicity and promotion campaign for the exhibit. This committee will ensure that the opening and launch of the exhibit achieve maximum media impact. The campaign will make use of the Museum's established relationships with New England print and television media and national magazines and writers on science and technology. All publicity materials will recognize significant supporters of the exhibit.

Currently, over 100,000 people visit the Museum each year. This figure is expected to double with the addition of several major new exhibits. Boston hosts over 13 million tourists a year, and half of the Museum's visitors come from outside Massachusetts — a sizable percentage are foreigners. Overall, the Museum appeals to visitors of all ages, interests, and backgrounds. Studies show a significant portion to be well-educated, and affluent, while forty percent are students. Education and outreach programs are continually expanding the scope of the Museum's audience.

RECOGNIZING SPONSORS

Cash contributors to the exhibit will be recognized according to the following guidelines:

- **$100,000 or more:** prominent acknowledgement in all Museum press releases regarding the exhibition, and in all published materials directly pertaining to the exhibit, such as gallery leaflets, and pre-and-post-visit educational materials for school groups. Underwriters in this category will head in large type-face the list of sponsors on a credit panel placed prominently in the gallery. In addition, such sponsors will be granted use of the entire Museum free-of-charge for a function (subject to availability).

- **$75,000 to $99,999:** recognition in all exhibit publications and press releases, though less prominent than the major sponsors. The names of contributors in this category will follow those of the major underwriters on the gallery credit panel. They will also receive the same benefit of use of the Museum for a function.

- **between $25,000 and $74,999:** acknowledgement in exhibit publications associated with the exhibit, but not in press releases. Their names will follow below those donating $75,000 or more on the gallery credit panel.

- **under $25,000:** acknowledgment on the gallery credit panel.

In-kind donations are accounted for and credited separately from cash donations. All sponsors will all be invited to a pre-opening reception, and will be listed on all invitations to the exhibit's opening reception.

If a promotional poster for the exhibit is produced, those benefactors contributing $10,000 or more will be listed in order and prominence according to the size of their contribution.

Supporters providing in-kind donations of equipment or services will be acknowledged on a separate credit panel displayed in the exhibit gallery.

Milestones of a Revolution

Estimated Budget

ITEM	Cash Cost	In-Kind Donation
Exhibit Development	$113,000	
Exhibit Design	$36,000	
Electronics/Effects	$53,000	$50,000
Programming	$20,000	$10,000
Computer Hardware		$65,000
Graphic Design and Production	$40,000	$20,000
Fabrication	$335,000	
Video	$90,000	$90,000
Educational Materials	$16,000	
Public Relations	$50,000	
Overhead	$29,000	
TOTAL:	**$782,000**	**$235,000**

MILESTONES OF A REVOLUTION:

PEOPLE AND COMPUTERS

A Planning Grant Proposal
Submitted to the
National Endowment for the Humanities
Divison of General Programs

from
The Computer Museum
300 Congress Street
Boston, MA 02210

June 9, 1989

COVER SHEET CONTINUATION

The Computer Museum was incorporated in 1982 as a public non-profit institution dedicated to educating the public about computers, preserving the history of the technology, and interpreting the change it has wrought. It is the only institution of its kind in the world.

The Computer Museum possesses the world's most comprehensive collection of computers and related artifacts, as well as extensive film, video, and photo archives, and has an unprecedented joint collections agreement with the Smithsonian Institution. The Museum also possesses a small, well focused research library for staff and visiting scholars. Housed in an 19th-century warehouse, The Computer Museum's exhibitions, collections, archives, offices, auditorium, production facilities, and store occupy 56,000 square feet.

The Computer Museum appeals to people of all ages and backgrounds. Each year, 100,000 visitors from around the globe come to see the Museum. Fifty-five percent are students. Journalists, professionals, and scholars draw on the Museum's resources. Outreach programs are continually expanding the scope of the Museum's audience.

This proposal requests support for the planning and background historical research for a major new exhibition entitled ***Milestones of a Revolution: People and Computers.*** This exhibition will interpret the broad impact the computer has had over the past forty years on the way we live, work, and think. By focusing on changes in the entire social context in which the computer has developed, the exhibit will enhance the general public's appreciation of the relationship between technology and culture. Thus will it improve their understanding of the modern world.

During the planning process, staff and consultants will explore ***themes*** central to a penetrating understanding of the computer in our minds and in our civilization. These themes will include: the ***mythical dimensions*** of the computer, how the computer ***affects and reflects society*** and its ***values,*** the ***ethical dilemmas*** posed while ***solving problems*** with computers, the source and catalyst of ***innovation,*** and the process of social and individual ***adaptation to changes*** in computer technology.

In the final exhibition, these themes will be conveyed to the public through an artifact-based environment that incorporates photographs, ephemera, film, and other exhibit techniques to create a sense of both how and in what context computers were used. The exhibition will be complemented by educational materials and programs and an informative "catalog." The products of the planning activities will be complete conceptual plans, exhibit text and labels, a prototype interactive system for formative evaluation, educational materials, and a collection list.

The Project Director will be Dr. Oliver Strimpel. Other members of the Museum's staff involved in the project will include: Gregory W. Welch, Exhibit Developer, Dr. Gwen Bell, Director of Collections, Richard Fowler, Exhibit Designer, Adeline Naiman, Director of Education, and Daniel Griscom, Exhibits Engineer. The principal consultants to the project will be: Professor I. Bernard Cohen (emeritus), Harvard, Dr. Merritt Roe Smith, MIT, Dr. David Marc, Brandeis, Dr. Ruth Schwartz Cowan, SUNY Stony Brook, and a further historian yet to announced.

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PROJECT NARRATIVE

OVERVIEW

The Computer Museum seeks support from the National Endowment for the Humanities to perform the planning and background historical research for *Milestones of a Revolution: People and Computers,* an interpretive exhibition that will present the history of the computer and its use and explore in depth themes central to the impact of the computer on society from an historical perspective. The goal of the exhibition is to enable people of all backgrounds to gain a sense of how computer technology has developed and affected the way we live, work, and even think. It is essential that the public's understanding encompass, not only changes in technology and society, but the humanistic dimensions of these changes. In pursuit of this goal, we will investigate the humanities themes in the history of computers by pursuing the following courses of inquiry.[1]

1) The Computer and Myth. Like any powerful force in society, the computer has a mythical dimension. How does the computer embody eternal themes in human consciousness (e.g., the Prometheus myth), and how has this shaped the popular perception of the technology? The portrayal of the computer in public media will be an important source for investigating this theme.

2) The Social Impact and Conditioning of the Computer. The computer is an empowering tool. But whom does it empower and for what purposes? Does its use affect basic social structures and relationships? To what extent do the computer's essence and use reflect the values and paradigms of the societies in which it has evolved and is employed? An exploration of where and to what ends com-

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[1]These themes are expanded in the Content section of this proposal.

puters have been used over time will provide us with insights on these issues.

3) The Computer Solves Problems and Creates Dilemmas. While their use allows people to arrive at answers to problems previously unsolvable, the use of computers also poses many dilemmas. We will examine this issue in several instances; for example, the effect on democracy of using computers to forecast election results, and the implications for the right to privacy of large databases of personal information. Other dimensions of this theme we will explore include these: What processes exist for resolving such dilemmas in our society and overseeing the application of computers? How are our society's values and priorities set with respect to the application of technology?

4) The Wellspring of Innovation. How does the development of computer technology reflect the pervading stereotypes and ethos of the culture? Are those involved in creating and using the technology heroic, entrepreneurial engineers (modern "cowboys" as it were), pressing ever onward outside of the mainstream, or corporate bureaucrats and organizations driven strictly by profit? Another intriguing aspect of this theme is whether the development of computers is the product of successive instances of human creativity, the manifestation of *homo faber*, man as tool-maker, or determined by "autonomous" economic and technological exigencies? The historical development of the computer industry and the characters involved will provide clues to these questions.

5) Social and Individual Adaptation to Change. Computers, during their short existence, have changed more rapidly than any other technology. Changes in the technological infrastructure demand adaptive responses on the part of social institutions and individuals. How has this characteristic of the computer affected its development and implementation? How has it changed our notion of obsolescence? How and which individuals have adapted or failed to adapt to the computer? Has it increased rifts in the population between the "knowledgeable" and the "uninitiate"? Finally, how great a change do computers represent? Do the quantitative effects of computers constitute a qualitative change?

An historical perspective will provide us with insights on these important issues that we could not derive simply from an analysis of the present. Furthermore, it will be interesting to observe whether notable turning points have occurred in terms of these themes. Finally, through an examination of these themes, the exhibition will provide the public with a deeper, more critical awareness of the inextricable interaction of technology and culture, which will help them better understand the world around them.

Investigations of themes that focus on people, society, and human culture are not new to the field of the history of technology. However, computers themselves are a comparatively recent phenomenon, and the study of their history even more so. While some literature exists on the history of computers, it is predominantly technology-oriented; studies of the historical influence of the computer on human lives are largely lacking.

Since no body of scholarship exists that specifically addresses the themes we propose to study, the Museum will bring together a group of scholars who are concerned with the social, economic, and cultural impact of technology on the modern world to create an exhibition that reflects a meaningful, humanistic interpretation of the history of the computer era. These scholars will work together with museum professionals and educators to examine the issues outlined above and to formulate an interpretation of these themes that can be conveyed in an effective exhibition.

The Computer Museum is in a unique position to undertake such a project. Its collection of historic computers and related artifacts is unequaled , and it possesses extensive film, video, and photographic archives related to the history of the computer. The exhibition will draw heavily upon these resources. Furthermore, in accordance with the Museum's mission, it will create an exhibition distinct from any other. While two projects are under way at the Smithsonian Institution that touch upon computers, *Milestones of a Revolution* will be the only exhibition to examine critically the broad impact that computer technology *per se* has had on our world from a humanities perspective.

The final product of the project will be a 3,750 square-foot, permanent exhibition and accompanying educational materials and programs that will be distributed to schools. We also anticipate producing a "catalog" that will be an informative and widely readable book to be distributed nationwide. Some interactive components of the exhibition will be designed in such a way that copies may be readily made for other museums and educational institutions.

To preserve the scholarly and critical integrity of the exhibition, it is essential that it not be entirely supported by private industry.

RATIONALE

> If we wish to have any clear notion about the machine, we must think about its psychological as well as its practical origins; and similarly, we must appraise its esthetic and ethical results. . . The vast material displacements the machine has made in our physical environment are perhaps in the long run less important than its spiritual contributions to our culture.[1]

Thus, spoke Lewis Mumford in 1930. Though appropriate enough at the time, today, as we attempt to come to grips with our increasingly computerized society, his words ring prophetic.

When we compare today's world with that of 1930, we observe monumental changes in they way people live, work, and think.

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[1]Lewis Mumford, *Technics and Civilization,* (1934; rpt. New York: Harcourt Brace Jovanovich, 1963), Introduction.

Obviously many factors have contributed to these changes: wars, weapons, economics, and demographics to name a few. However, if we examine the underlying infrastructure of society between 1930 and today, we note that one particular technology has changed dramatically over this period and had broad effects upon modern society: the computer.

In only a few decades, computers have assumed a central role in the maintenance and growth of modern civilization. Just as the steam engine powered the Industrial Revolution, the computer may well be the engine of a new epoch of change in our world, the information revolution. Schools already teach computing, and to provide their students with perspective on the transformation in which they are taking part, many instructors include computer history in their curriculum. Similarly, every day more people are employed in computer-related occupations; they, too, seek to understand the context of their work.

Though increasingly rapid, such processes of change take place over time. Consequently, people look to the past to gain perspective on the present and future. As the computer continues to affect all our lives more deeply, the need to know more about its origins, the historical process of its development, and the humanistic implications and dynamics of its evolution continues to grow.

It is to satisfy this need that The Computer Museum is developing the exhibit *Milestones of a Revolution: People and Computers.*

OBJECTIVE

In the introduction to his work, *Technics and Civilization,* Mumford described the objectives of his study of the history of technology:

> Not merely must one explain the existence of the new mechanical instruments: one must explain the culture that was ready to use them and profit by them so extensively.[1]

The Computer Museum will pursue a similar goal in explaining the existence of this new *electronic* instrument, the computer. *Milestones of a Revolution* will explore how modern society and culture have been shaped by, and have shaped, the development of the computer to give the general public, not only a better comprehension of how the computer has come into being, but more generally, a better appreciation for the interaction of technology and human culture, and thereby, a better understanding of the modern world.

CONTENT

The exact content of the exhibition will be determined during the planning phase of the project. However, in crafting the interpretation of the history of the computer and determining the precise artifacts, photographs, and films that will be included in the exhibit, the Museum staff, consultants and advisors will pursue an investigation of the themes addressed in the following discussion.

1) The Computer and Myth

Myth is the basic symbolic representation of human beings' understanding of themselves and the world about them. Therefore, to

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[1]Mumford, p. 4.

understand an aspect of civilization fully, it is crucial to explore its mythical dimensions, its position in human consciousness. *Milestones of a Revolution* will examine the position of the computer in myth.

Greek mythology credits the creation of man to Prometheus, a titan to whom Zeus gives the responsibility of fashioning man from earth. Prometheus pitied his weak creation's vulnerability to nature and stole for mankind the empowering tool of fire from Mount Olympus, for which he is sorely punished. Prometheus thus symbolizes a beneficent and fatherly force that helps humanity master the environment. His spirit imbues technology with positive connotations. Technologies, such as the dynamo and nuclear power, are often portrayed in Promethean terms as saviors; to wit: the recent hoopla in the popular press over the prospects of cold fusion as a potentially ideal solution to humankind's energy needs reflects the tendency to view technology as the modern Prometheus, the selfless protector and provider who is an essential character in the panoply of mankind's desiring.

Computers, too, have been viewed in a Promethean light. The prospect of replacing mental drudgery with tireless and selfless "thinking" machines has led to speculation about an age of leisure in which humankind would be freed from toil. Press accounts of early computers that sparked the public imagination to consider the implications of these "giant electronic brains" often depicted the computer as miraculous, nearly omniscient entities. Their use of personifying metaphors sometimes went so far as to give the impression that the computer exercised free will. Indeed, the very characteristic of the computer that distinguishes it from all other technologies, the ability to follow instructions to accomplish tasks generally thought of as the exclusive domain of the human *intellect*, has heightened its personification. Computers are machines that aid us by providing us with answers; in a world of ambiguity, their mechanical rationality and accuracy are reassuring and friendly. Many of the computer characters in popular media, from

Star *Trek* to *Lost in Space*, reflect this picture of the computer as a human's loyal friend. This ascribing of human qualities to the computer reinforces its casting in the role of Prometheus, the friendly giant. However, it also leads to wariness of the computer's "intentions."

If Prometheus represents humankind's faith in technology's beneficence, the Golem or Frankenstein myth symbolizes humankind's fears of technology's potential malevolence. The Frankenstein myth reflects our fears of losing control of our own creations. The very personifying characteristics that lead people to think of the computer in friendly terms also cause them to be suspicious of it. Likewise, the rationality that has been seen as comforting also becomes terrifying; the computer may share some of our abilities but not our values. That the computer can in many respects emulate human behavior arouses fear that it might think and act independently, resisting, and or surpassing, our control with little or no regard for such human values as liberty and freedom. Such depictions of the computer abound: for example, the "existentially tormented" HAL in Arthur C. Clarke's *2001: A Space Odyssey*, or the computer that takes over the world in the film *Colossus*. Also counterbalancing hopes for an age of leisure, are fears that the computer and computer-controlled machines will displace many human workers.

Whether friend or foe it is obvious that the computer is a potent character in the human imagination. As a potent technology it embodies fundamental hopes and fears that form part of human psychology and myth. An exploration of this theme in the exhibit will give the public a deeper appreciation for the computer, not just as machine, but also as symbol.

2) The Social Impact and Conditioning of the Computer.

Like any useful tool, the computer increases people's potential and ability to affect the world about them. Therefore, if we are to gain a notion of the impact the computer has had on society, we must examine whom it has empowered, and how it has been used. Causality in history is rarely, if ever, a one-way street. Thus, it is also imperative to examine how the computer reflects the cultural context in which it emerged and the character of the people involved in its development and proliferation. As David F. Nobles attests: "technology is not simply a driving force in human history, it is something in itself human; it is not merely man-made, but made of men."[1]

Until comparatively recently, computers were too expensive to be used by private individuals. Computers in the United States emerged out of the technological environment of World War II, a period that Thomas P. Hughes, in *American Genesis,* has characterized as one of large-scale system-building. The early massive and expensive computers were integrated into just such large military, government and corporate organizations, and their essence and use reflected the characteristics that Hughes identifies as as essential to such systems: "centralization, synchronization, order, and control and, of course, gigantic scale."[2] Noble, in *America by Design,* has identified the emergence of such "science-based industry" with the professionalization of engineering and the broad application of its techniques to arranging social and industrial structures. The interpenetration of historical forces is clearly visible in this context, for not only did computers reflect the systemic thinking that pervaded the environment in which they emerged, but for years they in turn fostered the further growth of organizations based in such thought. Those to whom computers were empowering tools generally worked within the structure of large private or public organizations. The large-scale processing of information, upon which highly centralized, global corporations or nationwide bureaucratic structures

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[1]David F. Noble, *America by Design: Science, Technology and the Rise of Corporate Capitalism,* (New York: Knopf, Inc., 1977), p. xxi.

[2]Merritt Roe Smith, "America's Insatiable Passion for Technology," Boston Globe, 4 June, 1989, Sec. A, p. 16, col. 1.

depended, could not have been accomplished but for the computer. Thus, it could be argued that the computer worked to fulfill institutional objectives and, consequently, reinforced existing social structures.

In the late 1960s and 1970s, the advent of more widely available, unmonitored access to computers made possible by "time-sharing," particularly in academic environments, allowed the more diverse, independent, and at times iconoclastic, application of the computer. This was also a period of social and political upheaval and activism, and many of the college students who cut their teeth on computers during this epoch embraced the "anti-establishment" sentiments of their times. These individuals formed something of a "computer counterculture" and contributed to the spread of computer use beyond the confines of the large institutions. In recent years, this trend toward greater decentralization has continued with the proliferation of the personal computer. By putting greater powers of control and communication of information in the hands of the individual, some argue, the computer is a democratizing force. For example, the personal computer and "desktop publishing" may have as liberating an influence upon discourse and the exchange of ideas as the moveable-type printing press did. Observers, such as Esther Dyson, are intrigued by the way private citizens in the U.S.S.R. are using the personal computer to create communication networks.[1] Computer networks may indeed realize Marshall McLuhan's "global village." Though causality is difficult to establish, recent years have also witnessed a trend away from monolithic organizations toward greater decentralization of authority both in government and in industry. There can be no doubt that over the last twenty years the precipitous drop in the price of computers has expanded their use to ever-larger portions of the population in the United States. While market forces have obviously played a role in

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[1]Esther Dyson, "Three Weeks that Shook My World," Release 1.0, 21 May 1989.

conditioning this movement, is it not also a reflection of the democratic and individualistic ideals of our culture?

An investigation of the social context and impact of the computer will also illustrate to the public larger issues crucial to understanding technology. Many consider technologies to have developed according to the dictates of their "inherent nature." The exhibit will dispel this misconception by illustrating that machines reflect the minds of their makers and the spirits of their times. The visual impact and design of computers from different periods will help reinforce this idea.

3) The Computer Solves Problems and Creates Dilemmas.
We use computers to solve problems, whether weather forecasting or balancing bank accounts. Indeed, technology is generally seen as a positive phenomenon. However, if we examined this more critically we note that the use of computers can raise problematic issues. We will explore several such cases.

In 1952, a computer was first used to predict the results of a presidential election. Such predictions have proven so accurate that today some question whether they are not undermining the electoral process on which democracy is based. Are voters in California actually voicing their own choice, or merely responding to the advance notice of the winner provided to them by computer predictions based on their past behavior and instantly polled results from the East Coast?

In the 1960s, the government and private corporations increasingly computerized their operations. This allowed them to serve increasing numbers of citizens and customers more efficiently, but it also led to depersonalization and alienation. The system became more highly valued than the individual. The computer represented a rigid structure to which humans had to adapt. If your name was too long for the memory allotted to it in the phone company's computer, your name was truncated. Computers were the natural extension of, and a lynch-pin in, the Taylorized workplace; individual workers were adjuncts to the machine, their purpose to feed it information. While increasing efficiency, the computer exacted a price: it reduced flexibility.

The expanded use of computers allowed the government and private interests to accumulate and process information on vast numbers of individual citizens. In the 1970s, as the Social Security number became a standard reference key to all government-held personal data, and the sale of databases became increasingly common, people began to voice concern that computers posed a significant threat to our right to privacy. We have all experienced the most innocuous form of this threat: "personalized" junk mail. However, if advertisers can so easily gain access to information about us, what prevents others from also doing so without our knowledge and consent? Daniel Bell recorded the following Congressional finding:

> The subcommittee has discovered numerous instances of agencies starting out with a worthy purpose but going so far beyond what was needed in the way of information that the individual's privacy and right to due process of law are threatened by the very existence of [such databank] files. . . .[1]

While some might see the computer as a democratizing technology, other critics have seen the computer as the instrument of Orwell's Big Brother. For example, Theodore J. Lowi has observed "as a result of information technology, man's power over his environment will increase greatly and his susceptibility to manipulation will rise proportionately."[2]

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[1]Daniel Bell, "The Social Framework of the Information Society," in *The Microelectronics Revolution: The Complete Guide to the New Technology and Its Impact On Society*, ed. Tom Forester (Cambridge: The MIT Press, 1981), p. 541.

[2] Theodore J. Lowi, "The Political Impact of Information Technology," ibid., p. 454.

Computers are linking remote parts of the globe and performing many chores essential to the operation of modern civilization. This has caused some to raise concerns about our growing dependency on computers. Such apprehensiveness has been reinforced by recent violations of high-security computer networks by computer-borne "viruses."

In the context of these dilemmas, we will explore such issues as whether and how we as a society can resolve such problems, and how the decision to implement computers is made.

4) The Wellspring of Innovation.

The lone inventor has long been a popular heroic figure in American myth. Epitomized in Thomas Edison, he combines elements of Horatio Alger and the pioneer spirit: he forges onward into territory unknown; civilizing its wilderness he is rewarded by riches. Seeking the fount of innovation is an intriguing aspect of the study of the history of technology through which a technology becomes a window on the social forces and values at play during a particular period.

In the earliest period of the development of computers, prior to World War II, we encounter the "pioneers," such men as Howard Aiken, Konrad Zuse, John V. Atanasoff, George Stibitz — scientists and engineers faced by a problem who had the fortitude to built the tools needed to solve it, often in adverse environments. With the advent of the War, however, computer development took on a new character as the military blazed the trail for government initiatives that spawned many of the major innovations in computers over the next several years. Cold War sentiments fueled military investments in weapons systems, such as the SAGE air defense system, that relied heavily on computer power. Computers enter the realm of the "organization man."

At the initial opening of the commercial market in the early 1950s no start-ups survived. Only large corporations could afford the investments necessary to create both the technology and the market. The captains of industry, such men as Thomas J. Watson Sr., the President of IBM, rather than the lone inventor, were the heroes of this chapter in the story of computers. However, in contrast to other technologies and industries, such as steel and automobiles, that matured rapidly and came to be ruled by an oligopolistic handful of corporations, the development of new technologies created continually changing conditions in the computer industry.

The application of the transistor to computers in the late 1950s and early 1960s opened up the field to a whole new set of competitors. The role of the small-timer reemerged. This time around, some of the start-ups, such as Control Data Corporation founded by William Norris, and Ken Olsen's Digital Equipment Corporation, survived and even flourished. The space race proclaimed by President John F. Kennedy in 1961 provided a further boost to the computer industry and created favorable conditions for technological innovations by explicitly aligning social priorities behind a scientific and technical enterprise. Out of the space program's demand for small, reliable computers came many developments in computers, perhaps most notable, the integrated circuit, developed independently by Robert Noyce of Fairchild Semiconductor and Jack Kilby of Texas Instruments. While this shifted investments into, and broadened, the semiconductor industry (to a degree an offshoot of the computer industry), it had little immediate impact on the composition of the computer industry.

That changed once more, however, with the advent of the microprocessor, the "computer on a chip," in the mid-1970s. The lone inventor once more had fresh territory to explore: the personal computer market. Two of the most notable, irreverent figures who started companies in their garages and made millions in a few short years are Steve Jobs and Steve Wozniak, the founders of Apple Computer. Compaq, a small concern, on the strength of its personal computers became the fastest growing company in U.S. history. Are such figures as Bill Gates, the Harvard dropout who founded Microsoft, and Mitch Kapor, the Boston deejay who started Lotus, the modern equivalents of Thomas Edison, "high-tech heroes" as it were, or has the skyrocketing fortunes to made in this industry fostered a new breed of greed?

Consequently, we observe that, because of a rapid series of monumental innovations, the computer industry has been continually rejuvenated, and thus, there remains room for the individualistic, entrepreneurial "inventor." Indeed, some might claim that innovation occurs so rapidly that large organizations have great difficulty responding to favorable climates for innovation or producing significant breakthroughs. What is more, as software becomes an increasingly important element of the industry and requires minimal investment beyond "sweat equity," the conditions conducive to the "rogue" inventor would appear to remain.

This examination of what amounts to the business history of the computer industry, its principal players, and its social context, will provide us with clues as to what drives the process of innovation in computer technology. How much of it is social climate and agenda? How much springs from the activities of established enterprise? How much comes from individuals? What motivates innovatio: a creative impulse, or an economic calculation? Oral interviews with many of the leading figures in the industry should provide insights on these questions.

5) Social and Individual Adaptation to Change.

Just as rapid innovation in computer technology has created an industry of unique character, so too has it placed unique demands on society and individuals. In *Future Shock*, Alvin Toffler identifies a malady that he attributes to individuals' inability to adapt to the ever-increasing pace of change.[1] The popularity of Toffler's ideas,

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[1] Alvin Toffler, *Future Shock*, (New York: Bantam Books, 1970).

particularly in Japan, demonstrates the empathy many people feel for this theme in the modern world.

The sociologist William F. Ogburn identified technology as an environment, similar to the social and natural environments, to which human beings must adapt. Ogburn postulated that technological change builds a momentum all its own, that a new technology is implemented and applied, simply "because it was there." This thesis of "technological determinism" implies that insufficient human contemplation is involved in the process of implementing technology (as might also be inferred from some of the dilemmas we discussed above). Since technology seems to progress autonomously, Ogburn observed, human institutions, values, and priorities are often left by the wayside. This phenomenon he labeled "social lag."[1]

While the thesis of technological determinism and social lag has been widely disputed, there can be little doubt that, though it may or may not accurately describe the process of technological "progress," it does reflect the sentiments of many people in modern society, who feel left behind and alienated by the rapid and monumental shifts in their technological environment, changes typified and in many cases driven by innovations in computer technology.

We shall explore the strains that such rapid technological change has put on individuals and institutions. With computer equipment progressing at such a rate that it becomes "obsolete" in a few short years, what sorts of changes in decision making have organizations had to adopt to remain up-to-date? How effectively do educational institutions prepare citizens to cope with such a constantly changing environment? And, most important, who is able to adapt to the technology?

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[1]William F. Ogburn, "Technology as Environment," in *Technology and Change*, ed. John G. Burke and Marshall C. Eakin, (San Fransisco: Boyd & Fraser, 1979), pp. 154-160.

Though some have argued that the proliferation of computers, particularly for personal use, has disseminated control of the technology beyond the "technological priesthood," in a movement similar to the Protestant Reformation, it still remains the case that a limited portion of the population has access to computers and adequate training in their use. Inner-city and rural schools serving poor populations, owing to already strained resources, have not been as successful in acquiring the equipment necessary to provide valuable instruction in computers to their students. The rapidity of the very developments that on one level appear to have a democratizing affect on the use of computer technology, may actually perpetuate and exacerbate the rift between the "technological initiates" and the "technologically illiterate." We shall critically examine the historical development of the use of computers for indications of a "reformation."

Finally, although we have selected the word "revolution" as part of our working title for the exhibit, part of the planning phase of the exhibit will be to explore exactly how "revolutionary" the impact of the computer has been. The word revolution connotes rapid, radical, and <u>fundamental</u> change. While even a cursory glance at the history of computers reveals progress unprecedented by any other technology, deeper reflection upon the matter brings into question whether in fact they have had significantly altered the human condition. True, computers have brought new problems within the realm of solvability, they have allowed us to solve old problems in new ways, and have raised new dilemmas, but how drastically has this changed human life? Nonetheless, sufficient quantitative change can bring about qualitative change. Have computers reached this threshold point? Drawing on the notion described by Thomas Kuhn in *The Structure of Scientific Revolutions,* [1]we shall examine this issue by looking for evidence of the emergence of new

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[1]Thomas S. Kuhn, *The Structure of Scientific Revolutions,* (Chicago: Univ. of Chicago Press, 1970).

"paradigms" of thought and technology structures linked to the computer technology.

APPROACH AND PRELIMINARY DESCRIPTION

Milestones of a Revolution will occupy 3,750 square feet of permanent gallery space in The Computer Museum. The project will also incorporate the production of educational materials and programs for teachers and students. To expand the reach of the exhibition further beyond the walls of the Museum, we are considering the production of a "catalog" in the form of a book that can be read without reference to the exhibition and that might be distributed nationally.

The following description is the product of preliminary planning discussions between Museum staff members and members of our advisory committee, as well as other experts. It is by no means a commited plan for the exhibit but is meant to serve as one possible scenario that can serve as a framework for investigating and interpreting the issues the planning phase will address.

In contrast to traditional history exhibits, which tend to be static displays built around artifacts, *Milestones of a Revolution* will be a multimedia and multidimensional experience built around artifacts. The essence of learning is curiosity, and the expression of curiosity is questioning. *Milestones* will integrate artifacts and video with interactive elements to create an environment that challenges visitors and is responsive to their hunger to learn, an environment where they can actively explore a more complete representation of the past according to their own questions and interests. This is particularly important since we wish to convey the social context and broad ramifications of computers from the past. By being multilayered and rich in content, the exhibit will be personally relevant to, and will better serve, the needs of a diverse audience.

In order to structure a presentation that will meaningfully portray the complex process of history to a museum audience, a preliminary committee has identified a strategy that will guide the visitor through the complex terrain of the technological development of the computer: the milestone approach. Rather than focus on the innovations themselves, which may yet take years to have any significant impact, the committee chose to focus upon the fruition and integration of a new idea that reflected a new technical, social, or operational environment. This "milestone" approach will be less overwhelming than a more dense "timeline" and will, hence, more effectively enhance the understanding of the visitor with little prior computer-related knowledge.

So far we have envisioned these "milestones" to be represented by distinct modules in the exhibit. The centerpiece of each module might be a vignette focusing on a "seminal" machine in the history of computing, one of the the "crown jewels" of the Museum's collection. These "milestones" will be chosen according to their ability to convey the themes described in the previous section of this proposal. The vignettes will incorporate artifacts, ephemera, manikins, and photomurals into accurate reconstructions of the environment in which computers were used. Surrounding each vignette will be an interpretive presentation exploiting text, photos, graphics, and interactive video. These media will reinforce the vignettes to impart a vivid impression of the interpenetration of technological and social change.

Adjacent to each vignette will be an important and innovative interpretive element of the exhibit: the *Interactive History Navigator*. Using computers and special interactive software that we shall design, visitors will be able to pursue the questions that the vignette brings to mind. The systems will harness video, photos, graphics, animation, and simulation in aiding the visitors' explorations. Likewise, the computer will allow visitors to put themselves in someone else's shoes to appreciate how computers affected the lives of people in the past. The vignette will give visitors a glimpse of time past; the *Interactive History Navigator* will, in essence, allow visitors to "travel" through it.

Though the exhibit will present a coherent interpretation of the history of computers and their social impact, the effectiveness of this message will depend upon our framing the presentation in a manner that visitors can relate to their own lives. Our audience is diverse, so it is imperative that our presentation be flexible enough to appeal to many different perspectives. When visitors are involved in the interpretive presentation, it becomes relevant to them. Thus, while the Museum will compile and organize all the information in the *Interactive History Navigator*, through their use of the computers in the exhibit visitors will create in their own minds a view of history that is meaningful to them. The very attribute that makes the computer useful in so many disciplines, its ability to organize and sift through vast quantities of information and present it in a meaningful form, makes it ideally suited to presenting history in an exhibit. That this is an exhibit on the history of <u>computers</u> makes it even more appropriate.

Problem solving will be used as an interpretive device as well. Visitors will encounter situations that present them with economic, social, and ethical dilemmas. Resolving these dilemmas will give visitors a better sense of the historical process of technological development and implementation and the complex issues involved.

<u>An Example</u>
Let us examine how these techniques might be used in the context of a display centered on the Univac I, the computer that launched the U.S. computer industry. This will illustrate how some of the primary themes of the exhibit might be conveyed.

The Univac I will be the centerpiece of a display that treats the early commercially available computers. An outgrowth of the immediate post-War projects, and still far from becoming the commodity they are today, the Univac I and other early computers available for purchase broke the barrier between the government or university laboratory and the marketplace, between scientific applications and business applications. It represented a critical step from the one-of-a-kind computer to the mass-produced machine and marked the entrance of the computer into society.

As visitors approach the display, their attention will be drawn first to the Univac I installation. From the heavy, gray-metal, "streamlined" design of the machine, the clothing of the operator, and a calendar hung on the wall, visitors will be able to "locate" the time period of the vignette. Other visual impressions, such as the size and evident complexity of the machine with all its lights and buttons, will convey to visitors information about this epoch in computing; computers of the 1950s were not even remotely "user friendly." They were built to be impressive and awe-inspiring, to look powerful. In this manner the artifact will speak for itself. These impressions will be reinforced and augmented by supporting text panels that describe the incredible expense of owning and operating a Univac I, how 100 people were required to operate it, and so on.

A video monitor suspended to one side of the setting will show Walter Cronkite and Charles Collingwood covering the Univac I predicting Eisenhower's victory in the 1952 presidential election. The contemporary attitude toward computers is revealed in the very language of Cronkite's comment: "This is the face of a Univac." So, too, will the treatment of the computer in Art Linkletter's popular game show *"Aren't People Funny?"* where a Univac computer arranged compatible couples from among the show's contestants. In both cases, the computer is personified and mystified, treated as an inscrutable and omniscient creature with virtually superhuman abilities. The mythologizing of the computer during this period generally characterized it as a benign colossus, a "Prometheus."

Just as the Univac I led computers into business, it also led them into the public arena. The film clip covering the Univac I predicting the results of the 1952 election will provide a vivid example. Visitors will be asked to consider the effect this practice has had on the democratic process; thereby, illustrating to them one of the central themes of the exhibit: computers solve problems and create dilemmas.

The vignette and supporting media will present a wealth of information to visitors. Incorporated into the displays beside the vignette will be a computer that invites visitors to satisfy their curiosity and to pursue any questions the display may have raised in their mind.

"Got a question? Ask it here." an *Interactive History Navigator* invites the passing visitor. On the screen, is an image of the Univac I and a series of questions: "Who developed the Univac I?" "Who bought it?" "How fast was it?" "What else was going on at the time?" "So what?" The questions will be designed to appeal to the interests of diverse visitors, from enthusiastic engineers to tough-minded teenagers.

Selecting the "Who developed the Univac I?" button will trigger a short video sequence showing an image of J. Presper Eckert and John W. Mauchly. A narrator's voice will identify them:

> John W. Mauchly and J. Presper Eckert, Jr. were pioneers in computer design at the Moore School of Engineering in Philadelphia. However, constrained by the school's policy on patents, they and several other engineers left to form their own company. Together this group produced the Univac I, the first computer available for sale in the United States.

Immediately, the computer screen will present such topics as "biographical information," "previous work," "others who worked on the project," and "success of the venture" that the visitor might wish to explore. The further the visitor pursues a particular course of inquiry, the more detailed the presentation will become.

Not everyone may be so ambitious, patient, or enthusiastic. If a visitor selects the response "So what?" the computer agrees:

> "You know, at the time, most people agreed with you. In the 1950s, few saw the computer as anything more than a gadget for scientists. Some even saw it as threatening. For example . . . ."

At this point, the computer would run a clip of the confrontation between Spencer Tracy and Katherine Hepburn as he tries to automate her office in the movie, *The Desk Set*. (She objects to the dehumanizing aspects of the computer.) Encountering views sympathetic to their own in an exhibit helps break down skeptical or intimidated visitors' hesitation; they will be encouraged to delve further.

The selections of video and text that the *Interactive History Navigator* will display will be carefully crafted to convey and to reinforce the central themes of the exhibit. For example, problem solving on the computer will play an important role in the interpretation of this module. Some visitors will view the adoption of innovative technologies as an inevitable and natural decision. Others, when they see the $1 million price tag of the Univac I and its, by today's standards, limited capabilities, may ask themselves why anyone would have spent so much money on such a machine. The *Navigator* will enable visitors to investigate this issue. Visitors will be asked to play the role of a president of an aircraft company faced with the decision of whether to purchase a Univac I. At their direction, the *Navigator* will present visitors with information they wish to consider to make their decision. For example, the costs of designing an airplane with and without Univac I might be compared. Other considerations the "president" must weigh are the effect on his employees of computerizing his operations, and the prestige it will lend his company to have such a sophisticated piece of equipment. Confronting these difficult issues will show visitors that the adoption of a new technology is by no means a clear-cut decision, that it has many ramifications the visitor may not have considered, and that ultimately the decision rests with people.

At every point in the *Interactive History Navigator,* options will be structured in such a way that the visitor may return to a more general level of inquiry or break off on a tangent to pursue a new course of investigation. Of course, visitors may continue to explore topics that capture their interest at greater levels of detail. Though the museum and its consultants will carefully select the options available to the visitors and the interpretation of the content of the system, simply having access to such a diversity of materials and the ability to draw connections between events, trends, and changes in their own minds will give visitors a better appreciation for the complexity of the historical process.

The computer will allow the visitor to navigate the full terrain of the past in which the vignettes are landmarks. Though the opening display on each *Interactive History Navigator* will relate specifically to the vignette where the station is installed, each station will have access to the complete database of the entire exhibit. Thus, using the *Interactive History Navigator,* the visitor may move forward or backward in time to establish links between the events portrayed in the discrete vignettes and to gain a broader historical perspective that includes events and trends that happened between and around the milestones. Historians agree that history is a complex web of diverse and intertwining forces coming together to influence any particular event or development. Such a display will enable people to traverse this web and and gain a better sense of its intricacies.

The richness of material that we will be able to present through this technology would be impossible to approach using conventional media; it would simply overwhelm and intimidate visitors if presented in any other manner; it is almost as if we are opening up our entire archival collection to all our visitors yet still providing a structure that gives it meaning. That computers can actively engage, and dynamically respond to, visitors is icing on the cake, albeit very important icing. Our goal is education; encouraging participation is pedagogically sound practice.

EDUCATIONAL VALUE

On a general level, the educational value of this project will be to encourage the better appreciation of the historical process and the interaction of technology and culture. This will enhance the general public's understanding of the society in which they live.

On a specific level, the exhibition will contribute to an improved understanding of how computers (which the public already recognizes as an important and influential technology) have arisen, how they have affected our society and, in turn, been shaped by our values and culture, and what impact all this has had on our lives as human beings.

WORK PLAN

The products of the planning activities will be complete conceptual plans, exhibit text and labels, a prototype interactive system for formative evaluation, educational materials, and a collection of photographs and films to be used in the exhibit.

What Has Been Done

In **June, 1988**, the Exhibitions Committee of the Museum's Board of Directors approved the develop of a major new exhibition on the history of the computer and its impact. That **fall**, Dr. Gwen Bell, Director of Collections, began the concerted acquisition of historically significant artifacts. In **December**, Greg Welch was hired as Exhibit Developer of the project, and a Preliminary Planning Committee was formed. In **January 1989**, the Committee held its first meeting to discuss the needs of the general public and the objectives and general approach of the exhibit. In February, the Museum, in consultation with experts, proposed a structure for the interpretation of the exhibit's content. This proposal was refined and elaborated at a meeting of the Museum's Collection Committee in February and at the second meeting of the Preliminary Planning Committee on **March 15**. Artists rendered a vision of the exhibit, a budget and timetable were defined, and fund-raising began. In **April**, several major artifacts that may form part of the exhibit were acquired, including components of a Univac I system unearthed in a garage in Tennessee and a Cray 1M computer from Cray Research, Inc. A proposal for an equipment grant was submitted to Apple Computer, Inc.. On **May 15**, the Committee met and reassessed the overall interpretive message of the exhibit.

Future Activities

1) Completing Preliminary Work. Over the **summer and fall of 1989**, the preliminary planning phase of the project will be completed. The Museum staff and designer Richard Fowler will create a master plan that incorporates the exhibit space into the overall framework of the Museum. Mr. Fowler will also set preliminary design specifications for the gallery space. Greg Welch will continue to coordinate fund-raising activities, to establish cooperative relationships with private institutions, and to identify sources of background information and exhibit materials. Toward the end of this preliminary period, in late **fall 1989**, Mr. Welch will oversee the hiring of two research assistants and a software developer. The former two will be graduates in history or similar fields of study with strong research and organizational skills. The software developer must have experience not only in programming but also in the design of visual displays of information. In the case of the latter, Mr. Welch will work with the supplier of the computer equipment in selecting the best candidate.

Work on refining the exhibit proposal will continue to provide a foundation for future discussion. All consultants will be kept abreast of the project's progress and provided with materials to prepare themselves for the full planning phase.

2) A Three-phased Planning Project. We have broken the planning of the exhibit into three phases: investigative, collection, and creative.

I. Investigative Phase

In **January 1990**, the Museum will host a meeting of all the exhibit's consultants to discuss the course of research and exposition of the exhibit's primary themes. Of particular importance will be discussion of the central interpretive metaphor of the exhibit. Unless these are redefined at the time, we anticipate that thereafter research on the central themes of the exhibit will be broken into three "paths": studying the computer's socioeconomic impact (themes 2, 4, and 5), its cultural/intellectual impact (themes 1, 3, 5), and the sociocultural context in which this technological development took place (themes 1, 2, and 4). The group will break into teams to focus on planning a course of study for investigating and interpreting each of the three areas in the context of the central themes of the exhibit. Dr. David Marc will provide advice on the course of research in the cultural impact and social context areas. Dr. Ruth Cowan(and an economic historian yet to be determine) will advise on the development of the socioeconomic research. Dr. I. B. Cohen and Dr. Merritt Roe Smith will also provide assistance in planning these efforts and overall guidance.

Over the **next month**, Greg Welch will participate in and oversee the research activities of the two assistants, while maintaining communication with the consultants. After one month's time, independent meetings of each team will be held to define the interpretation and content of the themes it is exploring. In these meetings, the team, under the direction of the advisor, will determine the topics and events that must be included in the exhibit to express successfully the themes in question. This in turn will dictate which artifacts, photographs, videos, and other materials must be collected for the exhibit.

Concurrent with this activity, Mr. Welch will work with the software developer to specify the organization and presentation of the *Interactive History Navigator*. After these specifications have been approved in a staff review, the developer will commence writing a prototype for formative evaluation.

II. Collection Phase

Following the final investigative team meetings, the Museum staff will enter a tw-week phase in which the directions of the teams will be compiled into a coherent overall plan and outline. This will include creating a master list of all films, videos, photographs, artifacts required for the exhibit. The staff will then enter the collection phase of planning; it will last **three months**.

One of the research assistants will be given charge of the collection of video and film footage, the other of acquiring photographs and artifacts. Following the recommendations of a conservation committee's report sponsored under a grant from the Institute of Museum Services, this assistant will work in conjunction with the Museum's Collections Manager and Dr. Gwen Bell in evaluating the restoration artifacts may require. Mr. Welch, during this phase, will work on refining the interpretation of, and integrating, the exhibit's primary themes. The software developer will work to complete the prototype.

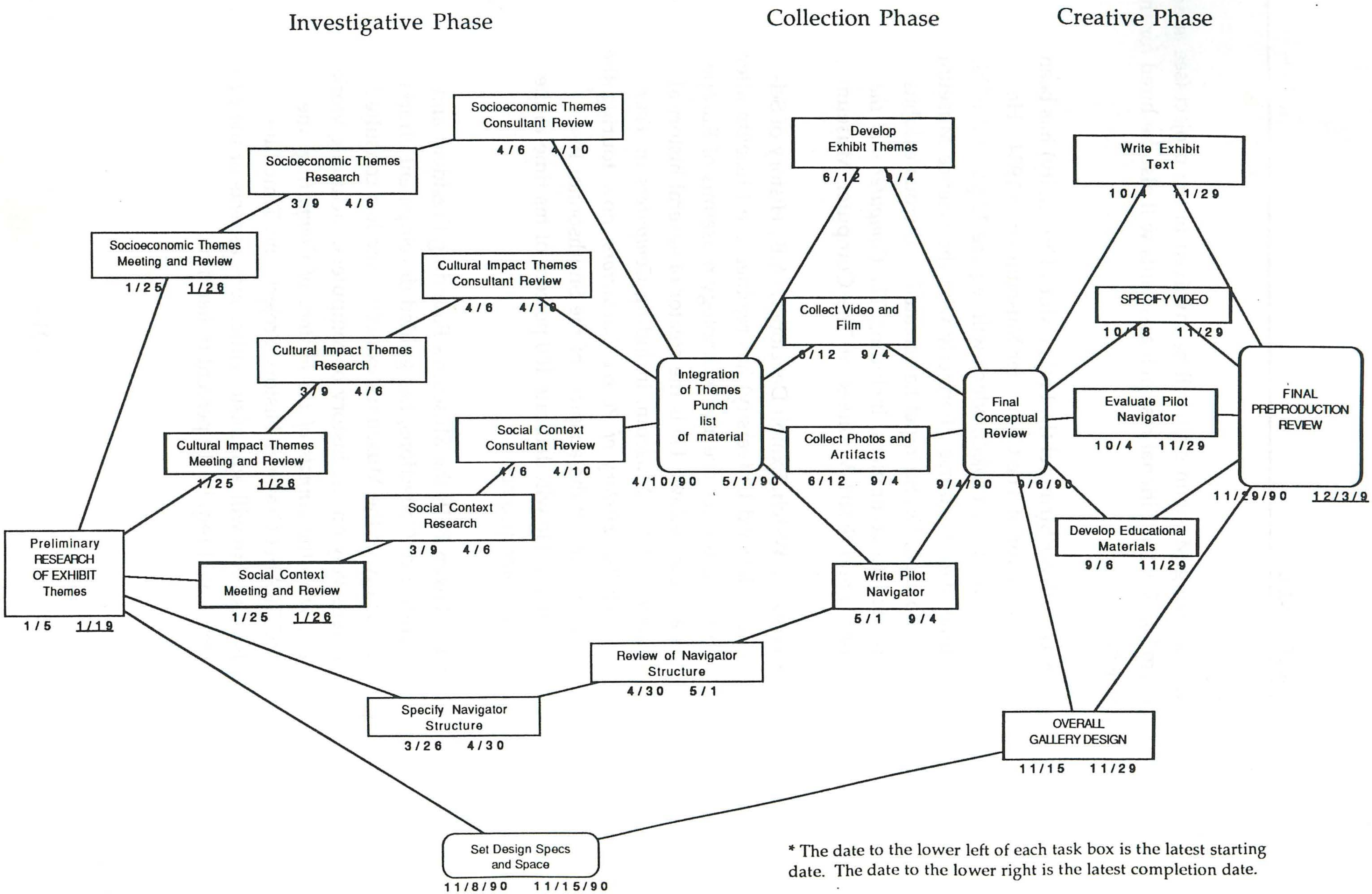
III. Creative Phase

In **September 1990**, the advisors will all convene for a final conceptual review of the exhibit. Pending approval of the exhibit's content and approach, including the central interpretive metaphor, the project will enter the creation phase of planning. Mr. Welch will take charge of **writing the exhibit text.** One assistant will work on specifying the **video** selections for the exhibit, the other on assisting the Museum's Director of Education, Adeline Naiman, in the creation of **educational materials and programs** to complement the exhibition. Advisor Jane Manzelli will collaborate on this effort. The **software** developer will **evaluate** and refine the *Navigator* prototype. Richard Fowler will formulate the **preliminary overall designs** of the exhibition.

All materials produced during this period will be collected for a final pre-production review meeting in **December, 1990.**

Please refer to the chart on the following page for a timetable of these activities.

Timetable*



* The date to the lower left of each task box is the latest starting date. The date to the lower right is the latest completion date.

PERSONNEL

Staff

The following Museum staff will be involved in the project (see attached resumés). Two additional research assistants will also be hired for this project.

- **Dr. Oliver Strimpel** (D. Phil., Oxford University) has been the Curator of The Computer Museum since 1984. He will direct the project, which will require 20 percent of his time over its course. Formerly with the Science Museum in London, Dr. Strimpel has created numerous exhibits related to computers, including *The Computer and the Image* and *Smart Machines,* at The Computer Museum.

- **Gregory Welch**, Exhibit Developer, (A.B., History of Science, Harvard University) has rejoined the Museum after studying the science and technology museums of Europe as a Shaw Fellow. He is the creator of several historical exhibits at the Museum, including *Computers in Your Pocket: The History of Pocket Calculators,* now touring the country under the auspices of the Smithsonian Institution. He will dedicate 100 percent of his time to the *Milestones* project.

- **Dr. Gwen Bell**, the Museum's Founding President and Director of Collections, has guided development efforts for many of the Museum's exhibits. She has consulted extensively on the history of computers, including working with the *Annals of the History of Computing,* the SIGGRAPH Graphics History Project, and Time-Life Books. She will administer collections aspects of the project. It will require 10 percent of her time.

- **Richard Fowler** will join the team in June, 1989, as Exhibit Designer. He is the Designer Director of England's award-winning National Museum of Photography, Film, and Television. Mr. Fowler will spend one year at the Museum; 10 percent of this time will be dedicated to this project.

- **Adeline Naiman**, (A.B., History and Literature, Radcliffe) the Museum's Director of Education, is an expert on the use of computers in education and has been Director of HRM Software and of Technical Education Research Centers. Author of books and columns on the use of computers in education, she is vice-chair of the Massachusetts Educational Technology Council. She will spend 10 percent of her time working on the project overseeing the creation of educational materials and programs to accompany the exhibit.

- **Daniel Griscom**, the Museum's Exhibits Engineer (B.S. Computer Science, Massachusetts Institute of Technology) will work closely with the software developer in the implementation of the *Interactive History Navigator*. This will account for 10 percent of his time.

Consultants

The Computer Museum has succeed in drawing together a distinguished committee of consultants to investigate and elaborate the central themes and content of the exhibition. These include scholars of the history of science, the history of technology, and cultural history. We anticipate adding an economic historian to their ranks shortly. The consultants who have already committed themselves to the project are:

- **Professor I. Bernard Cohen**, (emeritus) Harvard University, is a distinguished figure in the study of the history of science. He is an expert on Sir Isaac Newton and is author of, among many publications, *Revolution in Science.* He has long had an interest in and is one of the foremost authorities on the history of computing. He has worked with the office of Charles and Ray Eames and consulted for IBM on the creation of historical exhibits. He recently published articles on the work of Howard Aiken and Charles Babbage and is in the processes of writing Aiken's biography. He has provided input during the preliminary phase of the planing.

- **Dr. Ruth Schwartz Cowan**, SUNY Stony Brook, has written extensively on the impact of technology on women and social institutions. She has taught courses on social studies of science and the history of technology. She will bring an appreciation of the interaction of technology and society to the *Milestones* exhibit.

- **Dr. David Marc**, Brandeis University, has written extensively on social impact of television. His books <u>Comic Visions: Television Comedy and American Culture</u> and <u>Demographic Vistas: Television in American Culture</u> have been widely acclaimed. He will bring to the project the insights of a cultural historian.

- **Professor Merritt Roe Smith**, Massachusetts Institute of Technology, is an award-winning author of books and papers on the history of technology. Among his many advisory roles, he serves on the executive committee of the Council for Understanding Technology in Human Affairs. He is also President of the Society for the History of Technology. Dr. Smith's broad vision of technology in American society will place the role of the computer in context.

Advisors

The Museum depends on the efforts and expertise of many volunteers. To ensure technical accuracy and well-formulated interpretation in the exhibit, we have drawn together a group of experts in computer hardware and software, communications, and education. These advisors include.

- **Charles W. Bachman**, president of Bachman Information Systems. He is a former Vice-president of Cullinet Software and holds many patents for his work in database management systems. Among many honors, he received the prestigious Association for Computing Machinery (ACM) Alan M. Turing Award.

- **C. Gordon Bell** of Ardent Computer, formerly Associate Director for Computer and Information Sciences for the National Science Foundation and Senior Vice-president of Engineering at the Digital Equipment Corporation, was the architect of Digital's computers from the establishment of the minicomputer through the VAX series, Encore's multiprocessors, and Ardent's graphics supercomputers. He is the recipient of the ACM's Eckert-Mauchly Award.

- **Gardner Hendrie** is a member of the venture capital group Sigma Partners. Hendrie designed several minicomputers and led the design of Stratus Computers' fault tolerant systems. He is Chairman of the Computer Museum's Board of Directors.

- **Jane A. Manzelli** is the coordinator of computer curriculum for the Brookline, Massachusetts, Public Schools, one of the most respected school systems in the country. She has prepared a curriculum on computer history for middle school and high school students and is very knowledgeable about young students' understanding, what they will bring to the exhibit, and what they will be able to assimilate.

- **Christopher Morgan**, formerly Editor-in-chief of *BYTE* and *Popular Computing* magazines and a Vice-president of Lotus Development Corporation, now collects and sells rare books related to computing. His technical background includes a post as Senior Design Engineer with Pratt and Whitney.

- **Jonathan Rotenberg** is Founder and President of the Boston Computer Society, an organization that unites over 30,000 computer users across the country and disseminates information on the use of personal computers.

RESOURCES

Aside from The Computer Museum's own collections, archives, and library, this project will draw on many resources in the planning and creation of the exhibition. The Museum already has a joint collections agreement with the Smithsonian Institution, under which it may borrow computer artifacts not being displayed in their exhibits. For example, we currently have on loan parts of a Univac I system. We will also exploit the resources of the Charles Babbage Institute, which includes the largest archives pertaining to the history of the computer. For more diverse research purposes we expect to use the library and archives of the Museum of Broadcasting, the Hagley Museum, area universities, and corporations, such as Time-Life and IBM.

The Computer Museum was incorporated in 1982 as a public non-profit institution dedicated to educating the public about computers and preserving computer history. It possesses the world's most comprehensive collection of historic computers and related artifacts, as well as extensive film, video, and photo archives. Its 25,000 square feet of exhibits range from reconstructions of early computer installations to state-of-the-art displays on computer graphics, artificial intelligence, and robotics. *Milestones of a Revolution* will be the cornerstone of a four-year, three-million-dollar project to redevelop 12,000 square feet of existing galleries and add 5,000 square feet of new exhibits. This project will ensure that the Museum's exhibits will serve an an ever-broader audience.

A Diverse Audience

The Computer Museum appeals to people of all ages and backgrounds. Each year, 100,000 visitors from around the globe come to see the Museum. Half come from outside Massachusetts, and a sizable percentage come from outside the U.S. Fifty-five percent of the Museum's visitors are students; over half of these come on school tours. Families account for forty percent of visitorship, and the mix between men and women is fairly even. Studies show that a significant portion of the Museum's visitors hold higher degrees. Journalists, professionals, and scholars also draw on the resources of the Museum's collections, archives, and knowledgeable staff. Outreach programs are continually expanding the scope of the Museum's audience. And, in addition, the Museum has two traveling exhibitions that have been seen by museum-goers across the country.

A Mandate to Educate

The mission of the Computer Museum is —

- to educate and inspire people of all ages and backgrounds through dynamic exhibitions and programs on the technology, applications, and impact of computers.

- to preserve and interpret the history and promote the understanding of computers worldwide.
- to be an international resource for research into the history of computers and to encourage informed perspectives on the topic.

Consequently, education permeates exhibit design and function throughout the Museum, and in addition, the Education Department prepares and delivers programs within and outside the Museum that are based on exhibit topics and serve diverse audiences.

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The
Computer
Museum

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March 23, 1990

Gardner Hendrie
Sigma Partners
P.O. Box 1158
Northboro, MA 01532

Dear Gardner,

The latest meetings of advisors and consultants to the *Milestones* project were successful and productive. I have enclosed the minutes from these meetings. We are very close to a workable definition of the exhibit's approach and general presentation and must now move to nailing down the precise content.

I have enclosed worksheets that begin to organize the various themes and topics of the exhibit by milestone. (They are working documents—we are not commited to them.) Please examine these sheets for any topics, events, people, technologies, etc. that you would delete or add. I will provide you with more detailed materials prior to the next meeting, **April 26, from 12:30-6:00**, when the advisors and consultants will meet together. **(Note: the time has been changed due to scheduling difficulties.)**

Lastly, I have begun the search for a research assistant. In case you know of any appropriate candidates, I have enclosed the job description.

We look forward to seeing you again soon.

Sincerely,

Gregory W. Welch

Gregory W. Welch
Exhibit Developer

MILESTONES OF A REVOLUTION

Advisory Committee Meeting
February 15, 1990
2:30pm-5:30pm

MINUTES

In attendance:

Gordon Bell, Gwen Bell, Richard Case, I. Bernard Cohen, John Diebold, Richard Fowler, Jane Manzelli, Chris Morgan, Jean Sammet, Oliver Strimpel, and Greg Welch

Purpose:

To introduce new members of the Committee to the exhibit, and to discuss in the context of three milestones how the exhibit will convey some of the major themes in the evolution of computing.

Introduction:

Planning and Sponsorship
Dr. Strimpel presented the purpose of the exhibit in the context of the Museum's mission, the progress of fundraising, and the schedule of the project. The possibility of touring the exhibit was discussed , but deemed impractical. Potential European sponsors of the project were suggested, among them, Siemens, Bull, and Nixdorf.

Approach and Content
Greg Welch presented the rationale for presenting history through milestones and described the nine milestones previously selected with reference to a preliminary floor plan. Several points were raised:

- the inclusion of artifacts from the Museum's existing timeline among the milestone vignettes
- the importance of the user's role in the development of computers
- the value of being able to investigate the antecedents and descendents of each milestone
- whether a system of questions could be developed that could be treated at each milestone

General Discussion:

An International Focus

Gwen Bell raised the issue of how international the scope of the exhibit should be. John Diebold felt an international perspective would shed light on different patterns of integrating computer into society. In particular he mentioned two points:

- the contrast between the "smart roads" and other national and transnational initiatives Europe and Japan and the model for computer permeation in the U.S.
- the value of investigating developments that have not taken place

Pulling the Exhibit Together

Chris Morgan proposed creating "segways" between milestone that would take a larger view, place the milestones in context, and help visitors negotiate the "scene changes" from one vignette to another. Mr. Diebold stressed the importance of understanding the visitor's needs and expectations.

How to present FORTRAN and COBOL?

Discussion focused on how to present the concept of higher level programming languages in a manner that visitors could appreciate the significance of developments such as FORTRAN and COBOL. Mr. Morgan offered two possible approaches:

1) present the techniques an tools used by programmers and how they have changed over time
2) through a single application (e.g. playing tic-tac-toe) should how it would have been programmed at different points in time.

Jean Sammet suggested a different approach: showing the expression of a problem (such as adding three numbers) in machine code, symbolic assembly code, and FORTRAN respectively. COBOL could be shown calculating a payroll. She stressed the additional difference that whereas FORTRAN was formulated specifically for the IBM 704, COBOL, from the very outset was conceived to be used on many machines. Various suggestions were made as to how this presentation could be made more compelling:

- illustrate the amount of time it took express a problem at different levels of code
- portray the development as a struggle to use computers more effectively (could encompass other languages, such as APT, and operating systems too)
- compare the evolution of programming languages to the evolution of natural languages
- convey the excitement of learning FORTRAN in the early days
- appeal to the aesthetics of higher level languages
- use "laziness" as an explanation of the development

Richard Case pointed out that the difficulty of conveying the importance of such developments as COBOL is that in hindsight they appear trivial and obvious.

Richard Fowler questioned what form the actual vignette would take. Chris Morgan proposed a series of video screens portray how a circle has been drawn over the ages. Gordon Bell proposed leaving the space empty to reflect the ephemerality of software. Mr. Fowler felt that might work.

PDP-8

Industrial, agricultural, and health care applications were all offered as possibilities for the application displayed in the PDP-8 vignette. Laboratory data acquisition and the control of stadium score boards were also discussed. Monitoring a patient in an intensive care unit was felt to be an appropriate application. This could be complemented by a video displaying the myriad applications of minicomputers. Gordon Bell described the minicomputer as a chameleon of a machine.

The IBM System/360

Jean Sammet summarized the importance of the IBM System/360:

1) the first commercial family of upwardly-compatible computers
2) it could be used equally effectively in both scientific and business data processing applications.

She felt that is was therefore perhaps appropriate to display two installations side-by-side. She recommended a business use (e.g. insurance) next to a scientific application such as in the space program. Dr. Strimpel questioned whether then it might not also be appropriate to show the whole family somehow. Photographs and scale models were recommended as means of displaying the whole family. While the use of a 360 in a developing country was offered as a possible installations it was concluded that perhaps this was better left for the PC area.

MILESTONES OF A REVOLUTION

Consultants Committee Meeting
February 22, 1990
12:30pm

MINUTES

In attendance:
Daniel Bell, Gwen Bell, Richard Fowler, David Marc, Adeline Naiman, Howard Segal, Merritt Roe Smith, Oliver Strimpel, Greg Welch

Purpose:

To introduce new members of the Committee to the exhibit and to discuss what humanities themes in the evolution of computing the Milestones exhibit should seek to convey and how it should do so.

Introduction:

Planning and Sponsorship
Dr. Strimpel presented the purpose of the exhibit in the context of the Museum's mission, the progress of fundraising, and the schedule of the project.

Approach and Content
Greg Welch discussed the rationale for presenting history through milestones and described the nine milestones previously selected.

General Discussion

Individual Perspectives
Daniel Bell delineated eight themes the exhibit might treat:

1) what have computers meant in the lives of people
    - have had less of direct impact than TV
2) computers have contributed in the latest change in the nature of work from
    - man against Nature, to
    - man against fabricated nature, to
    - game between persons
3) shift from machine technology to intellectual technology

4) three trends in the underlying matrices in which computers are imbedded are:

1. movement from mechanical to electrical to electronic
2. process of miniaturization
3. digitization

5) problems associated with computers -- technological glitches in highly complex systems (e.g. report by McNeil/Lehr 2/21/90)

6) computers as emblematic of the a new relationship to knowledge, particularly the centrality of theoretical knowledge

7) the distinction between data, information and knowledge

- data is like a name index
- information is a subject index (organized under a rubric)
- knowledge is a judgement of what constitutes a subject

therefore, there has not been a knowledge explosion, merely information explosion

8) modeling as form of understanding the world—four problems as applies to computers:

1. modeling things to things (robotics)
2. modeling things to people (human interfacing)
3. modeling people to people (communication between people through computers) very difficult
4. modeling of things to judgements (AI)

Roe Smith then provided insights into how he thinks about technology:

- technology as expanding knowledge
- technology as a social force
- technology as a social product

The last idea he felt ought to be central to the exhibit. In particular, he stressed that the important role of the government and military in the evolution of computing ought to be highlighted. For example, Robert Fano commented that in the 1960s his original ARPA grants to start Project MAC "educated a generation of computer scientists." Smith mentioned the Edward R. Morrow report on automation circa 1956 as a good source for vintage film material characterizing the nexus between government, university and private enterprise in the development of computers.

Bell added that the evolution of Project MAC out of an investigation of which computers to purchase for MIT illustrates how a novel solution in one area can break open whole fields. He cited the Commission on the Year 2000 (1965) as a source for examining how people in the past looked toward the future and noted that at the time many people were apprehensive toward computers because they were perceived as a powerful tools available only to an elite and that this elicited proposals of setting computers up as utilities available to all, similar to electricity and telephones. The PC and networking has essentially obviated this fear. In this context, Bell expressed concern that the exhibit portrayed an almost Darwinian notion of the evolution of the computer, whereas the preceding examples demonstrate how its course is really punctuated by jumps, mutations, reorganizations, etc.

Howard Segal felt that perhaps touching upon the inaccuracy of the prognostications of many of the early pioneers might help counterbalance the notion that computers have evolved along an inevitable and rational path. He added that people should leave the exhibit with a sense of:

- the expectedness of the development and proliferation of computers
- the way the early fear of computers and automation has dissipated

David Marc commented upon the awe and excitement with which technological innovation was received in the US by describing a 1948 report by Edward R. Morrow in which the audience were the first people in history to see both the Atlantic and the Pacific simultaneously. Marc continued by contrasting the massification of the TV and the computer. In contrast to the television, computers have entered most people's lives through verticalized applications, such as banking, self-ticketing terminals, etc.

Addressing the Public's Concerns

Discussion then focussed on answering the questions visitors might have regarding how computers have affected the world. The conclusion was that, though generalized questions tended to over simplify or distort problems, it was important to help shed light on concerns visitors might have. The privacy issue and fear of job displacement were offered as examples of dilemmas that cause people concern. (It was felt that conducting surveys of visitors' concerns could guide this effort.)

Arranging the Themes Within the Exhibit

In discussing how the exhibit should treat the many themes proposed, the consensus was that rather than string a single issue across many milestones, it would be better to highlight it at the most salient point. The importance of different issues changes over time as technology changes and creates new agendas. For example, the military and the space program were very important elements in the 1960s, whereas networking in the 1980s expands the importance of the marketplace. This sort of treatment would serve to "thicken" the milestones approach, which was deemed an appropriate strategy.

Illustrating the Dynamics of Technological Developments

One way to avoid the appearance of the inevitability of the development of computers was at each milestone to examine the problems that provoked the development of new technologies and also to investigate unexpected developments, deadends, and bottlenecks in the course of the evolution of computers. The example of the unfulfilled promise of machine translation was offered as an illuminating failure. A curious characteristic of technological innovation is that it moves forward but looks backward at the same time. By referring to the evidence of old designs implemented in new technologies clearly visible in the transition from stage coach to rail carriage and from buggy to automobile, this principle could perhaps be illustrated in the less intuitive case of the transition from one basic circuit component technology to the next in computers. The people involved in the development of computers are also crucial elements of the story of the exhibit.

The image of the computer in popular narrative

Another element essential to illustrating the social impact of the computer is to portray how the public has perceived the technology. David Marc testified to the following depictions of computers:

- seven different TV episodes playing on the idea of computer dating. (the computer always makes a mistake)
- four episodes of the Twilight Zone where the computer or robot becomes love-object (in all, the computer must teach the person that love can only exist between humans)
- Art Linkletter's show, "People are Funny," used a computer to make dates between contestants. (The computer is filmed to make it appear colossal.)

The common theme united these portrayals of computers is the question what is the machine's relationship to love? According to Marc, the machine is a tragic figure; it reawakens the capacity for love, but "sacrifices" itself.

The Paradoxical Mythical Identity of the Computer: Slave or Master?

Marc set out the competing roles of the computer in popular myth:

- the computer as monster that will de-humanize and enslave us
- the computer as savior from irksome toil, our slave without guilt

Ellul analyzed the machine as evidence of mankind's hubris, an attempt to overcome the burden of labor placed upon it by the Fall.

Roe Smith discussed the paradoxical perception of the computer in the case of the introduction of computers to machine shops where, in contrast to being welcomed as a toil-saving device, it is resented as controlling and de-skilling the human workers. Daniel Bell, however, contested that this is somewhat of a false problem, that if you take a longer-term view you see the computer is in fact part of a trend toward more technically skilled labor. He felt it would be illuminating to depict the shifts in occupations that have accompanied the proliferation of computer.

These competing perspectives on computer are epitomized by the debate on technology between Emerson and Thoreau. Segal emphasized that computers, like all technological advances, are always mixed blessings. He cited the number of jobs that have been displaced by computers versus the number of new jobs that have been created through the use of computers., or the promise of the "electronic cottage" versus the "electronic sweat-shop." Oliver Strimpel felt that such debates and dilemmas could be instantiated through videos of people taking confronting stances.

Computers, Imperfection, and Acceptable Risk

Another paradox emerges in the implementation of complex systems, such as networks, where benefits are poised against risks of vulnerability. Citing the case of the 15 million-line program for a 747, which theoretically might contain 50,000 lines with errors, Daniel Bell felt it might be valuable for the exhibit to discuss the levels of acceptable risk in various fields and how are these risks judged and arbitrated.

The Computer as an Instrument of Social Change
Have computers actually changed social structures and organizations? Daniel Bell asserted that the answer to this lies in examining whether the locus of control has been changed by computers, and he argued that it has been. Real-time computing, communication, and control at a distance have changed the dynamics of power. For example, international, real-time currency markets mean that the control of its currency's exchange rate now lies beyond national governments.

The Computer and Democracy
Discussion briefly touched upon the impact, potential and actual, of the computer upon the democratic process. On the one hand, the use of computer polling has had a debatable effect upon the legislative and electoral processes. While on the other, mass communication and computer tallying offer the potential for true participatory democracy. But, would this be desirable?

Treating the Humanities Themes Within the Milestones

1) Pre-Computing (Punched Cards)
The theme of the positive administration of social programs versus the de-humanization of quantified social engineering was discussed. Again emerged the notion of information processing technology as both problem solver and creator.

Recording-keeping as an essential element of civilization was also touched upon. In using the Social Security application we must put it in the context of the large-scale gathering of statistics for the administration of social policies. "How do you keep your records?" was offered as a question that could link visitors to this theme. "What is the most important number in your life?" "What's your number?" were also suggested.

Numbers and people seemed to be the focus of the discussion of these various ideas. A quote from the Bible pertaining to numbers could illustrate the centrality of numbers to the human experience. Henry Adams also discussed the importance of numbers. What is the relationship between human values and individuality and numbers? The notion of exponential growth arises during this period. (Rittenour (sp?), Del Sola Price) The growth and proliferation of telephones is also linked to numbers. The need for information processing technologies was fueled by the explosion in and need to expand and make meaning of quantified knowledge.

(The idea of using toke (sp?) machines that calculated odds on horse races was offered as an alternative to the punched card-S.S. application. Lottery numbers?)

2) The Computer Emerges (Whirlwind)
Linking the development of the computer with developments in theoretical mathematics, such as Turing's work, and the Monte Carlo method was emphasized. Just as "numbers" was the word summing up the first milestone, so might "codes" be the word representing the presentation at this milestone. Reference was made again to Turing, the work at Bletchley Park, the Enigma machines, etc. Again people have a personal connection with codes: PIN codes, security codes, etc.

However, as the Whirlwind started out as a machine designed for fire control for ships, and ended up doing real-time flight simulation—an illustration of how technology is often used for purposes other than the intended—"simulation" would seem the appropriate word to capture the essence of this machine. The importance of including interviews of people who worked on the machine was stressed.

3) The Computer Goes to Market (UNIVAC I)
While the first milestones illustrated the computer breaking into government and military applications, the UNIVAC I represented the computer breaking into the business market. Its use also coincided with the increased centralization and erection of very large business organizations. (This could be confirmed by speaking with Alfred Chandler at MIT.) Post-WWII was the era of the emergence of the modern corporation.

The relationship between the computer and labor was discussed. The computer as a strike breaking tool, in the case of the Cadillac Seville strike, where GM threatened to take the tapes with the data for the tools to Mexico, was offered as an example, so too was the film of the computerized press being installed at the NY Times. However, it was felt that this might be more appropriate in the PDP-8 area.

Since the UNIVAC I was the first computer to receive wide-spread public attention, it was felt one of the important themes in this area should be the public perception of the computer. Gwen Bell recounted references to the "IBM Univac," and Roe Smith recalled smart kids being called "UNIVAC" in school. In fact, "The Computer Goes Public" might be a better title for this milestone.

4) Telling Computers What to Do (FORTRAN and COBOL)
"Control" was suggested as the central theme in this milestone. That people control computers via programming and programming languages and that they do so according to certain agendas and to certain ends is a crucial part of this story. People and what they do in programming and designing languages are also important here. In some sense the rapid proliferation of programming languages is the search for the Universal Key to knowledge, a search stretching back through Leibnitz and Pascal.

All this activity then leads to the evolution of the computer programming profession and the software industry. While early programs on the pioneering machines was many times done by women, once the occupation is professionalized it is dominated by men. The emergence of the profession might be illustrated by census data showing when the profession was first listed and its growth over time. (In fact, in 1963 the growth curve predicted that by 1990 everyone would be a programmer.) The intersecting cost curves of hardware and software is an important element of this milestone.

Likewise, the culture surrounding computers and the idea of the computer nerd might become an element of this display. The transition from the computer nerd as the organization man to the counter culture hero might be touched upon. Perhaps videos could introduce visitors to actual programmers. The television ads for schools of programming might be a source for film.

The essential story in this vignette is giving the machine instructions.

5. Big Business Buys the Computer (IBM 360)
Standardization and uniformity are important themes here. Comparisons might be made with other standards with which the public is familiar: audio tapes (8-track vs. cassette), video (beta vs. vhs).

To counter act the impression of Whiggism, the growing dependency on computers could be highlighted and the vulnerability to failure. (Examples?)

The civil rights movement would be the social backdrop to this milestone. On the one hand the computer is part of a larger trend toward increasingly rapid flow of information which led to greater social self-awareness and faster response. On the other, the computer is "the machine," the tool of the establishment, as referred to by Mario Salvio in his famous speech at Berkeley.

6. Real-time computers (PDP-8)
Real-time computing, networking, monitoring, process control were discussed as the key topics of this milestone.

Discussion passed over the Supercomputing (CRAY-1) milestone and proceeded to the Personal Computing milestone.

8. Personal Computing
Information retrieval and analysis on a personal level was the central theme discussed. This trend has had ramifications on the organization of work. The sale of computers in retail stores is emblematic of the trend toward downsizing, and the growing focus on personalized services provided by smaller organizations may be signalling the obsolescence of the large corporation. Bennetton was offered as an example of the new organization built upon centralized information and decentralized, customized production. Al Chandler is writing about this. The PC is part of the Post-Fordism era, the earliest examples of which are European.

9. The Ubiquitous Microprocessors
How many computers do you own/use? One theme that was offered as relevant to this area was the change in public perception of the computer from at first fear and apprehension to complacent acceptance and eager embracing of the technology.

Conclusion

The committee agreed to meet in April with the Advisors, but emphasized the importance of having a very concrete agenda drawn up and a synopsis of the exhibit distributed ahead of time for discussion.

Title/topic

Computing Before Computers

1940

Tech./Use Punched Card Accounting Machines used by Social Security Administration

Themes

- Manipulating numbers essential to civilization
- Punched cards used in administrative and commercial applications.
- Need for data processing and calculating technologies predates the computer.
- Technology has benefits and costs—in this case, facilitates social programs, but at price of defining person as a number.
- Human clerks execute the program, are components of the system.

Context

- Depression Era (US Social Security Act, Wealth Tax Act, 1935)
- Emergence of social engineering, large federal government and buracracy
- 40-hour work week established in US (1938)
- 1936 Dale Carnegie: "How to win Friends..."
- Chaplin, "Modern Times" (1936)
- Hoover Dam ('36)
- First issue Life magazine (1936)

People

- Thomas J. Watson Sr.
  - President and Founder of IBM
- Roosevelt
- Wallace Eckert
- Vannevar Bush
- Comeric
- people from S.S.A

Polemical Issues

- individualism vs. assigning a number

Other Comp. Tech.

- Adding machines
  - Burroughs, Monroe, Marchant, Oedner
- Punch card tabulators
  - Remington Rand, Powers Samis
- Cash Registers
  - NCR
- Analog devices
  - Bush Differential Analyzer
- Toke machines

Other Tech. and Science

- Telegraph
- Telephone
- Radar (1935)
- Radio (30 million in US)
- TV (1938, 20,000 in NYC) (Edward R. Morrow broadcast)
- Ballpoint pen (1938)
- Jet engine (1937)
- Nylon patented (1937)
- Helicopter (1939)
- Blue Riband competitions

Perception

Future

- Continued in use through 1960s

Failures, Deadends, Bottlenecks

- lack of programmability and calcuating speed?

Interactives

- What's your number?
- Simulated punched card.

Outside U.S.

Title/topic

The Computer Emerges

late 1940s

Tech./Use Whirlwind I, scientific application at MIT for military

Themes

- Computers developed to overcome computational barriers in sceintific applications
- United developments in theoretical mathematics with engineering advances.
- WWII provided impetus.
- Experimental machines built by non-specialists.
- International dialog and cooperation
- Stored program made computers a unique tool.
- Machines likeWhirlwind inaugurated computer *simulation* of reality.

Context

- WWII, Cold War, and consequent military sponsorship of research and engineering.
- Orwell's 1984 (1949)
- McCarthyism
- Establishment of UN.
- Emergence of large-scale and heroic science

People

- Zuse, Atansoff, Aiken, Stibitz
- Eckert-Mauchly, etc.
- Turing, Flowers, and other British pioneers
- von Neumann (and fellow who developed Monte Carlo method)
- ERA folks

Polemical Issues

- military-funded research (Weiner)

Other Comp. Tech.

- ABC, Z1, ASCC, Model K, Bell Model 1
- ENIAC, Colossus, Z2-4
- EDSAC, EDVAC, Manchester Mark I

Other Tech. and Science

- Electron microscope, RCA 1940
- Helicopter, 1940
- Dacron 1941
- Kaiser's "Liberty" ships
- magnetic recording tape invented 1942
- Manhatten project--A-bomb exploded July 16, 1945
- Xerox, 1946
- Sound barrier broken, 1947
- Transistor

Perception

- nescience and misconception "giant electronic brain"
- "heroic inventors"

Future

- SAGE system—continuing military impetus for innovation.
- inaccurate predictions by pioneers?

Failures, Deadends, Bottlenecks

- memory crunch

Interactives

- stored program

Outside U.S.

Title/topic

The Computer Goes Public

1951

Tech./Use UNIVAC I, in large-scale private business use

Themes

- emergence of an industry as computers become commercial products.
- computers generally very large, expensive equipment affordable by only few large organizations
-

Context

- post-War economic boom, growth of very large business organizations

People

- corp head of Remington Rand
- other big users with vision of computer (Rockefeller, Nielson, folks at GE?)

Polemical Issues

- Pollock and Weber: "Revolution of the Robots," and Whyte's "The Organization Man" (1956)
- effect of computer polling and prediction on democratic process.

Other Comp. Tech.

- IBM 701, 650, etc.
- LEO, Ferranti, Bull?
- other U.S. manufacturercs?
- German manufacturers (Zuse, Siemens)
- vacuum tube technology

Other Tech. and Science

- color television (1951)
- H-bomb (1952)
- Contraceptive pill (1952)
- atomically generated electricty first used (1955)

Perception

- UNIVAC I used in CBS election prediction — "that miraculous electronic brain"
- awe—UNIVAC I used in Linkletter's "People Are Funny"
- smart kids called "Univac's"

Future

UNIVAC I set precedent for mainframes

- company eventually became UNISYS

Failures, Deadends, Bottlenecks

- were there companies that failed? Eckert-Mauchly computer corp?

Interactives

Outside U.S.

Title/topic

Telling Computers What to Do

later 1950s

Tech./Use The development of FORTRAN, COBOL, and operating systems.

Themes

- increased use of computers stimulates efforts to make their use more efficient
- "control" central issue
- emergence and importance of programmers, the profession and the industry (census data)
- search for standard—but profileration
- cost cruves of hardware and software

Context

- Galbraith's "The Affluent Society" (1957)
- Parkingson's law (1957)
- Beat Generation
- Elvis Presley

People

- Backus
- Hopper
- others?

Polemical Issues

- as "programming" became a profession became male-dominated.

Other Comp. Tech.

- operating systems
- many higher-level languages

Other Tech. and Science

- Sputnick (1957)
- NASA established 1958
- Nuclear submarine "Nautilus" pass under North Pole (1958)
- laser (1960)

Perception

- Computer professional as "nerd" or "organization man"?

Future

- FORTRAN and COBOL continue to be used.
- many other higher-level langauges followed

Failures, Deadends, Bottlenecks

- re-programming costs
- promise of Machine Translation

Interactives

- Programming & Computer Languages

Outside U.S.

Title/topic

Big Business Buys the Computer

mid-1960s

Tech./Use IBM System/360 in Travelers Insurance application

Themes

• growth in large-scale business data processing
• data bases made possible by mass-storage technology
• privacy issue
• "family" approach is attempt to apply standards
• standardization and unifromity central element of 360 family and large businesses

Context

• growth of multinational corporations
• Civil Rights and Student movements
  - Martin Luther King, Malcolm X, Mario Salvio
• Beatles
• Ralph Nader, "Unsafe at Any Speed," (1965)
• Selma, Alabama riots (1965)
• Eastern Seaboard balckout (1965)
• NY World's Fair

People

Bob. O Evans
Gene Amdahl
Richard Case, other IBMers
users, analysts

Polemical Issues

• information is power and is also subject to abuse
• privacy issue surrounding databases
• vulnerability from dependence on computers
• computer as tool of establishment (Mario Salvio) vs. part of increased facility for communication and organization

Other Comp. Tech.

• mass storage devices
• other systems
• Snow White and the seven dwarves: GE, Honeywell, Control Data, RCA, Burroughs, NCR, Univac
• Japanses firms: NEAC, others?
• European firms?

Other Tech. and Science

• first heart transplant operation

Perception

• fears of computers as powerful tools for an elite—proposals of "computing utilities"
• computer dating episodes, Twilight Zone episodes

Future

• Commision on the Year 2000 (1965)

Failures, Deadends, Bottlenecks

• Josephson junction technology (1962)
• software "crisis"

Interactives

Outside U.S.

Title/topic

Real-time Computing

late-1960s

Tech./Use PDP-8 in hospital application (?)

Themes
- smaller, cheaper computers expanded use
- networking, monitoring, process control, distributed processing
- affordable to smaller organizations or as components in larger systems (OEM industry)

Context
- M.L. King assasinated (1968)
- escalation of Vietnam War
- wide-spread student riots
- musical "Hair" (1968)
- movie "2001: A Space Odyssey"
- Woodstock (1969)

People
- Ken Olsen
- Edson De Castro
- An Wang

Polemical Issues
- computer & labor: spares from toil or displaces? (computerization of NYT vs. figures of technocial employment)

Other Comp. Tech.
- SDS
- CCC
- ATMs
- ARPANET

Other Tech. and Science
- First heart transplant (1967)
- Pulsars discovered (1968)
- "The Double Helix" Watson & Crick (1968)
- Concorde's first test flight (1969)
- Apollo moon landing (1969)
- use of DDT and cyclamates and MSG in food restricted
- GM recalls thousands of cars

Perception

Future
- minicomputers proliferate

Failures, Deadends, Bottlenecks
- Viatron?
- magnetic buble memory

Interactives

Outside U.S.

Title/topic

Supercomputing

late 1970s

Tech./Use CRAY-1 computer system at Lawrence Livermore Laboratories

Themes

- powerful computers change process of science and engineering
- simulation takes place of experimentation
- miltary funds much of this development
- technology becomes a national secutiry priotity
- parallel processing techniques

Context

- Space shuttle makes first flight (1977)
-

People

- Seymour Cray
- George Michael and other users?
- others?

Polemical Issues

- national security vs. dissemination of scientific knowledge

Other Comp. Tech.

- other supercomputing projects? Japanese?

Other Tech. and Science

- neutron bomb tested (1977)
- Alaskan oil pipeline
- discovery of the quark (1977)
- test-tube baby born in England
- Amoco Cadiz oil spill off England

Perception

- awe?

Future

Failures, Deadends, Bottlenecks

Interactives

How fast are computers?

Outside U.S.

Fifth Generation Project in Japan

Title/topic

Personal Computing

early 1980s

Tech./Use IBM PC in home or small business setting

Themes

• cheap, microprocessor-based computers inaugurated the era of one computer-one person
• the computer becomes a personal/professional tool
• access to and analysis of data
• affects the organization of work
  - smaller scale, personalized services and products characterize the post-Fordism era
• grass-roots computing—counter culturist, hobbiests, engineers

Context

• success of Benneton or other similiar European organization?
• shift toward more technically-skilled labor
• shift of locus of control—more decentralized

People

• Truoung
• Wozniak
• Jobs
• Kay
• Gates

Polemical Issues

• electronic cottage vs. electronic sweatshop

Other Comp. Tech.

Kenbak
Apple II
Commodore
Radio Shack
PC Clones (Compaq, etc.)
European machines?
• Japanese machines
• Third World manufactureres
  - Korea, Brasil
• Software: MS-DOS, CPM, Lotus, Wordprocessors

Other Tech. and Science

Perception

"Machine of the Year"

Future

Failures, Deadends, Bottlenecks

Interactives

• Computer census

Outside U.S.

Title/topic

The Ubiquitous Microprocessor

mid-1980s

Tech./Use Microprocessors embedded in most electronic devices as control elements

Themes

- microprocessors (computers) have become pervasive—they have found their way into the control elements of almost all electronic and electrical systems.
- people in fact "use" many more computers than they are aware

Context

- microchips become international commodoties and national priorities
- growth of Silicon Valley

People

- Ted Hoff, Federico Fagan
- Carver Mead and Lynn Conway
-

Polemical Issues

- should government support national semiconductor industry?

Other Comp. Tech.

- RISC chips
- parallel processing computers
- Fifth Generation languages

Other Tech. and Science

Perception

- from fear and awe of early computers the public is now accepting and complacent, if not eagerly embracing them.
- "You tell us"

Future

- "Smart" houses and roads?

Failures, Deadends, Bottlenecks

Interactives

- "You tell us"

Outside U.S.

The
Computer
Museum

300 Congress Street
Boston, MA 02210

(617) 426-2800

JOB OPENING

The Computer Museum is seeking a Research Assistant to work on the development of a major, multi-media exhibit chronicling the evolution of computing.

Candidates must be independent, motivated workers, with a strong research background and excellent communication skills. In addition to providing general assistance to the Exhibit Developer, the responsibilities of the position will include performing the background research for specific sections of the exhibit, collecting photographs, films, and artifacts for inclusion in the exhibit, and producing a monthly exhibit newsletter. Familiarity with computers beyond word processing not necessary, but helpful. Background in contemporary history desirable.

The Museum wishes to fill this position on a part-time basis through May, and full-time thereafter through May 1991. This can be negotiated. Salary: $18,000.

This position is ideal for anyone seeking to enter the museum field, or for a young scholar who wishes to see the fruits of his/her labor do more than collect dust on a shelf. The Computer Museum is the world's only museum dedicated to preserving and presenting computer technology to the general public. It is a young, dynamic institution with many exciting projects underway. Located at Museum Wharf, (near the South Station subway stop) the Museum is easily reached by public transportation.

Applicants should send a cover letter and résumé to:

Research Assistant Search
The Computer Museum
300 Congress Street
Boston, MA 02210.

Milestones Next Major Exhibit

Milestones of a Revolution is the next major exhibit planned by The Computer Museum. Slated to open in Spring 1991 and filling two bays currently unused on the sixth floor, it can be constructed over the next year unhindered by other museum activities.

The tremendous success of The Walk-Through Computer, recently opened, will give a boost to the fundraising and implemetation of Milestones. Attendance has dramatically increased since the opening, and the public relations department estimates that 200 million people have heard of The Computer Museum in the last fiscal year. Milestones will build on that success by offering a definitive exhibit on the history of computers—an essential element of the world's only computer museum.

NEH Proposal Furthers Planning

The recent submission of a proposal to the National Endowment for the Humanities has substantially advanced the planning of the exhibit. In this Implementation Proposal Greg Welch has articulated the major themes of the exhibit as established by advisors and consultants to the project.

Among the themes to be treated in the exhibit are "Technology," "The dynamics of technological change," "The computer as social product," "The social context," "The font of invention, "Ethical debate," and "Myth and public perception."

Ideas explored under the heading "Technology" will explain the changes in technology which have affected the construction of computers over the years: the punch card, the vacuum tube, the transistor, and the silicon chip. These inventions and others will be featured in the vignettes corresponding to the appropriate time periods. "Dynamics of technological change" will illustrate the complex process of competing techniques involved in every breakthrough and challenge the perception of technological progress as a steady, inevitable march forward. "The computer as social product" will allow visitors to explore the influence of the social environment on the development of computer technologies. Closely linked to this theme will be "The font of invention," an examintaion of the actual institutions and individuals involved in the creation of the machines of each era.

"Ethical debate" will treat issues raised by computers at different points in time, such as debates surrounding the effect of automation in factories or the problem of computer crime. "Public perception" will demonstrate the role the computer has played in the public imagination, examining its depiction in popular culture over time.

Woven through the nine milestones, in the form of text, graphics and interactive exhibits, these themes will bring continuity to the separate vignettes and enable the visitor to leave with a deeper understanding of the computer and its development, and the interaction of technology and society.

Preliminary Floor Plan Established

A preliminary floor plan was produced this June in conjunction with the proposal submitted to the National Endowment for the Humanities.

A primary concern in the planning of this exhibit has been to ensure that the visitors understand where they are in time as they move through the milestones. The design incorporates short corridors between each vignette which lead visitors down the central path by visually framing each vignette. The presentation within each will set the stage for the upcoming milestone by providing information about the social and political climate of the period.

The first corridor leading up to will display a photo of Roosevelt signing the Social Security Act amidst images of the 1930s, from soup kitchens to car advertisements. "Brother Can You Spare a Dime" will play as visitors traverse the tunnel to enter "Of Clerks, Cards, and Collators." The corridor leading visitors on to "Born of the War" will feature images of planes overhead and sound effects of wartime, and the following corridors will continue in the same vein. By guiding visitors through the milestones and providing a format to present the broader social context of each era, each of these "time corridors" will help visitors locate themselves both in the exhibit and in history.

Insider's Grapevine

Pulling Together A Team

As the Museum gears up for the Milestones exhibit, Rachel Hellenga has joined the project as a research assistant for the project. She will be collecting historical materials for the video disk displays, tracking down ephemera to include in the vignettes, producing the newsletter, and doing background research on some of the milestones.

Brad Larson comes to the Museum with extensive experience in the use of technology in museum exhibits. Currently on the staff of the Children's Museum, he will design the interactive video programs to be included in the Milestones exhibit.

Marcia E. Cohen has recently joined the project as a volunteer, pitching in with the production of publications and using her experience as a costume designer to work with the mannequins and the backgrounds in each vignette.

History Buffs...

Do you have a 1978 calendar in your attic? A 1940s telephone? A newspaper from the fifties? A New Deal poster? What about computer paraphernelia from times gone by? Ephemera from each decade will add greatly to the realism of the vignettes and bring them to life for visitors.

A wish list is in the making as Milestones moves into the collections phase of the project: any suggestions for items to include or leads to such items are very welcome.

The information in this newsletter is preliminary material. Please contact the Museum's Exhibits Department for further information.

Milestones of a **Revolution**

Newsletter #2

People and Computers

Milestones Materialize

After a year of discussion among academics, industry advisors, and museum staff, the content of the Milestones exhibit is taking shape. Nine milestones will present significant changes in how computers were used and the social impact they have had.

The exhibit will begin in the mid-1930s with a milestone entitled "Of Clerks, Cards, and Collators." Visitors will enter a 1930s government office and see a punch card machine demonstrate how it performed the data processing required by the newly established Social Security policy. In the second milestone, visitors will walk into the heart of the Whirlwind computer. Entitled "Born of the War," this milestone will illustrate the influence of military research on the development of the computer.

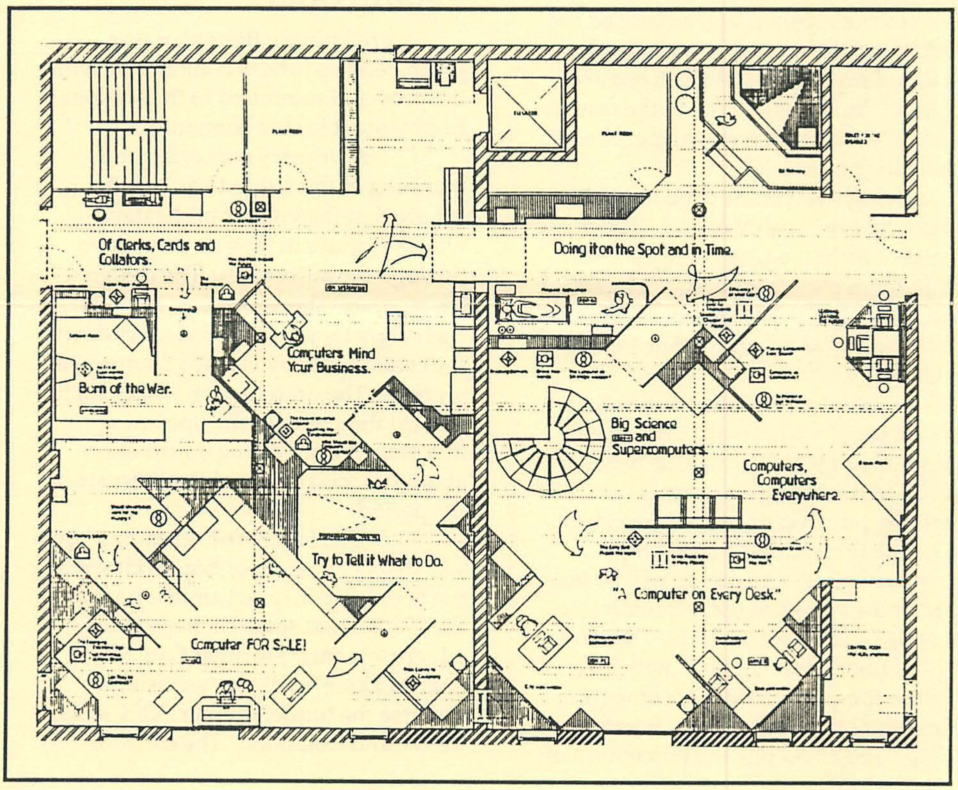
Set in the early 1950s, "Computer for Sale!" will show the first computer commercially available in the United States: the UNIVAC I. National television's portrayal of the UNIVAC I as an "electronic brain" illustrates the public perception of computers at the time. The next milestone, "Try to Tell it What to Do" will focus on software. A film will dramatize the forces, needs, and people that came together to influence the development of programming languages such as FORTAN and COBOL. The fifth milestone, "Computers Mind Your Business," is set in the mid-1960s. This vignette will portray an IBM System/360 in a large insurance company and illustrate how computers became indispensable tools to large corporations and scientific endeavors.

"Doing it on the Spot and in Time" brings visitors into the early 1970s when the development of minicomputers made computers smaller and more affordable. To convey the proliferation of computer applications during this era, this milestone will feature two vignettes: a PDP8i monitoring a patient in a hospital and a second minicomputer in use at an oil refinery.

"Big Science and Supercomputers" will show computers developed for scientific research in the late 1970s. Visitors will "travel" to England where a CRAY-1 system predicts the weather, illustrating the need for a machine which could very quickly perform vast calculations.

In a very different, but contemporaneous, trend in computing, the growth of personal computing from grass roots to an institution will be the topic of "A Computer on Every Desk." This milstone will feature a hacker's desk with an Apple II and an office desk with an IBM PC. The final milestone, "Computers, Computers, Everywhere," will unveil the microprocessors which surround visitors in everyday objects, such as a VCR, a thermostat, an answering machine, a microwave oven, and parts of a car.

A final area in the exhibit will allow vistors to reflect upon what they have learned and to make predictions about what the future may hold.



The Computer Museum

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