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This entire issue is now online at:
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This issue of Core is a wonderful demonstration that being a computer museum is about more than just collecting old computers. It is about designing physical and web-based exhibits to explain the excitement of trying to build smart machines. It is about telling hillbils unknown spy stories leading to the development of Russian computers during the Cold War. It is about bringing classic machines from 40 years ago back to life. It is about the changing fashion in how computers are promoted and sold. It is about building a comprehensive and eclectic collection that includes make-shift hardware, legendary software source code, historic t-shirts, computer-generated 45 RPM records, and news releases about attempted espionage of computer technology.

All these efforts represent different aspects of the same mission: the information revolution is having a profound effect on our civilization, and we owe it to future generations to preserve, understand, and explain how it came to be. To do so, we collect objects of all types as the raw material, we recreate historical conditions for study, and we describe what we know to others. These goals are lofty and important.

But we also do it because it’s fun! Would we have restored the PDP-1 if it wasn’t the “Spacewar! Machine?” Maybe, but maybe not. The man-machine conflict in the computer chess exhibit is the essence of science fiction. The Zelenograd story is in the best tradition of dramatic spy thrillers, except that it’s true. The story of the computer is just not the facts of technological development: it is a rich human story.

What of the chapters that are being written now? The pace of development in computers blurs the distinction between past and future. The British psychiatrist R. D. Laing said, “We live in a moment of history where change is so speeded up that we begin to see the present only when it is already disappearing.” Unlike those who study the history of the printing press or the Crusades, we are both burdened and privileged by having the object of our study evolving in our lifetimes. What an experience that is!

I hope you enjoy this and future issues of Core, and get involved in the effort to preserve computing history. We live in a remarkable time of technological change and should celebrate it joyously.

Len Shustek

Len Shustek is the Chairman of the Computer History Museum. He has been the co-founder of two high-tech companies, a trustee of various non-profit, a director of several corporations, and on the faculty of Carnegie Mellon and Stanford Universities.
Chess is a very ancient game. It probably came to the west from Persia (Iran) via India during the reign of the Persian king Chosroes (c. 576 A.D.). For much of the last fifteen hundred years, chess has been popular with the ruling classes as a test of tactical and strategic acumen, a test whose lessons could possibly be applied to the world stage itself. Indeed, in the Middle East, chess is known as “the game of the king,” and for just five years earlier, in 1849, the word “chess” (from the Persian signifying “the king is dead,” thus “Checkmate.”

Although it had royal origins, chess was also popular with the less privileged, since it is inexpensive, requires no more than a board with 64 black and white squares and some game pieces. Chess boards themselves could be status symbols but the game itself, of course, was no respecter of persons. While it is easy to learn—even children can attain remarkable proficiency—chess has been associated with intellectual pursuits since its earliest beginnings. Since the rules were easy to program into a computer and it had nearly infinite (10 to the 120th power) possible games, chess was interesting to early computer pioneers as a test bed for ideas about computer reasoning. As pioneers in the 1940s sought ways to understand and apply computers to real-world problems, they began almost immediately to use chess.

The Turk

But the story begins not with the birth of the computer in the 1940s, but with an experienced chess player who, in 1769, invented a machine to play chess. Wolfgang von Kempelen built a mechanical chess player called “The Turk.” As part of his desire to rise in social position, Von Kempelen created The Turk as an entertainment and presented it to the Empress Maria Theresa of Austria-Hungary. The Empress and her court were stunned by The Turk’s strong play as well as by its mysterious movements which seemed to indicate it was “thinking.”

Word of The Turk spread quickly throughout Europe and it became a sensation. It would travel to public fairs and royal courts for the next 85 years, amazing audiences and playing such well-known figures as Napoleon Bonaparte, Voltaire, Benjamin Franklin, and even Charles Babbage (who would later design and build one of the earliest mechanical calculating machines). Although some of The Turk’s observers guessed its secret, most had no idea that the source of its playing strength was a human chess player carefully hidden inside.

Although The Turk was eventually revealed to be a magic trick, the drive to build a machine that could think or mimic human abilities continued throughout the 19th and 20th centuries. Indeed, European craftsmen built automata (literally: self-guided machines) that could write, sing, play musical instruments, and even type musical instructions. These automata grew out of the Enlightenment concept of humans as machines that could be understood through rational principles. The movements of automata were usually guided by clockwork mechanisms, which were becoming a mature technology by the mid-19th century. Such creations were illusion, of course, no more intelligent than the human beings capable of capturing and constructing them. The era of automata ended about 1900 at a time when the world’s scientific knowledge was evolving into a system based on mathematical-understanding principles. This brought together an “algorithm” and “metaphysics” or references to mystical (i.e. non-ratio-
Dr. Dietrich Prinz wrote the first limited chess program in 1951. Although the computer was not powerful enough to play a full game, it could find the best move if it was only two moves away from checkmate, known as the “mate-in-two” problem.

Minimax allowed the computer to search a game tree of possible moves and counter-moves, evaluating the best move on its turn and the worst move on its opponent’s turn. The “alpha-beta pruning” technique ignored or “pruned” branches of the search tree that would yield less favorable results, thus saving time. Today most two-person game-playing computer programs use the minimax algorithm with the alpha-beta pruning technique.

The NSS chess program ran on the Johnnac computer, which is on display in the Computer History Museum’s Visible Storage area.

By the early 1960s, students at almost every major university had access to computers, which inevitably led to more research on computer chess. It was in 1959 that MIT freshmen Alan Kotok, Elwyn R. Berlekamp, Michael Laiterburn, Charles Niessen, and Robert A. Wagner started working on a chess-playing program for the IBM 7090 mainframe computer. Their program was based on research by artificial intelligence pioneer John McCarthy. By the time they had graduated in 1962, the program could beat amateurs.

Richard Greenblatt, an MIT programmer and accomplished chess player, looked at this earlier MIT program and decided he could do better. He added 50 heuristics that captured his in-depth knowledge of chess. His MacHack VI program for the DEC PDP-6 computer played at a level far above its predecessors. In 1967, it was the first computer to play against a person in a chess tournament and earned a rating of 1400, the level of a good high school player.

This early success led to giddy predictions about the promise of computers. In fact, psychologist and artificial intelligence pioneer Herbert Simon claimed in 1965 that, “machines will be capable, within 20 years, of doing any work that a man can do.”

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BRUTE FORCE

Work on computer chess continued, mainly in universities. By the 1970s, a community of researchers emerged and began to share new techniques and programs. The introduction of annual computer chess tournaments, hosted by the Association for Computing Machinery (ACM), also created a friendly but competitive atmosphere for programmers to demonstrate and test their programs. Tournament organizer Monty Newborn said of these tournaments: “Play was often interrupted to reevaluate an aiing computer or terminal. The audience howled with laughter. For the participants, however, it was a learning experience.”

At the same time, computers were doubling in speed about every two years. Early computer pioneers tried to make their programs play like people do by relying on knowledge-based searches (or heuristics) to choose the best moves. A new generation of researchers included heuristics, but also relied on increasingly fast hardware to conduct “brute force” searches of game trees, allowing the evaluation of millions of chess positions—something no human could do.

In fact, it was in 1977 at Bell Laboratories, when researchers Ken Thompson and Joe Condon took the brute force approach one step further by developing a custom chess-playing computer called Belle. Connected to a minicomputer, by 1980 Belle included highly specialized circuitry that contained a “move generator” and “board evaluator,” allowing the computer to examine 360,000 positions per second. This custom hardware revolutionized computer chess and was so effective that in 1982 at the North American Computer Chess Championships (NACCC), this $17,000 chess machine beat the Crazy Blitz program running on a $10 million supercomputer. It was a harbinger of how more nimble systems would meet, and ultimately bypass, the performance of much larger machines.

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In this period, chess software also made dramatic progress. The programs CHESS (developed at Northwestern University), the Russian KAISSA, and Thompson and Gondon’s Belle introduced several novel features, many of which are still used today. One of most powerful techniques was “iterative deepening,” a technique that gradually increased the depth of the search tree that a computer could examine, rather than searching to a fixed depth. This allowed the most efficient use of the limited time each player was given to choose a move.

Although computer chess programs had improved significantly, they were still not a match for the top human players. In fact, in 1968 International Master David Levy made a famous bet against John McCarthy that no chess program would beat him for the next 10 years. The Canadian National Exhibition in Toronto in 1978 presented Levy with an opportunity to defend his bet. The top program, CHESS 4.7, would be participating in the tournament. “Until 1977,” said Levy, “there seemed to be no point in my playing a formal challenge against a human player.” Levy won his bet.

**MIGHTY MICROS**

Just as Levy was winning his bet, home computers, such as the Apple II, TRS-80, and Commodore PET, were introduced. It wasn’t long after their introduction that programmers began writing chess programs for these machines so that anyone with a microcomputer could play chess against a computer. Before these commercially available machines, the first microprocessor-based chess programs were produced by hobbyists who shared information openly through computer clubs and magazines. One of the first such programs was Microchess, written in 1976 by Peter Jennings. Microchess sold several million copies and demonstrated that there was an audience for early computer games. Interestingly, some of the early profits came from Microchess赛 were used by the company Personal Software, which had purchased Microchess from Jennings, to help finance the marketing of one of the first spreadsheet programs, VisiCalc.

By the early 1980s, computer software companies and others began selling dedicated chess computers and boards. One of the most successful was the Chess Challenger, sold by Fidelity Electronics. Even though Chess Challenger played below amateur-level chess, the novelty of the product made it an instant success. Other consumer chess boards included interesting features such as feedback and evaluation, which allowed beginners to improve their game. Boris, a Chess Challenger rival, displayed messages in response to the player’s moves such as: “I expected that.”

Annual computer-to-computer competitions also stimulated improvements. The World Microcomputer Chess Championships (WMECC) started in 1989. Funding came from chess software manufacturers, who hoped that placing well in the competition would lead to increased sales. Each year the top programmers refined their code in an effort to win the next World Championship title. Although this competitive atmosphere spurred the development of high-quality chess programs, many early participants lamented the loss of collegiality and openness. Some microcomputer-based programs began challenging mainframe and supercomputer-based programs. For example, in 1989, Sargon, running on a personal computer, defeated the chess program AWTT running on a six-million dollar mainframe computer.

**CHALLENGING THE MASTERS**

As computers steadily played better chess, some developers began to turn their attention to the ultimate challenge: defeating the best human player in the world. The Fredkin Prize, established by Ed Fredkin at Carnegie Mellon University in 1980, offered three prizes for achievement in computer chess. The top prize of $100,000 was for the first program to defeat a reigning World Chess Champion.

One of the centers of such development was Carnegie Mellon University. In the mid-1980s, two competing research groups developed separate chess computers, one named Hector and the other named Chess 4.5. Hector’s developers believed that their program would win the Fredkin Prize, and Chess 4.5’s developers believed that their program would win the Fredkin Prize. In the end, neither program won the prize, but the competition led to increased sales of chess programs and boards.

**Organizer Monty Newborn said of these tournaments:** “Play was often interrupted to resuscitate an ailing computer or terminal. The audience howled with laughter. For the participants, however, it was a learning experience.”
In 1982 at the North American Computer Chess Championships (NACCC), the $17,000 chess machine, Belle, beat the Cray Blitz program running on a $10 million supercomputer. It was a harbinger of how more nimble systems would meet, and ultimately bypass, the performance of much larger machines.

**DEEP BLUE**

The goal to defeat the top human player seemed within reach and the recognition that would come to whoever built a system to do so got one company interested in the challenge. IBM.

IBM Deep Blue was based on IBM's RS/6000 SPX supercomputer consisting of 33 processors in two towers (shown). The 48 identical custom chess chips (integrated circuits) allow the system's performance as a chess playing machine. It calculated 200 million positions per second, at times up to thirty moves ahead.

In 1996, Deep Thought was renamed Deep Blue. By now it could examine 200 million chess positions per second (or about nine to 11 moves ahead) The team felt that Deep Blue was ready to face Kasparov again. At that year's ACM annual conference in Philadelphia, Deep Blue and Kasparov played a best-of-six games match.

In the first game, Deep Blue made history by defeating Kasparov, marking the first time a current World Chess Champion had ever lost a game to a computer. Kasparov bounced back, however, to win the match with a score of 4-2. At the end of the match, to the delight of the IBM team, Kasparov remarked, "In certain kinds of positions it sees so deeply that it plays like God."

Kasparov quickly agreed to a re-match challenge for the following year. To prepare, the team tested the machine against several Grandmasters, and doubled the number of processors. Simultaneously, microprocessors were steadily advancing, leading to David Kattinger's microprocessor-based program, WChess, which in 1994 achieved worldwide acclaim when it won the world's top American Grandmasters at the Intel-Harvard Cup "Man vs. Machine" tournament.

Deep Blue (1997) was based on IBM's RS/6000 SPX supercomputer consisting of 33 processors in two towers (shown). The 48 identical custom chess chips (integrated circuits) allow the system's performance as a chess playing machine. It calculated 200 million positions per second, at times up to thirty moves ahead.

Deep Thought I circuit board, 1988 ca., specialized chess processor.

Deep Blue defeated the best human chess player using large amounts of calculation. But was it a thinking machine? As Murray Campbell, Deep Blue team member, pointed out, "I never considered Deep Blue intelligent in any way. It's just an excellent problem solver in this very specific domain." Campbell's remark's bring to mind Alan Turing's observation that to determine whether a machine is intelligent requires only that it fool a human into believing so. In other words, there is no objective test for intelligence that lies outside of human perception. Though some argue that human thinking is simply a form of calculation and therefore amenable to computer simulation, many disagree. Beyond extremely impressive achievements in specific domains—which will have far-reaching effects on our lives—a machine that can reason in general terms is still quite a few years and many startling breakthroughs away.

Deep Blue's victory over Kasparov was the result of deep thinking and careful planning. Kasparov's win was swift but the team learned many valuable lessons and spent the next seven years refining the machine's software and adding more custom processors.

To promote its image as a leader in computer technology, IBM supported the development of a computer that could beat the World Chess Champion. The Deep Blue team included (left- right) Joe Howe, Joel Benes, Jerry Brooks, Peng-Hsiung Hsu, C.J. Tan and Murray Campbell. IBM also hoped that this research might have applications to complex problems in business and science. Courtesy of IBM Archives, CHM# L062302000
Google’s use of inexpensive personal computers as the backbone of its search engine was born of necessity since founders Larry Page and Sergey Brin did not have much money for equipment. By building a system based on commodity PCs, Google’s aim was to maximize the amount of computational horsepower per square foot at low cost.

This do-it-yourself rack was one of about 30 that Google strung together in its first data center. Even though several of the installed PCs typically failed over time and could not be repaired easily, these “corkboard” server racks—so-called because the four PC system boards on each of its trays are insulated from each other by sheets of cork—launched Google as a company.

—Chris Garcia

Google corkboard server rack
Date: 1999
Collection: Object
Donor: Gift of Google
CHM#: X2839.2005

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Espionage and senate hearings: it’s all in a day’s work for the museum’s Information Technology Corporate Histories Project (ITCHP). This May 5, 1982 news release from Software AG of North America announces that company president John Maguire gave testimony before the U.S. Senate Permanent Subcommittee on Investigations regarding the continued Soviet acquisition of U.S. technology. Maguire provided a first-hand account of the personal interactions that he and other Software AG employees had with Soviet agents over several years, beginning in 1979. That year, Maguire was contacted by a Soviet agent who sought to purchase the source code for Software AG’s database management system, ADABAS. Without the agent’s knowledge, Maguire notified the FBI of the agent’s attempt to obtain the technology. Maguire then cooperated with the FBI by tape-recording conversations with the agent regarding a possible transaction. Thanks to Maguire’s cooperation, the agent was eventually charged and sentenced for his efforts to obtain the source code.

The complete document and many others related to the case, including Maguire’s full statement, are available on the museum’s website.

—Sarah Wilson
Selling the Computer Revolution

By Paula Jabloner

WHAT’S YOUR PROBLEM? Is it the tedious record-keeping and the endless, tedious, routine work of commerce and industry? Or is it the inelegant, mechanical, unscientific methods of solution? Perhaps your problem is now considered impossible because of prohibitive costs associated with conventional methods of solution. The UNIVAC SYSTEM has been developed by the Eckert-Mauchly Computer Corporation to solve such problems. Within its scope come applications as diverse as an air traffic control, census tabulations, market research studies, insurance records, aerodynamic design, oil prospecting, searching chemical literature and economic planning.

In 1951, the first UNIVAC was delivered to the U.S. Census Bureau. Remington Rand, which had bought out the two inventors the year before, created a “UNIVAC Division,” and eventually delivered 46 machines at prices of over $1 million each.

1950s: TRADITION DOMINATES IN THE FACE OF INNOVATION // The UNIVAC brochure (possibly the first computer marketing brochure) does not accurately represent the marketing strategies typically developed in the 1950s when computers were usually marketed as “super-calculators,” not general-purpose machines. Marketing materials were usually narrowly targeted to either business or scientific users, rather than both, as UNIVAC attempted.

Underwood was one of about 30 firms entering the computer business by the early 1950s. In 1956, their Elecom “50,” “The First Electronic Accounting Machine,” was deliberately not marketed to businesses as a “calculator,” but rather for its “accurate-low cost accounting,” which positioned it as an advanced calculator (see pg. 18, item B). Marketing that emphasized similarity to earlier products promoted acceptance of a new product by making it seem to be an extension of existing equipment and techniques.

Yet Elecom is a word created from the first three letters of electronic computer. The brochure iconography uses the canonical stylized Bohr model of the atom so effectively used throughout the 1950s as shorthand for “modern,” “space-age,” and “advanced.”

BUTTONED-UP COMPUTING // As is typical of the computer industry “life-cycle,” by the early 1960s, many of the office products vendors had already left the business, including Underwood. The Control Data 160-A Computer brochure from 1962 markets the same computer for commercial and scientific uses while squarely selling the machine as an electronic computer—not an advanced calculator (see pg. 18, item C).

Fourteen years after the first UNIVAC brochure, Control Data makes many similar claims, advertising the 160-A for “general data processing, data acquisition and reduction...peripheral processing...scientific computing with FORTRAN...civil engineering problems...biomedical experimentation and analysis.” The 160-A is a “low cost” scientific wonder. The technologically savvy person and/or the businessman could read more than five pages of specifications, including that of a magnetic core memory “consisting of 8,192 words...divided into two banks of storage—each with a capacity of 4,096 12-bit words and a storage cycle time of 6.4 microseconds.” The 160-A was sold as a serious business or scientific tool, with men in suits operating the machine that retailed for $60,000.

FASHION COMPUTING // In sharp contrast to the brush cut and slide-rule culture of the scientific user, the 1966 Electronic Associates, Inc. brochure for their Digital Computing System represents an unusual front cover and perhaps the first computer photo shoot that acts in imitation of fashion photography (see pg. 18, item D). Though not Miami Beach, the computer is fully accessorized with peripherals, posing in an outdoor courtyard replete with a model lounging by the fountain. For the bargain minded, the 640 was available at prices starting below $350,000.

Most important, the EAI 640 strikes a balance between the work it can do and the cost to do it. Simply stated, balance means value. The EAI 640 Digital Computing System offers the best value available in small scale computer systems.
By the mid-1960s, advertisers were stressing the flexibility, versatility, expandability, and capacity of the computer to make logical decisions. The computer had come a long way, from being an “advanced calculator” to part of a complete information management system.

**MINIS EVERYWHERE //** By 1970, the tenor of computer marketing had changed again due to the expanding markets achieved with lower cost minicomputers and timesharing services. The DEC PDP-11 brochure shows the joint evolution of the mini-computer and mini-skirt (item E). It is one of the first brochures with women appearing in non-traditional roles. On page five, two women are shown in white lab coats while pursuing research. Possibly this is why the brochure emphasized hard-to-find clerical workers.

One of the most difficult problems facing business today is increasing the productivity of costly, hard-to-find clerks and secretaries. RSTS-11’s power and flexibility offer the benefits of reduced costs, increased customer satisfaction, and increased job satisfaction for clerical workers.

Many advertising campaigns of the 1970s focused on revolutionizing the office through the promise of office automation with a PDP-11, starting at just $20,000.

**COMPUTING FOR THE MASSES //** Is Software Development Getting You Down? Some brochures were just too eye-catching to pass-up, such as Leeco’s 1981 Dimension software (item F), which assisted programmers in writing software. Like so many other marketing materials, the brochure’s pitch centered on taking “advantage of state-of-the-art technology while slashing costs.”

Twenty-five years after the Elecom “50,” technology professionals are starting to forego business attire. Any brochure before the 1970s would have shunned the rolled up sleeves, off kilter ties and chaos depicted in this front cover image. The brochure also illustrates another persistent aspect of the computer industry–short-lived companies. Just as Underwood stopped producing computers by 1960, we are so far unable to locate any information about Leeco.

The 1980s and onward saw the mass marketing of computers as they started becoming ubiquitous in everyday life. But the industry first had to convince people that they needed a computer in their home by encouraging the belief that innovations in the computer industry would make life better. For popular appeal, computer companies made use of well-known celebrity spokespersons such as William Shatner for Commodore or Jack Nicklaus for Atari, along with the use of popular media (TV and mass market periodicals for the first time) and imagery.

One of the most famous TV ads of all time may still be Apple’s “1984” Super bowl commercial. Playing on Orwellian themes of centralized, bureaucratic control—a reference to IBM’s perceived dominance of the computer market—Apple introduced their new personal computer with, “On January 24 Apple Computer will introduce Macintosh. And you’ll see why 1984 won’t be like 1944.”

The personal computer industry has been spectacularly successful. In 1984, as the first Mac was being marketed, 8% of American households owned computers. Almost 20 years later in 2003, 62% of American households (70 million), had one or more computers (55% with Internet access). What a dramatic change from the 1950s, when marketing consisted of extremely targeted mailings to a very small group of interested professionals.

It is 2030 and the Computer History Museum’s “Selling the Computer Revolution”—version 10 has just been announced. What will bring smiles from 2006? The 2008 Consumer Electronics Show, just might provide some intriguing possibilities. Many of the pitches revolve around celebrity, fashion, and size. Will the descendants of the iPod be just as fashionable in 2030?

Appearances by actors Robin Williams and Tom Cruise make it apparent that celebrity marketing is here to stay in the electronics industry. Unlike William Shatner hawking Commodores over 20 years ago, now many technologists have become superheroes in their own right—think “Steve, Bill, Larry and Sergey.”

The staff, volunteers and interns working on the project had a great time reflecting upon the technological advances, marketing strategies, and iconographic changes in the world of tech marketing while creating the website. We hope you’ll enjoy the exhibit just as much. Though not celebrities, we hope you’ve read our marketing pitch—so go turn on that computer, type in www.computerhistory.org/brochures and explore the 261 brochures through curated topics–decades, categories and applications—or a keyword search.

Paula Jablonski is archivist at the Computer History Museum.

**SELECTED WEBSITES**

- [Computer History Museum](http://www.computerhistory.org)
- [The Museum of Science Fiction](http://www.museumofsciencefiction.com)
- [The Computer History Museum’s Online Exhibit of Computer Brochures](http://www.computerhistory.org/brochures)
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• Discount admission to special museum activities
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• Museum memento
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Call 650.810.1026 or join online at www.computerhistory.org/contribute/individual/

Over the past two years, I’ve had the privilege of working with a dedicated, brilliant bunch of guys to bring one of the museum’s PDP-1 minicomputers (first shipped in 1961) back to an operational state. The machine is currently restored, and will soon be moving from the restoration lab into the museum’s demonstration area where it can be seen by all.

In the early 1960s, Bob Savelle used a light pen on the screen of the DEC Type 30 display, which was the display for the PDP-1. The power supplies in the Type 30 took many, many months to fix. This was, in large measure, because the restoration team didn’t want to summarily replace the originals with modern units, and because they had no schematics or other documentation of the supplies, which therefore required reverse engineering. 

He Saw the Cat: Computer Speech, 45 RPM record
Date: 1963
Collection: Media
Donor: Gift of Warren Yogi
CHM#: X3119.2005

Bell Labs was one of the earliest research groups to explore computer speech. During the late 1950s and early 1960s, various scientists there undertook research in computer voice synthesis for possible application to the telephone system.

While they sound primitive today, these early experiments reflected one of the most important research programs in the world attempting to place computer speech on a firm scientific foundation.

The highlight of this recording is the song “Daisy,” performed on an IBM 7094 computer in 1961 with special speech hardware. When film director Stanley Kubrick heard this recording some time later, he decided to use a version of it to form the “dying” words of the ethically-ambiguous HAL 9000 computer in Kubrick’s masterpiece, “2001: A Space Odyssey.”

—Chris Garcia
The original proposal for restoration was written in 2001 when the museum was based at Moffett Field. Joe Fredrick, Eric Smith, and I produced our final proposal on November 4, 2003. The PDP-1 itself was running on May 18, 2004, and the complete machine was fully restored as of November 1, 2005, almost two years to the day since beginning of the project.

Team members have now begun working on the "maintenance phase" and will continue as long as we wish to keep the machine running.

**Getting Started**

The team was comprised mostly of alumni of Dave Babcock's IBM 1620 restoration team, which pioneered the restoration program at the CHM, so we had a good idea of how to go about the project. We had the three of us (Joe as the hardware lead, Eric the software lead, and me), the machine, and a task.

We did no "recruiting" of restoration team members; we figured that if people wanted to help, they would hear about the new effort by the media or by being associated with the museum! In fact, that turned out to be a very good way to acquire team members, and our initial expanded team thus included: Bob Lash, Peter Jennings, Rafael Skodlar, and Al Kossow. Each member came with an impressive array of experience and passion.

Bob Lash had used a PDP-1 at Stanford; Peter Jennings brought a wealth of experience in electronics and old electronic equipment restoration; Rafael Skodlar used to be a DEC service technician on later DEC gear; and Al Kossow is a document scanning and software archiving wizard extraordinaire. Without Al's ceaseless efforts to acquire and scan in PDP-1 documentation and software, we would still be tugging in programs via the panel switches!

We decided to hold our restoration meetings on Tuesday evenings from 6-9 pm. We promised all that no matter how interesting or hopeful an effort might be, we would always be out of the lab by 10 pm. This scheduling and rule worked out quite well for this project.

The team proceeded to do the things all restorations must do: Check and verify the power supplies, inspect for missing or broken parts, replace dangerously frayed power cables, etc. In these early stages, it served it, as it is part of the artifact. Eric whipped up a USB interface to Linux, and we could read the contents of core and pre-store it, as it is part of the artifact. Eric whipped up a USB interface to Linux, and we could read the contents of core and pre-reference the IBM1620 restoration.

**Ongoing Operations**

One of our buddies from the 1620 Restoration Project, electronics genius R. Tim Coslet, decided to join our group, and it took barely a nanosecond to have him welcomed to the team. You see, we had a few "ground rules" and one of them was that existing team members voted on whether a prospective member should join the team. Everybody got one vote, and it had to be unanimous.

This kept our team cohesive. Shortly afterward, Lyle Bickley, a well-known long-time restorer of vintage computers with a wealth of experience also joined the team. One advantage of having more members on the team was the ability to attack several problems during the same work session. So, for example, while Joe and Bob were reforming capacitors, Rafael and Peter could be inspecting and repairing cooling fans, and Eric and Al could be reading in more PDP-1 software paper tapes.

In fact, the entire project was driven by a "checklist" that was written on the whiteboard. Checkmarks showed up as words of main memory, which is good old 12K (three 4K banks) of memory. We knew that having this program running would also help build a bridge between people who were their own age in the early 1960s. Right about this time, Peter Samson joined our group. Peter, you see, was one of the original contributors to Spacewar! (Steve Russell, who helped the team at our kickoff meeting, and who has all along helped via email, was the main Spacewar! creator, and he had help from Peter Samson, Martin Graetz, Wayne Witanen, Alan Kotok, and Dan Edwards.)

Peter also had a trick or two up his sleeve. It turned out that he had written a four-part, music-playing program "in the
For the longest time, we all joked that for months that it was “tagged and bagged” and its replacement was marked with red nail polish or red tape. Removed old parts had recorded its service lifetime, it darn well had better be put back into working order in a matter of days at most!” Well, yes.

We carried over Dave Babcock’s “Principles of Restoration” from the IBM 1620 restoration project. We were always mindful that we were working on an artifact— that we were to “do no harm.” Any decisions on this point were made as a group, and, even then, if we thought we needed further clarification or assistance, we didn’t hesitate to contact Dag Spicer, the museum’s senior curator, for advice.

Whenever a component was replaced, we carried over the Type 30 mechanism, and also typing on the keyboard, which was ready. In fact, we had invited Ken, a student is ready, Ken Sumrall arrived when the Soroban mechanical typewriter. It wasn’t for lack of trying, it's been a problem, but for Peter, well, obviously, the thing to do was to reverse-engineer the machine data sets on paper tape. There was just one problem: Peter was unable to find his original source code. Well, after all, we have a working PDP-1 that has been carefully brought back to functioning. And we believe this is the only functioning PDP-1 in the world!

Although we did have some documentation on the Soroban’s operation, including a complete adjustment manual that Al Kossow found, it was still quite a task to get it working again. Ken wondered if it would ever work! And of course by that time, the project was being called “The Soroban Restoration Project”—not because everybody was working on the Soroban, but because it took months and months to finally “checkmark” on the whiteboard.

**AND SO, IT WORKS!**

You might ask, “Why did it take so long to restore this machine? After all, during its service lifetime, it does well had better be put back into working order in a matter of days at most!” Well, yes.

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In early 1973 an American spy operating under the cover name Philip Staros overcame his claustrophobia and squeezed into the crowded control room of a brand new Soviet Tango-class submarine as it plunged under the icy waters of the Baltic Sea. The largest diesel-powered submarine ever built, the Tango was created to elude and destroy American nuclear submarines.

Speaking confidently in flawless Russian, Staros was demonstrating to a group of Soviet admirals how the Uzel, the first digital computer used in a Soviet sub, could track several targets simultaneously and calculate how the torpedoes should be aimed and fired. He and another American, Joel Barr, known in Russia by the KGB-supplied alias Joseph Berg, had led the team that designed the Uzel.

The story of how Staros—whose real name was Alfred Sarant—came to be onboard that submarine, and of how he and Barr created the Uzel and many other advanced Soviet military technologies, begins in New York in the 1930s. It is a Cold War drama combining espionage, high technology, romance, and betrayal. And it hinges on a question that is as relevant today as it was seven decades ago: Why do intelligent young people dedicate their lives to ideological fantasies?

Six decades later, Barr vividly remembered the personal circumstances that led him to embrace communism as a teenager during the Depression. First there was a “tremendously harrowing scene” when marshals evicted his family from their Brooklyn apartment, then their shame at relying on charity for groceries, and finally the miserable tenement “with no toilet in the apartment, no hot water, only a coal stove for heat,” and elevated trains roaring by twice per minute just feet from the windows.

The Communists’ analysis, that the nation was run by and for a tiny, greedy elite that oppressed the workers, seemed plausible to Barr, as it did to thousands of other young people who grew up in the 1930s in New York’s Jewish ghetto.
Barr enrolled in City College of New York (CCNY), the most radical campus in America, to study electrical engineering. Like other colleges it had two main political groupings, instead of identifying themselves as Democrats or Republicans, however, CCNY students’ allegiance was divided between Stalin and Trotsky. The faculty published an underground Communist publication, Teach-er and Worker, that echoed the Daily Worker.

Barr quickly associated himself with the Stalinists and joined a Young Communist League chapter headed by Julius Rosenberg. After graduating, Barr, Rosenberg and many of their CCNY friends joined the Communist Party. Their world was turned upside down on August 21, 1939, by news of the Soviet Pact. Barr’s friends remained in the Party and, as Jews who understood Hitler’s intentions, in doing so they crossed the line from the left edge of the political spectrum into the territory of the zealot.

After a decade of economic depression, Barr and his comrades considered themselves fortunate to find any work, so they took jobs with virtually the only employer that was hiring, the military.

When Barr started at the U.S. Army Signal Corps Laboratory in the summer of 1940, everything about the technology he was working on, even the word “radar,” was a military secret. Although the job was intellectually stimulating, contributing to the war effort was troubling to Barr and his comrades. The Communist Party of the U.S., following the line dictated by the Kremlin, was stridently opposed to American preparation for war or assistance to Great Britain.

Rosenberg conceived of a way out of the dilemma, a solution that would allow low-salaried communists to work for the military while remaining true to their ideals. The answer was star-ting the blueprint and manual delivery system. This was the “stand-off.”

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Barr remained in covert contact with the KGB as he traveled in Europe, enjoying a bohemian life. He arrived in Paris on July 4, 1949, and convinced Olivier Messiaen, a world famous avant-garde composer, to accept him as a student. Events at home, especially newspaper stories about the arrests of Soviet spies, troubled Barr. Worry turned to panic in June 1950, immediately arrest him, the Bureau interrogated Sarant intensive-ly for a week, hoping that he would crack. Sarant kept his cool, however, and managed to give the FBI the slip. Accompanied by Carol Dayton, a neighbor with whom he’d been having an affair, Sarant escaped to Mexico. Each left a spouse and two young children behind.

Sarant and Dayton contacted Polish intelligence officers in Mexico City. Their escape was straight out of a spy novel, includ-ing hiding in safe houses for months, wearing disguises, carrying false passports, waiting for a moonless night to wade across a river.
The Scientific Center at Zelenograd, headquarters for the Soviet Union's 30 and then sent to Moscow. Barr, who had been working as an engineer in Prague, was brought to the Soviet capital for a dramatic reunion with his old friend. Sarant, who was given the name Philip Staros, presented himself to the Russians as a brilliant engineer who had been thwarted because of his communist beliefs. The KGB believed him, or at any rate was willing to let him prove himself.

The trio was sent to Prague, where Sarant and Barr were put in charge of a team of engineers and tasked with creating a computer that received input from radar, predicted a plane's course and reported on them to his father. The engineer's name was Sergei Khrushchev. In August 1962 Sarant drove the first stake into the ground marking the beginning of construction of Zelenograd. Barr and Sarant's origins were kept secret: Barr's wife didn't learn of his communist beliefs until after his death.

Barr and Sarant's most lasting physical legacy, beyond Zelenograd, became the Soviet version of Silicon Valley, a non-event.

The two Americans retreated to Leningrad where they were commissioned to build computers and microelectronic components for the Soviet space program, the Red Air Force, and civilian industry. The CIA and American technical journals learned about some of Sarant and Barr's computers and, without having any idea that they were designed by Americans, rated them as among the best ever produced in the USSR.

A Rand Corporation journal suggested in 1972 that one of their computers, the Elektronica K-200, signaled "some fundamental shifts and improvements in Soviet design policies." The authors had no idea how correct they were when they wrote that "everything we know about [the Elektronica K-200] suggests technological transfer: transfer of technology from a qualified, capable (by Soviet standards) design and production environment to an application environment long thwarted by unreliable, inappropriately sized monsters produced by other Soviet computer designers, the would be needed to create new generations of computers, including a novel ferrite core computer memory that was likely more advanced than anything in the U.S. at the time.

In 1962 Staros and Berg received a visit from a young engineer who was looking for help with some components of a cruise missile guidance system. He was quite impressed by their achievement and offered to assist them. Sarant told Khrushchev that the future of Soviet power lay not in its capacity to roll tons of steel or make enormous dams, but in its ability to manipulate atoms and molecules. The key to catching up with and surpassing the West, he said, would be microelectronics, a word Sarant had introduced into the Russian language.

Sarant proposed the creation of a secret city dedicated to microelectronics. To his and Barr's astonishment, Khrushchev agreed on the spot. Within months an official decree establishing a new city on the outskirts of Moscow was formally promulgated. The Soviet leader personally signed the papers inducting Sarant into the Communist Party of the Soviet Union and making him a citizen. In August 1962 Sarant drove the first stake into the ground marking the beginning of construction of Zelenograd.

Although it was widely known that they were not Russians, Sarant and Barr's origins were kept secret: Barr's wife didn't learn of his communist beliefs until after his death. Barr and Sarant's meteoric rise was largely due to Khrushchev's role in conceiving and designing Zelenograd, which rapidly friends and reported on them to his father. The engineer's name was Sergei Khrushchev. In August 1962 Sarant drove the first stake into the ground marking the beginning of construction of Zelenograd.

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Among the quietest and most dead-ly submarines in the world, Kilo subs equipped with Uzels are operating today in the fleets of China, Iran, and India. If the Chinese launch an attack on Tai-wan, the Iranians decide to scuttle tank-ers in the Persian Gulf, or India attacks Pakistan’s sea lanes, the torpedoes will be aimed and the craft will be navigated with the assistance of a computer designed by two American Soviet engineers. About the time the Uzel was completed, Barr and Sarant’s fortunes took a turn for the worse. One of their leading antagonists, the head of the Leningrad Party branch, was pro-moted to a candidate member of the Politburo. Through a series of maneuvers, their autonomy was reduced and finally eliminated. Sarant found himself a position as the director of a new artificial-intelligence institute in Vladivostok, as far away from Leningrad as a person could get and still remain in the Soviet Union. Barr stayed behind, retained a super-sized salary, but had few or no of-ficial responsibilities.

Sarant died from a heart attack in 1979 and was eulogized in Izvestia as “a tireless scientist, a talented organizer who for many years gave all his strength and bright talent to the development of Soviet science and technology.” There wasn’t a mention of his foreign origins.

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Barr split the remainder of his life between the Soviet Union and his family in Russia. He was a genuinely devoted family man, with a wife and four children. But at the same time, he was more interested in talking about what could have or should have been than what really happened.

After Barr died I started to put together the picture from intelligence files, interviews with friends, colleagues and relatives—and it quickly became clear that his life and the life of his friend, Alfred Sarant, were far more interesting than I’d realized. Not only were they fascinating individuals, but they had played significant roles both as spies for the Soviet Union during World War II and as pioneers of Soviet high technology.

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Tell us what you know about the personal lives of Barr and Sarant and their families.

As a journalist, I have reported on the intersec-tion of technology, science and public policy for over twenty years. I met Joel Barr in Moscow in 1990. I was researching an article about opportunities for American companies to acquire the rights to Soviet technology. He was introduced to me by a Russian named Joseph Berg. It was clear within seconds that he wasn’t Russian; he sounded like a grown up Bugs Bunny, and on accent like that could only come from New York. The afternoon that we met he took me to Zelenograd, the Soviet Silicon Valley, although he didn’t mention its role in creating it.

We developed a close friendship, I visited him in St. Peters-burg several times and he lived at my home in Washington for weeks and months at a time. We started to work on his autobiography, but the project never got far because Barr was more interested in talking about what could have or should have been than what really happened.

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This is part of a Cray-3 supercomputer, a liquid-cooled machine that had a theoretical performance of 15 GFLOPS (billion floating point operations per second) and that used exotic gallium arsenide (GaAs), instead of silicon, for its circuitry. The Cray-3 was designed to be the fastest machine in the world: a computation that took the fabled 1946 ENIAC machine 67 years, for example, could be completed by the Cray-3 in just one second.

A 2-octant (four-processor) machine consumed 90,000 watts of power (enough to power 35 average U.S. homes) and, like the Cray-2, was cooled by immersion in Fluorinert, a liquid, non-conducting fluoro carbon also used as a blood plasma substitute. One observer of a running Cray-3 described peering at the liquid cooled machine’s interconnect wires through the top cover and seeing them “...waving like kelp in a sea current.”

As the computing world moved to massively parallel computer architectures, machines like the C-3 ceased being attractive. Although Cray Computer Corporation (CCC) shipped one complete 2 octant (4-processor) Cray-3 to NCAR, another to a U.S. intelligence agency on a trial basis, and had a third 4 octant (8-processor) machine in-house, the market failure of the machine forced CCC into bankruptcy. Estimated cost of a full system was $30,000,000.
Artifact donations (alphabetical by donor's last name)

IBM Model K Head Disk Assembly (HDA), X3425.2006, Gift of Carmin Adams

Shugart Associates Model SA400 5 1/4" floppy disk drive, X3186.2005, Gift of James Adkisson

Assorted electronic games (1970s), X3448.2006, Gift of Dwain Aidala

Assorted IBM software, X3144.2005, Gift of Mike Albaugh


Intel 80960 and i486 microprocessor databooks (c. 1988), X3197.2006, Gift of Diane Alexander

Assorted Turbo Pascal software & manuals, X3389.2006, Gift of Jonathan Allan

Modula-2 software development system, X2765.2004, Gift of Jonathan Allen

Collection of 435 computer buttons, X2832.2005, Gift of Dorothy Allen

AltaVista promotional items, documents, X2654.2004, Gift of AltaVista


Apple Pippin game system (S/N 1) and others, X2769.2004, Gift of Dr. Gilbert Amelio
Assorted Honeywell manuals, X3264.2006, Gift of Donald R. Ames

Radio Shack Catalogs (1979-1987), X2636.2004, Gift of John Amos


Trial software assortment, X3066.2005, Gift of Karl W. Anderson

Apple Macintosh software, X2594.2004, Gift of Rick Andrews

Three Rivers PERQ 1 computer (c. 1983), X2778.2004, Gift of a anonymous donor

"NETSCAPE All Hands Meeting" (May 28, 1998) videotape, X2859.2005, Gift of a anonymous donor

“Only the Paranoid Survive ....," book by Andy Grove, X2989.2005, Gift of a anonymous donor

“Paradiso” Philippe Kahn CD recording, X2973.2005, Gift of a anonymous donor

Appletalk and Resedit reference books, X2836.2005, Gift of a anonymous donor

IBM 1.8" and 3.25"glass hard disk platter, X3125.2005, Gift of a anonymous donor


Sun Microsystems historical paper anthologies, X2956.2005, Gift of a anonymous donor
MIT LCS t-shirt, X3135.2005, Gift of a anonymous donor


Xerox PARC and DEC System Research Center documents, X2734.2004, Gift of a anonymous donor

WGBH/PBS "They Made America - Thomas J. Watson, Jr." DVD (2005), X3348.2006, Gift of a anonymous donor


Claris MacPaint and Microsoft Word for Macintosh software (1991), X2748.2004, Gift of a anonymous donor

SRI ARC/NIC Collection (1970s), X3257.2006, Gift of a anonymous donor


Sharp PC-1211 programmable calculator, X2763.2004, Gift of Tom Apple

International PC keyboards, X3171.2005, Gift of Geoff Archer

Apple-related text, software, audio, videotapes, ephemera and hardware, X2768.2004, Gift of Jim Armstrong

UNIVAC I salesman’s model - 12 pieces (1952), X3276.2006, Gift of Larry G. Arnett

Arapple (Arabic Apple II), manuals, software (1980), X3132.2005, Gift of Sami Asfour
PCB layouts for Apple III main logic board, X2845.2005, Gift of Colette Askeland

John V. Atanasoff papers, X2656.2004, Gift of Dr. John V. Atanasoff

Apple Macintosh "MacPaint" source code, X2948.2005, Gift of Bill Atkinson

Original Binae photograph (1949), X2606.2004, Gift of Albert A. Auerbach, PhD

Article on computer dating, 1959, X2598.2004, Gift of Sylvia Auerbach

Personal documents & photographs of Albert Auerbach, X3351.2006, Gift of Sylvia Auerbach

Article describing Hollerith Census Machine in “The Manufacturer and Builder” (1890), X2829.2005, Gift of Dave Babcock


"Wizards and their Wonders" photograph collection (1996), X2692.2004, Gift of Louis Fabian Bachrach


"On the Edge: The Spectacular Rise and Fall of Commodore" book (2005), X3498.2006, Gift of Brian Bagnall

Assorted calculation aids, assorted IBM mainframe documents (c. 1960-70), X3183.2005, Gift of Chuck Baker

"Merry Christmas from Honeywell Electronic Data Processing" 45 rpm record, X3166.2005, Gift of William Baker
Microsoft Windows 3.1 operating system (1992), X3176.2005, Gift of Carl A Baltrunas


Honeywell Multics documents, X2683.2004, Gift of J. N. R. Barnecut


Items relating to the IBM 1360 Photodigital Storage System, X3076.2005, Gift of Bill Bartz


DEC/Compaq Alpha design team t-shirts, X3213.2006, Gift of Allen Baum

DEC pocket reference cards, X2908.2005, Gift of Robert Beazley

Documents on assorted computer companies, X2979.2005, Gift of Jay Beck

SPC related videos, documents and ephemera (c. 1990), X3530.2006, Gift of Janelle Bedke

Honeywell Multics manuals, X2838.2005, Gift of Daniel Beeghly

History of computing books, X2953.2005, Gift of C. Gordon Bell

Assorted books and ephemera relating to computing, X3209.2006, Gift of Gordon Bell

Assorted books, movies, ephemera, X3169.2005, Gift of Gordon Bell

Assorted posters related to computing (c. 1990s), X3486.2006, Gift of Gordon Bell

Collection of scanned manuals, books, images, and papers, X2740.2004, Gift of Gordon Bell

DEC Engineer’s orientation manual (1980), X2792.2004, Gift of Gordon Bell

Historical computing posters (c. 1975-1990), X3100.2005, Gift of Gordon Bell

"Great papers in computer science" book (1996), X2701.2004, Gift of Gwen and Gordon Bell

Computer manuals, promotional brochures, X2645.2004, Gift of Gwen and Gordon Bell

ViaTV video phone and computer posters, X2634.2004, Gift of Gwen and Gordon Bell

"The Powersharing Series" computer pioneer audio interviews (32), X3357.2006, Gift of Gwen Bell

Curta Type I calculator demonstration model, X3117.2005, Gift of the Bell Family Foundation

IBM, Apple software collection (c. 1984), X2751.2004, Gift of Frank Belvin

Personal papers of Robert Bemer, X3054.2005, Gift of Betty Bemer
IBM 5150 personal computer & software, X2993.2005, Gift of Henry E. Bender


Assorted calculators, X3148.2005, Gift of Robert Bennett and Susan Chung

Commemorative IBM Model 10 Card Punch, X2593.2004|102630236, Gift of Paul Benson

Core memory stack for HP Omega, X2802.2004, Gift of Arndt Bergh


IBM 1620 computer system documents (c. 1964), X3350.2006, Gift of Frances Bernstein

Assorted computer-related board games, X3445.2006, Gift of Barbara Berry

Sun SparcStation 1+, X3058.2005, Gift of Fabrizio Bertocci


OS/2 software and manuals, X2775.2004, Gift of Allen Best

PDP-12 minicomputer, software & manuals, X3057.2005, Gift of Lyle Bickley

IBM marketing brochure “The World of Numbers” (1958), X2991.2005, Gift of Pete Blackburn

Personal photographs of IBM machines, X3497.2006, Gift of Dick Blaine

Sears Bowmar Calculator (1973), X3382.2006, Gift of Dick Blaine

Misc. software, X2846.2005, Gift of Michael Blasgen


CDs of early digital audio recordings (1977-1979), X3068.2005, Gift of Jules Bloomenthal

AFIPS Conference proceedings (1972-1986), X3394.2006, Gift of Arnold James Blum

Assorted documents, X2587.2004, Gift of Pete Bolles

FlexOS T-shirt, software and documents, X3512.2006, Gift of Peter Bolton

Russian PC software, X2687.2004, Gift of Charles Bornstein

IBM reference manuals, X2923.2005, Gift of William R. Boswell

DEC and IBM manuals, X3025.2005, Gift of Leo Bourne

Apple Newton MessagePad and accessories, X2774.2004, Gift of Dave Brackenbury
Early Apple Computer publications, documents, X2617.2004, Gift of Lilyann Brannon

Digital Research Presentation Team photograph, X3513.2006, Gift of Frieda Bresk

Microsoft OS/2 Software Developers Conference VHS tapes (8), X3287.2006, Gift of Dave Briccetti


Scientific American, "Machines That Think" article (April, 1933), X3285.2006, Gift of Bob Brubaker

Osborne documents and materials, X3225.2006, Gift of Alan Brudno

Honeywell mainframe software development records, X2901.2005, Gift of G. Edward Bryan

Paper tape of chess game between Hubert Dreyfus and MacHack VI (1967), X3278.2006, Gift of Bruce Buchanan

Approximately 2,000 manuals, X2592.2004, Gift of Thomas J. Buckholtz and Helen T. Buckholtz

HP Exemplar memory & processor boards, X3485.2006, Gift of Al Budriunas

Canon Cat computer and printer (1987), X3019.2005, Gift of John "Sandy" Bumgarner

Counting mechanism, Archimedes calculator (c. 1906), X2663.2004, Gift of Judith Burdhardt
Assorted documents on early computers (ca. 1945-1960), X3507.2006, Gift of Dorothy Burkhart

Novus 3500 Slide rule calculator, X2762.2004, Gift of Patrick M. Burns

Still image: Cray poster, X3322.2006, Gift of Jim Burton

"Understanding Computers" series (1986), X2760.2004, Gift of Susan Burwen

Intel ephemera, X2821.2005, Gift of Jack Busch

DEC and TI handbooks (1973-1975), X2771.2004, Gift of Lawrence Butcher

Microprocessor System Development Kits (SDK) for AMD and Intel (c. 1980), X3299.2006, Gift of Myron A. Calhoun

SYMBOL machine documents (c. 1965-1970), X2696.2004, Gift of Myron A. Calhoun

Two SYMBOL machine printed circuit boards and documents (c.1970), X2715.2004, Gift of Myron A. Calhoun

DEC manuals & early DEC slides, X2849.2005 , Gift of Mike Callahan

Convex Computer Corporation staff photo (1988), X3153.2005, Gift of Anne and Mike Capella

Apple Newton prototype assortment, X2779.2004, Gift of Steve Capps

Intecolor Corporation brochure, X3239.2006, Gift of Albert P. Carlson
"CACM and ACM Computing Surveys" (1972-1995), X3063.2005, Gift of Eric Carlson


Galactic Empire game (c. 1980), X2631.2004, Gift of Doug Carlston


Commodore 774D electronic calculator, X2896.2005, Gift of Matthew L. Carr

Intel PDS-100 development system & software, X2776.2004, Gift of Jack Carsten

Univac coding template, IBM "THINK" Notepad, & others, X3484.2006, Gift of Mr.s Nelle E. Carter

IBM DOS version 2.00 (1983), X3178.2005, Gift of Paul Casey


I/O Telecomputer (1981), X2860.2005, Gift of Heidi Cavagnolo

Pac-Man monitor topper (ca. 1980), X3259.2005, Gift of Stacey Chaney

Prime Computer manuals, X3215.2006, Gift of Reginald Charney

PFS: Graph, Harvard Graphics v. 2.301, Professional Write software, X3515.2006, Gift of Mario Chavez
Two Internet network node maps, X2591.2004, Gift of William R. Cheswick

Books on computer history and operating systems, X2891.2005, Gift of Don Chiasson

Fifty-one framed photographs from Cisco's "A Day In Cyberspace" exhibit, X2938.2005, Gift of Cisco Systems, Inc.

"Internet Strategy Workshop" (1995), X3404.2006, Gift of Craig Cline


SYMBOL machine manuals, X2641.2003, Gift of Bob Cmelik

Borland C++ and Database Tools Version 4.5, X3518.2006, Gift of Glenn Cochran

Timex Sinclair 2068 computer, peripherals, software & manuals (1983), X3315.2006, Gift of Karen Coerver

Apple-related ephemera, t-shirts, publications and Apple II peripherals (1980-1990), X3031.2005, Gift of Jerry and Carol Cohen


LOTUS logo satin jacket, X2590.2004, Gift Raines Cohen

Cray-2 ECL logic board in lucite (1985), X2632.204, Gift of Tony Cole
Apple Computer, Inc., 20th Anniversary Macintosh system, X3490.2006, Gift of Robert E. Coletti

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Early IBM manuals, X2580.2004, Gift of Leo Collins

Burroughs manuals, X2861.2005, Gift of W. David Collins

Unisonic 1011 and 811 pocket calculators, X2999.2005, Gift of Joseph Collonge

Robosphere posters, X3000.2005, Gift of Silvano P. Colombano

Oral History of Murray Campbell, X3256.2006, Produced by the Computer History Museum.

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"The Legacy of Shockley Labs" poster signed by early employees (2006), X3459.2006, Produced by the Computer History Museum

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Oral History of Robert Erickson, X3414.2006, Produced by the Computer History Museum.


Oral History of Peter Jennings, X3093.2005, Produced by the Computer History Museum.


"Fritz GrandMaster Challenge” chess game (2003), X3234.2006, Purchased by the Computer History Museum.
“BBS: The Documentary” 3-DVD set (2004), X3268.2006, Purchased by the Computer History Museum

Assorted computer chess software (c. 2005), X3240.2006, Purchased by the Computer History Museum

Krypton Deluxe Talking Touch Chess (2004), X3296.2006, Purchased by the Computer History Museum

ACS Archives - Lynn Conway, X3167.2005, Gift of Lynn Conway

Apple" Slick 50" logic board and IC remover (c. 1997), X2752.2004, Gift of John Cook

GO Corporation Penpoint operating system (c. 1992), X2764.2004, Gift of Steven Cook

Commodore AL-100 computer, X2950.2005, Gift of Mac Copas

MIT Computer Science and Artifical Intelligence Laboratory photographs, X2944.2005, Gift of Emily Corbato

Linux-related documents, software & ephemera, X3098.2005, Gift of John "Jack" Cormode

Commodore Amiga 3000 computer system (1990), X3291.2006, Gift of Adam Costello

Microprogram cards for IBM 360/25, X2885.2005, Gift of Russell Couch

APL-related books, manuals and ephemera, X2746.2004, Gift of Harley Courtney

Electric Pencil word processor software for the PC & manual, X3359.2006, Gift of Harley Courtney
MCM/70 APL Computer, X2621.2004, Gift of Harley Courtney

Assorted Ephemera (2004), X3270.2006, Gift of Lee Courtney


Instructional books by Adam Osborne, X2583.2004, Gift of Lee Courtney

Early vacuum tube operational amplifiers (c. 1960), X3203.2006, Gift of William J. Cowell, Jr.

Deep-sea telephone cable samples (1950s), X2895.2005, Gift of Jeff Craemer

Java Technology Concept map, X3221.2006, Gift of Audrey Crane

COMDEX-related documents, X2890.2005, Gift of Brodie J. Crawford

"The Computer Bowl - 2005" t-shirt with contestant autographs (2005), X3295.2006, Created at the Computer History Museum

Documents, photographs, & movies related to the PDP-1 restoration (2003-2006), X3509.2006, Created by the Computer History Museum PDP-1 restoration team

HP 300 computer system, documents, software, X3146.2005, Gift of E. David Crockett

IBM APL, REXX, LISP, CP/67 documents, X2702.2004, Gift of Harlan Crowder
CONVEX C3800 supercomputer commemorative plaque, X2975.2005, Gift of Candy Culhane

IBM System/360 nameplate & spare bulbs for operator console (1969), X3321.2006, Gift of Frank da Cruz


IBM 2315 Disk Pack, X2798.2004, Gift of Gary Davidson

"PL/I-80 Command Summary" brochure (1980), X3532.2006, Gift of G. Gervaise Davis

Photographs and text related to IGFET technology, X3523.2006, Gift of John DeBolt


“32 Basic Programs for the Coleco ADAM Computer” book, X3096.2005, Gift of Ralph Delange

Apple Macintosh mouse engineering prototype (c. 1984), X3029.2005, Gift of Bud Delisle

Assorted IBM and minicomputer manuals, X3265.2006, Gift of Douglass Delong

Magnetostrictive Delay Line (c. 1969), X3048.2005, Gift of Douglass Delong

National Semiconductor Novus calculator (1972) & "1st West Coast Computer Faire" t-shirt (1977), X3288.2006, Gift of Richard Delp

Apple shirt and button collection (1980s-1990s), X2630.2004, Gift of George Deriso
EICO test equipment, X3205.2006, Gift of Richard Dessling

Early textbooks on logic & computer design (1951-1963), X3302.2006, Gift of Joanna DeVries

Intel Pentium Processor plaque (1993), X2825.2005, Gift of Vinod Dham

Tempest-rated Sun SPARCstation & monitor, X2695.2004, Gift of Dr. Whitfield Diffie

IBM 7030, 1360 and 1130 manuals and documents, X3050.2005, Gift of James Vernon Dimmick

"ARCNET" documents, X2970.2005, Gift of Lewis Donzis


Sun Microsystems, Inc. mousepad signed by Andreas Bechtolsheim, Bill Joy, Vinod Khosla, and Scott McNealy, X3428.2006, Gift of Ben Dubin

Early PDA collection, X2649.2004, Gift of Donna Dubinsky

Design documents and prototype of ROLMPHONE, X3061.2005, Gift of Gregory Dumas

Over 350 CD-I disks and associated players, X3044.2005, Gift of the DVD Association (DVDA)


Personal research notes of the computer industry (1980s and '90s), X2957.2005, Gift of Esther Dyson
Pen Computer assortment & software, X2807.2004, Gift of Dr. Richard Easton

"HELLO WORLD(S)!': From Code to Culture: A 10 Year Celebration of Java Technology" book, X3434.2006, Gift of Glenn T. Edens

PFS: First Choice, X3525.2006, Gift of Sam Edwards


Assorted software, X3275.2006, Gift of Barbara Ehrenborg

International keyboards (5), X2627.2004, Gift of IBM Corporation

ILLIAC I paper tape, ILLIAC-related documents, X2684.2004, Gift of John Ehrman

"The SHARE Millenium Songbook" (1999), X2862.2005, Gift of John Ehrman

Assorted microcomputer software, X3468.2006, Gift of John Ehrman

Film, documents on FORTRAN's 25th anniversary (1982) & IBM "THINK" signs in Italian and Braille (1970), X3318.2006, Gift of John Ehrman

Manuals & personal documents relating to Illiac I & II supercomputers, X3492.2006, Gift of John Ehrman

IBM Microfiche cards on mainframe troubleshooting, X2879.2005, Gift of John R. Ehrman

Assorted brochures and other documents (1980s), X2799.2004, Gift of Ed Elizondo

Oral History of RAMAC follow-on, X3012.2005, Gift of David Emerson

IBM Type 85 Electrostatic Storage Tube (1953), X3064.2005, Gift of Bob Erickson

Papers relating to early barcode technology development, X3437.2006, Gift of A. John Esserian

Personal papers related to barcoding technology, X3491.2006, Gift of A. John Esserian

Personal papers relating to Digital Equipment Corporation (DEC), X3406.2006, Gift of Elizabeth Falsey

"ClickArt Personal Publisher" software, X3504.2006, Gift of Royal P. Farros

Apple Computer, Inc., LaserWriter printer & toner cartridge, X3483.2006, Gift of Amy Fasnacht

Intel 8008 photo and original specification document, X2817.2005, Gift of Hal Feeney

Classic computer science texts, X3251.2006, Gift of Edward Feigenbaum

ILLIAC-IV supercomputer mylar data strip (c. 1974), X3472.2006, Gift of Elizabeth Feinler

Commodore Amiga software, X2694.2004, Gift of Jake Feinler

Community Memory Project documents and terminals (1972-1974), X3090.2005, Gift of Lee Felsenstein
IBM, Lotus and Dataflex manuals, &c., X3038.2005, Gift of Lee Felsenstein


Apple Computer Unifile drive, X2622.2004, Gift of Philip H. Fleschler

Computer marketing videos, X3059.2005, Gift of David Fong

8KW core memory board from Data General Nova 2 minicomputer, X3479.2006, Gift of Doug Fortune

IBM manuals and print materials, X2607.2004, Gift of Les Foster

“FOWLGOL and FLOWGOL for the IBM 1620,” booklet, X2995.2005, Gift of Bob Fowler

Minitel 1 & Telic Alcatel teletext terminals, X3502.2006, Gift of France Telecom, Research and Development Division

Assorted software from Dayflo, Borland, Microsoft, IBM, Multimate, SuperCalc, Nestar, Information Unlimited & others, X3436.2006, Gift of Werner Frank

Personal papers of Werner Frank, X2983.2005, Gift of Werner Frank

MultiMate International Corporation, Multimate-specific keyboard, X3496.2006, Gift of Werner L. Frank


Assorted manuals, X2929.2005, Gift of Joseph and Barbara Fredrick

Microsoft Corporation XBox Video Game System & "Master Chief" foam statue, X3443.2006, Gift of Doug Free

Microsoft SPELL and BASIC, IBM Personal Computer (1984), X2972.2005, Gift of Microsoft Corporation

APL trivia cards & items, X2707.2004, Gift of James R. Freeman

12-tape set of John Cocke’s 35th anniversary at IBM “scrapbook” (1991), X2833.2005, Gift of Nancy Frishberg

Assorted programming manuals, X3185.2005, Gift of Michael G. Miller


ENIGMA dish towel from Bletchley Park, U.K. (2005), X3269.2006, Gift of Christopher Garcia

Fairchild pen, button, lighter (c. 1985), X3466.2006, Gift of Rita Gardiner


Memorex 1270, 3670 and 3660 parts catalogs, X3487.2006, Gift of Tom Gardner

TEAC Corporation FD-55GFR disc drive, X3080.2005, Gift of Tom Gardner

DEC PDP-6 circuit modules (c. 1963), X3103.2005, Gift of Robert Garner
IBM 1401 RPG & SPS source listings, X3508.2006, Gift of Robert Garner

IBM unit record machines videotapes, X2936.2005, Gift of Robert Garner


Microsoft Windows/286 Presentation Manager v. 2.1, X2893.2005, Gift of Terrall R. Garrison

Early Intel development system hardware & documents, X2826.2005, Gift of Robert Garrow

Collection of IBM manuals, X2787.2004, Gift of Mark Geary

Epson PX-8 portable computer (1982), X3134.2005, Courtesy of Michael J. Howe

Intel commemorative belt buckle & wine bottle (1977), X2813.2005, Gift of Edward Gelbach

Modular Programming Symposium Preprint (1968), X2604.2004, Gift of Dennis P. Geller

Assorted Slate materials (1989-1993), X3337.2006, Gift of Mark Gerrior


IBM Oral Histories, X2965.2005, Gift of IBM

Tektronix 909 desktop scientific programmable calculator & peripherals, X2900.2005, Gift of Kenneth P. Gilliland

Printout of MS-BASIC source code (1976), X2977.2005, Gift of David Gjerdrum

Borland, HP, IBM, Microsoft, Qualcomm, US Robotics literature, X2638.2004, Gift of George Glaser


Mainframe-era business computing documents, X2902.2005, Gift of George Glaser

Assorted humorous books on computing by Robert Glass, X3160.2005, Gift of Robert L. Glass


Apple-related ephemera, text, videocassettes, software, hardware and images, X2870.2005, Gift of AppleLore

Easel, Inc. t-shirt, X2640.2004|102626789, Gift of Eli Goldberg

Apple Lisa release poster, X2582.2004|102630214, Gift of William Goldberg

Apple Macintosh 512 EPROM Adapter Board, X2619.2004|102626827, Gift of William Goldberg

IBM Selectric type typeballs, English and Hebrew, X2805.2004, Gift of William Goldberg

Assorted personal computing magazines (1975-1990), X3451.2006, Gift of Mark Goldstein
GCC Maria 1702B Graphics Processor poster, X2841.2005, Gift of Steve Golson

OS-9 documentation, X2980.2005, Gift of Dave Good

MSA Coaster caddy with coasters, X3363.2006, Gift of Bill Goodhew

Early books on computers and society (1950s), X3187.2005, Gift of Jessica Gordon

Heath H89 computer (1979), manuals & software, X3099.2005, Gift of Carl A. Goy

Heath H8 microcomputer (1977), X3177.2005, Gift of Carl Goy

Royal-McBee edge puncher, X2928.2005, Gift of JM Graetz

Apple Computer MessagePad 120 and promotional buttons, X2610.2004, Gift of Maxine Graham

"Lotus Selects" catalog (1991), X2669.2004, Gift of Bea Gramann

ConSeal Personal Firewall demoware for Windows95, X3249.2006, Gift of James Grant

Data General manuals & arithmetic test program paper tape, X2831.2005, Gift of David Graybeal

Mountain Computer 1100A Intelligent Card Reader & manuals, X2913.2005, Gift of Michael E. Green

Intel ephemera, X2822.2005, Gift of Robert Greene

ADAPSO Brochure on disk copying, X2625.2004, Gift of Jim Gross

Documents relating to 1970s printers and processors, X2877.2005, Gift of Jim Gross, University of Wisconsin Sheboygen

Apollo Computer network outlet, Univac magnetic tape, X2573.2003|102630212, Gift of Jonathan Gross

CMU iWarp and TI GaAs microprocessor documents, X3145.2005, Gift of Thomas Gross

Assorted software on cassette (c. 1978), X3071.2005, Gift of Kathy Groves

"WYLBUR Overview" manual, X2960.2005, Gift of Dick Guertin

PL360 code on CD-ROM, X2974.2005, Gift of Dick Guertin


Opus Systems 32/30 add-on processor board (c. 1988), X2690.2004, Gift of Ronald F. Guilmette

HP 2648 software, X2795.2004, Gift of Peter Gulotta


Catalog of digital computer specifications and companies, X3460.2006, Gift of Richard Haines

Documents related to computer history (1981-1989), X3308.2006, Gift of Jan Half

Compute! magazine (1981-1990), X3018.2005, Gift of Tom Halhill


Harvard Graphics 3.0 and design team photographs, X3526.2006, Gift of Buck Hallen

Wylbur, Milten, Orvyl - Stanford University mainframe software, X2796.2004, Gift of Stanford University

Transcript "Management Systems for the Space Generation" - Plaintiffs v. IBM 1976, X3412.2006, Gift of Larry Hanson

Jepperson Sanderson aviation calculator, X2857.2005, Gift of Mrs. Raymond O. Hargis


Early Apple Macintosh software, X2737.2004, Gift of Gary Harris

"Harvard Project Manager 3.0" cover signed by team members, X3505.2006, Gift of Lee Harris

Assorted photographs relating to computer service companies, X3284.2006, Gift of Peter Harris

DYSEAC-related artifacts (c. 1954), X2647.2004, Gift of David Hartsig
PFS software and manuals, X3528.2006, Gift of Barbara Harvie


Assorted documents relating to floppy disk technology (1980s), X3223.2006, Gift of Marilyn Hasler

Ashton-Tate dBase II software package with disks and documentation, X3527.2006, Gift of John M. Hedblom

Rolodex REX cards, X3476.2006, Gift of David Henkel-Wallace

Manuals on IBM CPC, IBM 650, X3101.2005, Gift of Sarah T. Herriot

Data sheets on Honeywell instruments, X2994.2005, Gift of The Museum of American Heritage

Metal skip bar for the IBM 010, IBM Stick Printer Head, IBM 407 Print Wheel, IBM Key Punch Programmable, Two IBM components encased in Lucite, X2602.2004, Gift of Warren Higgins

Prolog development kit for Intel 4004, X2889.2005, Gift of Rhodes Hileman

Expander microcomputer, documentation (1981), X2626.2004, Gift of Bill Hill

Intel Mug (1985), X2812.2005, Gift of David House


Deep Blue v.2 custom VLSI processor (1997), X3095.2005, Gift of Feng-Hsiung Hsu
Photographs (scans) relating to Deep Thought (I & II), Deep Blue, & HiTech computer chess machines (c. 1988-1997), X3306.2006, Gift of Feng-Hsiung Hsu

Osborne manuals and newsletters, X3229.2006, Gift of Merrill Hulse

Electronic Parts Catalogs and Data books from Fairchild, Motorola, National, General Electric, RCA, IBM & others, X3401.2006, Gift of Leslie Hurwitz

Assorted photos and documents relating to the SWAC, EDVAC, Pilot Ace, & G-15 computers (c. 1947-1965), X3247.2006, Gift of Harry Huskey

Harry Huskey personal papers related to the SWAC computer (1948-1982), X3462.2006, Gift of Harry Huskey

DEC VAX 8600, X2733.2004, Gift of Sellam Ismail

Philco Electronics All-in-One Experimenter's Kit (1961), X3042.2005, Gift of Pearl S. Jackson

Assorted DEC photographs and ephemera, X3227.2006, Gift of Joanne and Irwin"Jake" Jacobs

Assorted blank punched cards & documents (ca. 1967-1980), X3494.2006, Gift of David L. Jaffe

Manuals for dBase III, GemDraw, & Wordstar (c. 1982), X3398.2006, Gift of David L. Jaffe

Manuals on Compuserve Information Service and DEC VT-100 terminal, X3317.2006, Gift of David L. Jaffe

Aldus PageMaker Version 5.0 software, X2853.2005, Gift of Dr. James M. Janky

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"Microchess" source code, program & documents (c. 1977), X3305.2006, Gift of Peter Jennings.

Luxor ABC 80 micromputer systems, X3345.2006, Gift of IT-ceum, the Swedish Computer Museum

Assorted COMDEX buttons, X3113.2005, Gift of Allyson Johnson

"Computer development (SEAC and DYSEAC) at the National Bureau of Standards" book (1955), X2700.2004, Gift of Bruce G. Johnson

Early IBM San Jose ephemera relating to Rey Johnson (1951-1991), X3312.2006, Gift of David R. Johnson

IBM Model 85 punched card collator & manuals, X3421.2006, Gift of Joel Jones

IBM optical scanning device, X2614.2004|102626822, Gift of Dr. Stephen A. Jove

"The World of Objects" DVD, X3520.2006, Gift of Philippe Kahn

IBM manuals, brochures, films and books, X2725.2004, Gift of Ray and Laurel Kaleda

PAM Medac 310 (medical accounting) system, X2967.2005, Gift of Roger Kammeier

Scan of Eckert and Mauchly Computer Corporation business plan (1946), X3232.2006, Gift of Mitch Kapor

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