Early Computing at the NIH

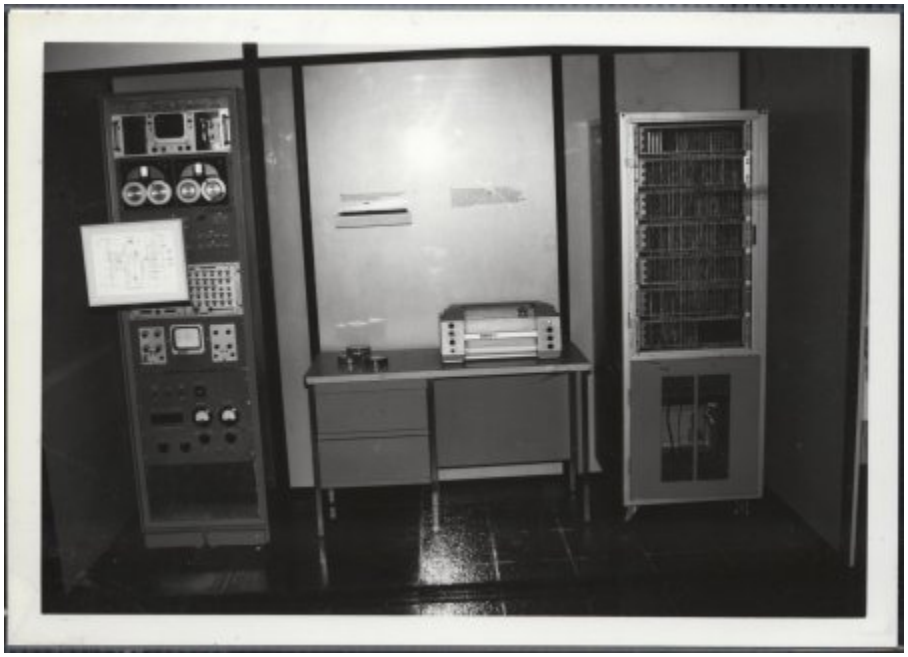
Computing at the NIH

Analog

LINC (Laboratory Instrument Computer), c. 1963

This machine is the direct ancestor of all personal computers. The Laboratory Instrument Computer (LINC), developed at MIT in 1963 by Wesley A. Clark and Dr. Charles E. Molnar, was revolutionary not for its circuitry, but for its new data storage medium: small, portable data tapes, allowing each user to have a personal record of their data and programs. Funded by the NIH and NASA and designed specifically for laboratory use, the LINC allowed scientists to control complex experimental conditions and collect multiple data points in real time, making ever more complicated hypotheses testable.

After the LINC prototype was developed, researchers were invited to apply for a chance to test a free LINC in their laboratory for two years; in return, they would need to spend a month in Boston learning to maintain and program the machine, and they would need to participate in written evaluations of its performance at specified intervals.



LINC Computer

Out of 72 proposals, 12 labs were chosen to evaluate the LINC. Many of the scientists had no prior training in computer programming or circuitry, but all learned enough over the course of a month to assemble the machines in their labs and operate them without help. The test labs worked on a variety of systems and questions, ranging from blood flow calculations in dogs, to operant conditioning in rats, to activation of single neurons in mice. After two years, all of the test labs agreed that the LINC had greatly enhanced their research, and all were loath to give up the machines loaned to them for the evaluation.

Fifty original LINCs were produced and shipped to laboratories around the country at a cost of $35,000 per unit—expensive, but affordable for important laboratory equipment. A typical LINC configuration included the computer and a rack holding the tape drive, a small Cathode Ray Tube (CRT) display, a control panel, and a keyboard. In contrast to the large mainframe computers typical of the time, the LINC could fit into eight square feet of space, and its components could be arranged in a variety of ways to make use of small amounts of precious bench space. Later LINC models were produced by private industry, and some of these companies were able to build on the underlying circuitry and programming to produce ever smaller computers for personal use, which eventually evolved into what we think of as personal computers today; however, the original machine, a highly specialized device for a very specific use, would never have been developed without government funding. [89.0001.014]

Read more about the history of the LINC here

DEC PDP8/E, c. 1965

Digital Equipment Corp. PDP8/e Computer

The PDP8/E, one of the models in the PDP/8 line of the first successful “mini-computers,” was introduced in 1965. The PDP models were based on the TX-0, a computer developed for hands-on laboratory use by Wesley A. Clark and Dr. Charles E. Molnar of MIT, members of the same team that designed the LINC. The TX-0 was designed to accept input directly to its core memory via a component termed I/O (Input/Output) and was equipped with a keyboard and a cathode ray screen that could display input and output. At that time, there was a free exchange of personnel and ideas between MIT and the fledgling Digital Equipment Corporation, better known as DEC, also located in Cambridge. One of DEC’s first products was the PDP-1, a machine that incorporated many features found on the TX-0. The PDP-1 was sold, rather than leased, to users who were encouraged to modify the computer to best suit their needs. After several rounds of improvements on the basic model, the PDP-8, launched in 1965, would prove to be a bestseller in the field of mini-computers.

The basic PDP-8 model came with 4000 words of memory split into 32 blocks of 128 words each. Supplemental memory was available with a tape drive first developed for the LINC computer and analogous to the later floppy disk drive. Hard copy output was printed via a teletype terminal. The combination of these capabilities with the relatively low price set by DEC — only $6,500 — led to the PDP-8 becoming a major commercial success. The PDP-8/E was one of the most common variants of the PDP-8; it was particularly attractive to users because of the many types of available input/output devices. PDP-8/E devices were used for office work, recording laboratory data, and controlling equipment during surgery. Over 50,000 units of the PDP-8 mini-computer were eventually sold, the last in 1979, fourteen years after the launch of the series.

This PDP-8/E pictured here was used by Dr. James V. Silverton, National Heart, Lung, and Blood Institute, who studied the structure and function of various chemical compounds to determine if they were suitable as drug treatments for diseases. [90.0002.003]

Digital

Olivetti Electronic Printing Calculator Microcomputer, P652, c. 1973

An Italian manufacturer, Olivetti is renowned especially for its lightweight portable mechanical typewriters. In the early 1960s the company seized on the availability of integrated circuits to develop a desktop computer to supplement or even replace their line of electric calculators. The Programa 101 was launched in 1965 at the New York World’s Fair and incorporated in early form many of the features of modern desktop computers such as memory, a keyboard, an onboard printer, and a magnetic card reader/recorder. The Programa 101 is often considered the first generally available desktop computer. The production of better computer chips in the early 1970s led Olivetti engineers to design a new computer based on the Programa 101: the P652.

Olivetti Electronic Printing Calculator, P652

The P652 increased the capability for handling trigonometric and logarithmic calculations and came with a standard keyboard for common mathematical functions as well as a number of special keys for entering routines and programs. The built-in printer recorded the input data as well as the results of calculations on a roll of paper. Programs could be input directly on the keyboard, by means of a built-in magnetic card reader, or by a punched paper tape reader. A number of peripheral devices, which were sold separately, increased the utility of this microcomputer. These add-ons included: a typewriter; an auxiliary disk data storage unit; a cassette tape unit for data and program storage; and an X-Y flat bed plotter. Olivetti also made a software library of programs for various technical routines available to users. The P652 was widely used for collecting data from biomedical experiments and subjecting that data to statistical analysis; it was often listed in the footnotes of publications from that era as having been used to analyze experimental results.

This computer was used by Dr. Harry R. Keiser, Clinical Director of the National Heart, Lung, and Blood Institute from 1976–1998. His primary research focus was on the activity of signaling molecules in metabolic diseases. Keiser published over 200 articles in medical journals and textbooks, and received a lifetime service award from the Washington Academy of Sciences. [89.0001.013]

Supercomputer

CRAY X-MP 22 Supercomputer, c. 1986

CRAY X-MP/22 Supercomputer

Bearing more resemblance to a modern art installation than a powerful supercomputer, the Cray X-MP/22 was the fastest computer in the world from 1983 to 1986. It ran at 105 MHz, then the quickest processing speed available, and was capable of performing 400 million calculations per second under optimal conditions. The circuits necessary to produce this processing power gave off so much heat that a conventional fan was insufficient for cooling; the circuit board had to be immersed in fluorocarbons in order to function properly. It was the first computer containing two processors that could be simultaneously accessed by a single program. Such superior technology wasn't cheap—each Cray X-MP was built to order and cost tens of millions of dollars.

This Cray X-MP/22 was used from 1986 to 1992 at the NIH's Laboratory of Mathematical Biology, a part of the National Cancer Institute, in the Advanced Scientific Computing Laboratory (ASCL). Although housed in Maryland, this computer was used via network by scientists across the country and has the distinction of being the first supercomputer dedicated solely to biomedical research. It was used in applications such as crystallography, DNA sequence analysis, image processing, molecular structure determination, and statistical analysis. [92.0010.001]

Hybrid

Hewlett Packard 9845-B Desktop Computer, c. 1980

At first glance, the Hewlett Packard (HP) 9845-B computer looks very much like the personal desktop computers that became available in the mid-1980s. However, both the price—over $25,000—and performance of this machine clearly indicate that it was designed for use by scientists and engineers. One of the first commercially available workstations, the HP 9845-B included a highly integrated, complete system with graphics and networking capabilities, a variety of input/output devices, and large amounts of processing power.

The HP 9800 series were the first HP computers that were supplied with a Cathode Ray Tube (CRT)-based monitor; it was also possible to add a monitor that displayed graphics, a feature not present in the standard monitor, whose display was restricted to alpha-numeric characters. The display screen offered the programmer or user a visual check of programming steps—available in BASIC, Pascal, or Fortran—as well as the opportunity to debug the program.

Hewlett Packard 9845--B Desktop Computer monitor

The graphics screen was particularly important for search programs that relied on user-input chemical structural diagrams to search large collections of compounds held by the National Cancer Institute or the Chemical Abstracts Service database of compounds.

While the stand-alone computer could be used to perform intricate mathematical operations, statistical calculations, and other heavy calculation-dependent applications, it did not have any of the application programs, such as a word processor or spreadsheet manager, that now are basic in computers. While workstations in general have been replaced by true personal computers, many of the top-selling HP 9845-B units still exist and are still operational, attesting to the ruggedness of the computer design.

Dr. Louis Sokoloff, Laboratory of Cerebral Metabolism, National Institute of Mental Health, used this HP 9845-B in his work on the deoxyglucose method—a method for measuring local glucose metabolism in the brain, used as a measure of brain activity, which has been used as the basis for PET scans. For this contribution to science, he won the 1981 Lasker Award. He also wrote user-friendly programs for the HP-9845 to statistically analyze his data. [06.0006.001]

Desktop

Mac Classic Apple M0420, 1990

Macintosh Classic

“Not long after I acquired the computer, I published five first-author scientific papers…in one year.” So said Dr. Thomas Wehr, NIMH, about his Apple M0420.

While critics dismissed the Macintosh Classic M0420 for having slow processing speeds, it was extremely popular due to its low price—less than $1000 if you didn’t require a hard disk. The low price combined with the availability of educational software made the Mac Classic the computer of choice for school systems in the early 1990s. Even after factoring in the additional cost of up to 4MB of RAM, its relatively low cost attracted new computer users such as Wehr, who didn’t require the extra computing power of an SE/30 or Macintosh II. While this was the last Apple computer to use the 8 MHz 68000 CPU (all future models would have at least 16 MHz of processing power), it did have some unique features, such as the ability to boot from ROM by holding down “command-option-x-o” at startup, and screen brightness control through a keyboard-controlled “brightness control panel” rather than a knob.

The spread of personal computers allowed scientists to easily write and edit their ideas, leading to faster publications. After acquiring the Mac Classic, Wehr said that it “revolutionized [his] approach to data-analysis, graphics and writing.” Wehr, the former chief of the Clinical Psychobiology Branch at NIMH, is best known for his research on the effects of light on the secretion of melantonin and on sleep. Wehr and NIMH colleague Dr. Norman E. Rosenthal identified and described Seasonal Affective Disorder (SAD), and developed light therapy to treat it well before Wehr’s success was amplified by the Mac Classic. Wehr went on to co-author “Circadian Rhythms in Psychiatry (Psychobiology and Psychopathology)” with Frederick Goodwin. [13.0014.002]

Laptop

Radio Shack TRS-80 Model 100, c. 1980

Although it looks more like a calculator, the TRS-80 Model 100 was the first easily portable computer. Light and compact enough to be carried in a briefcase, the TRS-80 Model 100 was a favorite of scientists, journalists, and computer enthusiasts alike. With the 8 row by 40 character LCD screen in the same plane as the full-sized QWERTY keyboard, it came equipped with the precursors of programs we would now expect a portable computer to have: a text editor capable of holding up to 11 pages of text, an address book, a schedule organizer, and a BASIC programming module. It also had a 300-baud internal modem, allowing users to transmit data over any telephone line. Four AA batteries allowed the machine to run for 20 hours, with a 6V power adaptor available for static applications.

Radio Shack TRS-80 Model 100 Portable Computer

Starting in 1979, the Tandy Corporation introduced a class of computers each designated as “TRS-80” with a suffix to indicate the model. They were sold through the Tandy-owned Radio Shack stores. The popular Model 100, introduced in March 1983, was actually a computer that Tandy licensed from Kyocera in Japan, where the machine had originally been designed and manufactured. Kyocera also licensed the design to Olivetti and NEC, each of whom went on to introduce proprietary versions of that machine. The TRS-80 Model 100 was wildly successful, selling over 6,000,000 units while it was in production, due to the ubiquity of Radio Shack stores. Bill Gates wrote the BASIC programming language available on the machine; it was the last version of BASIC in which he wrote the majority of the code.

This particular unit was used by Drs. Robert Highet and James V. Silverton of the National Heart, Lung, and Blood Institute. Highet and Silverton both studied the structure and function of various chemical compounds to determine if they were suitable to develop as drugs for treating diseases. [98.0016.001

Thinkpad w butterfly keyboard, c. 1996

IBM ThinkPad 701C, 2630 open

This laptop is a work of art: the IBM ThinkPad 701C is part of the design collection at the Museum of Modern Art due to its innovative design. Based on a bento box, the case opens to reveal a full-size folding keyboard and Trackpoint pointer, obviating the need for a mouse. At just 10 inches wide and weighing only 4.5 lbs, the 701C was the ultimate portable computer when it was released in 1995—making it the tool of choice for spies in movies such as “Mission Impossible” and “Goldeneye.” In addition to its sleek design, the 701C also boasted state-of-the-art features for the time: a 14.4Kbaud modem, a 75MHz processor, and the ability to wirelessly sync with other IBM devices.

The portability of the ThinkPad 701C made it popular among people on the go, such as scientists. This ThinkPad was used by Dr. Richard Nakamura during his tenure as Deputy Director of the National Institute of Mental Health (NIMH) between 1997 and 2007. Nakamura began as a postdoctoral fellow at the NIH in 1976. His research focused mainly on the anatomical basis of thought in primates. Outside of the lab, he coordinated NIMH’s Biobehavioral Program and later was chief of its Integrative Neuroscience Research Branch. From 2007 to 2011, he was the Scientific Director of NIMH; and in 2012 he became director of the NIH’s Center for Scientific Review. [13.0009.001]

Dolch Portable Add-In Computer P.A.C. 386 Model, c. 1989

At 20 pounds, the Dolch P.A.C. was a “desktop replacement” or portable computer that weighed almost as much as a desktop. It was meant to be plugged in for power — an extra battery was available but offered only one extra hour of power supply. Designed for maximum computing power in minimal space, the Dolch P.A.C. offered 1-8 MB of RAM, 20-170 MB of hard disk space, and up to six expansion slots. The display was electroluminescent and featured yellow text on a black background, said to enhance readability. With a $7,995 price tag for the basic model, the Dolch P.A.C. was clearly marketed towards serious users. And trade publications also appreciated its charms: PC Magazine lauded it as “the fastest portable on the planet” in its December 1989 issue.

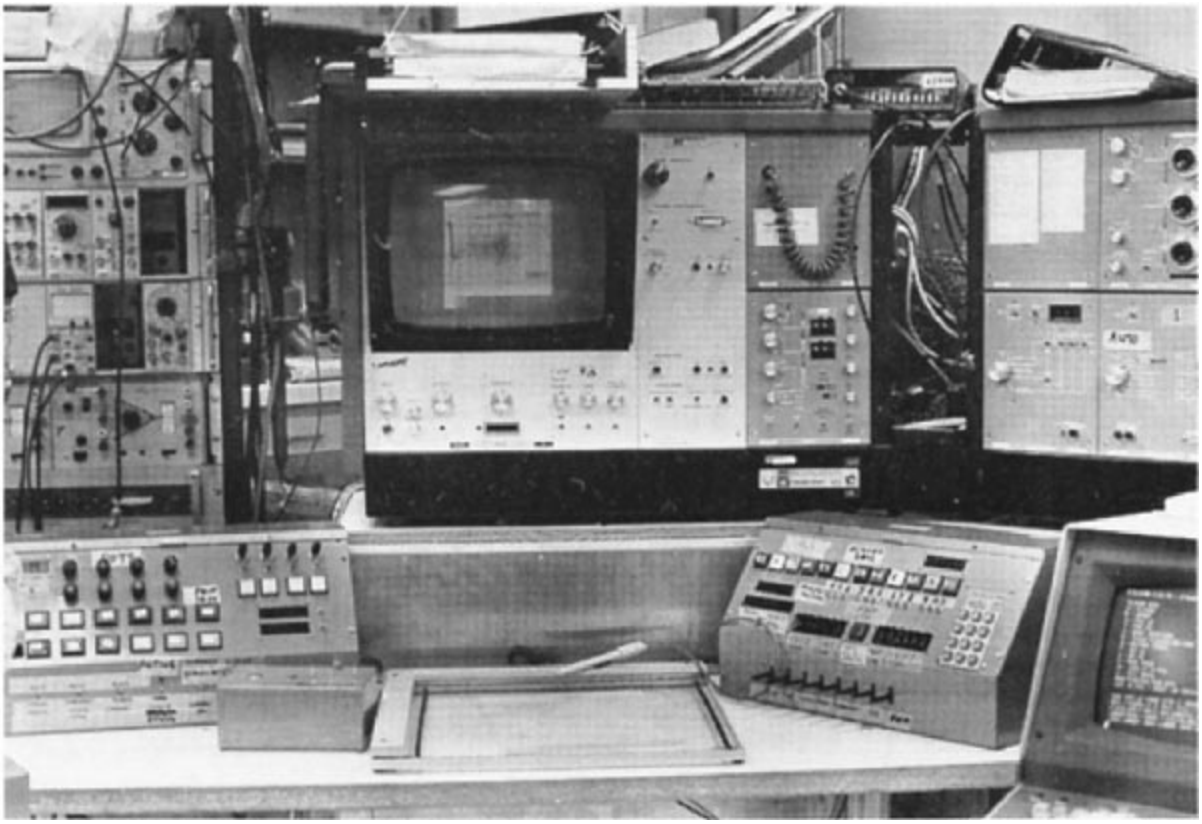
Dolch P.A.C. in open configuration

Dolch P.A.C. in closed configuration

This Dolch P.A.C. was owned by Dr. Barry Richmond, Chief of the Neural Coding and Computation Section in the Laboratory of Neuropsychology at NIMH. His laboratory studies the how information is encoded by single neurons, and as a result of this work, the laboratory developed an algorithm able to decode real-time neuronal firing in order to deliver real-time commands to a prosthetic device. [14.0004.001]

Hardware

The National Cancer Institute Real Time Picture Processor



Photograph of the Quantimet-TV and control-console for the RTPP using the BMON2 software. This was taken after we had moved the RTPP to the Park Building in Rockville, MD. (Reproduced from a figure with permission from *Environmental Health Perspectives*, 1980

The Real Time Picture Processor (RTPP) was one of the first special-purpose hardware computers developed for grayscale image processing and was designed to aid in biological image analysis. It was developed at the National Cancer Institute (NCI) of the National Institutes of Health (NIH).

Many properties of biological materials can be visualized directly using microscopy, electrophoresis, or other visualization mechanisms. The image subjects may have been improved before digital image capture using various detection-enhancement methods (such as stains, dyes, autoradiography, phase-contrast, interference microscopy, etc.) to visualize the data of interest. Digital image processing (see wikipedia.org and dictionary.com entries) is a method for the separation, detection, and quantification of the objects of interest in biological materials. Quantified data helps scientists perform more rigorous analyses of their biological experiments and improve the conclusions of their analyses.

There are two major goals of this history: to document the events and conditions that led to the creation of one of the first grayscale image processors, and to describe the highly effective complementary collaboration that alloAsilomar Third Engineering Foundation Conference on Automated Cytologywed this project to flourish. Occasionally, references will be made to other later advances indirectly related to the RTPP work that would not have happened without the RTPP.

More information about the Real Time Picture Processor (RTPP)