

CENTER FOR THE HISTORY OF INFORMATION PROCESSING

ARPANET is Twenty-Five

CBI Book Tells Story

*CBI examined the history of the ARPANET as part of its project for the Defense Advanced Research Projects Agency on the History of the Information Processing Techniques Office to be published in the forthcoming book **Changing Computer Technology: The Pentagon's Role, 1962-1986**, by Arthur L. Norberg and Judy E. O'Neill with contributions by Kerry Freedman. The Johns Hopkins University Press recently accepted the manuscript for publication in 1995.*

Twenty-five years ago the Advanced Research Projects Agency (ARPA) began to construct a resource sharing computer network among its contractors. This network became known as the ARPANET, a wildly successful wide-area packet-switching network which later evolved into the Internet.

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The IMP Development Group (left to right): Tritt Thatch, Bill Bartell, Jim Geisman, Dave Walden, Frank Heart, Ben Barker, Marty Thrope, Will Crowther, Severo Ornstein, and Bob Kahn. (c. 1970)

CBI's Year of Transition and Accomplishment

During the 1993-1994 fiscal year CBI made the transition to a new director. In October, Arthur Norberg left the Institute after 12 years and the new director, Bob Seidel, joined CBI in the middle of June. From November through the end of May, Judy O'Neill served as acting director of the Institute.

Collections

Bruce Bruemmer won gift agreements for the Control Data Corporation records from Ceridian Corporation and for the Griswold Papers from Ralph Griswold. The Association of Women in Computing-Twin Cities, James P. Cordes, Sue B.

Dorn, George Gray, Robert M. Gordon, Daniel McCracken, Severo Ornstein, Montgomery Phister, Emerson Pugh, Marlene Ross, and Michael Weisbard also made donations.

In October, Susan Stepka started work at CBI as the Burroughs Project Archivist under an agreement with the Unisys Corporation. She rapidly brought the 500 cubic foot Burroughs Corporation collection under better control. Assistant Archivist Kevin Corbitt handled a record number of reference requests, catalogued a large number of oral history interviews and processed the

Calvin Mooers papers and the market literature collection. Bruce Bruemmer produced a new brochure describing CBI's archival activities, placed CBI's finding aids on the University Libraries' gopher Internet file server, and on the World Wide Web.

Publications proliferate

CBI staff published many articles and book reviews during the year and completed a multiyear study of ARPA's Information Processing Techniques Office:

Bruce Bruemmer published "Work

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Kevin Corbitt, CBI's assistant archivist, was honored by the Society of American Archivists at their September conference for "volunteer service to archival colleagues and the profession during the 1990 through 1994 SAA annual meetings." (photo courtesy of Theresa Brinati).

CHARLES BABBAGE INSTITUTE NEWSLETTER

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E-Mail Addresses for CBI Staff

Robert W. Seidel, Director
rws@maroon.tc.umn.edu
Judy E. O'Neill, Associate Director
jeo@maroon.tc.umn.edu
Bruce Bruemmer, Archivist
Bruce@fs1.itdean.umn.edu
Kevin D. Corbitt, Assistant Archivist
K-Corb@vm1.spcs.umn.edu
Susan A. Stepka, Project Archivist
S-Step@vm1.spcs.umn.edu
General e-mail address for CBI staff
cbi@vx.cis.umn.edu
Telephone: 612 624-5050
Fax: 612 625-8054

Recent Publications

Charles Babbage, *Passages from the Life of a Philosopher*. Edited with a new introduction by Martin Campbell-Kelly. New Brunswick, NJ: Rutgers University Press; Piscataway, NJ: IEEE Press, 1994.

Geoffrey C. Bowker, *Science on the Run: Information Management and Industrial Geophysics at Schlumberger, 1920-1940*. (Inside Technology). Cambridge, MA/London: MIT Press, 1994.

Arno Borst, *The Ordering of Time: From the Ancient Computus to the Modern Computer*. Translated by Andrew Winnard. Chicago, IL: University of Chicago Press, 1993.

Steven Casey, *Set Phasers on Stun and Other True Tales of Design, Technology, and Human Error*. Santa Barbara, CA: Aegean Publishing, 1993.

Paul Carroll, *Big Blues: The Unmaking of IBM*. New York: Crown Publishers, 1993.

James Cortada, *The Computer in the United States: From Laboratory to Market, 1930-1960*. Armonk, N.Y./London: M. E. Sharpe, 1993.

Subrata Dasgupta, *Creativity in Invention and Design: Computational and Cognitive Explorations of Technological Originality*. New York: Cambridge University Press, 1994.

Dirk de Wit, *The Shaping of Automation, a Historical Analysis of the Interaction between Technology and Organization, 1950-1985*. Hilversum, The Netherlands: Verloren, 1994.

Mark W. Greenia, *Computers and Computing: History of Computing, A Chronology of the People and Machines that Made Computer History*. Sacramento, CA: Lexikon Services, 1993.

Mark W. Greenia, *History of Computing: An Encyclopedia of the People and Machines That Made Computing History* [a full encyclopedia on diskette]. Antelope, CA: Lexikon Services, 1994.

Brian Harris, *Babs, Beacon, and Boadicea: A History of Computing at British Airways and Its Predecessor Airlines*. Hounslow, U.K.: Speedwing Press, 1993.

Bettina Heintz, *Die Herrschaft der Regel: zur Grundlagengeschichte des Computers*. Frankfurt am Main/NY: Campus, 1993.

The History of Electronic Computing:

the Beta Release. New York: Association for Computing Machinery, 1993.

History of Programming Languages Conference (1993: Cambridge, MA). *History of Programming Languages Conference (HOPL-II): Preprints*. New York: ACM Special Interest Group on Programming Languages, 1993 (SIGPLAN Notices, 28: 3).

Robert Heller, *The Fate of IBM*. London: Little Brown, 1994.

Gerald J. Holzmann and Bjorn Pehrson, *The Early History of Data Networks*. Los Alamitos, CA: IEEE Computer Society Press, 1994.

Werner Kunzel, *Allwissen und Absturz: der Ursprung des Computers*. Frankfurt am Main: Insel, 1993.

J.A.N. Lee, *Computer Pioneers*. Los Alamitos, CA: IEEE Computer Society Press, 1994.

Owen W. Linzmayer, *The Mac Bathroom Reader*. San Francisco: Sybex, 1994.

N. Metropolis and Gian-Carlo Rota, eds., *A New Era in Computation*. (Articles originally appeared in *Daedalus*, 121:1 (Winter 1992). Cambridge, MA/London: MIT Press, 1993.

Harvey P. Newquist, *The Brain Makers*. Indianapolis, IN: Sams, 1994.

Optical Character Recognition in the Historical Discipline: Proceedings of an International Workshop. St. Katharinen: Max-Planck-Institut für Geschichte In Kommission bei Scripta Mercaturae Verlag, 1993.

Peter L. Perrotta, *A History of Computer-Assisted Medical Diagnosis at Naval Submarine Medical Research Laboratory*. Groton, CT: Naval Submarine Medical Research Laboratory, 1993.

Peter H. Salus, *A Quarter Century of UNIX*. Reading, MA: Addison-Wesley, 1994.

Annalee Saxenian, *Regional Advantage: Culture and Competition in Silicon Valley and Route 128*. Cambridge, MA: Harvard University Press, 1994.

Howard P. Segal, *Future Imperfect: The Mixed Blessings of Technology in America*. Amherst, MA: University of Massachusetts Press, 1994.

George R. Stibitz, *The Zeroth Generation*. S.I., Privately printed, 1993.

Recent Publications continued on page 7...

Gopher makes CBI Resources available on the Internet

Archives throughout the world are beginning to use the Internet to provide access to information about their programs and collections. CBI has joined their ranks with the establishment of an Internet Gopher on the University of Minnesota Libraries server. The Gopher software, developed at the University of Minnesota, is the foundation for most of the public information available on the Internet. It is distributed freely and enables the establishment of public servers that are available at any time to individuals around the world.

The CBI Gopher includes general information about the Institute and popular CBI documents, such as the description of the Tomash Fellowship, a bibliography of the Reprint Series in the

History of Computing, staff hours and e-mail addresses, and information about becoming a Friend of CBI. However, the CBI Gopher really proves its usefulness in creating access to CBI's collections. Most important is the availability of archives finding aids, which until this point had to be mailed or e-mailed individually. During the past month the CBI staff have worked to reformat all of the CBI's finding aids and load them in the CBI Gopher. Now, researchers have access to the full text of collection descriptions, and can conduct keyword searches through a Wide Area Information Server (WAIS) on the directory. This new access to finding aids is particularly helpful to researchers who must travel to CBI to use its archival



collections. The Gopher allows them to analyze collections for the most pertinent materials, so their research visit is as efficient as possible.

Other valuable information on the CBI Gopher includes a full list of oral

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and Pleasure: Archival Low Technology and Other Amusements" in the *MAC Newsletter* 21:3 (Midwest Archives Conference, 1993) 23-25; Kevin D. Corbitt and David J. Klaassen, edited "Writings for Archivists, 1991," for the *American Archivist* 56:4 (Fall, 1993): 750-793; Arthur L. Norberg wrote "New Engineering Companies and the Evolution of the United States Computer Industry," for *Business and Economic History* 22:1 (Fall, 1993): 181-193; and Norberg and Seidel coauthored "The Contexts for the Development of Radar: A Comparison of Efforts in the United States and the United Kingdom in the 1930s," in Oscar Blumtritt, *et al.*, *Tracking the History of Radar* (Piscataway, NJ: Institute of Electrical and Electronic Engineers, 1994): 199-216; Judy E. O'Neill reviewed Stuart Leslie's *The Cold War and American Science: The Military-Industrial-Academic Complex at MIT and Stanford* for *Annals of the History of Computing* 16:2 (Summer 1994): 74-75. She also wrote descriptions of CBI for the *Analytical Engine: Newsletter of the Computer History Association of*

California 1:2 (October 1993), 21-26; and *Antenna: Newsletter of the Mercurians, Society for the History of Technology* 6:1 (November 1993), 3.

Bob Seidel summarized "A Half-Century of Service," in the *Los Alamos National Laboratory Research Highlights 1993* (Los Alamos, NM: Los Alamos National Laboratory, 1994): 56-57; wrote "Accelerators and National Security: The Evolution of Science Policy for High-Energy Physics, 1947-1967," for *History and Technology* 11 (1994): 361-391; and his talk, "The Development of the Atomic Bomb," was published in Gerald W. Thomas, Monroe L. Billington, and Roger W. Walker, *Victory in World War II: The New Mexico Story* (Las Cruces: New Mexico State University, 1994): 125-133. He also reviewed Ronald Baucom's *The Origins of SDI, 1944-1983*, for *Technology and Culture* 34:4 (Oct., 1993): 973-5, and Stuart Leslie's *The Cold War and American Science: The Military-Industrial-Academic Complex at MIT and Stanford*, for *Chemical & Engineering News* 72 (May 23, 1994): 43-44.

In December 1993, Norberg and O'Neill delivered *Changing Computer*

Technology: The Pentagon's Role, 1962-1986, to Johns Hopkins University Press, which will publish it in fall, 1995.

Professional Activity

Bruce Bruemmer presented national oral history cataloging guidelines developed by his workshop to the Society of American Archivists (SAA) and the Oral History Association, cochaired the SAA Public Information Committee, and served on the local arrangements committee for the 1994 Fall Midwest Archives Conference in St. Paul. Bruce also summarized the Research Libraries Group symposium in the University of Minnesota *LibraryLine* and in a report of the Commission on Preservation and Access. He served on the search committee for the CBI Director, chaired a Library task force on conservation and served on Library personnel and review committees and a planning committee for a proposed archives building. Judy O'Neill served as the Happenings Department editor for the *Annals of the History of Computing*, conference cochair for the 1993-94 technical conference of the Association

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A Harvest of Research in the History of Information Processing

Scholars at the Society for History of Technology (SHOT) and the History of Science Society (HSS) presented a rich harvest of research in the history of information processing in October.

The maturing of the field is evident in the papers presented at both meetings, which show that historians of science and technology are beginning to cultivate important interpretations of the role of information processing in shaping modern society.

Society for History of Technology

The SHOT meeting at Lowell, MA featured three sessions and two informal meetings on the history of computing.

In the first session, "Electronics, Business Strategy, and the State," Paul Edwards of Stanford University led off with his talk "Why Build Computers? The Cold War, Project Whirlwind, and Air Defense, 1945-58." He argued that Whirlwind was constructed for air defense purposes, it had important consequences for the technical and industrial development of computers, and that the rationale for its development evolved in concert with military requirements.

Daniel Holbrook of Carnegie Mellon University, in his paper "Technical Advance and the Organization of R&D: The Cases of Shockley and Fairchild," argued that Fairchild, by concentrating on product development rather than basic research, eclipsed its parent.

Former CBI Director Arthur Norberg read CBI Associate Director Judy O'Neill's paper, "'Prestige Luster' and 'Snowballing Effects': IBM's Development of Computer Time-Sharing," which examined IBM's role in and response to the development of time-sharing, illustrating the non-technological criteria that even "high-technology" companies use to decide what products to develop and market.

Paul Ceruzzi commented that O'Neill's paper had best addressed the issue of who won and who lost in these historical episodes.

The second session, "The Computer in Historical Context," examined

developments in analog and digital computing in the United States before and after World War II, and the diffusion of computer technology to the Netherlands.

In his paper, "Theory and Practice: Obstacles and Opportunities in the Development of the British and American Differential Analyzers" Mark Bowles of Case Western Reserve University argued that America superseded Britain in the development of the first differential analyzer because the British favored theoretical approaches while American engineers celebrated practice and wed it to science, especially where, as at MIT, close financial connections with industry focussed their attention on practical problems.

Larry Owens of the University of Massachusetts suggested in his paper, "Teaching the Computer to Count: The Struggle to Define Computing at MIT, 1940-1950" that "postwar reformers found engineering labs and workshops slightly distasteful, especially those that emphasized the practical work believed to displace more theoretical, science-based courses from the engineering curriculum" and that it was the quest for the greater generality achieved by the physicist, and, incidentally, fundamental to the two great technical achievements of the war, radar and the atomic bomb, which made "general purpose" digital computers more attractive to MIT than the differential analyzer rather than the obvious appeals to speed or flexibility.

Dirk de Wit, of Erasmus University, Rotterdam read a paper "Computer, Culture and Power: An Organizational Perspective on the Development of Computer Systems," compared three Dutch users of computer systems to identify those elements which favored or retarded the diffusion of new technologies over a thirty-five year period.

CBI Director Bob Seidel commented on the changing estimations of theory and practice revealed in the first two papers. He pointed out the advantages of an organizational approach in linking broader social and cultural factors to

specific developments in the field.

A third session on Control, Information, and Management Systems 1930-1960 featured papers "From Machinery to Information: Control System Research at MIT in the 1930s," by David A. Mindell of the Massachusetts Institute of Technology, "The Whirlwind Computer and the Development of Systems of Information and Control" by Jay Forrester of the Massachusetts Institute of Technology, and "As Fast as Technology Will Allow": PERT and the Spinning of Seamless Webs in Cold War R&D Management," by Eric P. Rau of the University of Pennsylvania and a comment by Ronald Kline of Cornell University.

At the History of Computing Special Interest Group, Atsushi Akera reported on the University of Pennsylvania plans to celebrate the ENIAC's 50th anniversary. Paul Ceruzzi asked potential book reviewers for the *Annals of the History of Computing* to contact Peggy Kidwell, (MAH0L46@sivm.si.edu, telephone (202) 357-2392). Books that should be reviewed should be sent to her as well.

CBI director Bob Seidel and former Director Arthur Norberg also met informally with historians of computing David Allison, Bill Aspray, Paul Ceruzzi, Michael Mahoney, and Michael R. Williams to talk about critical issues in the history of computing.

History of Science Society

The History of Science Society met with the Society for Social Studies of Science (4S) at New Orleans, Louisiana, October 12-16, 1994. CBI Director Bob Seidel presented a talk in the HSS/4S Session on American Nuclear Policy and Domestic Culture, 1946-1963, entitled "Nuclear Policy, Computers, and Big Science, 1946-1963," in which he traced the activities leading to the formulation

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Pugh Adds IBM Oral Histories to CBI Collection

During the 1980s the International Business Machines Corporation (IBM) sponsored historical research on its own computer technology.

Emerson Pugh and his colleagues have published four books based on this work, including *The IBM Magnetic Film Memory Development Effort* (IBM: T. J. Watson Research Center, 1981), *Memories That Shaped an Industry* (MIT Press, 1984), *IBM's Early Computers* (with Charles Bashe, Lyle Johnson, and John Palmer) (MIT Press, 1986), and *IBM's 360 and Early 370 Systems* (MIT Press, 1991) (with Johnson and Palmer).

These histories represent an enormous amount of research on IBM's early computer technology, including many oral histories interviews conducted by the four authors. CBI now holds the transcripts of these important interviews, thanks to Pugh's efforts.

Eight volumes compiled by Caroline C. Coppola contain 140 of Pugh's interviews for the studies of memory development, 125 interviews for *IBM's Early Computers*, and 85 interviews for *IBM's 360 and Early 370 Systems*.

The list of interviewees is a *Who's Who* of early computer development at IBM: Gene Amdahl, James Birkenstock, B. O. Evans, Cuthbert Hurd, Phil Lincoln, John McPherson, Emmanuel Piore, James Pomerene, Jan Rajchman, Louis Russell, Q. William Simkins, R. Blair Smith, Thomas Watson, and many others are included.

Individuals who represented competing firms, such as Sidney Rubens of Univac, are also among those interviewed for the project.

The interviews are available for use at CBI only. Copyright of the transcripts remains with interviewees, so any extensive publication of the interviews requires their permission. Contact the CBI archives staff for further information.



When you move...

Please let us know your new mailing address. This will ensure your receiving the CBI Newsletter on a timely basis and also save us postage costs. Thank You.



A rotary press at the clean room in IBM's Poughkeepsie plant, where magnetic ferrite cores were produced at a rate of about 70 per second (ca. 1960).

IBM Strategy for Magnetic Core Production

Excerpt from interview of James Birkenstock by Emerson Pugh in Armonk, N.Y., on May 25, 1982 (IBM's Memory Technologies Interviews, Birkenstock, page 2):

JB: Well, we got into the business but we didn't produce 100 per cent of our own cores in those early stages of ferrite core memory development and manufacture. We, at one time, reached a point where we were making, except for special variety cores, pretty close to 100 percent of our own requirements and this primarily came about because there wasn't an equally competent and cost effective source of supply on the outside in those days.

EP: So your feeling is that in the case of ferrite cores, we were driven into it by the fact there were no adequate

vendors. Perhaps partly because of the General Ceramics reluctance to become a vendor of the class we were interested in. Perhaps if they had played the game differently, we would have ended up buying all of our ferrite cores.

JB: General Ceramics missed a great opportunity ...to team with IBM, but they got greedy and they weren't willing to put in the capital, weren't willing to give IBM a reasonable amount of freedom of action, and weren't reasonable about the royalties that they thought was fair for the use by IBM of their patents. Consequently, IBM was literally forced to make the majority of its cores.



Gopher

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history interviews currently open to research, access policies to the material, instructions for searching CBI collection information on the University of Minnesota Library catalog and the Research Libraries Group Eureka database, and some sample images. The images are among CBI's most popular photographic images, including some new discoveries from work being conducted on the photographic archives of the Burroughs Corporation records (under a grant from the Unisys Corporation). These images were digitized in the JPEG format, which requires software able to view the format. The address for CBI's Gopher is:

**gopher://cutter.lib.umn.edu:70/11/
subject-list/archives-spec/babbage**

Another method to get to the Gopher is to start at the University of Minnesota Gopher (which is included on most

Gopher software packages), and choose the Libraries option. This will lead to the University of Minnesota Libraries Gopher. CBI can be found under the subject list/archives and special collections directories. Still another method of finding the Gopher is to conduct a VERONICA search on "Babbage." Note that, like many other Internet tools, servers tend to be very busy in mid-afternoon and evenings. If you encounter severe delays, try again at another time of the day.

The archives staff chose to post information about collections on the Internet because they felt that a high percentage of CBI's users would have access to Internet tools. During its first month of operation, CBI's Gopher has logged 127 different users, of which about half were not connected to the

University of Minnesota. Many of these users logged in from the United Kingdom, Canada, Denmark, and other countries. Comments about the Gopher from users are valued and encouraged.

The next step on the Internet for CBI is to establish itself on the World Wide Web (WWW). Through freely available software packages such as MOSAIC or CELLO, the Web allows the use of a graphics and hypertext links that are not available on the Gopher. CBI plans to maintain a presence on both Gopher and WWW, relying on the Gopher for most text-based material and using the Web for graphic-oriented information. Look for an announcement about CBI on the Web in an upcoming issue of this newsletter.



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for Women in Computing (Twin Cities Chapter) and the University of Minnesota Institute of Technology Women in Science and Engineering (WISE) committee. She made a presentation at the Midwest Junto for the History of Science.

While at Los Alamos, Bob Seidel organized the History of Science Society Annual Meeting for 1993 in Santa Fe, New Mexico, and served on its Committees on Independent Scholars, Dibner Visiting Historians, and Meetings and Programs. His paper, "Computers and Research in the AEC Labs," was presented at the XIX International Congress of History of Science in Zaragoza, Spain, August 28, 1993.

Tomash Fellow

CBI awarded the Tomash Fellowship to Patricia Hemmis, who is writing her dissertation on the symbols and metaphors associated with the first generation of computers in the United States.

Facilities

CBI upgraded its computer equipment with four new workstations and a new laptop computer, and networked all of its workstations through the Institute of

Technology Office server so that common word processing software, file sharing, and back up facilities are now available. Support for this initiative came from the IT Dean and the University of Minnesota Libraries.

Forging a Strategic Intent

After assuming the directorship in June, Bob Seidel initiated a strategic planning process to help guide CBI development. The Unisys corporation generously made available the services of a planning facilitator, Roger Grothe, to guide the first phase of the process, when members of the Charles Babbage Institute staff and representatives of the Charles Babbage Foundation trustees and of the University of Minnesota met at the Earle Brown Center at the St. Paul Campus of the University on September 30, 1994, to formulate a strategic intent for CBI.

The group reviewed CBI's mission and agreed to broaden the third element of the mission to: Preserve and make accessible sources for the history of information processing, and formulated several goals: CBI must continue to acquire new collections and advocate the

acquisition of records by other archival programs, to achieve a state of the art archives center, to enhance education in the history of computing, and to increase our visibility.

At the meeting of the Charles Babbage Foundation Board of Directors on October 18, we discussed the results of this strategic planning exercise and presented estimated costs of the new initiatives the staff believes necessary to accomplish our goals.

The Foundation is now formulating a development plan to meet the needs of the Institute over the next few years and to enable us to accomplish our strategic intent.

Although the transition of CBI is not yet complete, the completion of a major research project and the successful search for a new director make 1993-1994 a landmark year in the history of the Institute. As we look forward to the "Year of the Computer" in 1996, we see many opportunities to contribute to the history of information processing.



ARPANET is Twenty-five

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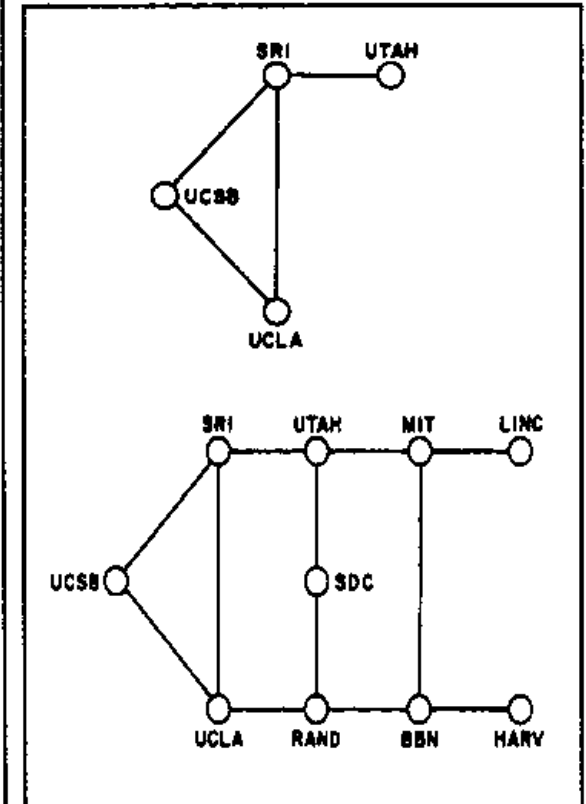
By the middle 1960s, the Information Processing Techniques Office (IPTO) of ARPA had computing research activities underway across the continental United States. The contractors used different computer systems including some that were unique, such as the Project MAC system at MIT and the developing ILLIAC IV supercomputer at the University of Illinois. An effective connection between the machines would allow IPTO to fund a large system in one location and have it economically used without regard to the physical location of the machine or the researcher.

During 1966 Robert Taylor, the director of IPTO, began an active campaign to begin a network project and searched for someone to join ARPA and run the project. By the end of 1966 Taylor pegged Lawrence Roberts for the job. Roberts joined IPTO in early 1967 and within three years developed the prototype for a packet-switching wide-area computer network; the four-node initial configuration of the ARPANET was in place.

IPTO awarded a contract to Bolt Beranek and Newman (BBN) in January 1969 to work on implementing the physical network. In September 1969, people from BBN installed the first Interface Message Processor (IMP) at the University of California Los Angeles (UCLA) making it the first node in the network. The IMP provided a standard interface to the network. This greatly simplified the network by removing the problem of connecting incompatible computers. That problem was now left to each site to solve as it connected its host computer to the IMP.

By the end of the year, the initial four-node configuration was complete. In addition to UCLA, the network consisted of the University of California Santa Barbara, Stanford Research Institute (SRI), and the University of Utah. The ARPANET expanded steadily and operated with a wide variety of hardware and software systems. From the four sites that comprised the network in January 1970, the network expanded to 13 by January 1971 and 23 by April 1972. These nodes included DEC PDP-10s and PDP-11s, IBM 360s, General

Electric 645 Multics system, Burroughs 6500s, Xerox Data Systems Sigma-7, and the ILLIAC IV.



Two configurations of the ARPANET. The first shows the network as it looked at the end of 1969; the second represents the 10-node network that was in place by early 1971. □

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Jan van den Ende, *The Turn of the Tide: Computerization in Dutch Society, 1900/1965*. Delft, The Netherlands: Delft University Press, 1994.

Ellen van Oost, *Nieuwe Functies, Nieuwe Verschillen. Genderprocessen in de Constructie van de Nieuwe Automatiseringsfuncties, 1955-1970*. Delft, The Netherlands: Eburon, 1994.

G. Pascal Zachary, *Show-Stopper!: the Breakneck Race to Create Windows NT and the Next Generation at Microsoft*. New York: Free Press and Maxwell Macmillan International, 1994.

Konrad Zuse, *The Computer, My Life*. Berlin/NY: Springer-Verlag, 1993.

Articles of Interest

Gar Alperovitz, "Distributing Our Technological Inheritance," *Technology Review*, 97:7(1994): 30.

William Aspray, "The History of Computing within the History of Infor-

mation Technology," *History and Technology*, 11:1(1994): 7-19.

William Aspray and Bernard O. Williams, "Arming American Scientists: NSF and the Provision of Scientific Computing Facilities for Universities, 1950-1973," *Annals of the History of Computing*, 16:4(1994):60-74.

Derek Barber, "The Origins of Packet Switching," *Computer Resurrection: The Bulletin of the Computer Conservation Society*, Issue 5 (Spring 1993): 17-22.

Martin Campbell-Kelly, "Charles Babbage and the Assurance of Lives," *Annals of the History of Computing*, 16:3(1994):5-14.

Andrew Collin, "Andrew Booth's Computers at Birkbeck College," *Computer Resurrection: The Bulletin of the Computer Conservation Society*, Issue 5 (Spring 1993): 11-16.

Mike Cowlshaw, "The Early History of REXX," *Annals of the History of*

Computing, 16:4(1994):15-24.

David M. Frohlich, "The History and Future of Direct Manipulation [of Computer Interface]," *Behaviour & Information Technology* 13:6(1993): 315-329.

Peter Galison, "FORTRAN, Physics, and Human Nature," in *The Invention of Physical Science: Intersections on Mathematics, Theology, and Natural Philosophy Since the Seventeenth Century: Essays in Honor of Erwin N. Heibert*, Mary Jo Nye, Joan L. Richards, and Roger H. Stuewer, eds. Dordrecht, the Netherlands: Kluwer Academic Publishers, 1992.

George Gray, "The Early DATA-TRON Computers: A Foundation for the Growth of Burroughs" *UNISPHERE* (July 1994): Pages 56,50,51.

Mark Halpern, "Dreams That Get Funded: Programming Rolls Its Own

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Reality," *Annals of the History of Computing*, 16:3(1994):61-69.

Hans Dieter Hellige, "From Sage via Arpanet to Ethernet: Stages in Computer Communications Concepts between 1950 and 1980," *History and Technology*, 11:1(1994): 49-79.

Lars Heide, "Punched-Card and Computer Applications in Denmark, 1911-1970," *History and Technology*, 11:1(1994): 77-99.

T. A. Heppenheimer, "How IBM Did It," *Audacity*, 2:2(1994): 52-61.

Jan Rune Holmevik, "Compiling SIMULA: A Historical Study of Technological Genesis," *Annals of the History of Computing*, 16:4(1994):25-37.

Paterson Hume, "Development of Systems Software for the Ferut Computer," Special Issue on Computing in Canada, *ISEE Annals of the History of Computing* 16:2 (1994):13-19.

Peggy Aldrich Kidwell, "Adders Made and Used in the United States," *Rittenhouse* 8:3 (1994): 78-96.

Norman Krim, "Vannevar Bush and the Early Days of Raytheon," *IEEE Aerospace and Electronic Systems Magazine*, 8:10(October 1993):3-6.

Fred N. Krull, "The Origin of Computer Graphics within General Motors," *Annals of the History of Computing*, 16:3(1994):40-56.

J.A.N. Lee, "Unforgettable Grace Hopper," *Reader's Digest*, (October, 1994): 181-185.

David Martin Luebke and Sybil Milton, "Locating the Victim: An Overview of Census-Taking, Tabulation Technology, and Persecution in Nazi Germany," *Annals of the History of Computing*, 16:3(1994):25-39.

Robert M. Metcalfe, "How Ethernet Was Invented," *Annals of the History of Computing*, 16:4(1994):81-88.

Alan Q. Morton, "Packaging History: The Emergence of the Uniform Product Code (UPC) in the United States, 1970-1975," *History and Technology*, 11:1(1994): 101-111.

Brian Randell, "The Origins of Computer Programming," *Annals of the History of Computing*, 16:4(1994):6-14.

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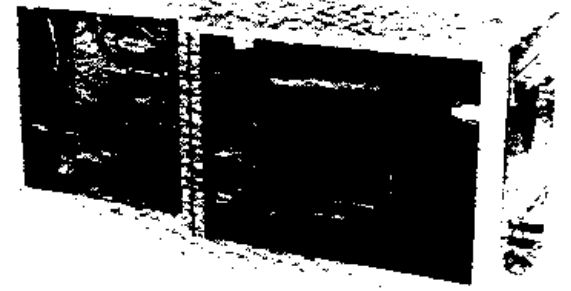
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A Williams Tube memory assembly from the Standards Western Automatic Computer (SWAC), ca. 1950. The Williams Tube was the subject of an article by Tony Sale (see Recent Publications). CBI Photograph 1560.

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Harvest

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of computer policy in the Atomic Energy Commission.

NSF Workshop on Digital Libraries

The HSS meeting was preceded by a National Science Foundation Workshop on Digital Libraries in Science and Technology Studies. Many historians are now developing digital libraries to assist in research and teaching and a number of them presented demonstrations of their libraries at the Workshop.



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100,000 Pictures Capture History of Burroughs Corporation



A display of the check processing system of the Burroughs B101 at the Exchange Bank and Trust of Dallas, photographed on June 19, 1960. Note the model's dress, which includes MICR (Magnetic Ink Character Recognition) numerals. This photograph is one of about 100,000 images in the Burroughs Corporation Records Project, which moves into its second year courtesy of the Unisys Corporation. The project archivist will shift from organizing and describing the paper records to working with the audio/visual collection. The photographs in the collection depict the entire visual history of Burroughs from its origin as the American Arithmometer Corporation of the 1890s to its merger with the Sperry Corporation in 1986.

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