

CHARLES BABBAGE INSTITUTE NEWSLETTER

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CENTER FOR THE HISTORY OF INFORMATION PROCESSING

Progress on DARPA Study

The historical study of the Information Processing Techniques Office (IPTO) of the Defense Advanced Research Projects Agency (DARPA) involves an analysis of their sponsored research program, management style, and influence. The investigation of the program and style is based on the records and public statements of IPTO, comments of contemporaries, and oral histories recorded with participants—both program staff and researchers—and observers. CBI staff have examined records in the IPT Office and in the National Archives, statements before Congressional hearings, and the archives of many of the organizations that received funds from IPTO, such as MIT, Carnegie-Mellon University, and Stanford University. Oral histories have already been recorded with nine managers and sixteen researchers.

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Initial conclusions of this study reveal that DARPA/IPTO played a substantial, maybe even a decisive, role in the development of computer science and engineering technology in the 1960s and 1970s. Results of IPTO projects stimulated basic research programs in universities and corporations. These programs focused on the frontiers of the computer science field and changed computer science from a marginal program into a theoretical and experimental discipline.

The program affected industrial developments in two ways. First, the plans and results of university projects became part of corporate activities through development and construction subcontracts. Second, IPTO encouraged other areas of industrial programs through direct R&D contracts.

The IPTO program promoted the transformation of the computer science field. It provided the support for important educational programs that led to significant personnel contributions needed in all areas of the field. Through its encouragement of industry, it contributed to the change in the country's economic base that resulted from the advances in and growth of the computer industry. IPTO achieved these results through a sustained, coherent program and a lean, quick-response management structure.

These two themes, coherence and management style, plus a third, the convergence of objectives between the research community and the Department of Defense, are the main elements around which our history of IPTO will be designed.

The study of the influence of the IPTO program has a wider focus through the development of case studies. Four case studies are in process: time-sharing; networking; graphics; and certain areas of

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Abbate Chosen as Second Tomash Fellow

Janet Abbate has been awarded the second Adelle and Erwin Tomash Fellowship in the History of Computing by the Charles Babbage Institute. Ms. Abbate is enrolled in the Ph.D. program at the University of Pennsylvania with emphasis on material culture and history of technology. She received a B.A. *cum laude* in American History and Literature from Harvard College in 1985 and an M.A. degree in American Civilization from the University of Pennsylvania in 1988.

Ms. Abbate's research project concerns the origins and development of computer networks and a comparison of the ARPANET with networks both in other

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Ms. Janet Abbate

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artificial intelligence. With changes in staff at CBI, these studies are now the responsibility of Ms. Judy O'Neill, research associate at CBI (time-sharing, networking); Professor Kerry Freedman (graphics); and Professor Arthur Norberg (artificial intelligence). Norberg is also responsible for the general history of IPTO described above. For the first six months of the study Dr. William Aspray was associated with the project, and much of the project's structure resulted from discussions with him. The case studies on time-sharing, networking, and graphics are well advanced, and there follow brief reports about them by O'Neill and Freedman. The relevant IPTO parts of these case studies will be used to justify statements of influence used in the general history. The study, in monograph form, is scheduled for completion in the first half of 1991.

Arthur L. Norberg

CHARLES BABBAGE INSTITUTE NEWSLETTER

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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.

DARPA Study Progress Report

Two important innovations in computing in the 1950s made the widespread use of computers possible: time-sharing and networking. These innovations go beyond specific hardware or software developments to basic changes in the ways computers are used and understood. DARPA played an important role in each of these developments. The DARPA study will include a detailed examination of both computer time-sharing and networking and how DARPA fostered and funded these important developments.

DARPA did not always play the same role in advanced research in computing. The case of computer time-sharing indicates that DARPA's early success in this area was primarily due to its ability to finance the work that many people in the academic computing community wanted to pursue. DARPA took on a different role in the development of computer networking. It developed a new computer networking approach, packet switching, to connect the DARPA-supported research centers that were spread across the United States. There was not very much community support for the network, so DARPA had a much more direct role in its development and, to some extent, forced the network on its research centers.

The primary sources of information for the history of computer time-sharing and networking are published accounts, proposals, reports and letters in government and university records, and the personal recollections of individuals involved in these developments. Interviews with some of the participants in these developments are being conducted to supplement the written documents. These interviews are being added to the Oral History Collection at CBI. □

Judy O'Neill

History of Computer Graphics Case Study

One part of the DARPA project is a case study focusing upon historical developments in interactive computer graphics until 1980. While some foundational developments emerged before 1963, computer graphics were not considered interactive until Ivan Sutherland's demonstration of Sketchpad that year. The primary conceptual focus of the early research DARPA funded was on human-computer communication rather than on issues of representation. The influence of the Sketchpad system, developed at Lincoln Laboratory, and the Rand Tablet (presented in 1964), funded by DARPA, became apparent with the proliferation of paint systems beginning in the early 1970s. DARPA also played an important role in a number of later developments that led to applications of interactive graphics such as flight simulation and aiding decision-making.

During the period studied, technical developments in computer graphics centered around three topics: input devices, output devices, and graphics languages. Early interactive input devices included light pens and data tablets. Changes in the characteristics of devices such as pen plotters, line printers, and vector and raster displays have been vital to the development of graphics systems. Many of the graphics languages developed during the period studied did not receive widespread use because they were machine-dependent.

The study relies on primary sources such as papers published in IEEE journals and AFIPS conference proceedings. Interviews of innovators in the field and overviews of the history written by people who were part of that history have been informative. However, the interviews and overviews have also presented problems because they often report only what has been agreed upon as significant; they do not always illustrate the processes through which these agreements have emerged. Pictorial references are particularly important to this study because seeing the visual characteristics of graphics systems is vital to understanding their conceptual connections and distinctions. □

Kerry Freedman

International Perspectives on the Role of Government in the Development of High-Technology Industry (Commentary)

[The Summer 1989 *CBI Newsletter* reported on a history of computing session to be held at the Society for the History of Technology annual meeting in Sacramento (October 1989). The session included papers by John Peter Collett and Olav Wicken (Norway) on the Norwegian computer industry, Arthur Norberg (United States) on the government's role in the United States industry, and Tom Wang (United States) on developments on the Pacific rim. Henry Lowood commented on the three presentations. Lowood's comments were so insightful about the themes in the three papers and so informative about the field of history of computing generally that we decided to publish them here. It is not necessary to have read or heard the three papers to appreciate his remarks. We offer them here as guidance for scholars in the field and for persons wishing to know one scholar's view of the present state of the field.]

Society for the History of Technology (SHOT) Annual Meeting, 14 October 1989

by Henry Lowood, Stanford University

In recent years, the field of multi-disciplinary, multi-dimensional investigations of high-technology industry has taken shape. Historians of technology, economics, and science, economists, regional geographers, policy analysts, and others are measuring the parts and pieces of this beast, the true species of which has not yet been fixed. Today's session underscores the diversity of its subject matter, and it also provides an occasion to take stock of some salient issues and problems.

Rather than considering the papers by Arthur Norberg, John Peter Collett and Olav Wicken, and Tom Wang seriatim, I propose to organize my commentary around three topics, referring to their papers as I move along. The items on my agenda are: first, the problem of sorting out policy objectives and influences in the development of high-technology industry; second, the drift of institutions

concerned with economic or technological development toward an increasingly strategic point of view over the last two decades; and third, perspectives offered by international comparisons.

The dominant theme in this session has been the impact of government policies and actions on technology-based industries and, in Arthur Norberg's paper, the technology-based discipline of computer science. The librettos have been similar, asking questions like: What kinds of roles have government agencies played? What has been their impact, and how effective have they been in these roles? Have these impacts reflected coherent policies?

These are questions that are crucial to our understanding of the institutional dimension of postwar science and technology, as anyone familiar with the literature on federal funding for physics or electronics research can testify.

The papers we have just heard add a further dimension to our assessment of government agencies and the programs they supported have had on the development of high-technology industries. This facet increases the complexity of an institutional assessment many-fold. A policy-guided initiative promoting a particular technological direction may have positive or negative ramifications for industrial development generally, or positive ones for some sectors and negative ones for others.

For example, Leslie Brueckner and Michael Borrus have concluded in their fine study on the commercial impact of the Very High Speed Integrated Circuit Program, supported by the Department of Defense, that "current DoD policies work at cross purposes to the civilian strategies necessary to succeed in future semiconductor markets."¹ Also, a mix of different policy initiatives and government actions can interact over time to move industrial development in an unforeseen direction, as Collett and Wicken have shown today for the case of the Norwegian computer industry.

Taking the three papers together, three kinds of policy objectives can be identified, each corresponding to a broad sector of interest.² I will call these the public, private, and research sectors.

The public interest, as it concerns high-technology industry, is focused on job creation and reduction of unemployment. Collett and Wicken show that in Norway the National Labor Union and its leading economists championed this cause. The Union stimulated public policy toward improving industrial productivity in order to create jobs. It suggested programs for priming the R&D pump, such as Kjell Holler's proposal for a public "development company." Now, the aim of reducing dependence on any one particular industry mitigates somewhat the public policy objective of turning on a technological job machine. So fine tuning is necessary, and here it struck me as interesting that both Collett and Wicken and Wang identified the oil crisis of the early to middle 1970s as a factor in making knowledge-based industry more attractive in Norway and in Japan, respectively.

Collett and Wicken say that Norwegian industry responded to a recession following the oil crisis in 1973, while Wang notes that the Ministry of Industrial Trade and Industry stepped up its efforts to transform Japanese manufacturing as a result of the "oil shock." The result in both cases was that an economic crisis stimulated the pursuit of knowledge-based industrial diversification, not just development, even though the two countries sat at opposite ends of the international flow of energy resources. I would like to know more about this impact of the energy crisis, that is, how it may have acted globally, in various guises, to make high-technology industry more attractive as a public policy objective during the 1970s.

Private interests are clearly different from the public interest. They are centered on profit. High-technology industry fits in the spectrum of investment opportunities at the high-risk, high-return end during the innovation stage, when entrepreneurial success is still uncertain. Opportunities for conservative investment occur when an established company's prognosis over the medium-term

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Norberg Appointed to ERA Chair

Dr. Arthur L. Norberg, Director of the Charles Babbage Institute (CBI) at the University of Minnesota, has been appointed to that institution's Engineering Research Associates (ERA) Land Grant Chair for the History of Technology effective 1 January 1990.

In honor of the 40th anniversary of the founding of Engineering Research Associates, Incorporated in Minnesota and in recognition of the many contributions of the members of the company, several of the early personnel created a fund at the University of Minnesota to establish a chair in CBI. This initiative became part of the University's Capital Campaign (1985-88) to raise \$300 million. Monies donated to the ERA Chair Fund were matched on a one-for-one basis by the Permanent University Fund. The total amount in the ERA Chair Fund is \$1 million.

The ERA Chair is incorporated within the mission of the Charles Babbage Institute. Dr. Norberg's responsibilities as chair holder will be:

- to establish organizational goals in CBI and design and direct effective programs and activities to ensure their timely achievement (included among these goals are those that focus on historical research, instruction, archival development, and reference services);
- to maintain an active research program in the history of technology and related areas of history;
- to disseminate the results of the historical research conducted by CBI staff in a timely and periodic fashion in the contexts of lectures, public speaking engagements, nationally reputed publications, and other appropriate educational vehicles;
- to participate in the instructional activities of the Program in the History of Science and Technology, specifically, and the University of Minnesota, generally. □

Technohistory of Electrical Information Technology Workshop

*Deutsches Museum, Munich,
15-19 December 1990*

Call for Papers

This workshop is organized internationally because technological development of electrical information technology is not a national but an international historical process and because there are few researchers in the field.

Contributions can be in English or German.

The number of participants will not exceed thirty in order to guarantee full and complete discussion.

Instructions as to the contents:

The workshop is committed to a socio-historically oriented technohistoriography. The workshop will concentrate on the specific problems in electrical information technology. Contributions should concentrate on the development of technological facts but should assume that technological development is a complex process within the social development and that the driving forces are to be sought there. Reflections on social conditions and assessments should serve to structure the contributions.

During the two days papers will be presented and discussed. On the third day a visit to the Museum-exhibitions is planned.

The first day will be reserved for three balancing reports. Subjects are: The state of the history of first, technology of telegraphs and telephones; second, technology of audio and video-radio; and third, technology of computers. The reports should give as balanced and comprehensive as possible a presentation of these three areas.

On the second day, papers within the context of the workshop on research in progress or just completed may be presented. They should reflect the position of the project within the general system of electrical information technology and the three levels mentioned above. The papers should not exceed thirty minutes in length.

The final discussion will be devoted to analysis of the workshop results.

All participants can stay at the Museum. There will be facilities and opportunities for large and small discussions. The Proceedings of the meeting will be published as soon as possible.

For further information contact Oskar Blumtritt or Hartmut Petzold, Deutsches Museum, Postfach 260102, 8000 Munchen 26, Federal Republic of Germany, telephone 089-21-79-1, extension 271. □

Strimpel Named Executive Director of The Computer Museum

Dr. Oliver B. R. Strimpel became Executive Director of The Computer Museum, Boston on 29 January 1990. The appointment was made by the Museum's Board of Directors following the recommendation of a special committee after a rigorous national search.

When Dr. Strimpel arrived as curator of The Computer Museum in 1984, he possessed a vision of how computers could be used in exciting interactive exhibits to reach a wide public. He has moved The Computer Museum into the forefront of interactive computer exhibit design. Recently the Museum has begun to export exhibits to other museums and technology centers around the world.

Dr. Strimpel was specifically responsible for the Museum's most successful permanent exhibitions, "The Computer and the Image" and "Smart Machines," two 4,000 square foot galleries with more than sixty interactive stations. The Computer Museum's most ambitious exhibition to date, the giant "Walk-Through Computer"—opening to the public 23 June 1990—was also Dr. Strimpel's idea.

Before coming to The Computer Museum, Dr. Strimpel was Curator at The Science Museum, London, from 1979 to 1983. There he was in charge of the national collections of mathematics and mathematical instruments, and computing and data processing. □

IEE—The Bicentennial Conference on Computing

A forward-looking event to commemorate the 200th anniversary of the birth of Charles Babbage—London, 1–3 July 1991

The year 1991 marks the bicentenary of the birth of both Charles Babbage and Michael Faraday. One pioneered computing machines, the other, the industry on which much of modern electronics depends. The bicentennial year is one in which attention will focus on computing, its related industries, their significance to the economy and to society. The Bicentennial conference on Computing holds a central place in a rich program of academic, professional, and media events to commemorate these two great figures.

The Bicentennial Conference on Computing is a three-day commemorative event devoted to computing technology, theory, and practice. The program is designed to take stock of the present, envision the future, and review the past.

An invited panel of distinguished international speakers will participate in the program. Speakers will include figures at the forefront of modern computing, those who have contributed to seminal developments, and those with a historical perspective of the history of computing technology.

Aims

The Bicentennial Conference on Computing is intended to provide a critical review of computing technology, the computer industry, and the profession.

Its purpose is to provide a forum in which leading international figures from industry, the computing profession, and academia take stock of the present, envision the future, and, in so doing, draw on the past.

The occasion for the event is the 200th anniversary of the birth of the English computer pioneer, Charles Babbage. The conference is a central event in a rich program of commemorative bicentennial events during 1991.

Scope

Each day of the three-day conference has a unifying theme: hardware; software; the industry and advanced systems applications. Papers on the state of the art and on the future are interspersed with historical review papers during each of the conference days.

Hardware

Processor technology, neural networks/parallelism, communications networks, computer integrated manufacturing, Babbage (life and times), Babbage's engines.

Software

Programming (historical and modern), software engineering, the logic of programming, fifth generation.

Industry/Advanced Systems Applications
Evolution of the computer industry, European computer industry, artificial intelligence, SDI, Babbage and numerical calculation.

The program includes an evening reception at the Science Museum, London, with a preview of a commemorative exhibition on Charles Babbage and his work.

Poster Papers

The Organizing Committee invites Poster Papers on work in progress and on prospective developments. Facilities will be provided for Poster Paper contributors to display text and to exhibit relevant equipment.

A synopsis (single A4 page) describing the content of intended contributions should be sent to the Secretariat by 4 February 1991.

Who Should Attend?

The conference is designed for senior and middle managers from industry and government, computer professionals, and those with a personal or professional interest in the evolution of computing technology and the direction of future change.

Working Language

The working language of the conference is English, which will be used for all printed material, presentations, and discussions. Simultaneous translation will not be provided.

Scholarship Scheme

Student IEE members and Younger IEE members presenting poster papers at this Conference may be eligible for an IEE Scholarship to assist with the costs of registration fees and reasonable accommodation charges. Please indicate on your inquiry if you require further details.

Venue

Imperial College of Science, Technology and Medicine, Exhibition Road, South Kensington, London SW7 2AZ, United Kingdom

Organizers

The Computing and Control Division of the Institution of Electrical Engineers

In collaboration with

The National Museum of Science and Industry

In association with

Association for Computing Machinery
British Association for the Advancement of Science
British Computer Society
British Society for the History of Mathematics
Charles Babbage Institute
History of Science Society
IEEE Computer Society
Institute for Mathematics & its Applications
Institution of Mechanical Engineers
International Federation for Information Processing

Secretariat

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For further information and registration form, send name, address, phone and fax numbers to:

The Bicentennial Conference on Computing
IEE Conference Services
Savoy Place
London WC2R 0BL, United Kingdom.



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countries (such as France's CYCLADES) and in other institutional contexts (e.g., corporate networks such as the Xerox Internet, cooperative networks such as BITNET). This cross-cultural research will illustrate the crucial role of social and institutional factors in network development as well as underscore the fact that technical innovations must be integrated into existing technological systems and therefore reflect the needs and constraints of those systems.

Technical issues in this study include the problems of resource-sharing among computers, the evolution of switching technologies, and the development of network protocols and internetworking, including attempts to win acceptance for protocol standards such as ARPA's TCP/IP or the International Standards Organization's X.25.

These technical issues, according to Ms. Abbate, are embedded in a web of social relations that shape the development of and responses to the technology. She hopes to draw a picture of the personal and organizational goals that motivated network developers as well as the economic and legal conditions that constrained them.

She will also explore two significant cultural issues: first, the impact that different corporate or academic cultures had on the outlook and actions of their members; second, issues in computer culture such as differences in the perception of goals and problems between electrical engineers and computer scientists.

She will consider some of the wider social, cultural, and economic consequences of the development of computer networks to see to what extent the introduction of networks changed the conditions of work or the balance of power between different social groups. Finally, she intends to examine the economic and legal implications of the availability of computer communications networks and how public policy has evolved to regulate them and to control risks associated with their misuse.

Ms. Abbate will spend part of the 1990-91 academic year doing research at the Babbage Institute. □

ERA Founder Parker Dies

John E. Parker, president and a founder of one of the earliest electronic computer firms, Engineering Research Associates (ERA), passed away on 22 December 1989 at the age of eighty-nine. Parker was instrumental in establishing ERA in 1946, after heading Northwestern Aeronautical Corporation, a glider company in St. Paul, Minnesota. He was president of ERA until it became a division of Remington Rand (later Sperry Rand) in 1953, when he became vice president of the Univac Division. After his tenure with Sperry Rand, he became president and board chairman of Teleregister Corporation. He later served in the same capacities for the Bunker Ramo Corporation.

John Parker was an enthusiastic supporter of the Charles Babbage Institute and was an important force in the establishment of the ERA Land Grant Chair in the History of Technology at the University of Minnesota. He delighted former ERA employees with his attendance at CBI's 1987 symposium honoring the fortieth anniversary of the founding of ERA. He also participated in an extensive oral history interview that has become available for research in CBI's archives. □

UNIVAC Oral History Conference

The National Museum of American History and the Charles Babbage Institute, with support from the Unisys Corporation, will hold an oral history conference on the UNIVAC computer on 17 and 18 May 1990. The conference will be held at the Smithsonian Institution shortly after the opening of the Information Age Exhibit on 6 May. The goal of the conference is to document the development, marketing, and use of the computer through the comments of the machine's salesmen, engineers, and users. The conference will be moderated by Bernard Galler of the University of Michigan. CBI will be responsible for the editing and production of oral history transcripts. For further information, contact Anne Frantilla, Unisys Corporate Archivist, at (313) 972-0318. □



Mr. John E. Parker circa 1950

Preserving the History of the Aerospace Industry

Last November the National Air and Space Museum (NASM) of the Smithsonian Institution held a two-day conference to encourage the preservation of aerospace corporate records. It was intended to assist corporations in establishing an archival program by sharing information on approaches, practices, and research of the archival community. The conference attracted over one hundred registrants, including industry representatives, archivists, historians, and individuals from government. CBI's archivist Bruce Bruemmer was invited to speak on records selection in high-technology corporations.

The first session of the conference included a series of case studies involving established corporate archives. Jeffrey Sturchio (Merck & Co.), Anne Millbrooke (United Technologies Corp.), Edward Galvin (The Aerospace Corp.), and Philip Mooney (Coca-Cola Co.) made presentations relating to the benefits, use, establishment, and implementation of corporate archival programs. The second session featured presentations on significant issues affecting the preservation of records in a corporate environment. William Benedon (Lockheed Corp.) discussed records management, David Olson (Boeing Co.) described the use of archives in public relations, Daniel P. Byrnes (Pepperdine College) commented on legal issues in record keeping, and David Baldwin (MITRE Corp.) discussed security and regulatory issues.

The second day included a discussion by archivists about approaches to documenting large businesses. Helen Samuels (MIT) commented on the state of documentation in science and technology. Bruce Bruemmer (CBI) described the process of records selection, emphasizing the work that the staff of CBI had conducted during preparation of CBI's guide to documenting high-technology companies. Dennis Meissner (Minnesota Historical Society) reported on his institution's experiences with the acquisition of business records.

Martin Collins, co-director of the Glennan-Webb-Seamans Project for Research in Space History, outlined a five-point agenda for action after the

conference. First, he proposed to formalize a relationship between the NASM and the Aerospace Industries Association and the American Institute of Aeronautics and Astronautics. Second, NASM would prepare a position paper for organizing and implementing a preservation effort. Third, CEOs of aerospace companies would be sent a report on progress on documenting the industry. Fourth, NASM would prepare and distribute proceedings of the conference. Fifth, NASM plans to meet with individual companies to discuss concerns about records.

The conference was a important effort to convince corporations of the significance of their historical records, particularly in an industry that has been a prominent developer and user of computers. Further information about the conference proceedings may be obtained by calling Colleen Mason at NASM, 202, 357-2828. □

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becomes an easier call. In both cases, government agencies play an important role in directing the flow of investment.

The paper by Collett and Wicken brings this role out nicely by drawing attention to the distinction between stated policy and what they call "actual state activity." The palette of actions ranged from contracts let for the purpose of building specific industrial capacities to procurement, and they gave rise to entrepreneurial ripples, such as Kongsberg shifting its attention to fire control systems, the spinning off of new companies from research funded by the state, or filling orders from the Navy or the Norwegian civil administration. These measures stimulated product diversification and the creation of markets. They also functioned as success indicators to the private sector, signaling where investments would be profitable.

Collett and Wicken mention the appearance of venture capital for the computer industry during the late 1960s and 1970s. Reasonable investors followed in-

dications that a return would be favorable, such as a company winning government support in the form of R&D contracts, the participation of researchers from institutes like the Norwegian Defense Research Establishment (e.g., Norsk Data), and so on. If I read Collett and Wicken correctly, this mechanism existed before the meta-process became explicit public policy. By "meta-process" I mean the application of such mechanisms as tools for directing and strategically influencing economic development.

It is not easy to depict the interests of the research sector as a coherent whole, even if we limit our attention to university-based research. The traditional missions of the academic community—research and teaching—are often intertwined with economic development through such links as strings attached to government funding or industrial sponsorship of research. Established companies sometimes find it easier to generate innovations through strategic links with university laboratories than in-house. Government agencies can also take action to encourage these interactions between universities and industry in the interest of economic development.

Arthur Norberg's account illuminates a web of interests that brought together the nascent computer science community, federal support, and industry. He shows that the meeting point was a new focus on computing environments that encompassed task processing, information management, real-time response, and, for the military, the automation of command and control.

The title of Norberg's paper refers to a "convergence" of military and civilian aims regarding the development of computer systems. After reading Collett and Wicken's views on the consequences of government actions in the computer industry, I expected Norberg's paper to show how military pebbles caused ripples in the civilian waters of American computer science. But disciplines are not affected by funding in quite the same way as industrial concerns. Military funding supported computer science partly in response to a divergence of the technological needs of industry and the military circa 1960. Norberg tells us that, because computer technology had stabilized,

manufacturers could sell general-purpose machines to satisfy a variety of markets. If I am rendering his argument correctly, this situation had the interesting effect of lowering the profile of government support of R&D. The emergence of the new discipline of computer science then shifted attention to a different set of priorities centered on computing techniques rather than hardware breakthrough.

The Information Processing Techniques Office (IPTO) of DARPA responded to the funding needs of the new computer science, led initially by J. C. R. Licklider who, along with John McCarthy and others at the same time, served as a leading visionary of the disciplinary movement. One critical convergence consisted of a stable technological platform (the "standard computer," as Norberg calls it) from which the discipline jumped into the new field of computing techniques and environments, which was of particular interest to military sponsors. Another convergence consisted of Licklider himself, representing both DARPA and a disciplinary view. These convergences, especially the first, help to explain why so many prominent careers took substantial turns around 1960, as "hardware types" moved to problem areas such as artificial intelligence, Licklider's "man-machine symbiosis," and what Douglas Engelbart (a transplanted memory guy himself, who gained funding from the AFOSR and DARPA) called the "augmentation of the human intellect." In terms of cause and effect, the IPTO in the United States and the NDRE in Norway functioned quite differently, the former responding to a convergence of academic and military interests, the latter creating opportunities for private sector investment.

Another common thread in the three papers directs us to an evolution in the institutions and agencies affecting high-technology industry, especially on the governmental side, despite the great diversity of agencies, institutions, and disciplines: the Development Fund and the NDRE in Norway, DARPA and MIT in the United States, MITI in Japan, the Korean Institute of Electronics Technology, etc. The consistent pattern is the increasingly conscious "strategic" dimension in the activities of these entities over time. During the 1960s and early 1970s, the dominant mode consisted of responses to particular situations, crises, or convergences of interest,

whether in Norway, the United States, or Japan. By the late 1970s, however, a new vocabulary of government policy seems to have emerged, exemplified by MITI's "Vision of Industry for the 1980s" statement, issued in 1979; South Korea's Semiconductor Industry Fostering Plan of 1983; and the publication in Norway of governmental white papers extolling the computer industry and electronics as crucial elements in industrial development.

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First, high-technology industry has an international focus by virtue of its intimate connection with governmental efforts to ensure national competitiveness in the economic arena. Industries based on new research, it is argued, offer a greater capacity for rapid diversification and growth and thus create incremental jobs and investment opportunities. It is only natural that studies of this process compare models that have been used to manage it at the national level, since these models are elements in the international competition of economies.

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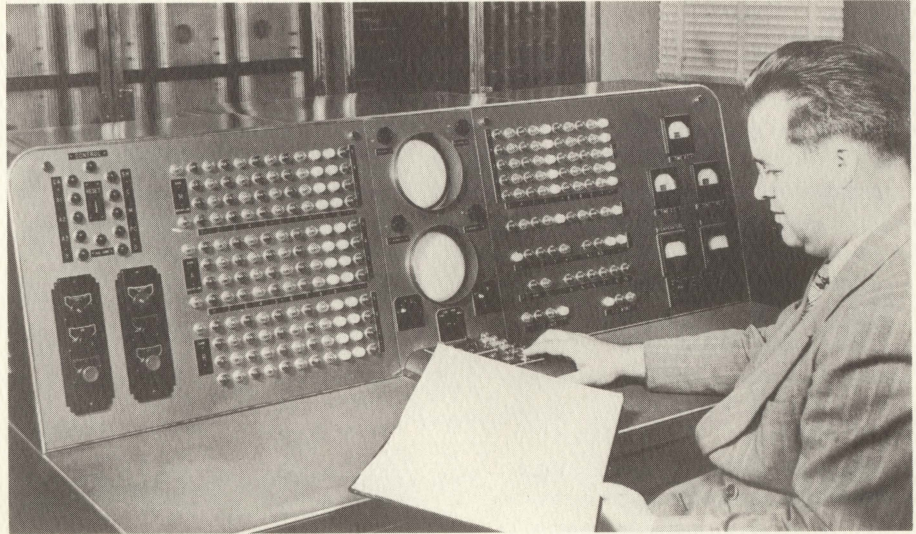
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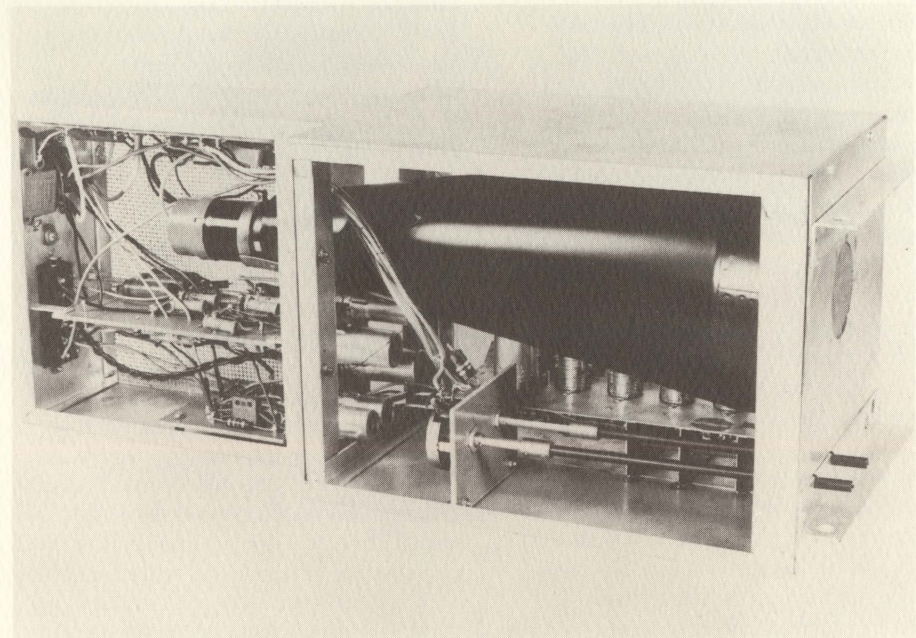
SWAC Nears 40th Anniversary

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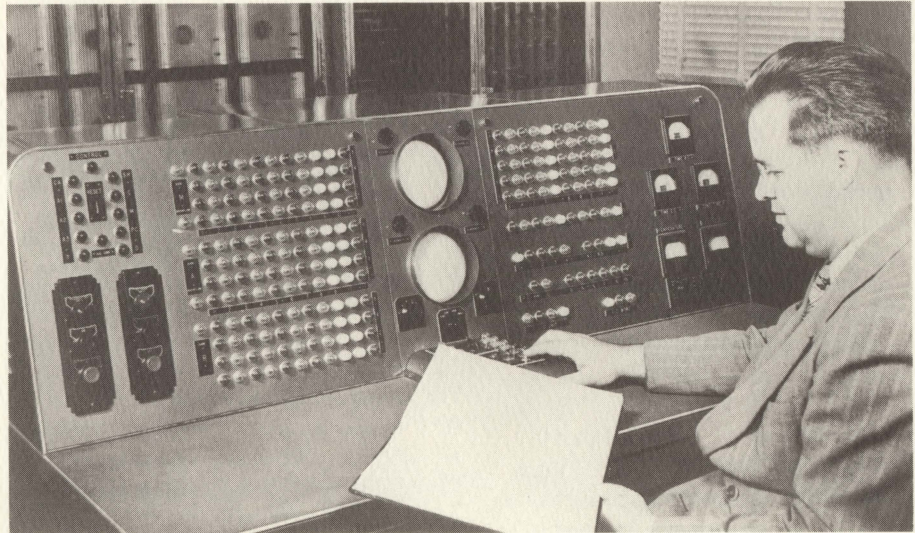
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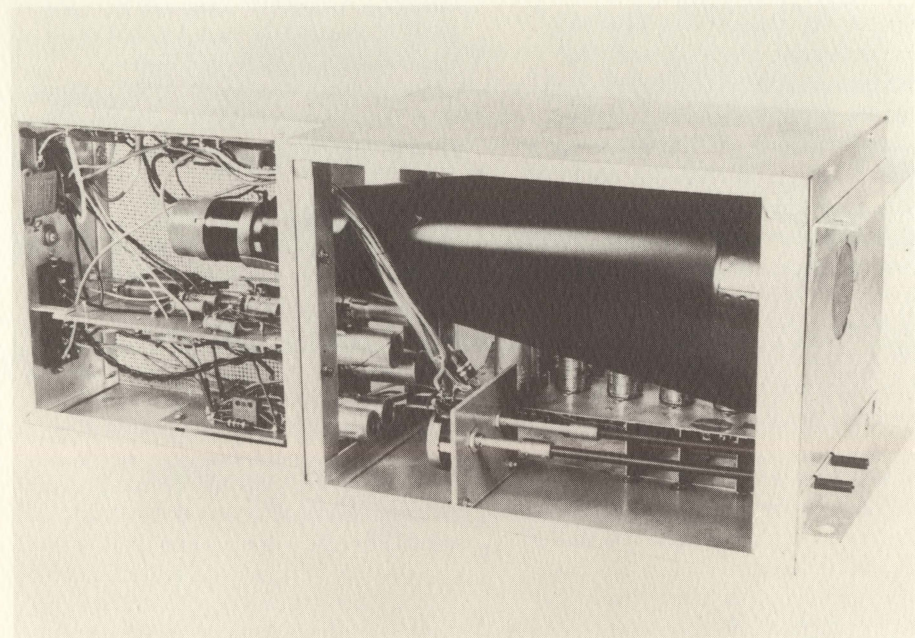
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Preserving the History of the Aerospace Industry

Last November the National Air and Space Museum (NASM) of the Smithsonian Institution held a two-day conference to encourage the preservation of aerospace corporate records. It was intended to assist corporations in establishing an archival program by sharing information on approaches, practices, and research of the archival community. The conference attracted over one hundred registrants, including industry representatives, archivists, historians, and individuals from government. CBI's archivist Bruce Bruemmer was invited to speak on records selection in high-technology corporations.

The first session of the conference included a series of case studies involving established corporate archives. Jeffrey Sturchio (Merck & Co.), Anne Millbrooke (United Technologies Corp.), Edward Galvin (The Aerospace Corp.), and Philip Mooney (Coca-Cola Co.) made presentations relating to the benefits, use, establishment, and implementation of corporate archival programs. The second session featured presentations on significant issues affecting the preservation of records in a corporate environment. William Benedon (Lockheed Corp.) discussed records management, David Olson (Boeing Co.) described the use of archives in public relations, Daniel P. Byrnes (Pepperdine College) commented on legal issues in record keeping, and David Baldwin (MITRE Corp.) discussed security and regulatory issues.

The second day included a discussion by archivists about approaches to documenting large businesses. Helen Samuels (MIT) commented on the state of documentation in science and technology. Bruce Bruemmer (CBI) described the process of records selection, emphasizing the work that the staff of CBI had conducted during preparation of CBI's guide to documenting high-technology companies. Dennis Meissner (Minnesota Historical Society) reported on his institution's experiences with the acquisition of business records.

Martin Collins, co-director of the Glennan-Webb-Seamans Project for Research in Space History, outlined a five-point agenda for action after the

conference. First, he proposed to formalize a relationship between the NASM and the Aerospace Industries Association and the American Institute of Aeronautics and Astronautics. Second, NASM would prepare a position paper for organizing and implementing a preservation effort. Third, CEOs of aerospace companies would be sent a report on progress on documenting the industry. Fourth, NASM would prepare and distribute proceedings of the conference. Fifth, NASM plans to meet with individual companies to discuss concerns about records.

The conference was a important effort to convince corporations of the significance of their historical records, particularly in an industry that has been a prominent developer and user of computers. Further information about the conference proceedings may be obtained by calling Colleen Mason at NASM, 202, 357-2828. □

PERSPECTIVES continued from page 3...

becomes an easier call. In both cases, government agencies play an important role in directing the flow of investment.

The paper by Collett and Wicken brings this role out nicely by drawing attention to the distinction between stated policy and what they call "actual state activity." The palette of actions ranged from contracts let for the purpose of building specific industrial capacities to procurement, and they gave rise to entrepreneurial ripples, such as Kongsberg shifting its attention to fire control systems, the spinning off of new companies from research funded by the state, or filling orders from the Navy or the Norwegian civil administration. These measures stimulated product diversification and the creation of markets. They also functioned as success indicators to the private sector, signaling where investments would be profitable.

Collett and Wicken mention the appearance of venture capital for the computer industry during the late 1960s and 1970s. Reasonable investors followed in-

dications that a return would be favorable, such as a company winning government support in the form of R&D contracts, the participation of researchers from institutes like the Norwegian Defense Research Establishment (e.g., Norsk Data), and so on. If I read Collett and Wicken correctly, this mechanism existed before the meta-process became explicit public policy. By "meta-process" I mean the application of such mechanisms as tools for directing and strategically influencing economic development.

It is not easy to depict the interests of the research sector as a coherent whole, even if we limit our attention to university-based research. The traditional missions of the academic community—research and teaching—are often intertwined with economic development through such links as strings attached to government funding or industrial sponsorship of research. Established companies sometimes find it easier to generate innovations through strategic links with university laboratories than in-house. Government agencies can also take action to encourage these interactions between universities and industry in the interest of economic development.

Arthur Norberg's account illuminates a web of interests that brought together the nascent computer science community, federal support, and industry. He shows that the meeting point was a new focus on computing environments that encompassed task processing, information management, real-time response, and, for the military, the automation of command and control.

The title of Norberg's paper refers to a "convergence" of military and civilian aims regarding the development of computer systems. After reading Collett and Wicken's views on the consequences of government actions in the computer industry, I expected Norberg's paper to show how military pebbles caused ripples in the civilian waters of American computer science. But disciplines are not affected by funding in quite the same way as industrial concerns. Military funding supported computer science partly in response to a divergence of the technological needs of industry and the military circa 1960. Norberg tells us that, because computer technology had stabilized,

manufacturers could sell general-purpose machines to satisfy a variety of markets. If I am rendering his argument correctly, this situation had the interesting effect of lowering the profile of government support of R&D. The emergence of the new discipline of computer science then shifted attention to a different set of priorities centered on computing techniques rather than hardware breakthrough.

The Information Processing Techniques Office (IPTO) of DARPA responded to the funding needs of the new computer science, led initially by J. C. R. Licklider who, along with John McCarthy and others at the same time, served as a leading visionary of the disciplinary movement. One critical convergence consisted of a stable technological platform (the "standard computer," as Norberg calls it) from which the discipline jumped into the new field of computing techniques and environments, which was of particular interest to military sponsors. Another convergence consisted of Licklider himself, representing both DARPA and a disciplinary view. These convergences, especially the first, help to explain why so many prominent careers took substantial turns around 1960, as "hardware types" moved to problem areas such as artificial intelligence, Licklider's "man-machine symbiosis," and what Douglas Engelbart (a transplanted memory guy himself, who gained funding from the AFOSR and DARPA) called the "augmentation of the human intellect." In terms of cause and effect, the IPTO in the United States and the NDRE in Norway functioned quite differently, the former responding to a convergence of academic and military interests, the latter creating opportunities for private sector investment.

Another common thread in the three papers directs us to an evolution in the institutions and agencies affecting high-technology industry, especially on the governmental side, despite the great diversity of agencies, institutions, and disciplines: the Development Fund and the NDRE in Norway, DARPA and MIT in the United States, MITI in Japan, the Korean Institute of Electronics Technology, etc. The consistent pattern is the increasingly conscious "strategic" dimension in the activities of these entities over time. During the 1960s and early 1970s, the dominant mode consisted of responses to particular situations, crises, or convergences of interest,

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Ms. Pamela McCorduck: Ms. McCorduck has published six books, both non-fiction and fiction, including "The Universal Machine" and "Machines Who Think," and numerous articles in periodicals. She has lectured before many business, professional, and academic groups, has appeared on radio and television, and has consulted for several organizations and firms. She is currently an editorial consultant for the IEEE journal *Spectrum*. She has been a lecturer in the department of English and Comparative Literature at Columbia University since 1980. She serves on the executive board of the American PEN Center. She is a member of the Authors Guild and the National Association of Science Writers. She was Distinguished Visitor at the Institute for Humanities Research at Indiana University/Purdue University in 1987, received Honorable Mention in the New Letters Literary Awards in 1986, and held a Faculty Lectureship at Kenyon College in 1986. She received her M.F.A. from the School of the Arts, Writing Division, from Columbia University.

Professor Daniel D. McCracken: Professor McCracken is current chairman of the Computer Sciences Department at City College, City University of New York. He is a past president of the ACM and past chair of the AFIPS History of Computing Committee. Since 1956 he has authored twenty-six textbooks on programming languages and related subjects. He is the 1989 recipient of the Norbert Wiener Award for Social and Professional Responsibility, given by Computer Professionals for Social Responsibility. He was elected Fellow of the AAAS in 1985 and is a member of the Computer Science Accreditation Commission. He received B.A. degrees in mathematics and chemistry from Central Washington University and an M.Div. *cum laude* degree from Union Theological Seminary. He served as adjunct professor at Columbia University before joining City College.

Mr. Frank C. Mullaney: Mr. Mullaney is a member of the boards of directors of

Dataproducts Corp., Analysts International Corp., and Dicomed Corp. He was a founder and director of Control Data Corporation and Cray Research Inc. and before that for Engineering Research Associates. He is a senior member of the Institute of Radio Engineers and a member of the ACM. In addition to being a founder of the Charles Babbage Foundation, he was a major supporter of the ERA Land Grant Chair in the History of Technology at the Charles Babbage Institute. He received a B.E.E. degree from the University of Minnesota.

Mr. Robert M. Price: Mr. Price is chairman of the board of Control Data Corporation, where he has served since 1961. He is a member of the boards of directors numerous other organizations, including International Multifoods, Cooper Industries, Appalachian Community Service Network, Fuqua School of Business at Duke University, Alpha Center for Public & Private Initiatives, and the University of Minnesota Foundation. He is on the Advisory Board of the Technology Policy Task Force for the Committee on Science, Space, and Technology, Co-chair of the Technology Committee for the Congressional Economic Leadership Institute, and a Fellow in the International Academy of Management. He received a B.S. degree *cum laude* in mathematics from Duke University and an M.S. degree in applied mathematics from Georgia Institute of Technology.

Dr. Emerson W. Pugh: Dr. Pugh is a research staff member at the IBM Thomas J. Watson Research Center in Yorktown Heights, New York. His primary interests are technology assessment, the history of computers, information storage technologies, and technology policy. He is president of IEEE and a member of the United Engineering Trustees Board, the governing body for the Engineering Societies Library, the Engineering Foundation, and the United Engineering Center in New York City. He was elected Fellow of the AAAS in 1977 and of the IEEE in 1972. He is also a Fellow of the American Physical Society. Previous to joining IBM he was an assistant professor of physics at Carnegie-Mellon University. He received a Ph.D. degree in physics from Carnegie-Mellon.

Mr. George M. Ryan: Mr. Ryan is the director of the International Students Center at the University of California, Los Angeles. He was a founding partner of

Office Automation Associates, engaged in the development of computer-based products for the office. He had been founder, chairman, and chief executive officer of CADO Systems Corporation and founder and head of Intercontinental Systems Inc., a manufacturer of automatic typewriters. He was chairman of the boards of ISA Software, Continental Telecom, Manufacturing Resources Inc., and Image Resources Inc. He is a founder of the Charles Babbage Foundation. He received a B.A.A. degree from the University of Wisconsin and began his professional career as a Certified Public Accountant with Touche Ross. Mr. Ryan was accepted by Lloyds of London as one of the first foreign underwriting members.

Dr. Merrit Roe Smith: Dr. Smith is the Metcalfe Professor of Engineering and Liberal Arts and professor of the History of Technology program in Science, Technology, and Society and History faculty at Massachusetts Institute of Technology. He was elected NEH-NSF Fellow of the Center for Early American Studies, University of Pennsylvania in 1985, Regents Fellow for the National Museum of American History, Smithsonian Institution, 1984-85, National Science Foundation Scholar in 1984, Guggenheim Fellow in 1983, U. S. Senior Fulbright Scholar, University of Linkoping, Sweden, 1983, Fellow for the AAAS in 1983, among many other awards and distinctions. He was vice president for the Society for the History of Technology from 1986-88 and was elected president of that group in 1988. He is a member of the AAAS, American Antiquarian Society, Society for Industrial Archeology, History of Science Society, American Historical Association among others. He received M.A. and Ph.D. degrees from The Pennsylvania State University.

Dr. Joseph F. Traub: Dr. Traub is the Edwin Howard Armstrong Professor of Computer Science and Professor of Mathematics at Columbia University, where he is also chair of the Computer Science Department. He also served as head of the Computer Science Department at Carnegie-Mellon University from 1971-1979. He has received numerous honors, including election to the National Academy of Engineering and as Fellow of AAAS. He is Chairman of the Computer Science and Technology Board of the National Research Council,

the operating arm of the National Academy of Sciences and the National Academy of Engineering. He serves on the Board of Governors of the New York Academy of Sciences. He is on the board of trustees of Columbia University Press. He received his Ph.D. from Columbia University.

Mr. Sam Wyly: Mr. Wyly is chairman of the board of Sterling Software in Dallas, Texas. Besides founding Sterling Software, Mr. Wyly founded a number of other companies, including NetAmerica, Earth Resources Company, Data Transmission Company, Computer Industries,

Computer Leasing Company, and University Computing Company (Wyly Corporation). He also served as chairman of the board of Bonanza International, Inc. He received the 1968 Jaycee award as one of America's Ten Outstanding Young Men and an honorary Doctorate from Louisiana Tech University in 1977. He served as trustee of Southern Methodist University for eight years. He is a founder of the Charles Babbage Foundation. He received a B.S. degree from Louisiana Tech and an M.B.A. degree from the University of Michigan.

Additionally, the following incumbent trustees will serve through 1990: **Paul Armer, Isaac L. Auerbach, William O. Baker, Walter M. Carlson, I. Bernard Cohen, Stephen G. Jerritts, Roger G. Kennedy, Chester I. Lappen, Douglas T. Ross, and Erwin Tomash;** and through 1991: **Hollis L. Caswell, J. Chuan Chu, Willis K. Drake, Bernard A. Galler, Arthur L. C. Humphreys, Joshua Lederberg, William C. Norris, and Kenneth H. Olsen.** □

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