

Arthur Norberg, the Charles Babbage Institute, and the History of Computing

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This issue of the *IEEE Annals of the History of Computing* originated with a desire to mark the retirement of Charles Babbage Institute founding director Arthur Norberg. In so doing, a number of Norberg's peers were invited to help celebrate and honor the CBI director's career while also appraising the history of computing field that Norberg helped create.

This issue of the *IEEE Annals of the History of Computing* originated with our desire to mark a moment in the history of the Charles Babbage Institute: the retirement of founding director Arthur Norberg. We wanted to create an event that would be properly festive and celebratory, and yet have a larger purpose as well. What better way to celebrate the career of a scholar such as Arthur Norberg than convening his friends and peers for an appraisal of the field that he helped to create?

As incoming CBI director, I took up the task of organizing the workshop with the active cooperation and essential support of CBI's associate director Jeffrey Yost. Together, we drew up an A-list of the historians of computing who might attempt a serious assessment of the field and not merely bestow polite felicitations on Arthur. The names came readily to mind: William Aspray, the first CBI-Tomash fellow, prolific author, energetic editor, and for some years associate director of CBI; Michael Mahoney, a senior peer and colleague of Arthur's, widely respected for his work on the history of computer science and software engineering, long-serving *IEEE Annals of the History of Computing* board member, and astute commentator on intellectual trends in the field; Martin Campbell-Kelly, co-author with Aspray of the Sloan Foundation-supported *Computer: A History of the Information Machine* and author in his own right of the ground-breaking history of the software industry, *From Airline Reservations to Sonic the Hedgehog*; and finally James (Jim) W. Cortada, who single-handedly has published more books, in several distinct fields, than some

entire history departments while simultaneously holding down an executive-level "day job" at IBM. We hoped that, perhaps if we were lucky, possibly two or three of these busy people might attend our planned two-day event.

To our astonishment and delight, we soon learned that all four of these colleagues were able, even delighted, to attend. Later, Steve Usselman, a leading business and technology historian who is preparing a major study of IBM's business strategies, joined the roster of speakers and commentators, which came also to include Erwin Tomash, CBI's founder and guiding spirit, and Arthur Norberg himself. At a coffee break during the conference, one of the University of Minnesota graduate students remarked, "You know, the speakers today are nearly the entire reading list for our history of computing course!" We asked each one to make an appraisal of the computing history field as a whole. This strategy allowed us to appeal to Arthur's modesty, and to shift the spotlight from his accomplishments to the evolution of the field. We chose a convenient weekend in early June 2006 when board members of the Charles Babbage Foundation could be in Minneapolis and add their perspectives to the discussion.

History of computing: A promising start

In 1980, when the Charles Babbage Institute came to the University of Minnesota, the history of computing was in a promising but early phase of its development. Just a year earlier, the *Annals of the History of Computing*

began publishing under the capable editorship of Bernie Galler and with the financial support of the American Federation of Information Processing Societies (1961–1990). AFIPS, originally comprising the Association for Computing Machinery, the American Institute of Electrical Engineers, and the Institute of Radio Engineers (the latter two having merged to form the IEEE in 1963), served as the US national representative to the newly formed International Federation for Information Processing. AFIPS members ran the principal regional and national computer conferences in the US from the 1960s onward. AFIPS also had an active history committee, chaired by Jean Sammet.

In his inaugural editorial, Galler captured the tone of this early community and highlighted its distinctive energy and enthusiasm. “Computing pioneers look enthusiastically to this journal,” he wrote, “with a sense of having made important contributions to knowledge, to science, and to the quality of life, and of wanting this contribution to be recorded and appreciated.” On the same page, Galler announced the 15-year rule—namely that the *Annals* would publish articles about events and developments that were at least 15 years in the past—to make sure, as he put it, that “our material can be placed in some historical perspective.”¹ The rule has been relaxed somewhat in recent years with the rise of the Internet, open source, and recent personal computer software developments that clearly merit historical attention.

That founding volume of the *Annals* gives a good idea of the state of the field at the time. The first issue featured articles by Nancy Stern on Binac, the computer-development project that had largely saved the Eckert-Mauchly Computer Corporation from bankruptcy; by John Backus on the history of Fortran, his own creation; by I.J. Good on the wartime code-breaking work at Bletchley Park; a document by F.J. Gruenberger describing the RAND Corporation’s JOHNNIAC machine; and a report on the (first) History of Programming Languages Conference.² It seems the history of software was present at the creation, notwithstanding the obvious emphasis on the pioneering digital computing machines. The second number of the *Annals* comprised a 100-page annotated bibliography compiled by Brian Randell and a valuable article by Erwin Tomash and Arnold Cohen on the early years of the Engineering Research Associates, which was merged along with the Eckert-Mauchly Computer Corporation to form the



Figure 1. In 1980, Erwin Tomash (at left), CBI’s founder, and Al Hoagland, AFIPS president, shared a light moment after signing an agreement to support the history of computing. Paul Armer, CBI’s first executive secretary, looks on. (Courtesy Charles Babbage Institute.)

Univac division of Remington Rand and, in time, a part of Sperry Rand.

In 1980 it would have been difficult to see the future of the Charles Babbage Institute, but there were ample signs that a secure base was in place. An inspiring vision was to unfold over the next decades. Readers interested in a full account can consult an earlier special issue of the *Annals* on the Tomashes’ contributions to the history of computing, William Aspray’s contribution to this issue, and the set of CBI’s *Newsletters* (1979 to the present).³ I believe that Arthur Norberg was CBI’s “founding” director, in the sense that it was his vision more than anyone else’s that shaped the fledgling venture and created the mature institution it is today, but he was not precisely CBI’s first director. CBI was formally incorporated on 28 November 1977.⁴ Paul Armer, the founder of computer science at RAND, and past president of AFIPS, served as its executive secretary during the two years that CBI had offices at 701 Welch Road in Palo Alto, California, and as associate director for an additional year after CBI moved to Minnesota.⁵ Armer worked closely with CBI’s founder (see Figure 1), Erwin Tomash,

CBI's archival capabilities were greatly increased in 2000 when it moved into Andersen Library, a state-of-the-art facility featuring underground climate-controlled storage.

who had entered the computer field himself in 1946 working for the Engineering Research Associates and later founded Dataproducts, a leading manufacturer of printers and peripherals. CBI's secure base rested on the active support and participation from the technical community, especially industry leaders and AFIPS members. Gene Amdahl led an active and successful Founders' campaign that resulted in two dozen sizable donations, and an exceptionally strong board of trustees further strengthened CBI's financial position.

Right time, right place

Several developments converged to bring CBI to the University of Minnesota in 1980.

Walter Bauer, Informatics president, chaired a permanent site selection committee, and looked for a university home that would offer established graduate-level programs in computing and history of science, excellent computer and library resources, and a solid university archive. "Archival capabilities are of considerable importance in choosing a host institution," wrote Pamela Gullard, CBI's staff editor, in the pages of the *Annals*. "The archival program will be one of CBI's primary functions."⁶ This thinking was considerably shaped by two reports authored by Arnold Cohen for the AFIPS computer-history committee. Cohen had also been an early member of the pioneering Engineering Research Associates, a noted computer designer in his own right, and a founding member of the CBI board of trustees.

Another key figure in Minnesota was Roger Stuewer, a historian of physics and founder of the university's history of science and technology program. Stuewer surveyed the Twin

Cities' remarkable heritage in computing history—local lore has it that three-quarters of the world's computers were made in Minnesota, at a certain moment in the early 1950s—and prepared a proposal to bring CBI to Minnesota.⁷ His proposal was successful, and Stuewer served for a year as acting director before Norberg's arrival as permanent director in September 1981.⁸

None other than Arthur Norberg has ably recounted CBI's subsequent quarter-century history.⁹ His biggest achievement was to balance the advice and suggestions he received from the members of the technical community that took such a deep interest in CBI with the insights, practices, and recommendations that Arthur knew, and indeed helped develop, from the world of professional history and archiving. These two perspectives did not always line up, as Aspray makes clear elsewhere in this issue. Archiving did become a major activity at CBI, where at least one and often two professional archivists have been on staff. CBI's archival capabilities were greatly increased in 2000 when it moved into Andersen Library, a newly constructed state-of-the-art archival facility with underground climate-controlled storage.^{10,11}

Oral histories were also prominent among the goals set by the AFIPS organizers, and Norberg helped shape a specific model of "research grade" oral histories, involving extensive preparation, detailed questioning, transcribing of the interview tapes, and Web-publishing the edited interviews whenever possible. CBI's oral history database now contains around 300 transcripts done by CBI staff and associates over the years, and we record more than 10,000 transcript downloads each year. Both the archives and the oral histories now form a major research infrastructure. Historians of computing are well aware of these riches, and one of our tasks in the coming years is to bring them to the attention of business historians, Cold War historians, and cultural historians who can benefit from using these materials. Already scholars from rhetoric and cultural studies have made this discovery.

One activity that Norberg vigorously advocated was for CBI to develop its own research program. Indeed, CBI's research projects, oral histories, and archiving activities have been complementary activities. CBI researchers have conducted studies with support from the National Science Foundation, National Endowment for the Humanities, National Historical Publications and Records Commis-

sion, DARPA, IBM, and other agencies and institutions. In addition to a large number of articles, chapters, and reports, CBI researchers have published eight major book-length studies.¹² In 2005, Norberg published *Computers and Commerce: A Study of Technology and Management at Eckert-Mauchly Computer Company, Engineering Research Associates, and Remington Rand, 1946–1957* (MIT Press), and Jeff Yost published *The Computer Industry* (Greenwood Press). Over the years, more than two dozen scholars have been named CBI–Tomash fellows and awarded financial support to complete their PhD research in some aspect of computing history.¹³ Finally, CBI’s ongoing research findings and accessible wealth of documentation helped shape Norberg’s active teaching efforts at Minnesota (see Figure 2).

The articles in this special issue offer an unusually wide overview of the history of computing, even though the task of taking stock of the field is difficult—and growing more difficult by the year. Perhaps it is simply no longer possible to refer to “the field” in the way that Michael Mahoney implicitly did, nearly two decades ago, in his pioneering historiographic treatment.¹⁴ It also is fair to acknowledge that not all themes that scholars are exploring have found their way into this special issue—and some of these themes have not yet been prominent in the *Annals*. As computing becomes more pervasive in society, I believe that researchers from fields far beyond the computing-history community will become in effect historians of computing. Historians and sociologists of science have begun exploring the consequences of computing and information-management techniques, such as databases, for the physical and biological sciences.¹⁵ Historians of technology have avidly embraced gender as a useful analytical category, and the historical exploration of gender and computing looms as a critical educational and policy concern as well as a challenging intellectual question.¹⁶ Scholars largely outside the *Annals* have explored the countercultural roots of computing and offered varied interpretations of computing’s cultural resonances.¹⁷ Other emerging themes in the history of computing are sketched in my article “Understanding ‘How Computing Has Changed the World’” elsewhere in this issue.

Based on a recent oral history, Aspray highlights Norberg’s professional training and experiences that led him to the history of computing and the CBI directorship. As I’ve



Figure 2. Arthur Norberg teaching a computer history class at the University of Minnesota. (Courtesy Charles Babbage Institute.)

mentioned, when CBI was created, the technical community played a large role institutionally in supporting CBI as well as intellectually in helping shape the field. With his background in physics, experience at Westinghouse, and professional development at Berkeley’s Bancroft Library and the National Science Foundation, Norberg was well positioned to assess and balance the varied directions articulated for CBI.¹⁸ Aspray observes that the outcome of these sometimes contentious discussions—“major intellectual disagreements” and even “battles” are his chosen terms—would largely determine the character of CBI’s programmatic activities and directly shape the evolution of the computing history field.

Although the professional community from AFIPS wanted CBI to confine itself to archiving functions, Norberg pressed for a larger and more expansive agenda. He found a more receptive audience in the industrial community for his vision of CBI that included a research mission. Everyone, it seemed, was happy to have CBI play some sort of clearing-house role, a central location for information about research and archiving projects, articulation of archival standards, and the contours of the computing-history field itself. (Norberg’s initial plans for more wide-ranging policy work and economic analysis were for the most part not pursued.)

History of computing research today

At CBI today, we work in the environment and institution framed by these debates and which evolved from their outcomes. While the

specific issues have changed in the ensuing 25 years, we are still very much concerned with these three areas. First, Norberg prevailed in the discussion on archiving and so CBI largely follows—and sometimes has led—standard professional archiving practices.¹⁹ We have not, and really could not, adopt the once-proposed “save everything” strategy. Yet even as our paper archiving is on a stable footing, we still face the question of properly documenting more contemporary developments in computing as well as the entire brave new world of “born digital” records.²⁰

In a second initiative, Norberg developed a particular model of oral history that has been influential across the computer-history field and beyond. CBI’s “research grade” oral histories are a clear departure from the loosely structured reminiscence or the journalist’s quote-hunting interview. They are a strong tool for a specific purpose. The extensive resources required for researching, preparing, conducting, transcribing, editing, and publishing them are demanding; and their use has been, practically speaking, limited to those pioneers or key figures where an in-depth interview is warranted and where the financial resources to do so are available. One weakness, however, of this oral history model is that other people involved in projects, institutions, or companies of interest are not given sufficient attention. Our challenge for the future is to evolve new modes and methods of doing oral histories so that we can properly record the experiences and accomplishments of the many varied users of computing and not only the designers or pioneers.

Finally, Norberg also successfully advocated that CBI take up an active research program of its own. CBI’s publication record, as I’ve mentioned, amply attests to his wisdom on this point.

Greater attention to the users of computing will be among the challenges faced by historians of computing in the coming years. Indeed, with his *Digital Hand* trilogy, Jim Cortada joins a growing number of business and technology historians who advocate greater sensitivity to users in the processes of designing, shaping, and diffusing technologies.²¹ The new emphasis on users is usually traced to Eric von Hippel’s *The Sources of Innovation* (1988) or Claude Fischer’s *America Calling: A Social History of the Telephone to 1940* (1992), and consequently a wide literature in economics, business history, science and technology studies, and history of technology has emerged around this theme.²²

In his article in this issue, Cortada focuses on the users of computing in the business world, on what he terms the “demand side” of computing history that is needed to balance the traditional concern with the “supply side” of computing history. In the *Digital Hand*, Cortada takes up an industry-level research strategy, looking at the 40 largest industries of the US economy, together accounting for some 80 percent of the nation’s GDP, including manufacturing, finance, media, telecommunication, education, and government. His research strategy lets him make an important systematic analysis across an exceptionally wide swath of the economy, and to make orderly comparisons between different industries and their uses of computing.

One of Cortada’s important findings is the “rampant incrementalism” that typified the business use of computing. This result is an important one to place alongside the many existing studies that focus on revolutionary computing projects, from MIT’s Whirlwind and SAGE, through IBM’s 360, down to the present day’s information technology juggernaut. Almost in passing, he hints at an extremely important finding with large implications for studies of productivity. Across the board, he finds, companies used computing primarily “to improve internal processes and operations” and only secondarily to acquire new customers or make new products. Notwithstanding our present fascination with dramatic and sweeping change, he finds that computers were most often introduced where they would “support conventional managerial practices” rather than upset corporate practices and policies. And he suggests important insights for understanding globalization in that a recent emphasis of computerization is to create “interchangeable components” consisting of people, business processes, and information technology.

The history of software is another emerging area in the history of computing. In some respects, software history was present at the creation. Early on, Jean Sammet’s *Programming Languages* (1969) led to her work on the AFIPS history committee, while Claude Baum’s *The Systems Builders* (1981) presents a history of SDC (System Development Corporation), the RAND spin-off that was the preeminent “university for programmers” in the late 1950s and early 1960s.²³ Also notable are the two volumes from the History of Programming Languages conference series and the recent third conference. Martin Campbell-Kelly, in assessing his own pioneering study

From Airline Reservations to Sonic the Hedgehog: A History of the Software Industry, leaves the impression that reviewers were critical of this work. It is important to note that his study has garnered significant praise as well. "Martin Campbell-Kelly has written a highly useful, arguably seminal, history of one of the world's most important industries," went the review in the highly respected *Journal of American History*.²⁴

Since 2000, it seems that software history has come into its own. That year the Heinz Nixdorf MuseumsForum in Paderborn, Germany, organized a major conference with the resulting volume *History of Computing: Software Issues* (2002) while CBI organized another conference at Xerox Palo Alto Research Center on the software products industry that grew up in the wake of IBM's decision in 1969 to unbundle its hardware and software.²⁵ Also during these years, CBI conducted an NSF-funded project "Building a Future for Software History" (1999–2003) that resulted in two dozen oral histories and several publications, including a 2,500-item annotated bibliography.²⁶ Subsequently, Burt Grad and the software history group at the Computer History Museum have sponsored a number of software-history conferences and oral-history sessions. The *Annals* has published results from two of these well-regarded events, on the software products industry (see vol. 24, no. 1, 2002) and on personal computer software (see vol. 28, no. 4, 2006) as well as memoirs from software pioneers Ernest Keet and Martin Goetz.²⁷ Recently, software history emerged as the focus of one of the four European Science Foundation-funded multiyear research projects examining the technological underpinnings of European integration.²⁸ With all these activities, although it remains difficult to predict how software history will develop, it has clearly become part of the mainstream of the field.

Acknowledgments

In addition to Jeff Yost, I would also like to record that CBI's resident staff took up the lion's share of organizing the June 2006 event that led up to this special issue concerning the history of computing; my heartfelt thanks to Carrie Seib, Karen Spilman, and Katie Baumhover Charlet. Support for this event from the Charles Babbage Foundation is also gratefully acknowledged, especially the leadership of then-board-chairman James Cortada and the assistance of Bob Castle, whose videotape of the daylong proceeding we hope to make

available via <http://www.cbi.umn.edu>. I appreciate comments received from Erwin Tomash, Arthur Norberg, Jeffrey Yost, Roger Stuewer, and the contributors to this issue; any errors are of course my responsibility.

References and notes

1. B. Galler, "About this Issue," *Annals of the History of Computing*, vol. 1, no. 1, July 1979, pp. 4-5.
2. The first History of Programming Languages Conference was held in Los Angeles, 1-3 June 1978; the second, in Cambridge, Mass., 20-23 Apr. 1993; the third in San Diego, 9-10 June 2007. See <http://research.ihost.com/hopl/HOPL.html> as well as T.J. Bergin, "A History of the History of Programming Languages," *Comm. ACM*, vol. 50, no. 5, 2007, pp. 69-74; doi.acm.org/10.1145/1230819.1230841.
3. See the special issue "Legacy of the Tomashes to Computing History," *IEEE Annals of the History of Computing*, vol. 23, no. 4, 2001, pp. 2-104; and the set of newsletters available at <http://www.cbi.umn.edu/about/newsletter.html>. A key essay for understanding the complex history of CBI and CBF is A. Norberg, "A Perspective on the History of the Charles Babbage Institute and the Charles Babbage Foundation," *IEEE Annals of the History of Computing*, vol. 23, no. 4, 2001, pp. 12-23.
4. CBI's names have varied in interesting ways. Originally conceived as the International Charles Babbage Society, it was formally incorporated as the Charles Babbage Institute. Its subtitles, through the years, have suggested that CBI was a center for information processing (reflecting a June 1979 agreement with AFIPS reported in the *CBI Newsletter*, vol. 1, no. 2, 1979), as well as for computing, computer science, or information sciences. In 2001, CBI became the Center for the History of Information Technology. See B.H. Bruemmer and E. Kaplan, "Realizing the Concept: A History of the CBI Archives," *IEEE Annals of the History of Computing*, vol. 23, no. 4, 2001, pp. 29-38; on page 38, note 1.
5. The University of Minnesota's Board of Regents' minutes record that Paul Armer resigned as associate director of CBI effective 30 June 1981; <http://conservancy.umn.edu/bitstream/123456789/62/3/UNA19810910.pdf.txt>.
6. P. Gullard, "The Charles Babbage Institute for the History of Information Processing," *Annals of the History of Computing*, vol. 2, no. 1, 1980, pp. 71-74, quote on p. 74.
7. The University of Michigan was the other finalist with a visit by the site selection committee; *CBI Newsletter*, vol. 2, no. 2, 1980.
8. Norberg served as CBI director during 1981–1993 and 1999–2006; Robert Seidel's five-year term as

director of CBI was 1994–1999. As acting director, Aspray served for four months during 1989; Judy E. O'Neill, during 1993–1994.

Shortly after the move to Minnesota, in early 1981, the Charles Babbage Institute and Charles Babbage Foundation were recognized as distinct entities. "The organization that has been known as the Charles Babbage *Institute* [original italics] for the History of Information Processing has been named the Charles Babbage *Foundation* [original italics]. ... What has been referred to as 'a center for the history of computing that will be located on the campus of some major university' has now assumed the name The Charles Babbage Institute for the History of Information Processing. This was done for practical reasons, essentially to clarify the difference between the administrative, policy, and fund-raising responsibilities of the parent body ..." See *CBI Newsletter*, vol. 3, no. 1, 1981, p. 2.

9. A. Norberg, "Twenty-Five Years of CBI," *CBI Newsletter*, vol. 26, no. 1, 2003, pp. 3-12; also in that issue see J. Yost, "CBI Historical Research," pp. 13-15, and E. Kaplan, "CBI Archives," p. 16.
10. A tour of this 600-foot-long underground facility usually persuades our visitors that CBI is indeed a serious place. I've paced out the total of our 250 individual archival collections at a bit more than 5,000 shelf feet. For information on Andersen Library and construction photos, see <http://andersen.lib.umn.edu/aboutandersen.html>.
11. The best introduction to CBI's archiving activities remains B.H. Bruemmer and E. Kaplan, "Realizing the Concept: A History of the CBI Archives," *IEEE Annals of the History of Computing*, vol. 23, no. 4, 2001, pp. 29-38.
12. For a listing of CBI staff publications, see http://www.cbi.umn.edu/research/staff_publications.pdf.
13. J.R. Yost, "CBI/Tomash Fellowship: Sponsoring a Generation of Scholars in the History of Information Processing," *IEEE Annals of the History of Computing*, vol. 23, no. 4, 2001, pp. 24-28.
14. M.S. Mahoney, "The History of Computing in the History of Technology," *Annals of the History of Computing*, vol. 10, no. 2, 1988, pp. 113-125.
15. See D. Mackenzie, "The Influence of the Los Alamos and Livermore National Laboratories on the Development of Supercomputing," *IEEE Annals of the History of Computing*, vol. 13, no. 2, 1991, pp. 179-201; W. Aspray and B.O. Williams, "Arming American Scientists: NSF and the Provision of Scientific Computing Facilities for Universities, 1950–1973," *IEEE Annals of the History of Computing*, vol. 16, no. 4, 1994, pp. 60-74; W. Aspray, "Command and Control, Documentation, and Library Science: The Origins of Information Science at the University of Pittsburgh," *IEEE Annals of the History of Computing*, vol. 21, no. 4, 1999, pp. 4-20; G.C. Bowker, *Memory Practices in the Sciences*, MIT Press, 2005; C. Hine, "Databases as Scientific Instruments and their Role in the Ordering of Scientific Work," *Social Studies of Science*, vol. 36, 2006, pp. 269-298; J. Agar, "What Difference Did Computers Make?" *Social Studies of Science*, vol. 36, 2006, pp. 869-907.
16. There is a sizable literature on computing and gender. See the special issues on "Women in Computing," *IEEE Annals of the History of Computing*, vol. 18, no. 3, 1996, pp. 3-55; and "Women and Gender in the History of Computing," *IEEE Annals of the History of Computing*, vol. 25, no. 4, 1996, pp. 4-72. See also J.S. Light, "When Computers Were Women," *Technology and Culture*, vol. 40, no. 3, 1999, pp. 455-483; J. McGrath Cohoon and W. Aspray, eds., *Women and Information Technology: Research on Underrepresentation*, MIT Press, 2006; V.A. Ladesen, "The Strength of Numbers: Strategies to Include Women into Computer Science," *Social Studies of Science*, vol. 37, 2007, pp. 67-92.
CBI is planning a workshop-conference on the theme of history, gender, and computing for May 2008. We wish to explore gender also through awareness of masculinity studies. See R. Oldenziel, *Making Technology Masculine: Men, Women and Modern Machines in America, 1870–1945*, Amsterdam Univ. Press, 1999; M. Lohan and W. Faulkner, "Masculinities and Technologies," *Men and Masculinities*, vol. 6, no. 4, 2004, pp. 319-329.
17. J. Markoff, *What the Dormouse Said: How the Sixties Counterculture Shaped the Personal Computer Industry*, Viking Penguin, 2005; T. Friedman, *Electric Dreams: Computers in American Culture*, New York Univ. Press, 2005; F. Turner, *From Counterculture to Cyberculture: Stewart Brand, the Whole Earth Network, and the Rise of Digital Utopianism*, Univ. of Chicago Press, 2006; M. Ito, D. Okabe, and M. Matsuda, eds., *Personal, Portable, Pedestrian: Mobile Phones in Japanese Life*, MIT Press, 2005. A title search for "culture" in the *Annals* database retrieves just one article: L.L. Beranek, "BBN's Earliest Days: Founding a Culture of Engineering Creativity," *IEEE Annals of the History of Computing*, vol. 27, no. 2, 2005, pp. 6-14.
18. A.L. Norberg, "The Origins of the Electronics Industry on the Pacific Coast," *Proc. IEEE*, vol. 64, no. 9, 1976, pp. 1314-1322.
19. B.H. Bruemmer and S. Hochheiser, *The High-Technology Company: A Historical Research and Archival Guide*, Charles Babbage Inst., Univ. of Minnesota, 1989, was embraced by the Society of American Archivists for setting standards in the

field of corporate archiving.

In 1997, Henry Lowood commented: "In the history of computing, the three indispensable guides remain *Resources for the History of Computing*, edited by Bruce Bruemmer, *The High-Technology Company: A Historical Research and Appraisal Guide* by Bruce Bruemmer and Sheldon Hochheiser, both published by the Babbage Institute, and *Archives of Data-Processing History: A Guide to Major U.S. Collections*, edited by James Cortada and published by Greenwood Press." See Lowood, "Archives and On-Line Resources," 15 June 1997, revised 27 June 2005; <http://www-sul.stanford.edu/depts/hasrg/histsci/comparch.html>.

20. For further discussion of CBI's ongoing practices and future challenges in archiving, oral history, and research projects, see T.J. Misa, "Organizing the History of Computing: 'Lessons Learned' at the Charles Babbage Institute," paper prepared for Conference on the History of Nordic Computing, 21-23 Aug. 2007; IFIPS Press, forthcoming.
21. J.W. Cortada, *The Digital Hand: How Computers Changed the Work of American Manufacturing, Transportation, and Retail Industries*, Oxford Univ. Press, 2004; J.W. Cortada, *The Digital Hand: How Computers Changed the Work of American Financial, Telecommunications, Media, and Entertainment Industries*, vol. 2, Oxford Univ. Press, 2006; and J.W. Cortada, *The Digital Hand: How Computers Changed the Work of American Public Sector Industries*, vol. 3, Oxford Univ. Press, 2007.
22. C. Fischer, *America Calling: A Social History of the Telephone to 1940*, Univ. California Press, 1992; E. von Hippel, *The Sources of Innovation*, Oxford Univ. Press, 1988; E. von Hippel, *Democratizing Innovation*, MIT Press, 2005; R. Schwartz Cowan, "The Consumption Junction: A Proposal for Research Strategies in the Sociology of Technology," *The Social Construction of Technological Systems*, W.E. Bijker, T.P. Hughes, and T. Pinch, eds., MIT Press, 1987, pp. 261-280; S. Wyatt, "Non-Users Also Matter: The Construction of Users and Non-Users of the Internet," *How Users Matter: The Co-construction of Users and Technology*, N. Oudshoorn and T. Pinch, eds., MIT Press, 2005, pp. 67-80; J. Yates, "How Business Enterprises Use Technology: Extending the Demand-Side Turn," *Enterprise and Society*, vol. 7, no. 3, 2006, pp. 422-455; D. Edgerton, *The Shock of the Old*, Oxford Univ. Press, 2007.
23. C. Baum, *The System Builders: The Story of SDC*, System Development Corporation, 1981, quote on p. 51. The SDC records (1955-1982) are embedded in CBI's records of the Burroughs Corporation, which acquired SDC in 1980; see CBI 90 series 98.
24. Published by MIT Press, 2003. Quote from review in *J. Am. History*, vol. 91, no. 1, 2004, p. 345.
25. U. Hashagen, R. Keil-Slawik, and A.L. Norberg, eds., *History of Computing: Software Issues*, Springer Verlag, 2002. For a report on the "Unbundling History" conference, see Events and Sightings, *IEEE Annals of the History of Computing*, vol. 24, no. 1, 2002, pp. 90-94; see also B. Grad, "A Personal Recollection: IBM's Unbundling of Software and Services," *IEEE Annals of the History of Computing*, vol. 24, no. 1, 2002, pp. 64-71.
26. The "Software History Bibliography," 2003, is available at <http://www.cbi.umn.edu/shp/bibliography.html>.
27. M. Goetz, "Memoirs of a Software Pioneer: Part 1," *IEEE Annals of the History of Computing*, vol. 24, no. 1, 2002, pp. 43-56; "Memoirs of a Software Pioneer: Part 2," *IEEE Annals of the History of Computing*, vol. 24, no. 4, 2002, pp. 14-31; E.E. Keet, "A Personal Recollection of Software's Early Days (1960-1979), Part 1," *IEEE Annals of the History of Computing*, vol. 26, no. 4, 2004, pp. 46-61, and "A Personal Recollection of Software's Early Days (1960-1979): Part 2" *IEEE Annals of the History of Computing*, vol. 27, no. 4, 2005, pp. 31-45.
28. See "Software for Europe (SOFT-EU)," programmatic introduction to a three-year effort (launched June 2007); <http://www.esf.org/activities/eurocores/programmes/inventing-europe/projects/list-of-projects.html>.

Thomas Misa's biography appears on page 7 of this issue.

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