

Proposal for SHOT 2009
Session Title: Materiality Meets Practice

Organizer: Thomas Haigh, University of Wisconsin—Milwaukee, thaigh@computer.org

Chair: JoAnne Yates, MIT Sloan School, jyates@mit.edu

Commentator: Gerard Alberts, University of Amsterdam, G.Alberts@uva.nl

Papers:

- Opening the Beige Box: Materiality and the Evolution of the IBM PC, 1981-1995 Thomas Haigh, University of Wisconsin—Milwaukee, thaigh@computer.org.
- Plug and Play: Standardized Connectors and Home Audio Reproduction, Jeffrey Tang, James Madison University, tangjd@jmu.edu
- The Right Job for the Tools: Transitioning to the Computer Age, Allan Olley, University of Toronto, allan.olley@utoronto.ca.
- The Material Origins of Virtualization, David Alan Grier, George Washington University, grier@gwu.edu

This panel is submitted by the SIG on Computers, Information & Society.

The panel includes scholars from three countries. It includes a blend of graduate students and faculty spanning the assistant, associate and full professor level. It is also diverse in terms of discipline, representing scholars working in departments of information studies, business communications, computer science, history of science, and science policy.

Session Abstract: Materiality Meets Practice

Computers are things and people manipulate them with their bodies. Information cannot exist without a physical medium. Communication is a material process. But writing on the history of information technology has tended to abstract away from the tangible and material. Rarely do we learn about the experience of using a particular machine, the layout of a computer center, or the issues involved in producing and assembling computer systems. But recent interest in materiality as a concept in science studies (associated particularly with the recent volume *Living in a Material World* edited by Pinch and Swedberg) challenges us to respect the fundamental importance of stuff to the history of technology (and allied fields such as labor history). This panel takes up that challenge.

Haigh and Tang are both concerned with the material aspects of information technology standards. Information technology and communication standards may seem dry and disembodied objects of study, but their functioning cannot be separated from physical objects and social practices. Haigh looks at the evolution for the IBM computer from 1981 to 1995 from a single proprietary product, to the original amid a sea of compatible imitators, to an informal industry standard, to an increasingly formalized standard. Despite, or he argues because, of rapid change in both industry structure and technological performance it was seemingly inconsequential physical details such as the size of the computer case, position of expansion cards, and keyboard connectors that remained the only immutable parts of the original design. They thus defined and limited the practices of system builders and computer tinkerers. Tang shifts to one of the most stable of all communication standards, the humble RCA jack used to interconnect hi-fi components. Restoring users and their practices to the picture, he shows that the ubiquitous connector was a source of frustration and complaint for decades.

Olley recreates the practices of scientific computation used with the IBM SSEC, an electronic computer of the late 1940s. He relates these practices to those used with manual calculation techniques, probing connections between changes in the material equipment of calculation and shifts in practice of science.

While the other panelists have been concerned with recovering the lost materiality of information, Grier explores the distinctive state of virtuality (once concisely summarized as “something that’s not really there, but behaves as if it was.”) Modern computers rely on virtual machines, virtual memory, and virtual addresses spaces to function. This distinctive version of immateriality has its own history, and Grier argues that the rise of the virtual machine is not simple result of economic or technological necessity but the preserved a distinct kind of social space for computation, a space in which the programmer retains a fundamental authority over the machine.

Our commentator, Alberts, has conducted his own research on the materiality of early computing and its relationship to labor practices.

Opening the Beige Box: Materiality and the Evolution of the IBM PC, 1981-1995

Thomas Haigh, University of Wisconsin—Milwaukee

Topic: The evolution of the IBM Personal Computer over the period 1981 to 1995 from a single product, to an original product with compatible imitators, to an informal industry standard, to an increasingly formalized standard. In particular the relationship of seemingly trivial physical features such as power supply connectors, keyboard sockets, and expansion card positioning to the structure of the personal computer industry.

Argument: IBM introduced its PC/AT in 1984. A decade later computers with the same fundamental architecture dominated the global market. Much had changed over that period. Memory capacities had increase a hundred fold, processors were dozens of times more powerful, and hard drives scores of times more capacious. High resolution screens showing millions of colors replaced chunky four color displays. Synthesized and sampled sounds replaced plaintive beeps. Operating systems had shifted from DOS to Windows. More fundamentally, IBM's share of the business had slumped to single digits and it had lost the ability to set new standards. Instead computers were assembled by many thousands of companies, and by millions of individual enthusiasts, using standardized commodity components such as motherboards, sound cards, and keyboards designed and manufactured by specialized companies. Innovation took place piecemeal, as these suppliers made incremental changes to their own parts with a faster processor or bigger disk drive. But because no single firm was able to impose changes on the overall architecture of the computer system, obscure physical details of the original design were now impossible to change. Enduring long after other aspects of the original design were changed, material characteristics such as the particular size and position of expansion card connectors became vital to aspects of the computer industry's de facto standard. As immutable aspects of a system in constant flux they precluded certain kinds of innovation, encouraged others, and exercised a powerful influence over industry structure.

Evidence: Personal computer publications from the 1980s and 1990s such as *PC Magazine* and *Byte Magazine*. The trade press, including *Computer World* and *InfoWeek*. Personal computers themselves, as material artifacts, in photographs, and through technical documentation.

Contribution to Literature: The ideas of platform competition and architectural innovation are increasingly prominent in work by economists and innovation theorists, and standards occupy an important position in work on technology policy. But these genres abstract away the physicality of technology. Historians of technology are familiar with Hughes' concept of technological momentum, a description of the social and economic institutions that grow around successful technological systems and act to preserve them. I argue that, while useful, this idea must be extended to apply to computer technologies. The modern PC is a heterogeneous federation of hundreds of different systems, standards and architectures. Momentum accrues to some of these (for example the Windows user interface and application program interface) but not to others. To understand how the PC architecture came to dominate the world and why the modern PC evolved as it did we must be able to draw links between the physical structure of the black (or in this case beige) box and the structure of the industry that created it. Little of a scholarly nature has been written on the history of personal computing in the 1980s, though the evolution of the IBM PC from machine to industry received a popular but deeply insightful telling in Cringely's *Accidental Empires*.

Plug and Play: Standardized Connectors and Home Audio Reproduction

Topic: When the lowly RCA plug finally began to fall out of favor as an audio connector in the 1990s, it marked the first time in nearly half a century that it some other plug became the preferred means to connecting audio components. Component audio features a system of individual components that can be purchased from different companies, arranged together to form a functional audio reproduction system. The standardization of such plugs almost from the start of the industry enabled a non-proprietary system for home audio. Having emerged in the 1930s and 1940s largely because no major company held enough sway in the component audio industry, the RCA plug frustrated users for decades.

Argument: The flexibility and consumer empowerment allowed by the component system was only possible because of standardized plugs and receptacles for interconnection. Yet complaints about the usability and quality of the RCA plug persisted for decades. Their physicality and role as connectors between components made them more difficult to change than other audio standards, such as equalization curves used in recording and playback. In many ways, the longevity of the RCA plug highlights how difficult standards for connection can be to change, absent a truly compelling technical advantage. For expert users, the difficulties posed by the plugs were more of an annoyance, but for more casual users, they could be a daunting obstacle that turned them off from high fidelity as a hobby.

Evidence: Most of the evidence for this paper is derived from published sources. To the extent that the attitudes of the fragment high-fidelity component industry are accessible, it is largely to be gleaned from publications of the *Audio Engineering Society*. Special-interest periodicals, such as *Saturday Review* and *High Fidelity*, and consumer-interest magazines like *Consumer's Research Bulletin* highlight the frustration of consumers with connections (when they weren't being ignored).

Contribution: During the past few years, several of us within SHOT have been working to highlight the importance of standards in the history of technology and in our everyday lives today. Following on Thomas Hughes's pioneering work – in which explicit discussion of standards is surprisingly minimal – scholars like Amy Slaton and others have begun to focus more directly on standardization. Some of the recent attention comes from historians of computing, as standards are more obvious in computing than in many other technical fields. The material aspects of standards, particularly the humble but ubiquitous technologies of plugs and connectors, received little attention from historians of technology since Fred Schroeder's 1986 *Technology and Culture* article on electrical plugs and receptacles.¹ Scholars in economic-related disciplines, by contrast, have developed an extensive literature on the topic from scholars like Michael Katz and Carl Shapiro, Paul David, Brian Arthur, and many others. But economics tends to the immaterial.

¹ "More 'Small Things Forgotten': Domestic Electrical Plugs and Recepticals, 1881-1931," *Technology and Culture*, v. 27, no. 3, July 1986, pp. 525-43.

The Right Job for the Tools: Transitioning to the Computer Age

Allan Olley, University of Toronto

Topic: The IBM Selective Sequence Electronic Calculator (SSEC) has been referred to by chronicler of IBM computers Charles Bashe as a transitional machine, because of its combination of older electromechanical technologies and new electronic components. In this paper I will describe how the SSEC demonstrates some aspects of another kind of transition; the transition from the methods used and the problems solved when computation is done by hand, table and desk calculator to the methods employed when automatic high speed machines are used.

Argument: I will start by briefly outlining the SSEC's hardware features and sketch why they are called transitional. I will then discuss some of the problems solved by the SSEC, such as the calculation of lunar positions, mechanical integration of planetary orbits and studies of turbulence and fluid flow. I will explain some of the history of these problems, highlighting differences in approach taken with the problems on the SSEC compared to earlier or later approaches. Examples will include the expected versus actual use of mathematical tables by the SSEC, in what sense the problems tackled by the SSEC were novel, and the difficulty in preparing a problem for the machine. I will show how work on the SSEC illustrates the state of flux that existed in techniques as well as technology at the time.

Evidence: In addition to published accounts of the SSEC and the work done on it, I will draw on archival sources from the IBM Archives, the Wallace J. Eckert paper's housed at the Charles Babbage Institute and the papers of A. Wayne Brooke. Eckert was involved in setting the specifications for the SSEC's operation and used it for extensive astronomical calculations. Brooke was chief operating and maintenance engineer of the SSEC.

Contribution to the Existing Literature: The talk will contribute to the literature discussing of the interaction between the computer and the practice of science. My talk will offer some specific examples of changes in scientific practice brought about by improvements in computing technology and also point out continuity with earlier practice. More broadly my paper speaks to the question of how new technology is adopted; the extent to which the SSEC acted as a straightforward response to existing demand versus the creation of new demands for use and on its users. The SSEC has been little discussed and its use occurs during a seminal moment in the history of computing.

The Material Origins of Virtualization

Topic: This paper discusses how machine architectures move from hardware into software, from circuits to emulators and virtual machines. The process began in the early 1960s, as computer scientists looked for ways of preserving the environment of a simple, single user computer on a complex, time-shared system. IBM developed in the mid 1960s. DEC and Intel followed in the 1970s and 1980s. All claimed that they were merely preserving an efficient way of dealing with computation but in fact all the groups slowly modified their claims to insist that their work was the most efficient way of securing a programming environment.

Argument: This paper will look beyond the economic argument for virtualization, which is grounded in investment in both code and people, and argue that virtualization and emulation preserved a distinct kind of social space for computation, a space in which the programmer retains a fundamental authority over the machine. This space, derived from Goffman's Front Stage/ Back Stage dichotomy, proves to be defended both by the software that makes virtualization or emulation possible but also by the claims made by the proponents of these kinds of systems. They claimed that virtual or emulated systems were not for everyone and hence were more secure and more flexible than ordinary multi-tasking systems.

Evidence: The primary data comes from the development of IBM's VM system and the papers that compared this system at AFIPS and other meetings. Like other marginal products at IBM (notably APL) the VM system attracted a cadre of supporters that at once touted the benefits of their work and argued that the environment was special and should not be available to common programmers. This contradictory argument both bound a core group of scientists together and excluded a less adventurous cohort of programmers. It not only sustained the development of such systems but also laid the foundation for the argument that emerged in the 1990s that these systems actually had better security features than traditional time-sharing systems.

Contribution to Existing Literature: The existing literature on architecture, such as Pugh, et al, *IBM 360 and early 370 Systems*, tends to these issues as an economic or social compromise of a relatively small group of stakeholders. This paper expands that literature to include a larger group of stakeholders who maintained an architectural environment in much the same way that Goffman maintains that an alliance of different groups maintain a backstage environment. It adds new categories to the problem of analyzing machine architectures in much the same way that *Martin's The Organizational Complex: Architecture, Media, and Corporate Space*. (MIT Press, 2003) helped to define how we look at laboratory space.

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Selected Academic:

University of Wisconsin--Milwaukee, Asst. Professor, School of Information Studies, 2004-
Indiana University, Bloomington, Visiting Assistant Professor, Informatics School, Fall 2003
Colby College, Visiting Instructor/Visiting Researcher, STS/Admin. Sci., 2001-3
University of Pennsylvania, History and Sociology of Science Ph.D. May 2003
Manchester University (UK), Department of Computer Science, B.Sc. & M.Eng, 1991-1995

Selected Recent Publications:

"Protocols for Profit: Web and E-mail Technologies as Product and Infrastructure" in *The Internet and American Business*, edited by William Aspray and Paul Ceruzzi, MIT Press, 2008: 105-158 (online).
"The Web's Missing Links: Search Engines and Portals" in *The Internet and American Business*, edited by William Aspray and Paul Ceruzzi, MIT Press, 2008:159-200 (online).
"Ein wahrer Eimer voller Fakten" (German translation of "A Veritable Bucket of Facts: Origins of the Data Base Management System") in «Nach Feierabend - Zürcher Jahrbuch für Wissensgeschichte» (Zurich Yearbook in the History of Knowledge), 2007.
"Sources for ACM History: What, Where, Why" (with Elizabeth Kaplan and Carrie Seib), *Communications of the ACM* 50:5 (May 2007):36-41.
"Remembering the Office of the Future: Word Processing and Office Automation before the Personal Computer," *IEEE Annals of the History of Computing* 28:4 (October-December 2006).

Other Publications, Honors & Service:

Around thirty other publications, including research articles, book reviews, obituaries, biographies, and a review essay. Around thirty published or forthcoming oral history interviews.

Twenty four competitively reviewed presentations, including five SHOT papers, three Business History Conference papers, and papers at the North American Labor History Conference and Hagley conference on the Technological Fix. Twenty eight invited presentations and departmental seminars including Tokyo University, ETH, UIUC, the Deutsches Museum, and a public keynote address at the 2005 CHOC workshop in Amsterdam.

Awards, Grants and Fellowships include: Center for 21st Century Studies Fellowship (2008/9), Software History Center Research Fellowship (2003), IEEE Life Member Fellowship in Electrical History (2000-01), Tomash Fellowship in the History of Information Processing (Babbage Institute, 1999-00), William Penn Fellowship (1995-99), Fulbright Award for post-graduate study in the US (1995-96)

Biographies editor and board member of *IEEE Annals of the History of Computing*

Chair, SHOT SIG on Computers, Information and Society, 2005-

Dr. Jeffrey Tang

Assistant Professor, Department of Integrated Science & Technology
James Madison University tangid@jmu.edu

Education:

Ph.D., History and Sociology of Science, University of Pennsylvania, Dec. 2004

Dissertation: Sound Decisions: Systems, Standards, and Consumers in American Audio Technology, 1945-1975

Committee: Ruth Schwartz Cowan (Supervisor, Penn), Joel Mokyr (Northwestern), Amy Slaton (Drexel), M. Susan Lindee (Penn)

M. A., History and Sociology of Science, University of Pennsylvania, Aug. 1999

Thesis: A Standard Edison Story: Compatibility Standards in Thomas Edison's Development of the Phonograph

M. Phil., Economic and Social History, University of Oxford, June 1996

B.A., Economics, Northwestern University, June 1994

Teaching (Selected):

Assistant Professor, Integrated Science and Technology Department, James Madison University, Fall 2005-present (1st year as Visiting Assistant Professor)

Instructor, University of Pennsylvania, School of Arts & Sciences, HSSC 009, Writing about Scientific & Technological Failures, Fall 2003-Spring 2005

Recent Publications:

Christopher Bachmann, Jeffrey Tang, Mike Kauffman, and Carl Puffenbarger, "Engineering for Non-Engineering Schools: A Hands-On Educational Curriculum That Addresses the Need for Renewable Energy through Undergraduate Research and Applied Science," *Proceedings of the American Society for Engineering Education Annual Conference*, 2008.

Professional Activities:

Secretary, SHOT Special Interest Group in Computing, Information, and Society, 2008-present

Member of American Society for Engineering Education, 2008-present

Member of Society for the Social Study of Science, 2005-present

Member of the Society of the History of Technology (SHOT), 1998-present

Recent Conference Presentations (selected):

"Gateway to Success: LPs, 45s, and the Format War that Wasn't," Society for the History of Technology, October 2008, Lisbon, Portugal.

"Engineering for Non-Engineering Schools: A Hands-On Educational Curriculum That Addresses the Need for Renewable Energy through Undergraduate Research and Applied Science," American Society for Engineering Education, June 2008, Pittsburgh, Pennsylvania.

"Armchair Engineering: The Empowerment of Users in High-Fidelity Audio," Society for the History of Technology, November 2005, Minneapolis, Minnesota.

"From Whence Hi-Fi?: User-Led Industrial Formation in High-Fidelity Audio Equipment," Business History Conference, May 2005, Minneapolis, Minnesota.

"Seen and Not Heard...or Vice-Versa?: Fidelity, Décor, and Home Audio Equipment in America, 1945-1965," presented at "The Spectacle of Technology," Hagley Fellows Conference, March 2005, Wilmington, Delaware.

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Education:

In progress: Ph.D at the Institute for History and Philosophy of Science and Technology at University of Toronto, 2003- .

M.A. at Institute for the History and Philosophy of Science and Technology at University of Toronto, 2003.

BSc., in Great Books and Physics at Brock University, 2002.

Thesis topic:

The impact of electronic computers on the astronomical calculation work of Wallace J. Eckert in the period following the Second World War.

Non-refereed Publications:

Book Review: "**David Alan Grier: *When Computers Were Human.*" *Isis*, **99** (4), December 2008, pp. 870-871.**

"Digitizing Measurement: Automatic Scientific Table Making." in *Proceedings of the XXV Scientific Instrument Symposium*, ed. Krakow, 2006, pp. 289-293.

Conference experience:

"Charles Babbage: Famous Object of Neglect." at the annual meeting of the Society for the History of Technology, October 19th to 21st, 2007, Washington, D.C..

"'In the most accurate way and by the shortest path.' E. W. Brown and calculating machines." at the Annual Meeting of the Canadian Society for the History and Philosophy of Science, May 28th to 30th, 2007, University of Saskatchewan, Saskatoon, Saskatchewan, Canada.

"Digitizing Measurement: Automatic Scientific Table Making." at the XXV Annual Scientific Instrument Symposium, September 6-9, 2006, Krakow, Poland.

"Savour of Extravagance: Punched Card Accounting Machines in Science, 1928-1945" at the Annual Meeting of the Canadian Society for the History and Philosophy of Science, May 29-31st, 2006, York University, Toronto, Ontario, Canada.

Academic Awards:

SSHRC CGS Scholarship 2004-2007.

Work Experience:

Teaching Assistanceship, September to December, 2007 for HPS210, Scientific Revolutions I.

Teaching Assistanceship, January to April, 2006 for HPS211, Scientific Revolutions II.

DAVID ALAN GRIER
Curriculum Vita

EMPLOYMENT

GEORGE WASHINGTON UNIVERSITY	1986 -
Associate Professor, Int. Science & Tech. Policy	2000 –
Associate Professor, Computer Science (Engineering)	2000 – 2004
Assistant Professor, Stat./Computer & Info Systems	1986 – 1999
Associate Dean, Elliott School of International Affairs	2005 –
Assistant Dean, School of Eng. & Applied Science	2002 – 2004
Director, University Honors Program	1992 - 2001

EDUCATION

Middlebury College	1978, B.A., Mathematics
University of Washington	1986, Ph.D., Statistics
Harvard University	1996, Cert. Ed. Admin.

PUBLICATIONS

Books:

TOO SOON TO TELL, John Wiley/Computer Society Press, February 2009
WHEN COMPUTERS WERE HUMAN, Princeton University Press, 2005.

Major articles:

John Backus and the business of programming, COMPUTERS IN SCIENCE AND ENGINEERING, vol 9 no 4, July/August 2007, p 69-70.
Irene Stegun, The Handbook of Mathematical Functions and the Lingering Influence of the New Deal, AMERICAN MATHEMATICAL MONTHLY, vol 113, no 7, August 2006, p 585-597.
Dr. Veblen at Aberdeen, Mathematics, Military Applications and Mass Production, in INSTRUMENTAL IN WAR, HISTORY OF WARFARE VOL 28, Steve Walton, ed., Brill, 2005, p 253-270..
Tablemaking for the Relief of Labor in HISTORY OF TABLEMAKING, Martin Campbell-Kelly et al eds, Oxford Univ Press, 2004, p 265-294.
The Rise and Fall of the Committee on Mathematical Tables and Other Aids to Computation, IEEE ANNALS, vol. 23, no. 2, p. 38-49.
Politics, Control and Computer Networks: The Chinese Student Lobby of 1989, COMMUNICATIONS OF THE ACM, vol. 14, no. 5, p. 137-45.
Henry Wallace and the Start of Statistical Computing, CHANCE, vol. 12, no. 2, p. 14-20 (May 1999).

Columns:

“In Our Time” and “The Known World”, COMPUTER 2007 –
(39 columns to date)

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Employment

Projects at TU/e (Technical University of Eindhoven), CWI (Center for Mathematics and Computer Science, Amsterdam), Radboud University and Twente University.

Radboud University (Nijmegen) head of Science & Society Program, 1992-2007.

University of Amsterdam, head of the Program in History of Computing, 2004-present

Teaching (at present) History of Computing, History of Mathematics, History of Science, Science and Society courses at the University of Amsterdam and at the Staatliche Akademie der bildenden Künste (Stuttgart, Germany).

Supervision of Phd Projects in History of Mathematics, History of Computing and Sociology of computing.

Education

MSc (Mathematics and Philosophy) University of Amsterdam, 1983

PhD (History) cum laude, University of Amsterdam, 1998

Editorship, member of editorial board

IEEE Annals of the History of Computing

Nieuw Archief voor Wiskunde

Jaarboek KennisSamenleving

Handbook for the History of Information Security

Project leader of the ESF “Inventing Europe”-project *Software for Europe*

Latest conference organized

Appropriating America, Making Europe, Amsterdam, January 15-17, 2009

Publications

‘On Connecting Socialism and Mathematics: Dirk Struik, Jan Burgers, and Jan Tinbergen’, G. Alberts. In: *Historia Mathematica* 21-3, pp. 280-305.

‘Mathematics in The Netherlands; A brief survey, with an emphasis on the relation to physics, 1560-1960’, G. Alberts, E. Atzema, J. van Maanen. *Handbook for the History of Science in The Netherlands*, K. van Berkel, A. van Helden. L.C. Palm (eds.) Leiden etc: Brill, 1999.

Jaren van berekening; toepassingsgerichte initiatieven in de Nederlandse wiskunde-beoefening, 1945 - 1960, G. Alberts. Amsterdam: AUP, 1998 (= *Calculative years; application-orientedness in postwar Dutch mathematics*)

Computers en hun gebruikers; een halve eeuw computergeschiedenis in Nederland, Adrienne van den Bogaard en Gerard Alberts (eds). *Studium* 1-2 (2008)

De KNAW en de Nederlandse wetenschap tussen 1930 en 1960, G. Alberts (ed), Amsterdam: Aksant, 2009.

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ACADEMIC EXPERIENCE

1980-Present **Massachusetts Institute of Technology**, Cambridge, MA.
Current title: Sloan School of Management: Sloan Distinguished Professor of Management.

SELECTED AWARDS AND FELLOWSHIPS:

Harold F. Williamson, Sr., Medal for mid-career achievement in Business History 1998
Newcomen Prize for article published in vol. 67 (1993) of the *Business History Review* 1994

Waldo Gifford Leland Prize, Society of American Archivists, for *Control through Communication* 1990

SELECTED PUBLICATIONS:

Books

Craig N. Murphy and JoAnne Yates, *The International Organization for Standardization (ISO): Global governance through voluntary consensus* (London: Routledge Press, 2009).
JoAnne Yates, *Structuring the Information Age: Life Insurance and Information Technology in the 20th Century* (Johns Hopkins University Press, 2005).
Control Through Communication: The Rise of System in American Management, Johns Hopkins University Press, 1989. Paperback edition, 1993.

Journal Articles

JoAnne Yates and Craig N. Murphy, "Charles Le Maistre: Entrepreneur in International Standardization," *Entreprise et Histoires*, 51(2008), pp. 10-27.
JoAnne Yates, "How Business Enterprises Use Technology: Extending the Demand-side Turn," *Enterprise and Society*, 7:3 (September, 2006), 422-455.
JoAnne Yates, "The Structuring of Early Computer Use in Life Insurance," *Journal of Design History*, 12:1 (1999), pp. 5-24.
JoAnne Yates, "Early Interactions between the Life Insurance and Computer Industries: The Prudential's Edmund C. Berkeley," *Annals of the History of Computing*, 19:3 (1997), pp. 60-73.
JoAnne Yates, "Co-evolution of Information Processing Technology and Use: Interaction between the Life Insurance and Tabulating Industries," *Business History Review*, 67 (Spring 1993), 1-51.

Chapters in Edited Volumes

JoAnne Yates, "Business Use of Information and Technology from 1880-1950," in *A Nation Transformed by Information: How Information Has Shaped the United States from Colonial Times to the Present*, ed. Alfred D. Chandler, Jr., and James Cortada (Oxford Press, 2000), pp. 107-135.
JoAnne Yates, "Evolving Information Use in Firms, 1850-1920: Ideology and Information Techniques and Technologies," in *Information Acumen: The Understanding and Use of Knowledge in Modern Business*, ed. Lisa Bud-Frierman (London: Routledge, 1994).
JoAnne Yates, "Investing in Information: Supply and Demand Forces in the Use of Information in American Firms, 1850-1920," in *Inside the Business Enterprise*, ed. Peter Temin (Chicago, IL: NBER and University of Chicago Press, 1991), pp. 117-154.

SELECTED PROFESSIONAL MEMBERSHIPS AND SERVICES:

Business History Conference, President, 2004-2005
Academy of Management, OCIS Division Chair, 2000-2001
Enterprise and Society, Editorial Board, 1999-
Business History Review, ad hoc reviewer
Technology and Culture, ad hoc reviewer