



Proposal for SHOT 2009

**Session Title: Paths Not Taken and Paths Retraced in the History of Information Technology**

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Chair: Helena Durnova, Technical University of Brno, [durnova@feec.vutbr.cz](mailto:durnova@feec.vutbr.cz)

Commentator: Peter Meyer, Bureau of Labor Statistics, [meyer.peter@bls.gov](mailto:meyer.peter@bls.gov)

Papers:

- Transmission Error: Fax, Failure, and Roads Less Traveled in the History of Technology  
Jonathan Coopersmith, Texas A&M University, [j-coopersmith@tamu.edu](mailto:j-coopersmith@tamu.edu)
- Manned Space Flight and Artificial Intelligence: “Natural” Trajectories of Technology and their Implications for Historians, Paul E. Ceruzzi, National Air and Space Museum, [ceruzzi@si.edu](mailto:ceruzzi@si.edu).
- From Computer Utility to Time-Sharing: Politics and Technology in the 1960s American Computer Industry, Chris McDonald, Princeton University, [cmcdonal@princeton.edu](mailto:cmcdonal@princeton.edu).
- The Pre-History of Portable Computers, Evan Koblentz, InfoAge Science Center, Wall, NJ, [evan@snarc.net](mailto:evan@snarc.net).

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

It addresses the conference call for “reconsideration of linear tales of innovation or destruction” and “new uses of old technologies.”

The panel includes both European and American scholars. It includes a blend of graduate students and more senior scholars. It also includes a practicing journalist/technology enthusiast and an economic historian working for the Bureau of Labor Statistics as well as academic historians.

**Session Abstract for  
“Paths Not Taken and Paths Retraced in the History of Information Technology”**

Stories about the history of information technology usually have happy endings. Each new generation of machines effortlessly outstrips the accomplishments of its predecessor. This year’s computer will have a thousand times the disk storage and hundreds of times more memory and processor power than one sold fifteen years earlier for a higher price. Bandwidth burgeons, features proliferate, resolutions sharpen, and megabytes give way to terabytes. Ever since ENIAC, the introduction of new computing technologies has involved breathless explanation of the huge benefits in time, cost, expense, and compactness they bring over outmoded alternatives.

Yet even here, perhaps particularly here, the historian has a duty to challenge the idea that the development of a technology follows a simple and predetermined evolutionary path. In fact the history of information technology is full of failures, unexpected twists, and the reinvention and reinterpretation of earlier innovations. Conceptions of success and failure are themselves socially constructed, and play a vital role in guiding the actual trajectories adopted by technologies. The participants in this panel are working to rediscover the complexity and messiness obscured by the myths of Moore’s law and the inevitable march of information progress.

Coopersmith lays the foundations for the panel with an examination of failure in the history of technology. Drawing on his own examination of the history of fax machines he argues for the necessity of looking for obscured failures even when studying what might seem an extremely successful technology and advances a general framework for those interested in understanding the success and failure of new technologies.

Ceruzzi contrasts paths taken and not taken in two distinct technological areas: manned space flight and artificial intelligence. He argues that the concept of an inevitable technological trajectory is crucial to understanding the evolution of these fields. However this is not because any such trajectory existed. Rather it is because leaders in each area both created and relied upon a general sense of the inevitability of particular developments to build a consensus behind their work.

McDonald addresses the history of timesharing. During the late 1960s the future of computing was widely believed to lie in public access via terminals to a small number of hugely powerful centralized computers. By analogy to the established pattern of electrical power these were to be known as computer utilities. While timesharing was an important technology, this dream was never realized and the 1970s were characterized instead by the spread of small and inexpensive computers. His work probes the relationship of concepts, expectations, and technologies.

Koblentz follows with a similar analysis of early attempts to create portable computers. While portable computer is now remembered as a creation of the early 1980s, many earlier attempts were made to build mobile computer systems and terminals from the 1950s onward. Unlike the personal computers of the early 1980s these were usually created by large corporations under government or military contracts.

As commentator, Meyer brings the perspective of an economist specializing in technological change to the session.

## **Transmission Error: Fax, Failure, and Roads Less Traveled in the History of Technology**

Jonathan Coopersmith, Texas A&M University

**Topic:** This paper offers a theoretical framework to understand and research the failure of new technologies. Failure is an integral and normal part of a technology's evolution. Failure extends from the commercial collapse of a firm promoting a new technology and the inability of a technology to profit in the marketplace to less obvious shortcomings like suboptimal performance, poor economics, and late delivery. Companies do not expect their new technologies to fail, but many – if not most – do and may destroy the promoting firm in the process. The history of faxing illustrates the wide range of failures that firms and technologies encounter in their efforts to succeed.

**Argument:** Many of the paths taken by proponents of faxing in the 19<sup>th</sup> and 20<sup>th</sup> century failed. Equally important, many paths were not taken. This paper will explore the wide range of options not followed at critical points in faxing's history, options that could have radically changed its evolution. The main types of uncertainty and options were whether to product compatible equipment; purchase specific patents; buy firms; pursue specific products, technological paths, and component development; invest in new markets; and commit personal and organizational resources to a new technology.

**Evidence:** Sources include material from American and European archives, oral history interviews, and a wide range of engineering and business periodicals. One practical problem is the survival of and access to data. People and firms do not like to provide information about their failures. Furthermore, when failed firms vanish, their documents often do too.

**Contribution to Literature:** Historians and other academics have paid minor attention to failure, focusing on success instead. Just as honest biography is more interesting and valuable than an admiring hagiography, so too does the history of technology benefit from a fuller understanding of its subject. Works such as *The Social Construction of Technological Systems* edited by Wiebe Bijker, Thomas Hughes, and Trevor Pinch have enriched the history of technology with concepts of trajectories and critical points. The limited research on failure, such as Eric Schatzberg's *Wings of Wood*, *Wings of Metal* and Margaret Graham's *Business of Research*, has provided fascinating studies of well-informed people and organizations working in their own self-interest making the wrong critical decisions. This paper extends these studies to the IT world and offers a broader theoretical framework to understand failure – and success. A complete history demands study and analysis of not only the roads taken, but also the roads not taken and the roads unsuccessfully taken as part of the tortuous, demanding, and uncertain path that technologies follow to move from an idea to a reality.

# **Manned Space Flight and Artificial Intelligence: “Natural” Trajectories of Technology and their Implications for Historians**

Paul E. Ceruzzi, National Air and Space Museum

**Topic:** This paper looks at a concept familiar to historians of technology, namely the notion of a natural trajectory of a technology. It presents two case studies taken from recent history: the United States’ manned space program from the 1950s to the present, and computer research in the pursuit of Artificially Intelligent (AI) machines. The paper shows that historians are right in criticizing the concept of a natural trajectory, yet at the same time, they often have been reluctant to abandon it.

**Argument:** I will begin by showing how the U.S. efforts to put human beings in space have been guided by perceptions of not one but two notions of a natural trajectory of technology. The first was an extension of winged, piloted aircraft such as the X-15, which would fly higher and faster until achieving space flight. That notion competed with an alternate trajectory, usually associated with Wernher von Braun, of a ballistic vehicle with only minimal lifting characteristics. To the detriment of the U.S. efforts, both were pursued in fits and starts, with neither paradigm becoming established.

During that same era, computer researchers envisioned a steady progression of ever more intelligent computing hardware and software, until machines would come into existence with an intelligence matching that of an educated human being. Once that was achieved (around 1990), these computers would quickly bootstrap themselves into even higher levels of intelligence, as they could now teach themselves. That did not happen, but unlike the case with space travel, it did not matter (with one major exception, discussed in this paper). Computing technology flourished anyway.

**Evidence:** There has been ample research and discussion of the manned spaceflight issue, which I will draw from mainly using secondary sources. For the research in AI history, I draw on the published and unpublished work of, and interviews with, a group of seminal figures who shaped this research including Richard Gabriel, I. John Good, Barry Boehm, J.C.R. Licklider, Doug Engelbart, and Tim Berners-Lee.

**Contribution:** The notion of a natural trajectory of technology, and its relation to the concepts of the social construction of technology and to technological determinism, has been discussed by numerous scholars. Perhaps the best is by Donald MacKenzie in his work, *Inventing Accuracy* (1990). Historians of computing, including Arthur Norberg and Judy O’Neil in *Transforming Computer Technology* (1996), and the popular but often-cited work by Pamela McCorduck, *Machines Who Think* (1979) have examined the early history of Artificial Intelligence, including its support by U.S. government agencies. In the 1997 book *Hal’s Legacy* practicing computer scientists and engineers discussed what progress had been made toward the vision of the 1960s vision of AI showcased in the film 2001. Few scholarly studies have carried this forward to the Internet and Personal Computer era, which this paper will address.

This study should prove useful to current debates concerning the history of the U.S. manned space program, where scholars including Alex Roland, Roger Launius, Michael Neufeld, and David Mindell have debated the notion of NASA’s desire to promote and advance a human presence in space in the aftermath of the triumph of the Apollo program and the perceived failure to follow through on a natural evolution from Apollo to other human missions.

# From Computer Utility to Time-Sharing: Politics and Technology in the 1960s American Computer Industry

Chris McDonald, Princeton University, Princeton, NJ

**Topic:** In the early 1960s, researchers at MIT, including John McCarthy and Robert Fano, developed the idea that with consoles attached by telephone lines to a time-shared computer, one could draw on remote computing power like electricity from a socket. The analogy led Fano and other computer researchers to imagine the eventual construction of one or more national computing grids, which could supply computer power and information services to thousands of widely scattered factories, offices, and even homes. These researchers disseminated this idea of a “computer utility” or “information utility” via demonstrations of the MIT time-sharing system and articles in the popular press. It inspired entrepreneurs like Charles Adams, whose KEYDATA was one of the first companies to offer remote time-sharing services, but it also sparked debates within the computer industry, debates that encompassed both entrepreneurs and established firms (such as IBM). One debate was at the technological and economic level. At issue was whether delivering computer power to remote locations made sense as a business model. The other was at the political level, mostly driven by concerns about the regulatory implications of the term “utility,” especially when the FCC began an investigation into computers and communications in 1966.

**Argument:** Members of the computer industry resolved both debates by the early 1970s: They accepted that time-sharing was a useful business model, but only in certain circumstances and for certain services, not as a general-purpose model for all computing needs. They addressed the political concerns by paring “computer utility” away from time-sharing. While the underlying technology of time-sharing provided the basis for a successful but limited time-sharing industry, the “total system” approach of a (perhaps federally-regulated) national computer utility providing all kinds of services became a road not taken.

**Evidence:** Much of my evidence comes from debates in the computer trade press of the 1960s and early 1970s, especially the magazines *Datamation*, *Business Automation*, and *Computers and Automation*. I also use proceedings from a number of business and academic conferences, especially those that focused on the question of the computer utility. Finally, I draw on the FCC records from the U.S. National Archives and interviews with participants.

**Contribution to Existing Literature:** This paper helps to resolve the apparent contradiction between histories of computing that emphasized the failure of the computer utility (for example, William Aspray and Martin Campbell-Kelly’s *Computer*) and more recent scholarship that has taken notice of the striking survival and health of the time-sharing industry, well into the 1980s (Campbell-Kelly and Daniel Garcia-Swartz, “Economic Perspectives on the History of the Computer Timesharing Industry.”) It also builds on efforts to understand the role of imagination in technological change (for example, Patrice Flichy’s *The Internet Imaginaire*). Whereas Flichy examined a set of concepts (such as the information highway and virtual communities) that converged successfully on and became permanently associated with the Internet, I examine the fate of a concept that never became attached to a successful technological project, despite the hopes and expectations of many in the academic world.

## **The Pre-History of Portable Computers**

Evan Koblentz, InfoAge Science Center, Wall, NJ

**Topic:** Portable computing is typically considered a wholly modern notion which was not commercialized until the 1980s by startups such as Osborne, Non-Linear Systems (Kaypro), and Compaq. However, there are many less common examples of portable computers before this era, which deserve credit as (at the least) technical pioneers. These forgotten pioneers opened a path that was not, at least in that form and at that time, taken.

**Argument:** There were three generations of portable computing that preceded the common history of this genre. The generations were mobile mainframes such as DYSEAC and MOBIDIC (1950s); analog suitcase computers such as the Donner Scientific 3500 and Mauchly Associates SkeduFlo (1960s); and digital portables such as the MCM, IBM 5100, and GM Research MicroStar (1970s). One might expect such dinosaurs of mobility to stem from the minds of hobbyists, but in fact, all of these computers had major corporate or government backing.

**Evidence:** My primary evidence is first-person interviews with key members of the development teams, by e-mail and telephone, carried out from 2004-2008 in preparation for a book. Interestingly, many of my sources said they were never interviewed by historians. I supplement these interviews with a variety of original technical publications, advertisements, original period articles from the media.

**Contribution to Existing Literature:** The ubiquity of portable computing today, seen in devices such as netbooks and smartphones, will eventually need to be studied by serious historians. But with a few exceptions such as the Xerox Dynabook concept and the Apple Newton, very little serious history so far exists about the roots of portable computing. The focus of my research is to contribute new data tracing the genre back to the earliest days of computing itself.

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### EDUCATION

Oxford University

D.Phil., Department of Modern History 1985

Princeton University

A.B., History and Philosophy of Science Program 1978

### CURRENT RESEARCH

History of the facsimile machine, 1843-present

Pornography and technology

### PUBLICATIONS

The Electrification of Russia, 1880-1926 (Cornell University Press, 1992).

The Dog That Did Not Bark during the Night: The "Normalcy" of Russian, Soviet, and Post-Soviet Science and Technology Studies, @ Technology & Culture 47,3 (July 2006), 623-37.

Does Your Mother Know What You *Really* Do? The Changing Nature and Image of Computer-Based Pornography, @ History and Technology 22,1 (March 2006), 1-25.

Flying the Unprofitable Skies: Commercial Aviation in America, @ in Jonathan Coopersmith and Roger Launius, eds., Taking Off: A Century of Manned Flight (Reston, Virginia: American Institute of Aeronautics and Astronautics, 2003), 93-108.

"Pornography, Technology, and Progress," ICON 4 (1998), 94-125.

"Facsimile's false starts," IEEE Spectrum, February 1993, 46-49.



## Paul E. Ceruzzi

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Paul E. Ceruzzi is Curator of Aerospace Electronics and Computing at the Smithsonian's National Air and Space Museum in Washington, DC.

Dr. Ceruzzi received a B.A. from Yale University and PhD from the University of Kansas, both in American Studies. Before joining the National Air and Space Museum, he was a Fulbright scholar in Hamburg, Germany, and taught History of Technology at Clemson University in Clemson, South Carolina.

He is the author or co-author of several books on the history of computing and aerospace technology: *Reckoners: The Prehistory of The Digital Computer* (1983); *Beyond the Limits: Flight Enters the Computer Age* (1989); *Smithsonian Landmarks in the History of Digital Computing* (1994); *A History of Modern Computing* (1998, 2<sup>nd</sup> edition, revised, 2003); and *Internet Alley: High Technology in Tysons Corner* (2008). He also recently co-edited, with William Aspray, *The Internet and American Business* (2008). His most recent journal publication was "Moore's Law and technological Determinism: Reflections on the History of Technology," in *Technology and Culture*, 46/3 (2005), 584-593. His current research and exhibition work concerns the use of computers for long-range space missions.

Dr. Ceruzzi has curated or assisted in the mounting of several exhibitions at NASM, including "Beyond the Limits: Flight Enters the Computer Age," "The Global Positioning System: A New Constellation," "Space Race," "How Things Fly," and the James McDonnell Space Hangar of the Museum's Steven F. Udvar-Hazy Center, at Dulles Airport. He is currently working on a new exhibit on space navigation, scheduled to open at the National Air and Space Museum in 2012.

# Christopher McDonald

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## EDUCATION

PhD **Princeton University**, History, begun September 2006

MS **Purdue University**, Computer Science, 2003

BA **Rice University**, Computer Science, 2000

## PRESENTATIONS

“A Companion in the Car: The Rise of Car Radio in the United States, 1929-1959,” *Annual Meeting of the Society for the History of Technology*, Lisbon, October 2008.

## TEACHING

T.A. for Science in the Modern World, Princeton University, Fall 2008

## HONORS/AFFILIATIONS

2009-2010 Tomash Fellowship in the History of Information Technology

Society for the History of Technology, 2006 - Present

History of Science Society, 2006 – Present

## RESEARCH INTERESTS

- The history of computers and computer science
- The history of communications technology
- Technology and the Cold War

## LANGUAGES

French, German, Spanish

## **Evan Koblentz**

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### **Experience**

Jan. 2008-Feb. 2009: Online Editor, *Wireless Week* (Advantage Business Media):

- *Wireless Week* is a trade magazine for service providers that covers news and trends in the cell phone industry
- Write 5-10 breaking news stories each week on topics such as new products, carrier partnerships, and R&D
- Write approx. one feature articles per week regarding big-picture industry trends and future prospects
- Established content partnership with a popular consumer-oriented cell phone discussion site
- Work closely with technical staff to help develop and test new technologies for our web site

Feb. 2007-Jan. 2008: Online Editor, *Electronic Component News* (Advantage Business Media):

- *ECN* magazine is devoted to helping designers and engineers in the component selection process
- Founded *The Efficiency Zone*, a web column for energy-efficient technology updates
- Administer the *ECN Design Network*, which are 15-minute online design tutorials
- Routine duties such as copy editing and posting daily and monthly news via a CMS
- Wrote a blog for sister publication, *Wireless Design & Development*

Jan. 2004-Oct. 2006: Editor-in-Chief, *FierceEnterprise* (FierceMarkets)

- *FE* was a daily e-mail newsletter published by FierceMarkets, aggregating news for anyone in IT
- Analyzed a dozen stories per day and wrote a weekly op-ed column about current news and trends
- Researched and wrote annual special issues to analyze the year past and ahead
- Researched and wrote weekly updates on mergers, acquisitions, and venture capital investments

July 2000-Dec. 2003: Senior Writer, *eWeek* (Ziff-Davis):

- Beat reporter for enterprise storage, backup/recovery, and disaster recovery (two and a half years)
- Beat reporter for outsourcing, web hosting, and application service providers (one year;)
- Also reported on databases, networking monitoring/testing, and servers
- Wrote approximately five stories per week; frequent travel; based in Woburn, MA

Jan. 1998-July 2000: Technology Editor/Staff Engineer, TMC Labs:

- TMC Labs is the product review arm of TMC, a publisher of monthly telecommunications magazines
- Magazines I supported included *CTI*, *Customer Interactions Solutions*, and *Internet Telephony*
- Role was to acquire, install, test, and report on hardware and software for call center, CTI, and VoIP users
- Also wrote a biweekly column about personal and small-office technologies for TMCnet.com
- Wrote approximately four reviews per month; frequent travel; based in Norwalk, CT

### **Related**

- Present: I co-founded and serve as president of a 180-member computer user group. The group formed in 2004. We operate a computer museum at the InfoAge Science Center in Wall, N.J., and we produce major annual events such as the Vintage Computer Festival East. Despite the economy, this group is financially sound, continues to grow, and has been recognized in media such as *Esquire*, *MSNBC*, and *PC World*.

- Present: As an expert in the history of the computer industry, I have worked with organizations such as *BusinessWeek*, *Computerworld*, *eWeek*, *History Channel / Modern Marvels*, *IEEE*, the *International Journal of Mobile Human-Computer Interaction*, *Reuters*, *Society for the History of Technology*, *Trenton Computer Festival*, and *VintageTech*. Currently I am writing a book about the evolution of portable computers from the abacus to the BlackBerry.

### **Education**

- May 1997 - Boston University College of Communications, all but thesis for MS in journalism
- May 1996 - Kean University, BA in English, minor in technology / industrial design

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**Fields of specialization:** Technological change; economic history; labor economics

### Education

Ph.D., Economics, Northwestern University, Evanston, Illinois, 2001.

Dissertation title: "Technological uncertainty and earnings inequality"

Faculty committee: Joel Mokyr, Joseph Ferrie, Christopher Taber

A.B., Applied Mathematics with Computer Science, Harvard College, Cambridge, MA, 1988.

### Working papers and publications

"Network of tinkerers: a model of open-source technology innovation" Nov 2007. BLS Working paper 413. <http://www.bls.gov/ore/abstract/ec/ec070120.htm>

"Proposed category system for 1960-2000 Census occupations." (with Anastasiya M. Osborne). Sept 2005. BLS working paper 383. <http://www.bls.gov/ore/abstract/ec/ec050090.htm>

"Turbulence, inequality, and cheap steel." Feb 2005. BLS working paper 375. <http://www.bls.gov/ore/abstract/ec/ec050010.htm>

"Preliminary estimates of multifactor productivity growth" (with Michael J. Harper) *Monthly Labor Review* 128:6 (June 2005), 32-43. <http://www.bls.gov/opub/mlr/2005/06/contents.htm>

Book review of *Productivity, Inequality, and the Digital Economy: A Transatlantic Perspective* by Greenan, L'Horty, and Mairesse for *Journal of Economics/Zeitschrift für Nationalökonomie*. Vol 81, No. 3, 2004.

"Episodes of collective invention." US Bureau of Labor Statistics Working Paper 368. August, 2003. Available at <http://www.bls.gov/ore/pdf/ec030050.pdf>

Entries for "Henry Cort", "Siemens-Martin process", and "Machine tools industry" in *The Oxford Encyclopedia of Economic History* (2003);

*The Weeks Report from the 1880 Census, online*. Edited. 2001-4.

<http://econterms.net/weeksreport/weeksdoc.htm>

*Online Glossary of Research Economics*. 1997-2004. At <http://econterms.com>.

"Integrating an Economics Glossary into any Web Site," with Martin Poulter. *Computers in Higher Education Economics Review*. Vol 13, No. 2. 1999. <http://econltsn.ilrt.bris.ac.uk/cheer>

### Presentations

"Technological discussions in U.S. iron and steel, 1871-1885", at Society for the History of Technology conference, Oct, 2006 (joint with Carol Siri Johnson).

"Network of tinkerers: a model of open-source innovation" Midwest Economic Association, Mar 2006; Bureau of Economic Analysis, July, 2006; Naval Postgraduate School, Monterey, CA, Aug 2006

"The airplane as an open-source invention" at Nov 2005, Social Science History Association conference; Asia-Pacific Economic and Business History Conference, Feb 2006, Brisbane, Australia; International Economic History Congress, Helsinki, Aug 2006; SHOT 2007 in Washington DC.

"Technological uncertainty and earnings dispersion in U.S. iron work 1866-1881" at Berlin Colloquium workshop of economic history, in Dec 2005; Society of Labor Economists conference, April-May 2004; American University, Oct 2003; Economic History Association, Sept 2003; Social Science History Association, Oct. 2002; University of North Carolina, spring 2002.

"Updated unified category system for 1960-2000 Census occupations" at Western Economic Association meetings in San Diego, July, 2006; Social Science History Association conference, Nov, 2006

### Other work experience

Senior Software Engineer and other software-related positions. Symantec Corp., Cupertino, CA. 1988-1994.

## Helena Durnová

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### Education

- 1996-2001 Ph.D. in history of mathematics;  
Ph.D. thesis: "A history of discrete optimization"  
1996.1999 Bc. in Management, Masaryk University, Brno  
1991-1996 Masters in Mathematics and English Studies, Masaryk University, Brno  
Diploma thesis: "Identity and Escape: Early Novels of George Eliot, Virginia Woolf, and Jeanette Winterson"

### Work experience

- 2002-present Lecturer at the Department of Mathematics, Faculty of Electrical Engineering and Communication, Brno University of Technology  
1999-2001 Lecturer at the Department of Mathematics, Faculty of Electrical Engineering and Information Technologies, Brno University of Technology  
1994-1997 English teacher at secondary medical school and language school

### Professional activities, memberships

- Member of SHOT SIGCIS and of History of IT society
- in Tensions of Europe network since 2007
- PI 2 in the Software for Europe project (SOFT-EU)
- Chair of the Committee for History of Mathematics and Physics at (Czech) Society for the History of Sciences and Technology and of the Union of Czech Mathematicians and Physicists (since 2007)
- Member of the editorial board of the journal *Dějiny věd a techniky* (History of Sciences and Technology; since 2002)
- Member of the (Czech) Society for the History of Sciences and Technology and of the Union of Czech Mathematicians and Physicists

### Selected recent publications

- "Antonín Svoboda (1907-1980): the Czech computer pioneer" (in Czech), *Pokroky matematiky, fyziky a astronomie* 52 (4), 2007, pp. 322-329.
- "Algorithmic thinking before computers" In: *XXV. International Colloquium on the Acquisition Process Management*, Brno, May 2007.
- "ALGOL and IFIP: a brief survey into the origins of the ALGOrithmic Langage". In: *Proceedings of the 5<sup>th</sup> Mathematical Workshop*, Brno, October 2006
- "*Otakar Borůvka and the Minimum Spanning Tree Problem*". In: *Mathematik im Wandel* 3, Franzbecker 2006
- "Alan Mathison Turing". In: *Proceedings of the 3<sup>rd</sup> Mathematical Workshop*, Brno, November 2004.
- "Discrete Optimization: A Chronological Survey". In: *Proceedings of the 6<sup>th</sup> Austrian Symposium on the History of Mathematics*, Neuhoffen/Ybbs, May 2002.