



Center for the History of Electrical Engineering

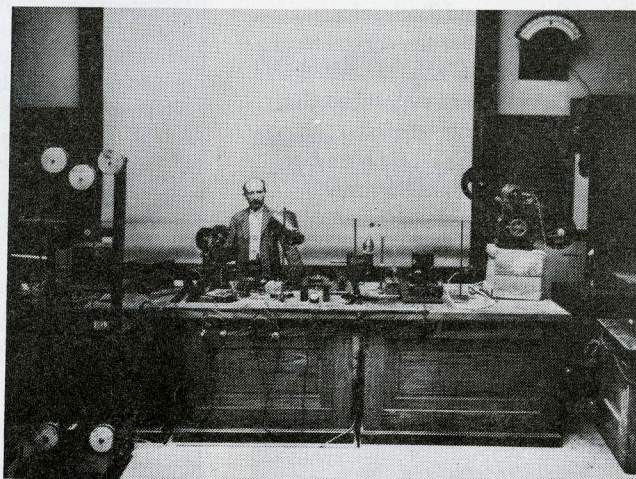
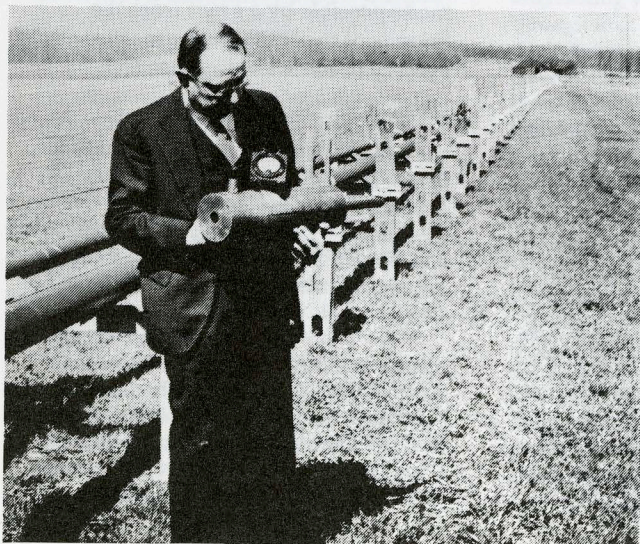
Newsletter No. 21 Summer 1989

Center Publishes Guide to U.S. Archives

The Center for the History of Electrical Engineering has published *Sources in Electrical History: Archives and Manuscript Collections in U.S. Repositories*, compiled by Joyce E. Bedi, Ronald R. Kline, and Craig Semsel. This is the first in a series of guides to be issued by the Center. The goal of the series is two-fold—to promote research in electrical history by making scholars and students aware of the diverse collections of primary sources and to encourage the collection and preservation of these materials by archives and manuscript repositories. The illustrated guide lists 1,008 collections in 158 repositories, primarily university archives and state historical societies, and contains subject and repository indexes. Future volumes will cover oral history collections in the U.S., U.S. business archives and private collections, and collections held in repositories outside of the United States.

Sources in Electrical History has a history of its own. The guide traces its origins to a project undertaken by David A. Hounshell more than a decade ago. According to Hounshell,

George Southworth, holding a resonant chamber used for tests of waveguide transmission, 1936. Two experimental transmission lines run behind him. Southworth's papers are in the AT&T Archives. AT&T Archives



Joseph Tykociner's papers are at the University of Illinois at Urbana-Champaign Archives. He is pictured here with the apparatus used in his public demonstration of sound-on-film motion pictures, 1922. University of Illinois at Urbana-Champaign Archives

In December 1971 the initial meeting was held of the History of Electrical Technology Group—Society for the History of Technology. Discussion centered about the need for identification and preservation of source materials and artifacts related to electrical history. It was suggested that the Smithsonian Institution, already a major repository for electrical artifacts, serve as coordinating center for such a project.

Responding to this suggestion, the Smithsonian's Division of Electricity and Nuclear Energy secured the cooperation of the History Committee of the Institute of Electrical and Electronics Engineers and financial aid from the IEEE's Life Member Fund. The Archive for the History of Electrical Science and Technology was then established with the following objectives: (1) to encourage the preservation of artifacts and manuscripts by coordinating their collection and placement [and] (2) to maintain a national inventory of collections of artifacts and source materials for electrical history.¹

Focusing on collections reported to the *National Union Catalog of Manuscript Collections* (NUCMC), with supplementary information obtained from various libraries and archives, Hounshell compiled *Manuscripts in U.S. Depositories Relating to the History of Electrical Science and Technology*, published in 1973. This guide listed about 250

Continued on page 2 . . .

collections and included descriptions of collection scope and content.

By 1980, however, Hounshell's guide needed updating. This became one of the first projects of the newly-founded Center for the History of Electrical Engineering at the IEEE. The process began as the Survey of Archives and Manuscript Collections Relating to Electrical Science and Technology (SAMCREST). Under the direction of Robert Friedel, the Center's first Director, David Rhees organized the survey in the summer of 1981. Supported by the IEEE Life Member Fund Graduate Student Summer Internship at the Center, Rhees researched the collections already listed by Hounshell, additional listings in NUCMC, collections cited in scholarly publications, and relevant repositories identified in the National Historical Publications and Records

The *Newsletter* reports on the activities of the Center and on new resources and projects in electrical history. It is published three times each year by the Center for the History of Electrical Engineering, Institute of Electrical and Electronics Engineers, 345 East 47th Street, New York, NY 10017 (212-705-7501).

IEEE History Committee 1989

James E. Brittain, *Chairman*
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Joyce E. Bedi, *Acting Director*
Craig Semsel, *Summer Intern*
William Goffredo, *Research Assistant*

The *Newsletter* is made possible by a grant from the IEEE Foundation.

Commission's *Directory of Archives and Manuscript Repositories*. Rhees defined the scope of the project.

...it was established that the principal goals for the summer would be to gather as much collection data as possible from published sources; to send out questionnaires to confirm our data and inquire about new collections; to identify finding aids and the procedures for obtaining them; to identify repositories interested in acquiring material in our subject area; and to promote archivists' awareness of electrical engineering history and of the role of the IEEE Center for the History of Electrical Engineering.²

The SAMCREST questionnaire was sent to 175 repositories. The returned forms verified or corrected information on previously-listed collections, but, more important, they also included descriptions of a surprising number of additional collections.

Nancy Perlman, the Center's Archivist from 1981-82, and Robert Casey, Assistant Historian at the Center in 1983, organized the files of questionnaires and assisted researchers wishing to tap this source of raw data pending its availability as an online database. This next phase of the project was set up by Friedel, Joyce Bedi, the Center's Curator since 1983, and Cathy Paci, one of the Center's Research Assistants. During the summer of 1984, Paci entered basic collection information into the database, while Bedi designed programs that would allow searching on a variety of levels.

Next, collection descriptions were added to the database. The long process of verifying, editing, proofing, and indexing this information for publication fell to Bedi, Ronald Kline, the Center's Director from 1984 to 1987, and a succession of Research Assistants, including Ann Benson, Suzan Walworth, and, especially, Craig Semsel. The subject index was prepared by Kline, while final editing, design, and the repository index were Bedi's responsibility. Jay Iorio, Manager of Information Systems for IEEE Standards, transferred the



The papers of Haraden Pratt, a prominent member of the Institute of Radio Engineers and the IEEE, are at the University of California at Berkeley.

Center for the History of Electrical Engineering

database from the Center's Victor 9000 computer to its Macintosh II, on which the guide was prepared.

Sources in Electrical History: Archives and Manuscript Collections in U.S. Repositories is available at a cost of \$15.00 prepaid. Please send a check or money order made payable to "IEEE" to *Sources in Electrical History*, Center for the History of Electrical Engineering, IEEE, 345 East 47th Street, New York, NY 10017. Publication of *Sources in Electrical History: Archives and Manuscript Collections in U.S. Repositories* was made possible by a grant from the Friends of the IEEE Center for the History of Electrical Engineering.

¹Hounshell, David A., comp. *Manuscripts in U.S. Depositories Relating to the History of Electrical Science and Technology*. (Washington, DC: Division of Electricity and Nuclear Energy, National Museum of American History, Smithsonian Institution, 1973), i.

²Rhees, David A. "Report of a Survey of Archival and Manuscript Collections Relating to the History of Electrical Science and Technology Conducted for the IEEE Center for the History of Electrical Engineering in the Summer of 1981," 1.

Center Director Appointed

William F. Aspray, Jr., has been named director of the Center for the History of Electrical Engineering. Since 1983, Dr. Aspray has been the associate director of the Charles Babbage Institute for the History of Information Processing and an adjunct professor in the Program in the History of Science and Technology at the University of Minnesota. Prior to joining the Babbage Institute, he held appointments as a lecturer in the Dept. of History of Science at Harvard University and as an assistant professor in the Dept. of Mathematical Sciences at Williams College.

Dr. Aspray received his Ph.D. in the History of Science from the University of Wisconsin at Madison in 1980. Since then, he has been active in the field of the history of computing, currently serving as associate editor of the MIT Press Series in the History of Computing, associate editor-in-chief of the Charles Babbage Institute Reprint Series, and reviews editor for the *Annals of the History of Computing*. Dr. Aspray is also a consultant to the exhibit on the information revolution being developed by the National Museum of American History, Smithsonian Institution (see *Newsletter* No. 18) and has conducted oral history interviews with more than 50 computer pioneers. The author and editor of numerous scholarly and popular books and articles, Dr. Aspray is currently working on a book on John von Neumann and the origins of modern computing, which will be published by the MIT Press next year.

Dr. Aspray will join the Center for the History of Electrical Engineering staff in mid-July.

IEEE Fellow in Electrical History Named

The 1989-90 IEEE Fellowship in Electrical History, supported by the IEEE Life Member Fund, has been awarded to Graeme Gooday, a post-doctoral scholar at the University of Kent at Canterbury. Dr. Gooday is continuing the research undertaken for his doctoral dissertation, "Laboratory Physicists and 'Electricians': The Growth of a Laboratory-Based Culture of Electrical Engineering, 1870-1900." He writes,

In this program, I will extend my doctoral research on the development of British experimental physics in the 1860s to 1880s by investigating the emergence of electrical engineering as a similarly measurement-oriented laboratory discipline in the 1880s and 1890s. The genesis of electrical engineering as a new domain of scientific industry in this period will be considered as the merging of two distinct traditions—the "rule-of-thumb" practices of British telegraphers and the laboratory-based expertise in precision measurement cultivated by academic experimental physicists such as William

Thomson. Although this study will be centered upon British electrical engineers and their institutional laboratories, salient comparisons will be made with contemporaneous developments in Germany and the U.S. to assess the significance of international rivalry and emulation in the international development of a laboratory-based culture of electrical engineering between 1870 and 1900.

The genesis of laboratory electrical engineering will be approached through four analytical themes: first of all, the role played by academic laboratory physicists in the early development of electro-telegraphic science; secondly, the way in which these physicists displaced the existing semi-quantitative practices of telegraphists in favor of laboratory methods of precision measurement; thirdly, the gradual professional and academic divergence of the communities of laboratory physicists and "electricians" which culminated in the foundation of autonomous professorships of electrical engineering in the 1880s and 1890s; and, finally, an analysis of the specialist laboratories for research and teaching created by the new generation of academic electrical

engineers, in order to identify the unique disciplinary characteristics of laboratory electrical engineering in the late-nineteenth century.

For information and application materials for the 1990-91 IEEE Fellowship in Electrical History, contact the Center for the History of Electrical Engineering.

Meetings . . .

International Congress on the History of Science

The 18th International Congress on the History of Science will be held in West Germany from 1-9 August at the Congress Center in Hamburg and the Deutsches Museum in Munich. The theme of the Congress is "Science and Political Order," examining the interaction of science, technology, and medicine with various political philosophies. A symposium on the "Social History of Engineers and Engineering Organizations" and a number of program sessions on topics in the history of technology are planned. These include "Patents and Standardization," "Methodological Problems in the History of Technology," "The Development of Writing the History of Technology," and "Transport, Communication and Utilities." For more information, contact Prof. Christoph J. Scriba, Institut für Geschichte der Naturwissenschaften, Büdesstrasse 55, D-2000 Hamburg 13, West Germany.

SHOT

The Society for the History of Technology will hold its annual meeting on 12-15 October in Sacramento, CA. This year's program will include presentations in alternative formats, such as posters, displays of photographs or other visual materials, or brief audiovisual or computer demonstrations. For more information, contact Thomas J. Misa, Chair, 1989 SHOT Program, Dept. of Humanities, Illinois Institute of Technology, Chicago, IL 60616 (312-567-3465/HUMMISA@IITVAX.Bitnet).

Briefs . . .

Center Accessions

The Center for the History of Electrical Engineering actively collects materials pertaining to the history of the IEEE and its predecessor organizations, the American Institute of Electrical Engineers and the Institute of Radio Engineers. In addition, the Center is building a collection of photographs, largely donated by members, that focuses on the working lives of electrical engineers. Two recent accessions are now part of this growing body of research material.

Martin Winner, son of the late Lewis Winner (LM), has donated a collection of his father's papers. For more than 30 years, Lewis Winner helped to organize the Institute of Radio Engineers' and then the IEEE's International Solid State Circuits Conference (ISSCC). Under Winner, the ISSCC became known for its high standards for technical presentations and for disseminating the latest information on integrated-circuit technology. In addition, Winner edited the ISSCC *Digest of Technical Papers*. Winner's early career in radio included positions as editor of the magazine, *Communications*, a technical public relations consultant for a number of radio and instrument manufacturers, and a host of a radio show on patent applications. The papers donated to the IEEE cover Winner's entire career, but are particularly rich in material on the ISSCC.

Eldo C. Koenig (LS) has made available a group of photographs documenting his work on analog computers containing photoelectric cells; in 1951, Koenig received the Alfred Noble Prize for his paper, "An Electric Analogue Computer Using the Photo Cell as a Non-Linear Element." After receiving his B.S.E.E. in 1943 from Washington University, Koenig joined the Allis-Chalmers Manufacturing Co. Except for his service as an engineer on the Manhattan Project, Koenig stayed with

Allis-Chalmers for nearly 20 years. During that time, he earned two masters degrees and his doctorate and became more involved with computer engineering. When he left in 1962 to join the faculty of the University of Wisconsin at Madison, he was director of the Engineering Computing Center. The photos now in the Center's collection date from Koenig's work on analog computers in the 1950s.

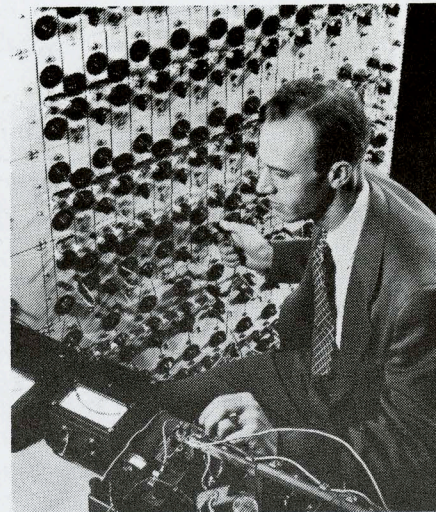
The preservation of original source materials is a primary concern of the Center for the History of Electrical Engineering. The staff will be pleased to assist individuals, companies, or other institutions in identifying papers, photographs, and artifacts of potential value and in arranging for their placement and maintenance in appropriate repositories.

Giovanni Giorgi Proceedings

The *Proceedings* of the Giovanni Giorgi Symposium that was held in Turin, Italy, in September 1988, will be published this summer. The Symposium commemorated Giorgi and his contributions to electrical metrology on the 50th anniversary of the confirmation of the Giorgi (MKS) System. A free copy of the *Proceedings* is available upon request by writing to Prof. Claudio Egidi, Dept. Elettronica, Politecnico, C.so Duca degli Abruzzi, 24, 10129 Torino, Italy. The volume will be sent via surface mail; please include a check for \$US20 for air mail postage.

Research Support Available from NSF

The Studies in Science, Technology and Society Program of the National Science Foundation (NSF) has issued a call for proposals for research in the history and philosophy of science and technology. The program supports research "on the nature and processes of development in science and technology; the interaction between science and technology and their impact on society; the interactions of social and intellectual forces that promote or retard the advance of science or technology; and the



Eldo Koenig at the controls of an electric analog computer that uses a photo cell as a nonlinear element, 1949.

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differences in the nature of theory and evidence in different scientific and technological fields." Five types of awards are being offered.

□NSF scholars awards in two categories: a Summer Scholars Award of up to \$10,000 for partial support of full-time summer research and NSF Scholars Awards of up to \$40,000 for partial support of one or more semesters of release time during the academic year;

□Grants for larger projects that require several investigators, collaboration among principal investigators, or the assistance of postdoctoral researchers, graduate students, or undergraduates;

□Grants for projects in the history and philosophy of science and technology in elementary and secondary education;

□Doctoral Dissertation Research Support; and

□Postdoctoral Fellowships and Professional Development Awards.

The next deadline for submission of proposals is 1 August 1989. For more information, contact the Program Director, Studies in Science, Technology and Society (HPST), National Science Foundation, 1800 G Street, NW, Washington, DC 20550 (202-357-9844).

New Publications . . .

The Newsletter's "Publications" section was prepared with the assistance of Prof. Thomas J. Higgins of the University of Wisconsin.

Books

Paul Eisler. *My Life with the Printed Circuit*. Cranbury, NJ: Lehigh University Press, 1989. 176 pp.

My Life with the Printed Circuit is the autobiography of Paul Eisler, an electronics engineer. Among Eisler's many inventions are the printed circuit and foil heating film. In this book, he discusses the successes and failures of invention from the inventor's perspective.

Born in Austria, Eisler received his Diploma in Engineering from the Technical University in Vienna in 1930. Soon after, he decided to leave the political problems of 1930s Austria behind and emigrated to England in 1936. The rights to one of the two patents that he brought with him—for an early printed circuit—were bought immediately by the Marconi Wireless Telegraph Co. Eisler was paid £250, which allowed him to begin experimenting on new inventions.

Eisler joined the engineering division of Odeon Theatres, concentrating on research and development, but lost his job when World War II broke out. He then went to work for Henderson & Spalding (H&S), a music and lithograph printing firm. Responding to wartime needs, H&S was interested in Eisler's work on what was to become his greatest success, the printed circuit. The company adapted its equipment to manufacture the new device; printed circuits found their first use in proximity fuzes, which controlled detonation of anti-aircraft shells.

After the war, printed circuits became an important part of the electronics industry. As a result, H&S formed a separate company—Technograph Printed Circuits Ltd.—headed by Eisler. In 1948, he demonstrated telephone exchange switches using printed circuit connections to prevent "crosstalk" and offered the patent for sale to the "Big Five"—Ericsson, General Electric, British Thomson Houston, Standard Telephone Cables, and Automatic Telephone & Equipment. All five rejected the offer.

H&S and Technograph, however, prospered through the 1950s. In order to expand the firms' operations, Eisler and H&S President Harold Strong approached the National Research and Development Corp. (NRDC) for funding. This proved to be an unhappy alliance for Eisler; the NRDC assumed partial control of Technograph's Board of Directors, dismissing some staff members and reducing funding for many of Eisler's projects. As soon as his contract expired, Eisler resigned.

Turning to freelance consulting in the late 1950s and '60s, Eisler founded Eisler Consultants Ltd. He also continued his inventive work, which he discusses in the last section of the book. He describes in detail his development of foil heating film, its applications in food warming, space heating, automobile-window defrosting, and waterbed heating, and its successes and failures in the marketplace. Eisler concludes his story with his views on the U.S. and British patent systems and of invention as a career.

Paul Eisler holds 67 patents in the United Kingdom and 59 patents in the United States. He heads Eisler Consultants Ltd. in Great Britain.

Other Recent Books

Curtis, Oliver B., Sr. *The History of the National Council of Engineering Examiners*. Clemson, SC: National Council of Engineering Examiners, 1988. 300 pp.

Hartcup, Guy. *The War of Invention: Scientific Developments, 1914-1918*. London: Brassey's Defense Publishers, 1988. 226 pp.

Stone, Alan. *Wrong Number: The Break-Up of AT&T*. New York: Basic Books, 1989. 320 pp.

Articles

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Bostick, Winston H. "Stockholm, August 1956, Revisited." *IEEE Transactions on Plasma Science* 17, no. 2 (April 1989): 69-72.

Brand, J.C.D. "The Discovery of the Raman Effect." *Notes and Records of the Royal Society of London* 43 (1989): 1-23.

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Diederich, P. "The Development of Civil Satellite Navigation in Europe." *Navigation (Journal of the Institute of Navigation)* 36, no. 1 (Spring 1989): 127ff.

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Kraus, John D. "Antennas: Our Electronic Eyes and Ears." *Microwave Journal* 22, no. 1 (Jan. 1989): 77-92.

Lee, J.A.N. "The Code-Breaking Computers of 1944." *Annals of the History of Computing* 9, nos. 3/4 (1988): 354-356.

McKelvey, John P. "Understanding Superconductivity." *American Heritage of Invention & Technology* 5, no. 1 (Spring/Summer 1989): 48-57.

Marihart, Donald J. "Mobile Radio Systems Applications in Electric/Gas Utilities—Part I." *IEEE Power Engineering Review* 9, no. 4 (April 1989): 47.

Mason, Michael. "The HP Used Equipment Market: An Historical Perspective and Look to the Future." *HP Professional* 2, no. 12 (Dec. 1988): 28-29.

Murphy, Erin. "Making and Baking those Old-Time Components." *IEEE Spectrum* 26, no. 3 (March 1989): 56-58.

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"Nikola Tesla's Life Achievements Honored by the IEEE." *IEEE Power Engineering Review* 9, no. 4 (April 1989): 13-15.

Packer, J.E. "Cable and Wireless [PLC] from Victorian to Modern Times." *IEE Review* 35, no. 2 (Feb. 1989): 63-66.

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Rudisin, Gerard J. "Thoroughly Modern Ada." *Mini-Micro Systems* 22, no. 3 (March 1989): 61-65.

Saba, Shoichi. "The Electric Industry—Past and Future." *Denki Gakkai Zasshi (Journal of the Electrical Engineers of Japan)* 109, no. 1 (Jan. 1989): 1-2.

Sumner, David. "Present at the Creation [of the American Radio Relay League]." *QST* 73, no. 4 (April 1989): 9.

Takahashi, Yuzo, Eisuke Masada, Toshikatsu Tanaka, Masaaki Ito, Motohisa Nishihara, and Masayuki Ieda. "Progress of Electrical Engineering in View of History—For Education and R&D of Electrical Engineering in 21st Century." *Denki Gakkai Zasshi (Journal of the Electrical Engineers of Japan)* 109, no. 1 (Jan. 1989): 5-12.

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Welter, Therese R. "Simulation: The Step Before." *Industry Week* 238, no. 5 (6 March 1989): 40-43.

Wilkins, David E.B. "From HF Radio to Unified S-Band: An Historical Review of the Development of Communications in the Space Age." *Acta Astronautica* 19, no. 2 (Feb. 1989): 171-190.

Wolfe, Ron. "Evolution of Computer Applications in Science and Engineering." *Research and Development* 31, no. 3a (21 March 1989): 14-20.

Wood, James. "AM Terrestrial Broadcasting: Past, Present and Future." *IEE Review* 35, no. 1 (March 1989): 89-91.

Worthington, William, Jr. "What Is This Man Up To? [an article on arc-light trimmers]" *American Heritage of Invention & Technology* 5, no. 1 (Spring/Summer 1989): 46-57.

"XE1CI: A Public Service Story—Part II." *QST* 73, no. 4 (April 1989): 79.

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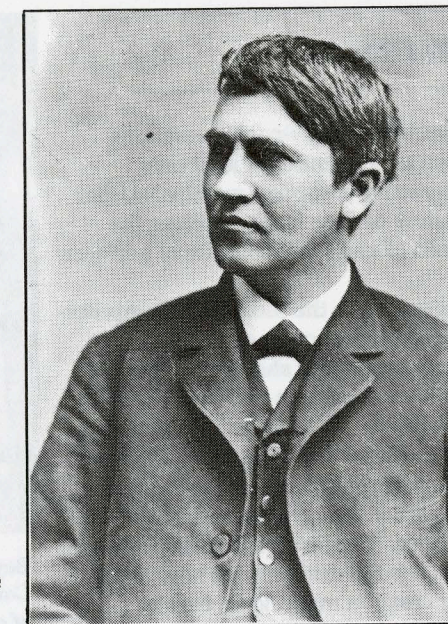
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Hard, Mikael. "In the Icy Waters of Calculation: The Scientification of Refrigeration Technology and the Rationalization of the Brewing Industry in the Nineteenth Century." Ph.D., dissertation, Dept. of History of Ideas and Science, Gothenburg University, 1988.

The Papers of Thomas A. Edison

At a ceremony held at the Edison National Historic Site on 12 May, the publication of the first volume of *The Papers of Thomas A. Edison* was announced. Titled *The Making of an Inventor, February 1847–June 1873*, the book inaugurated the series of 15 to 20 volumes of Edison documents being compiled by the Thomas A. Edison Papers staff, based at Rutgers University. In addition to the book edition, a more extensive microfilm edition is being issued, two parts of which have been published already.

Prof. Reese V. Jenkins, Director and Editor of the Edison Papers, hosted the ceremony. Other participants included Dr. Bernard Finn, Curator of the Division of Electricity and Modern Physics at the National Museum of American History, Smithsonian Institution; Morris Tannenbaum, Vice-Chairman of AT&T; Richard Waldron, Associate Director of the New Jersey Historical Commission; Fahy Whittaker, Superintendent of the Edison National Historic Site; Jack Goellner, Director of the Johns Hopkins University Press; and Dr. Edward J. Bloustein, President of Rutgers University. The program concluded with a demonstration of an operating original Edison stock ticker, an instrument Edison designed and manufactured during the period



Thomas A. Edison Edison National Historic Site

covered by the first volume. Using a vintage telegraph key, Robert Rosenberg, of the Papers staff, sent the message, "Isn't it a feat sublime, intellect hath conquered time"—the motto of the 19th-century journal, *The Telegrapher*—to the stock ticker, manned by Charles Hummel, a collector of Edison apparatus.

The 348 annotated documents presented in *The Making of an Inventor* illustrate both commercial and technical aspects of Edison's work on the key electrical technology of the

time, namely telegraphy in its many forms and functions. The richly-illustrated book includes personal and business correspondence, laboratory notes, sketches, photographs of artifacts, and legal records that allow readers to follow Edison's creative efforts from initial concepts to fruition or failure. These documents also provide insight into Edison's technical education and early career in telegraph offices and machine shops and place the inventor in the context of a national and international technical community.

The Thomas A. Edison Papers is sponsored by Rutgers University, the National Park Service, the Smithsonian Institution, and the New Jersey Historical Commission. Drawing primarily on the 3.5 million documents preserved at the Edison National Historic Site in West Orange, NJ, the selective microfilm and book editions compiled by the Papers are being published by University Publications of America and Johns Hopkins University Press, respectively. For more information on the project or on *The Papers of Thomas A. Edison*, vol. 1, *The Making of an Inventor, February 1847–June 1873*, edited by Reese V. Jenkins, et al. (Baltimore: Johns Hopkins University Press, 1989. 708 pp.), contact the Thomas A. Edison Papers, Rutgers University, New Brunswick, NJ 08903 (201-932-8511).

The Newsletter of the IEEE Center for the History of Electrical Engineering is sent three times a year free of charge to engineers, historians, and others with an interest in the history of electrical science and technology. If you have not already done so, please complete the form below and return it to the Center to be certain of receiving future issues.

Name _____

Address _____

IEEE Membership No. (if applicable) _____

Please send information on becoming a Friend of the Center _____

Exhibitions and Museums . . .

Beyond the Limits: Flight Enters the Computer Age

The electronic digital computer has become as necessary as fuel for getting an aircraft to its destination or a spacecraft into orbit. This "computer revolution" in aerospace is the subject of a new gallery, *Beyond the Limits: Flight Enters the Computer Age*, that opened on 12 May at the Smithsonian Institution's National Air and Space Museum.

Beyond the Limits traces the development of the computer and aerospace industries from the 1940s, when the typical "computer system" consisted of a room full of people working with slide rules, pencils, and paper. As electronic computers became smaller, lighter, more reliable, and more powerful, aerospace engineers found more applications for them. This diversification of the computer's applications in aerospace is illustrated in the gallery's seven exhibit areas—Design, Aerodynamics, Computer-Aided Manufacture, Flight Testing, Air Operations, Flight

Simulators, and Space Operations. Each area includes at least one interactive computer terminal so that visitors can see for themselves the kinds of tasks that computers perform.

For example, the section on Computer-Aided Manufacture contains a workstation that shows how an airplane design, in this case, the X-29, is built up. The design begins with a "wire frame" drawing, then proceeds to a solid figure, which is then smoothed and given a reflective surface. The result is a realistic image that lets the designer see how his or her creation might look, before committing resources to building it.

The story of the X-29 continues in the Air Operations section, where a full-scale model of this plane that is literally too unstable to fly without its on-board computers is displayed. A CRAY-1, one of the first production-model supercomputers, is also featured in the gallery; the CRAY-1 was used in the design and manufacture of the X-29. Other areas of the gallery highlight the use of computers in controlling air traffic, the role of the Apollo guidance computer in landing men on the moon and



Beyond the Limits: Flight Enters the Computer Age examines the evolving role of computers in aerospace technology.

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returning them safely to earth, and the capabilities of the Mariner 10's on-board computers that allowed the spacecraft to be directed through space by Earth-based controllers.

For more information on *Beyond the Limits: Flight Enters the Computer Age*, contact Paul Ceruzzi, Curator, Dept. of Space History, National Air and Space Museum, Smithsonian Institution, Washington, DC 20560.

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