IEEE History Center

ISSUE 65, July 2004

STATIC FROM THE DIRECTOR

By the time you read this, I should be on my way back from the UK, where – as reported last issue – a whole week of exciting events surrounding the centennial of the Fleming Valve will be taking place. A large part of the November issue will be dedicated to reporting on those activities.

However, I would like to point out now that a centerpiece of the celebrations will be the dedication of the Fleming Valve as an IEEE Milestone in Electrical Engineering and Computing. As you can see elsewhere in this issue [page 4], the Milestone Program continues to flourish. In 2005 the program will be 20 years old, and the number of Milestones has now surpassed 60. It is therefore fitting that the IEEE History Committee, which will also be meeting that week in the UK, has on its agenda a strategic review of the Milestones program. Now that Milestones are found in every IEEE Region and every IEEE technical area, it is time to take the program to the next level. I should be reporting on that in the next issue as well.

An IEEE milestone turns 95: The Shoshone 90kV line in Colorado, USA, 1909

The History Center's oral history collection also continues to grow by leaps and bounds, becoming an ever-increasing resource for journalists, educators, and historians of technology. And it turns out that another event that will take place during our UK trip will be an oral history workshop in conjunction with the IEEE UKRI Section, in order to explore how to get IEEE volunteers more engaged in the process.

Finally, the IEEE Virtual Museum continues to go strong. In its latest accolade, having previously been named to an annual "Top 100" list by *PC Magazine*, that magazine has now decided that the VM deserves a place on its "Top 100 Classics" list. Under the category "News You Can Use," it says, "IEEE Virtual Museum: Fun family-friendly exhibits tell the story of electricity and reveal its most interesting aspects. Also included: magnetism!"

So, once again, thanks to our readers for your interest and your continuing support of all of our activities.

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

The newsletter reports on the activities of the Center and on new resources and projects in electrical and computer history. It is published three times each year by the IEEE History Center.

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STAFF NOTES

Former IEEE History Center GA David Randall Publishes First Novel.
We are delighted to report that David Randall's novel *Clovermead: In the Shadow of the Bear* was published in June 2004 by Simon & Schuster. David Randall was an IEEE History Center graduate assistant from 2002 to 2003. According to a reviewer, "Randall has a beautiful way with words; reading *Clovermead* is a pleasure, not just an adventure.... The heroes, the enemies, and those that play both sides, are all complex characters, and the plot line doesn't miss a beat."

AWARD ANNOUNCEMENT

David Hochfelder Wins Newcomen-Harvard Special Award
David Hochfelder, a faculty member with the Edison Papers Project at Rutgers University (and former IEEE History Center Post-doc), has won the Newcomen-Harvard Special Award, which is "given every volume year to the best article in the *Business History Review* written by a graduate student or recent Ph.D. who has not yet published a book in the field of business history. Winners receive a cash prize of $500 and a scroll from the Newcomen Society of the United States." Hochfelder won for his article, "Constructing an Industrial Divide: Western Union, AT&T, and the Federal Government, 1876-1971," which appeared in the Winter 2002 issue.

SPECIAL THANKS

Special Issues of *Radio Pioneers 1945* Donated to History Center
The IEEE History Center would like to thank Philip Goodman for his recent donation to the Center of *Radio Pioneers 1945*, the 17 April 1980 special issue of *Electronics*, and the special transistor issues of *Proceedings of the IRE*. These issues contain many historical articles, as well as historical photographs, which will be of use to the researcher and the scholar. The IEEE History Center looks forward to adding them to its archives for the benefit of scholars.

INTERNATIONAL SPY MUSEUM

The latest addition to the Washington, DC, USA, museum scene is not another branch of the government-sponsored Smithsonian Institution, but a private, not-for-profit museum dedicated to.... espionage!

The mission of the International Spy Museum is to educate the public about espionage and to provide a dynamic context that fosters understanding of its important role in, and impact on, current and historic events. It does so in an engaging and entertaining manner that is attractive to children and adults while still managing to be substantive and educational.

Although the museum focuses on military and political intelligence and reveals the role spies have played in world events throughout history, it gives full attention to role of technologies–particularly electronic technologies in the 20th century. Visitors in one part of the museum can monitor those in another, even while perusing display cases full of real spy devices, such as an electronic transmitter hidden in an olive! Readers of this newsletter might be particularly interested in the entire room dedicated to the British World War II codebreaking work at Bletchley Park, complete with an Engima and an interactive chance to try your hand at codebreaking.

Cold War spy hub, Washington D.C.

Although the admission price gets a bit high for a large family, it is well worth a visit the next time you are in the U.S. capital. You can learn more about the museum at their interesting Website, **http://www.spymuseum.org/index.asp**.

HISTORY OF TELECOMMUNICATIONS CONFERENCE 2005

In conjunction with the Connected Earth Partnership – a consortium of British museums with an interest in telecommunications – the Science Museum in London is seeking to organize an academic conference, in the second half of 2005 projected to last for three days, on the history of telecommunications.

Themes considered include communications and the shifting loci of social power, the automation, analogue and digital revolutions, communications and empire, military power and technology transfer, the rise of satellite and mobile phone technologies, and material collections of telecommunications history. Other relevant histories such as those of electrical measurement, computing, and physics may augment these categories.

The conference proposal is at a preliminary stage and the organizers welcome input on feasibility, participation, and suitable date. Please contact Christopher Chilvers, Senior Research Fellow, Science Museum, **christopher.chilvers@nmsi.ac.uk**, phone +44 (0)20 7942 4183

MILESTONES

Newly-Approved Milestones Honor Timekeeping, Magnetic Memory, Electrifiction, and Fire Alarm Systems

Four new IEEE milestones have been approved for upcoming dedication, recognizing achievements in quartz timekeeping, computing, electrification, and fire safety.

The IEEE Tokyo Section will recognize the commercialization of quartz timekeeping. The SEIKO Quartz Astron wristwatch, went on sale on Christmas Day, 1969. It was accurate to +/- 5 seconds a month, or one minute per year. The watch used the oscillations of its quartz crystal to regulate its movements. The plaque inscription will read:

After ten years of research and development at Suwa Seikosha, a manufacturing company of Seiko Group, a team of engineers headed by Tsuneya Nakamura produced the first quartz wristwatch to be sold to the public. The Seiko Astron 35SQ was introduced in Tokyo on 25 December 1969. Crucial elements included a quartz crystal oscillator, a hybrid integrated circuit, and a miniature stepping motor to turn the hands. It was accurate to within five seconds per month.

IBM's advances in magnetic memory are being honored by the IEEE's Santa Clara Valley Section (California). In May, 1956 International Business Machines Corporation announced a new type of magnetic disk storage, whose reliability, rapid access, and low cost made interactive computing tasks feasible. The plaque citation provisionally reads:

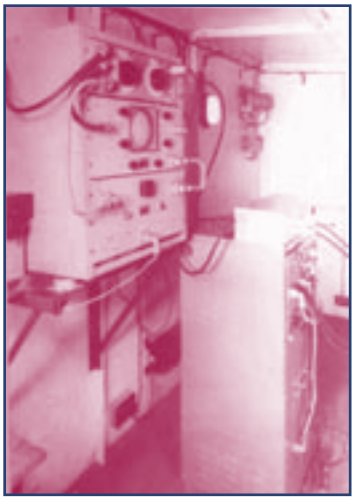
At this site in the mid-1950s, IBM developed the Random Access Method of Accounting and Control (RAMAC) machines. Introduced in 1956, these were the first computers to use magnetic disk storage. The extremely large capacity, rapid access, and low cost of magnetic disk storage have since made it a key technology for data and program storage for computers.
The third milestone honors William Stanley's 1886 system to provide alternating current in Great Barrington, Massachusetts. Stanley's system incorporated alternating current as well as transformers to adjust the voltage in the distribution system. The plaque citation will read:

On 20 March 1886 William Stanley provided alternating current electrification to offices and stores on Main Street in Great Barrington, Massachusetts. He thus demonstrated the first practical system for providing electrical illumination using alternating current with transformers to adjust voltage levels of the distribution system.

Boston, Massachussetts' electric fire alarm system, which provided a model for adoption by other U.S. cities, will also be honored. The system was invented by Dr. William F. Channing and placed in operation on 28 April 1852. The first alarm was received over the system on 29 April 1852 at 8:25 p.m. The plaque citation will be:

On 28 April 1852 the first municipal electric fire alarm system using call boxes with automatic signaling to indicate the location of a fire was placed into operation in Boston. Invented by William Channing and Moses Farmer, this system was highly successful in reducing property loss and deaths due to fire and was subsequently adopted throughout the United States and in Canada.

MYSTERY PHOTO CHALLENGE



Mystery Photograph #15
The IEEE History Center maintains a photographic archive of more than 3,700 images. From time to time images are donated without any identification. Can you help identify this photograph? We are interested in any details such as type of equipment, approximate dates, manufacturer, how/where used, and anything else of historical interest you would like to tell us.

The IEEE History Center has a web page that features the mystery photograph. You may email us your answer at **history@ieee.org**, or you can fill out an on-line form. **http://www.ieee.org/organizations/history_center/mystery_photo.html**

ELECTRICAL TECHNOLOGIES IN THE MOVIES: RADAR

In 1904 Christian Hülsmeyer patented and demonstrated what he called a "Hertzian-wave projecting and receiving apparatus adapted to indicate ... the presence of a metallic body, such as a ship ... in the line of projection of such waves." He did not succeed, however, in gaining the interest of either the German navy or international shipping companies, and he turned his attention to other matters. Some 30 years later, the threat of air warfare stimulated engineers in several countries to develop this technology, and radar systems became extremely important to all the major belligerents of World War II.

Not surprisingly, then, World War II movies often show radar in use. In the classic "Guns of Navarone" (1961), the two eponymous guns are radar controlled, and we see a rotating radar antenna and a radar screen. Radar screens, because they-graphically and sonically-indicate dangers, have been a favorite cinematic device from movies made shortly after the war, such as "Run Silent, Run Deep" (1958) and "No Time for Sergeants" (1958), to recent ones, such as "Saving Private Ryan" (1998) and "Pearl Harbor" (2001). The last-named movie shows the inside of the radar station on Oahu on 7 December 1941, but it incorrectly shows a plan-position-indicator screen (the familiar circular screen with rotating line). The oscilloscope screen in use at the time indicated an object by an upward blip on a horizontal line. The recent Austin Powers movies have made comic use of the imaging capabilities of modern radar screens ("Colonel, you better have a look at this radar. It looks like a giant ...").

During World War II, radar countermeasures became extremely important, and this too is shown in many movies. Chaff, the thin strips of metal foil released from aircraft, was shown in war movies and even in non-war movies, such as "Air Force One" (1997). Antiradar coating, first developed during World War II, is also seen in movies, such as with the stealth ship in the James Bond movie "Tomorrow Never Dies" (1997). And it was no doubt through movies that people learned that one could fly "under the radar." For example, in "Dr. Strangelove" (1964) Major T.J. "King" Kong says," At this height, why thy might harpoon us, but they dang sure ain't gonna spot us on no radar screen!"

The many civilian uses of radar in the modern world are, of course, also shown in movies. In "Close

Encounters of the Third Kind" (1977), there are detailed depictions of radar used for air-traffic control. In "Poseidon Adventure" (1972) radar on the bridge of a luxury liner is used to track a tsunami. In "Bull Durham" (1988) a radar gun is used to measure the speed of pitches. In "Lost in America" (1985) we see radar speed enforcement and hear a discussion of reasons it might be inaccurate. And in "Jurassic Park" (1993) we see ground-penetrating radar for paleontological research (though that technique is – in the movie – confounded with seismic profiling).

Many movies made in the first decades after World War II show that radar was then regarded as an unusual technology. In the science-fiction movie "Forbidden Planet" (1956), a spaceship approaching the planet detects that it is being "radar scanned," and an invisible monster is tracked by radar. In "Easy Rider" (1969) the view is expressed that UFOs and aliens have been visiting the earth ever since humans bounced radar off the moon in 1946. In "On the Beach" (1959) a person supposes that the global nuclear war started because some bloke looked at a radar screen and *thought* he saw something. And in "Adam's Rib" (1949), after receiving a slap on her backside, the wife (Katharine Hepburn) says to her husband (Spencer Tracy) "You meant that!", and he replies "What do you have back there, radar equipment?"

As always, we would be grateful for reports from readers of other interesting cinematic depictions of radar. You may contact us at **history@ieee.org**.

HURLEY SMITH'S POCKET SHIELD

Guest column contributed by Jeanette Madea, Ph.D

The pocket protector has long been associated with engineers. To the general public it conjures up images of a guy in a short-sleeve white shirt, glasses taped together, and "high-water" pants. Within the profession we know better. The pocket protector is simply a practical item, to preserve the integrity of those white shirts.

The original pocket protector was invented by Hurley Smith during the World War II. He was born in Bellaire, Michigan in 1908 and spent his first few years there. Unable to attend school formally, he completed high school by mail. By his mid-twenties, he had earned enough to return east and attend college. He enrolled at Queens University in Kingston, Ontario, earning a Bachelor of Science in Electrical Engineering in 1933. His first job upon graduation was marketing the newly invented Popsicle to retailers in Ontario. He said that his diet consisted mostly of Popsicles that first summer. 1933 was not a good time to be graduating from college.

Later he moved to Buffalo, New York where he worked for a company that designed electrical transformers. Smith learned that his employer was selling used (rewound) transformers and putting new plates on them claiming they were new. When the company was investigated, he refused to perjure himself as the heads of the company demanded, so found himself with a wife, five children, and no job.

While working in Buffalo, Smith was concerned not only about the ink and pencil stains that would get on the white shirts that were the required costume for any engineer in those days, but with the fraying around the edges of the pocket that the pressure from items in the pocket produced. Back then, the traditional housewife purchased shirts with the expectation they would last for a long time, even with constant washing, bleaching, and ironing.

Plastics used in manufacturing had become an exciting development during World War II, and Smith experimented with various materials for solving the fraying ink-stained shirt problem. He first used a stiff clear colorless plastic. He had tall, thin rectangles of this material made, then used a Pitney-Bowes letter folder to fold it twice, once approximately in half and once on one end to produce a flap that would extend over the top edge of the shirt pocket.

From the side, it looked like a check mark, unsealed at the sides. But it was just wide enough to fit into a shirt pocket with the back extending high enough to protect the back of the pocket and shirt above the pocket, and the flap fitting over the front of the pocket. He was awarded patent #2417786, Filed 3 June 1943, Issued: 18 March 1947 for the "Pocket Shield or Protector."

Smith constructed his first prototype in the attic of his house in Buffalo, having modified his wife's iron to heat the plastic enough to bend it properly. He modified the equipment over the years, and by the time he moved to New Hampshire the production of pocket protectors promised to provide enough income to allow him to quit engineering. He wanted to move the family to a location that was more economically promising. In 1949 he packed up the family and moved to Lansing, Michigan. During this time he maintained his membership in AIEE.

Smith set up his plastics business in Lansing and at times had several employees working with him. His primary product was the pocket protector, which he sold mostly to businesses for distribution to their employees or for advertising. By then he was producing the second generation of his invention, made of vinyl and heat sealed around the edges to make more of a pouch. The primary color was white although Smith also made them in colorless vinyl. With the white ones, he developed a way to imprint a logo or message on the flap and seal it with clear vinyl.

In his early years of production, he realized other companies were making and marketing the product he had patented. He decided not to pursue any legal action. Some of the first "infringers" he found out about were on the West Coast of the U.S., and he realized a legal battle would be difficult. He was satisfied at that point making as many as he could fill orders for.

The earliest type, the stiff plastic ones, were marketed by being inserted in a piece of lightweight cardboard designed like a man's pocket. So the pocket protector was slipped into the card as if it were being put into a pocket. This was called "carding."

Reminiscences *is a regular feature where we invite electircal engineers and historians of electrical and computer technologies to submit their accounts of how a particular technology came to be, or its impact on society. Please submit your articles to:* ***ieee-history@ieee.org***

AN EASY WAY TO MULTIPLY THE IMPACT OF YOUR SUPPORT

By: Karen Galuchie, IEEE Development Office

Did you know? You may be able to double or triple the amount of your gift to the IEEE History Center by using your employer's matching gift program. Matching gift programs not only give employers the opportunity to express their corporate philanthropy, but also demonstrate that they appreciate their workers by supporting the charitable organizations their employees' value. In addition to matching gifts from employees, some companies also match gifts from retirees and directors.
Are you eligible? Check to see if you or your spouse's company is listed below. If the answer is yes, then please inquire in your Human Resources or Community Relations Office to obtain a matching gift form, fill it out, and send it in with your next contribution to the IEEE History Center, which will benefit from your support. The IEEE Development Office is available to answer any questions you may have regarding this special giving program. Please contact us by phone: +1 732 562 5550; fax: +1 732 981 9515; or email: **supportieee@ieee.org.**

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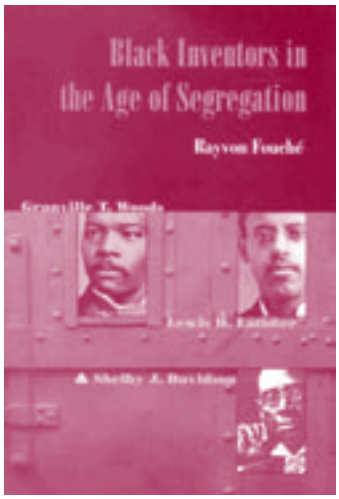

FOUCHÉ, RAYVON, *Black Inventors in the Age of Segregation*: Granville T. Woods, Lewis H. Latimer & Shelby J. Davidson, Johns Hopkins University Press, Baltimore, 2003.

Rayvon Fouché, a scholar of African-American cultural and intellectual history and history of technology at Rensselaer Polytechnic Institute's Department of Science & Technology Studies, who is himself black, has decided to explore how black inventors in the golden age of American invention negotiated the "difficult American racial terrain" (in his words). He does so by examining the lives of three important black electrical inventors of the late 19th and early 20th century in full historical detail and reclaiming their role as actors in history-as inventors and as people, as blacks, and as Americans. Doing so enables him to highlight their triumphs and contributions without losing sight of their humanity, or of the obstacles they faced.

Electrical technology turned out to be the fundamental technology of the 20th century, transforming American society and setting the stage for the 21st century. The white engineers of that time and medium–such as Bell, Edison, or Tesla–have become the paragons of the inventor. Fouché's choices–Granville T. Woods (1856-1910), Lewis H. Latimer (1848-1928), and Shelby J. Davidson (1868-1930), were also important inventors by a variety of measures. Each operated in a different milieu, however. Woods was an independent inventor; Latimer worked for a series of large corporations, culminating in his work for Edison General Electric, and Davidson held a government post. This variety enables Fouché to explore the diversity of social, economic, and political forces at play.

Fouché has organized his meticulously researched and well-written book as essentially three separate biographies. Because he emphasizes the uniqueness of the individuals and the role of an inventor as an actor in history, there is little attempt to compare and contrast the inventors within their chapters save for an introduction and a brief conclusion. Because none of these inventors has yet been given the full biographical treatment they deserve, this volume will serve as the best secondary source for each of their lives for some time to come. Some readers may be a little disappointed that Fouché did not try harder to draw broad conclusions, but that would have been exactly the opposite of his intent. This book can be highly recommended to all readers of this newsletter.

Available from Johns Hopkins University Press, 2715 North Charles Street, Baltimore, Maryland 21218, (410) 516-6900, **www.press.jhu.edu**, $34.95, hardcover, ISBN 0-8018-7319-3, 240 pp. 33 illus.

WEIGHTMAN, GAVIN *Signor Marconi's Black Box*, Da Capo Press, Cambridge, MA, 2003

Weightman's extremely readable biography of Marconi is also a suspenseful tale of the efforts and reverses in the race to span the north Atlantic with a radio signal. One of the aspects of Marconi as an inventor, which the book does a good job of bringing out, was that he pushed the bounds of what the technology of the time was capable of. The structural problems of erecting eighty-foot (or higher) antenna masts on windswept and exposed coastlines were daunting, and there were repeated collapses. The storage batteries for his transmitting stations were the height of four or five storey buildings. The reader gets a sense of how risky such a technological venture was – from a financial as well as an engineering point of view.

Weightman does an excellent job explaining the technology itself, and he adds interest to the book by devoting much space to Marconi's legitimate rival inventors such as Reginald Fessenden, as well as the outright charlatanism and financial swindles of the DeForest Wireless Telegraphy Company (whose misleading of investors provides a cautionary tale for understanding current high-tech stock market practices). The book tends to be favorable to Marconi, skating lightly over his personal peccadilloes, and it is a colorful and lively view of his life, and of the political and cultural events of the times. Readers interested in technology, in early twentieth century history, or in Marconi will find *Signor Marconi's Magic Box* a fascinating visit to Edwardian England, as well as a story of engineering triumph.

Available from Da Capo Books, Eleven Cambridge Center, Cambridge, MA 02142, **www.dacapopress.com**, $25.00, ISBN 0-306-81275-4, 312 pp., index, illus.

MISCELLANEOUS

Paul Bunge Prize
The German Chemical Society extends an international invitation for applications for the Paul Bunge Prize 2005. The award consists of 7,500 euros, and honors outstanding publications in German, English, or French in all fields of the history of scientific instruments. Besides the scientific work, applications should also include a curriculum vitae and a list of the applicant's publications. The deadline is 30 September 2004. Please send nominations to: Jutta Broll, PO Box 90 04 40, D-60444 Frankfurt/Main, Germany **j.broell@gdch.de**

Travel Grant Announcement
The Bakken Library and Museum offers Research Travel Grants for the purpose of facilitating research in its collection of books, journals, manuscripts, prints, and instruments. Up to a maximum of $500 (domestic) and $750 (foreign) is available to help researchers to defray the expenses of travel, subsistence, and other direct costs of conducting research at The Bakken. Minimum period of residence is one week. Application may be made anytime during the calendar year 2004 for research to be conducted during 2004. Elizabeth Ihrig, The Bakken Library and Museum, 3537 Zenith Avenue So., Minneapolis, MN., 55416, tel 612-926-3878 ext. 227, fax (612) 927-7265, **Ihrig@thebakken.org**

IEEE FELLOWSHIP

Chen-Pang Yeang is 2004-2005 Life Members Fellow in Electrical History

The IEEE History Committee has selected Chen-Pang Yeang as the 2004-2005 Life Members Fellow in Electrical History. Yeang is a Ph.D. student in MIT's program in Science, Technology and Society. He earned his B.S. in electrical engineering from National Taiwan University, his S.M. in electrical engineering from MIT, and his Sc.D. also from MIT.

Yeang's research is on the history of radio wave propagation and interferences between 1900 and 1936.

The IEEE Fellowship in Electrical History supports either one year of full-time graduate work in the history of electrical science and technology at a college or university of recognized standing, or up to one year of post-doctoral research for a scholar in this field who has received his or her Ph.D. within the past three years. The stipend is $17,000, and a research budget of $3,000 is available. The IEEE Fellowship in Electrical History is administered by the IEEE History Committee and sponsored by the IEEE Life Members Committee. Following is research the Fellowship has supported:

Past Fellows and Their Topics

1979 Ronald Kline	Steinmetz and the Development of Electrical Engineering
1980 W Bernard Carlson	Career of Elihu Thomson
1981 Robert Rosenberg	Electrical Engineering Education in America
1982 No Award	
1983 Lawrence Owens	Early Career of Vannevar Bush
1984 Andrew Butrica	Telegraphy and Electrical Engineering in France
1985 Paul Israel	Technological Innovation in the Telegraph Industry
1986 Jonathan Coopersmith	Electrification of Russia, 1880-1925
1987 Nelson Kellogg	History of Television
1988 Michael Gunderloy	Computing Activities of National Bureau of Standards
1989 Graeme Gooday	Laboratory-Based Culture in Electrical Engineering
1990 Mark Henry Clark	History of Magnetic Recording
1991 Gabrielle Hecht	Development of Nuclear Power
1992 Sungook Hong	John Ambrose Fleming
1993 Mary Ann Hellrigel	Adoption of Light and Power in Small Town America
1994 Ross Bassett	History of Metal Oxide Semiconductors
1995 David Morton	History of Magnetic Recording
1996 Christophe Lecuyer	Military Electronics Manufacturing
1996 Andrew Robertson	Transfer of Automatic Control Technology Between US & Japan
1997 Aristotle Tympas	Transition from Analog to Digital Computing
1998 Gary Frost	Failure of Early Frequency Modulation Radio 1900-1950
1999 Atsushi Akera	Scientific & Engineering Computing since WWII
2000 Thomas Haigh	Managing Information Processing in Amer. Corps.
2001 Cyrus Mody	Scanning Probe Microscopy
2002 Timothy Wolters	Evolution of Naval Combat Information Centers
2003 Leslie Berlin	Entrepreneurship and the Rise of Silicon Valley: The Career of Robert Noyce, 1956-1990

From the Stone Age...

Stone Age Culture
Babylonian Clay Tablets
Antikythera Reconstruction
Abacus/Soroban/Astrolabe
History of Numerals & Mathematics
History of Writing/Printing/Gutenberg
The Enlightenment/Bacon/Locke
Newton's *Principia* & *Opticks*
History of Electricity
Franklin/Volta/Faraday/Edison
Telegraph & Pony Express
Arithmometers & Comptometers
Antique Office Appliances
Cash Registers/NCRs/...
Burroughs/Monroe/Marchant/...
Telephones & Phonographs
History of Wireless & Electronics
Maxwell/Hertz/Marconi/Einstein
Fleming/De Forest/Farnsworth
Pocket/Portable Adding Machines
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SURF CITY

The Powerhouse Museum, Sydney, Australia

The Powerhouse Museum, Australia's largest museum, is located in Darling Harbour, Sydney. Its collection of 385,000 objects spans history, science, technology, industry, transport and space exploration, among others. The web site is a beautiful extension of the museum, highlighting museum exhibits, as well as online exhibits. One feature worth noting is the "Teacher Notes" that accompany each exhibit. One minor flaw is the lack of a search engine on the site.

www.powerhousemuseum.com

Lucent Technologies

Lucent Archives maintains a detailed history of the company, including Bell Labs history. It has a fact-filled timeline as well as individual histories of the transistor, UNIX, information theory and Claude Shannon, as well as the laser. It also includes a short biography of each Bell Labs' Presidents.

www.bell-labs.com/about/history/

Museum of Science, Boston

MOS is a delightful web site that contains a number of online exhibits featuring electricity, robots, and communications, among others. It also contains teacher, parent and visitor guides. The interactives use advanced graphics and are easy to navigate, as well as being highly educational.

www.mos.org

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