CRM

CULTURAL RESOURCE MANAGEMENT
Information for Parks, Federal Agencies, Indian Tribes, States, Local Governments, and the Private Sector

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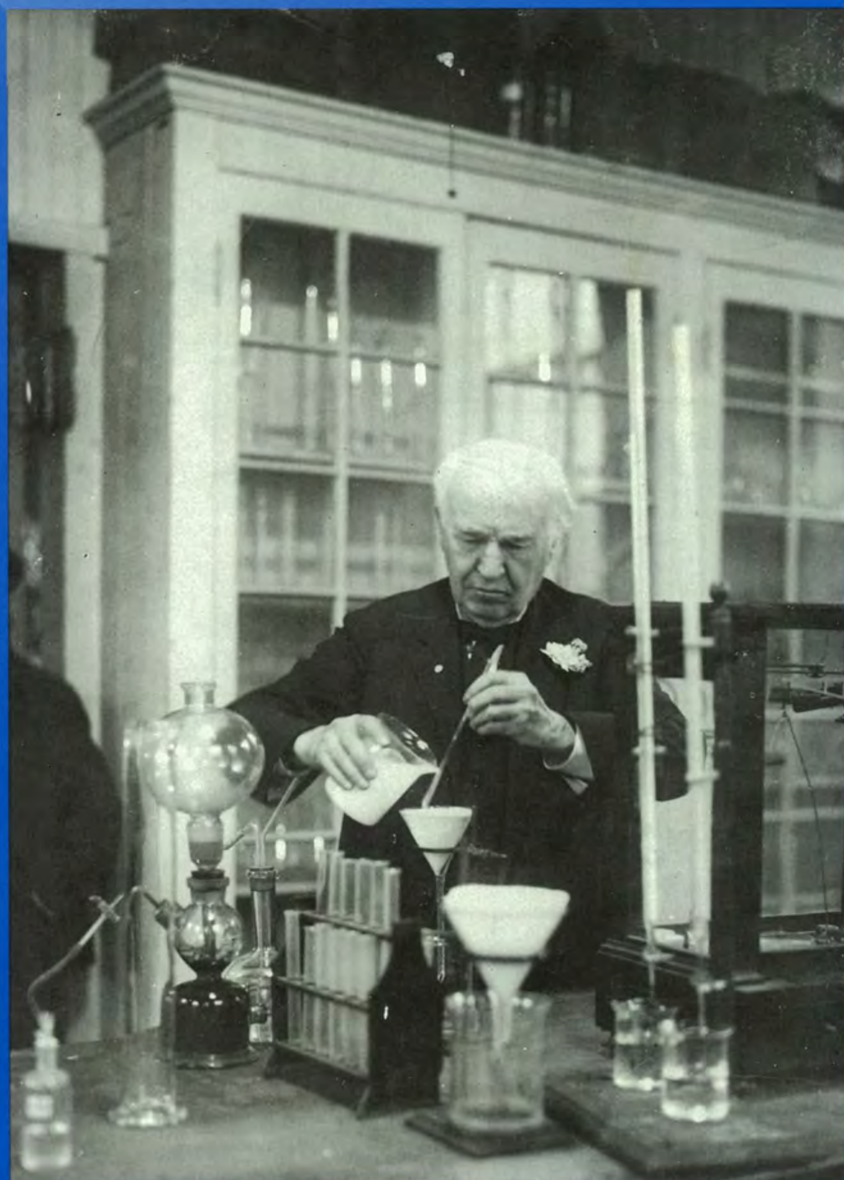
CRM and the History of Science and Technology



U.S. DEPARTMENT OF THE INTERIOR
National Park Service
Cultural Resources

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***CRM* CELEBRATING 20 YEARS OF PUBLICATION**

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CRM and the History of Science and Technology

Cover: Thomas Alva Edison in his chemistry laboratory, c. 1920s. Photo courtesy Edison National Historic Site.

Foreword

I am pleased to introduce this special theme issue of *CRM* on the history of science and technology. Inventions such as the telephone, electric light, and automobile have dramatically altered our lives. Scientific advancements have not only affected our material conditions, they have changed the way we think about ourselves and our world. The recently revised National Park Service Thematic Framework recognized the significance of these topics by listing "expanding science and technology" as one of its eight interpretive themes.

This issue comes at an appropriate time—the end of a year-long celebration of Thomas A. Edison's 150th anniversary. Born on February 11, 1847, Edison was one of this country's more prolific inventors. He continues to hold the record for the highest number of U.S. patents granted to an individual (1,093); and his inventions in telecommunications, sound recording, electric lighting, and motion pictures revolutionized 20th-century life. Perhaps his greatest achievements were his laboratories at Menlo Park and West Orange, New Jersey, which pioneered industrial innovation and served as models for the modern research and development facilities.

As the steward of his West Orange Laboratory, the NPS plays an important role in preserving the Edison story. The Edison sesquicentennial in 1997, which saw a variety of special events and programs, was an excellent opportunity to continue to expand on this role. Among other things, the Edison National Historic Site enlarged its off-site educational program, held a lecture series on innovation by scientists and business leaders, and organized a three-day conference that deepened our understanding of Edison's legacy. Also, park staff continues to manage the extensive collection of Edison artifacts and archives, and the site recently completed restoration of the buildings where Edison worked from 1887 to 1931.

Although Edison was a significant figure in the history of invention, he does not present a complete picture of our scientific and technological heritage. Edison did not work alone. Other people—working before, during, and after his life—also contributed to the stream of discoveries that have shaped our society.

The NPS, along with its public and private sector partners, manages a variety of resources related to these themes. Some of these resources date to the colonial period, such as the industrial village at Philadelphia's Historic RittenhouseTown and the iron foundry at Saugus Iron Works National Historic Site in Massachusetts. Others are of more recent vintage, like the DEW Line defense system in Canada or the nuclear test facilities in Nevada.

The articles in this issue discuss some of the problems historians, interpreters, and other CRM professionals face in identifying, preserving, and interpreting science and technology-related cultural resources. While the articles cover a broad range of topics, from colonial industrial practices to nuclear weapons research, this issue is not comprehensive. We hope the articles will stimulate further discussion of these important themes.

Maryanne Gerbauckas
Superintendent
Edison National Historic Site

The guest editor would like to thank Harry Butowsky, Beth Cantarella, Anne Markham, Greg Schmidl, and Ed Wirth for assisting in the preparation of this issue.

Richard Steacy

Pierce Mill
A Past With a Future

Pierce Mill, in Washington, DC's Rock Creek Park, is a restored gristmill based on Oliver Evans' pioneering mill system. Evans (1755-1819) developed an automated flour mill by connecting existing machinery with a system of horizontal and vertical conveyor belts, allowing grain to travel more efficiently from one stage to another. Evans' system earned him the third U.S. patent, granted in 1790, and was the basis of factory automation later introduced by Henry Ford and other industrialists. Evans' published description of his system, *The Young Mill-wright & Millers Guide*, went through 15 printings.

Pierce Mill operated commercially until 1897. When Congress created Rock Creek Park in 1890, the Mill was incorporated into the park's boundaries. From 1905 to 1934, the Mill served as a tea house, which saved the structure from the wrecker's ball. When it assumed stewardship of the park in 1933, the NPS decided to restore Pierce Mill as an operating water-powered gristmill. A deteriorated waterwheel and main shaft forced the park to shut the mill down in 1993.

The NPS, working with the newly formed Friends of Pierce Mill, Inc., is planning to rehabilitate the site. A Historic Resource Study and environmental assessment will be written. The goal is to make Pierce Mill operational again, to stage grinding demonstrations, and to enhance the interpretation of milling technology. The rehabilitation will eventually include replacement of the waterwheel, main shaft, and other wood mechanisms. Environmental concerns will require the restoration of Rock Creek water to power the mill. From 1971, piped municipal water powered Pierce Mill. The rehabilitation will take about five years and cost one million dollars. In an era of tight budgets, our partnership with the Friends of Pierce Mill will be essential to achieving our goal.

Pierce Mill, which might be the unofficial "Oliver Evans' National Historic Site," will incorporate more information about the inventor's life and work it into its interpretive program. In the future, the Mill will include an Evans' site bulletin and, hopefully, sponsorship of an Oliver Evans Science & Technology Fair.

Although broken, Pierce Mill is not closed. Its technology is still "interpretable" and includes displays, children's activities, films, talks, and group tours. A complete tour of the site called "The History & Technology of Pierce Mill" is offered every Saturday and Sunday at 11:00 a.m. Information about special programs can be found on the Mill's webpage, <http://www.nps.gov/rocr/piercemill>; or by calling 202-426-6908.

Richard Steacy is a park ranger at Pierce Mill, Rock Creek Park.

The Harold Cook Professional Library at Agate Fossil Beds National Monument

The expeditions of paleontologists in search of Miocene mammal fossils at Agate Springs Ranch exposed Harold J. Cook, son of Nebraska frontiersman James H. Cook, to science at an early age. The site is now Agate Fossil Beds National Monument in Nebraska. The monument portrays the story of this research in a new diorama and exhibit. Less familiar to visitors are the papers of three generations of Cooks as well as Harold's professional library. Thousands of letters, manuscripts, clippings, books, and reprints document fossil discovery, western ranching, Indian relations, and early-20th century views of science and religion.

Mostly self-taught, but with stints at the University of Nebraska and Columbia, Harold Cook was a player in scientific and museum circles in Nebraska, Colorado, and Wyoming. Cook was Curator of Paleontology at the Colorado (now Denver) Museum of Natural History in the 1920s, when important discoveries were made at the Folsom site. He later managed Scotts Bluff National Monument in the 1930s; and, when not publishing or ranching, he was active in exploiting oil and mineral resources of the region. The Cook Collection is partially cataloged and microfilmed and available to researchers by appointment.

Mary Doll and Jill Hanson

Preserving the History of the First Flight

Wright Brothers National Memorial

The Wright Brothers National Memorial commemorates the first flight at Kill Devil Hills, North Carolina. Photo courtesy NPS.

The next several years will be busy at Wright Brothers National Memorial, as park staff and partnership groups plan the 100th anniversary celebration of the first flight made by Orville Wright on December 17, 1903. While conducting initial flight experiments at their home in Dayton, Ohio, the Wright brothers sought a testing ground with wide-open spaces and steady winds. In the fall of 1900, the Wrights began their first round of experiments at Kitty Hawk, North Carolina, but soon settled on a site at nearby Kill Devil Hills. They returned in the fall of each year until they made their first flight in 1903.

Commemoration and preservation efforts at Kill Devil Hills began in 1926 with a congressional bill establishing the site as a national memorial. President Calvin Coolidge signed the legislation on March 2, 1927, and a small granite marker was placed at the site on December 17, 1928.

A commemorative plan developed for the memorial drastically altered the landscape at Kill Devil Hills. To preserve the hill used in the Wright's experiments and to prepare a foundation for a large monument, the War Department stabilized sand dunes with grass and other vegetation. A juried design competition for the monument attracted 36 entries. The winning design, submitted by the New York architectural firm of Rodgers and Poor, called for an Art Deco-inspired masonry shaft with relief carvings symbolizing wings on the sides. Measuring 61' high, the triangular-plan shaft rests on a star-shaped terrace. A light beacon at the top of the tower served as a navigational aid for planes in the area. The monument, dedicated in 1932, and the memorial site became a unit of the National Park Service in August 1933. The NPS completed the park's commemorative design by adding formal trails, roads, and plantings that defined the commemorative core of the park between the Rodgers and Poor Monument and the original granite marker.

Orville and Wilbur Wright conducted the first flight on December 17, 1903. Photo courtesy NPS.

The NPS recently completed a General Management Plan for improvement of the memorial in anticipation of the centennial. The plan calls for steps to ensure resource protection and visitor enjoyment of centennial events. The memorial was also the subject of a recent publication of the NPS Southwest Support Office in Atlanta. Written by William Chapman and Jill Hanson, *The Wright Brothers National Memorial Historic Resource Study* traces the history of the Wright brothers' experiments. The study also established the significance of the site and identified contributing elements of the original commemorative design in the National Register of Historic Places.

The First Flight Centennial Foundation, a primary fundraising organization for the 2003 celebration, is working with the NPS to improve visitor facilities at the memorial and to plan a series of celebratory events. Two major foundation projects include the rehabilitation of the Wright Monument in 1997 and the construction of a new visitor center by 2001. The foundation will replace the current 7,500 square foot visitor center with a spacious 17,000 square foot design. The new center will feature an interactive exhibit of the first flight. For information about the foundation, please write: The First Flight Centennial

Foundation, P.O. Box 80337, RDU Airport, North Carolina 27623, or call 919-840-2003.

Aviation and aerospace industries, along with professional organizations, have expressed strong interest in the celebration and, as 2003 draws near, more groups and organizations will join the commemoration. Congress is considering legislation for the establishment of a national commission. North Carolina has established the First Flight Centennial Commission to develop events honoring the first flight. The Commission has already begun a major education effort within the North Carolina school system. The 2003 Committee, established in the Wright brothers' hometown of Dayton, Ohio, leads the observation in Ohio. NPS staff at the Wright Memorial are working with the staff at Dayton Aviation Heritage National Historical Park, which was established October 16, 1992, to commemorate the contribution of the Wrights and the early development of aviation in the Dayton, Ohio, area.

Mary Doll is Superintendent of the Wright Brothers National Memorial.

Jill Hanson is a historian with the NPS Southeast Support Office in Atlanta.

NPS Sites Related to Aviation History

Crissy Field at Presidio of San Francisco, Golden Gate National Recreation Area

Dayton Aviation Heritage National Historical Park, Dayton, Ohio

Floyd Bennett Field, Gateway National Recreation Area, Brooklyn, New York

Indiana Dunes National Lakeshore, Porter, Indiana

Wright Brothers National Memorial, Kill Devil Hills, North Carolina

—Compiled by Ann Deines, historian
Dayton Aviation Heritage
National Historical Park

Liam Strain

Floyd Bennett Field
Gateway of Flight

Floyd Bennett Field, now part of the Breezy Point/Jamaica Bay Unit of Gateway National Recreation Area, played an important role in New York City's aviation history. The field was New York's municipal airport from 1930 to 1941 and the site of many record-breaking flights and technological advances during the Golden Age of Aviation.

Floyd Bennett's superior facilities, including steel-reinforced concrete runways, 10 million candlepower lights for night operations, and one of the first directional radio beacons, made it an ideal location for record-breaking transcontinental and transatlantic flights. The airfield was also used for the Bendix Cup airplane races. One of the more colorful pilots who broke records at Floyd Bennett was Roscoe Turner, who flew with a live lion cub. The media attention generated by these flights helped change public perceptions of aviation, which was still a novel means of travel.

Floyd Bennett Field was also the site of several technical innovations. Among the breakthroughs associated with the field are the Sperry autopilot used by Wiley Post in his 1933 around-the-world flight; Howard Hughes' global communications network created for his 1938 around-the-world flight; and a helicopter wench developed by Igor Sigorsky. Floyd Bennett also saw the first rotor-wing aircraft used for police work.

Today, the NPS interprets the contributions of Floyd Bennett Field to aviation history. Gateway NRA has developed the Historic Aircraft Restoration Project (H.A.R.P.), a Volunteers-In-Parks program dedicated to restoring vintage aircraft acquired by the park. The park also preserves eight original hangars, the original Administration Building (including the control tower), other related buildings, and the original runways and taxiway in its Historic District. Much more will be done to preserve and interpret Floyd Bennett Fields historic structures to help the public understand its aviation heritage.

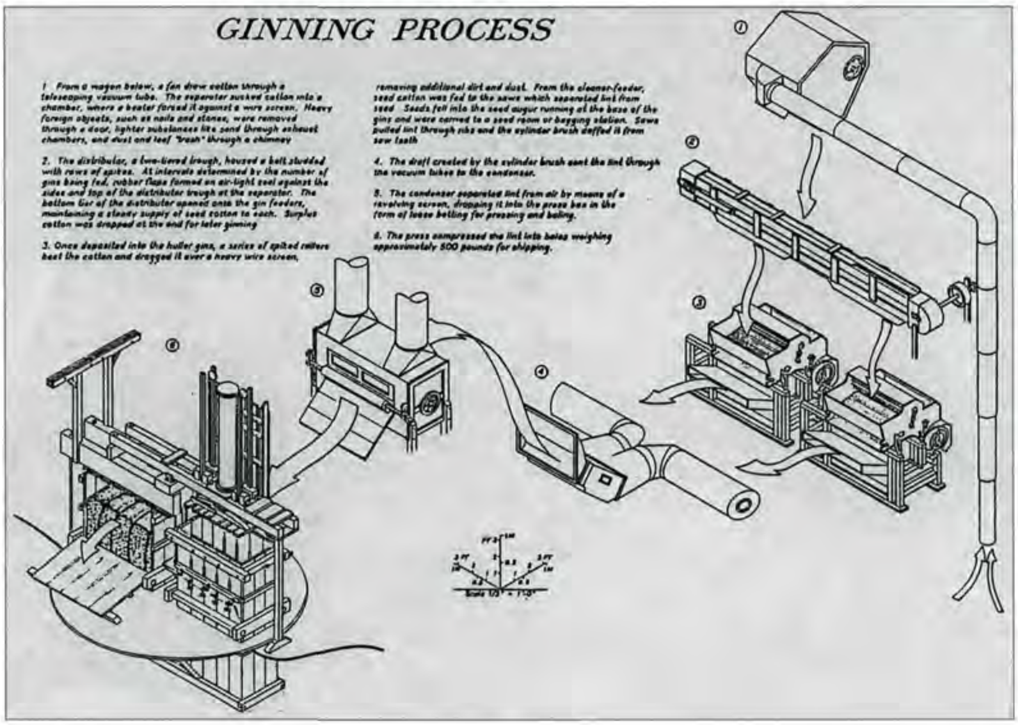
Liam Strain is a park ranger at Gateway National Recreation Area.

Richard O'Connor

Cotton Gins and Presses
Reading Industrial Artifacts at the Magnolia Plantation

Defunct industrial sites present unique challenges for documenting their construction and operation. Over time, buildings are modified for different purposes; and technologies are replaced or adapted. Because records are rarely maintained on outdated equipment and structures, the artifacts become important sources of information. However, they can also present hazy and contradictory evidence of how industrial sites functioned, as shown by the recent documentation of the gin house and equipment at Magnolia Plantation near Natchitoches, Louisiana, by the Historic American Engineering Record (HAER).

During most of the 19th and early-20th centuries, the Magnolia Plantation was among the largest cotton producers in Natchitoches Parish, Louisiana. Founded by Ambrose Lecomte II in the 1830s, the plantation eventually comprised more than 7,800 acres and, by 1859, produced over 1,100 bales of cotton annually. Since a tornado damaged the gin house and the steam engine shed in 1939, Magnolia has sent cotton to a commercial gin for processing.[1]



One of many structures on the site, the gin house contains cotton processing equipment used to clean the lint of seed and trash in preparation for baling and shipping. The construction date and original configuration of the gin house are still unknown because no documents about the structure exist. An 1850s map depicts a gin house at approximately the same location, but the present buildings size suggests a later construction date.[2] A large structure, especially in the context of southern agriculture, the building appears to have been constructed at once rather than added to over a period of years.

Nevertheless, the plantation owners extensively modified the gin house. The first-level floor in the wood screw-press area was a later addition, possibly upgrading a dirt floor for hay storage when cotton processing ended in 1939. The use of the area in front of the two-gin stand on the second level is not so clear. Gin position and joist pockets suggest the presence of flooring; but existing floor joists are also notched in a way consistent with the presence of yet another press—perhaps of the transitional metal screw variety. The floor in front of the hydraulic press reveals the likely location of the ramp used to transport baled cotton from the second to the first level. However, there is evidence of other uses for this area that is not easily explained, such as the difference in height between second levels in the north and south ends of the building. In addition, a seed storage area and lint room probably existed somewhere near the buildings center. Finally, a new roof, installed to protect the structure, obliterated traces of cotton processing equipment supports.

The age, origins, and method of operation of the two-and-a half story wood screw-press are mysteries. Style, timber size, hardware and joinery suggest antebellum construction; and the National Register nomination dates it as c. 1830. Mechanical engineer George Lowry suggested in 1898 that this type of press was prevalent from 1810 until the introduction of power screw-presses between 1840 and 1860 and the steam or hydraulic press in 1870. Yet, this technology appears particularly durable. According to Karen Gerhardt Britton, a recent authority on cotton ginning practices, Samuel A. Goodman Jr. purchased a nearly-identical press for his Tyler, Texas, farm in 1875. The press clearly predates the structure; and their seamless integration suggests that the press was built into the gin house when the structure was erected, probably sometime in the late-19th century.[3]

Little remains of the power source for the gin house equipment, particularly for gins predating existing equipment. Plantations the size of Magnolia could have easily used steam engines; evidence of steam-powered gins exists for plantations in other parts of the South. Steam engines were generally housed in separate buildings or, at Magnolia, in a shed behind the gin house; but the type and size of the steam engine once mounted on the footers at the rear of the house are unknown.[4] The separator, distributor, gins, and condenser were likely driven directly by the steam engine, with power transmitted via a system of shafts and belts.[5] The steam engine probably powered a hydraulic pump to run the press. The extant drive system consists of a main shaft, six wood belt wheels manufactured by the Reeves Pulley Company of Columbus, Indiana, and two metal

Eric DeLony

What Is HAER?

Last of the programs created as part of the "new preservation" in the late 1960s, the Historic American Engineering Record (HAER) was established to expand heritage memory to include the achievements of engineers, industrialists, and laborers. "New preservation" was begun in the 1960s by a group of historians, architects, and preservationists concerned with the alarming rate at which architectural landmarks and the scenic and historic quality of American cities were being destroyed by highways and urban renewal in the name of "progress." One of the results was the National Historic Preservation Act of 1966 and creation of the Office of Archeology and Historic Preservation within the National Park Service, now the Associate Directorship, Cultural Resources Stewardship and Partnerships. Since 1969, HAER has worked to ensure that engineering structures and industrial workplaces are recorded, and when possible, preserved along with historic architecture and other worthy resources.

Preservation through documentation has been the *modus operandi* of HAER as it has created a national archive of America's industrial, engineering, and technological achievements. Some of the sites recorded serve as the foundation for subsequent preservation efforts that transform communities and the way people think of the industrial workplace. Steel mills, factories, foundries, and the canal, road, and rail infrastructure now are beginning to be thoughtfully regarded and preserved with new insights. Through its federal authority, national standards, summer recording program, and Library of Congress archives, HAER has helped instill a national ethic to recognize the oft-forgotten contributions of engineers, industrialists, and laborers.

Since 1969 over 4,900 sites, structures, and objects have been recorded with over 53,000 photographs, 500 large-format color transparencies, 42,000 data pages, and 3,000 sheets of measured and interpretive drawings have been transmitted to the Library of Congress. Summer recording teams have been the heart of the HAER program. Since the program's inception 28 years ago, over 1,000 young people have had the opportunity of a "hands-on" experience documenting the nation's industrial, engineering, and architectural heritage every summer. Student hires remain the core of the summer documentation program, and the fundamental day-to-day philosophy of HAER recording remains the multidisciplinary team approach with a site-specific focus on the physical remains of engineering and industrial heritage. Documentation also is produced through the mitigatory documentation program administered by the Service Center Offices of the National Park Service. E. Blaine Cliver serves as Chief, HABS/HAER. Recording projects for the summer of 1997 included:

- Allegheny Oil Heritage Recording Project, Allegheny National Forest, Pennsylvania
- Continental Eagle Gin Company, Prattville, Alabama
- Hull-Oakes Lumber Company, Monroe, Oregon
- John A. Roebling Sons, Wire Rope Manufacturing Plant, Roebling, New Jersey
- Kalaupapa Water Collection System, Kalaupapa National Historical Park, Molokai, Hawaii
- Magnolia Plantation Cotton Gins & Presses, Natchitoches, Louisiana
- Mariscal Quicksilver Mine & Reduction Works, Big Bend National Park, Texas
- National Park Service Roads & Bridges Recording Program: Blue Ridge Parkway, Blowing Rock, North Carolina & Vinton, Virginia
- Natchez Trace Parkway, Mississippi/Tennessee
- Vicksburg National Military Park, Vicksburg, Mississippi
- Pennsylvania Historic Bridges-I, Harrisburg, Pennsylvania
- Southern Textile Project, Huntsville & Valley, Alabama, LaGrange, Georgia
- Steam Tug *Hercules*, San Francisco Maritime National Historical Park

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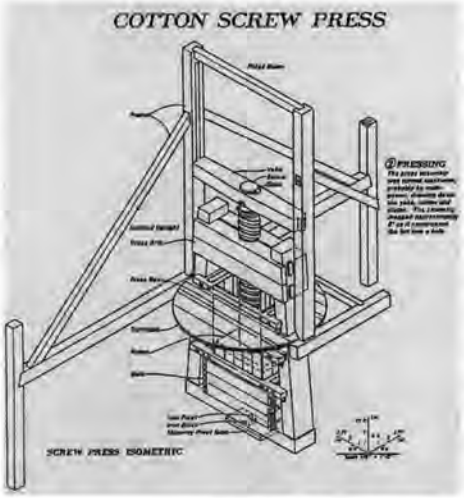
Eric Delony is chief of the Historic American Engineering Record.



wheels. Several other wood wheels are distributed around the barn.

Likewise, the power source for the wood screw-press and earlier gins is indeterminate. A similar press at the Goodman ranch at Tyler, Texas, now at Texas Tech in Lubbock, Texas, was mule-powered.[6] Other contemporary presses used draft animals; and it is likely, given the relative technological sophistication of the remaining screw-press, that the same was true of Magnolia. Yet, anomalies suggest another possible scenario. Unlike surviving contemporary presses, the Magnolia press has no prominent buzzard wings to which draft animals would have been attached. It would have been possible, if not very unusual, for the press to have been powered by humans. It is in near-perfect balance, with a low-friction metal pivot point requiring minimum power to rotate it and draw down the platen. Wear marks on the rotating slanted legs suggest that rope may have been wrapped around the inclined support members, possibly to attach a cross brace for a draft animal or a bar for humans.

Unlike both the gin house and the wood screw-press, the turn-of-the-century cotton ginning system at Magnolia is described in a series of patents in company literature provided by Tommy Brown of Continental Eagle Gin Company (successor to the Continental Gin Company), still at Prattville, Alabama, and by Thomas Oliver, who reconstructed a similar system at Old Alabama Town in Montgomery, Alabama. Beginning in the 1880s, Texan Robert Munger designed a series of pneumatic and mechanical processes that completely reorganized the hundred-year-old tradition of plantation ginning.[7] He sought remedies for the frequency and size of gin-house fires, the speed with which they spread, the trash still contained in seed cotton as it entered the gin, the impurities cast into the gin-house air, and the labor and time resulting from delays and congestion in moving seed cotton from delivery wagons to gin. By stabilizing the supply of cotton to the gins and dramatically increasing baling capacity with the development of the dual-box press, Munger's innovations transformed ginning from a set of discrete steps to a continuous process.

Most components of Munger's system are present at Magnolia, although the cotton suction apparatus is almost completely disassembled. The pneumatic elevator includes the fan currently outside the first level, various flue ducts randomly distributed about the gin house, and the vacuum box—presently detached and lying under the condenser, but originally attached to the distributor above the gin stand. The mechanical cotton distributor, still in place above the gin-stands, was designed and patented by Munger and manufactured by Continental Gin Company of Prattville, Alabama.[8]

The Magnolia Plantation gin house is a compendium of once state-of-the-art cotton processing technologies representing vastly different eras of southern history. The juxtaposition of equipment, some still in its original placement but some randomly strewn about, precludes a quick reading of its operation and seemingly defies confident explanation. The need to study and evaluate this equipment, the search for new sources to explain its nuances and contradictions, and the compelling desire to find it in its many historical contexts suggest that the richness of the resource lies precisely in the challenges it presents.

Notes

1 Part of Magnolia, including the gin house, is now in the Cane River Creole National Heritage Area.

2 The map was furnished by Dr. Ann Malone, who generously shared her work on other aspects of Magnolia's history.

3 National Register Nomination, continuation sheet 1, item number 7, page 2; George A. Lowry, *Ginning and Baling Cotton*, from 1798 to 1898, Transactions, *American Society of Mechanical Engineers*, vol. XIX (June, 1898), p. 819; Karen Gerhardt Britton, *Bale o' Cotton*, College Station, Texas, 1992, p. 48.

4 According to Ambrose Hertzog, in an interview with the author on September 17, 1996, the building housing a steam engine was destroyed in 1939, and the engine was then sold.

5 The absence of clutch assemblies and the presence of the drive pulley mounted directly on the line shaft, as on the contemporary gin outfit at Old Alabama Town, Montgomery, suggest that the Magnolia outfit was a direct connected gin. Thomas Oliver, *A Narrative History of Cotton in Alabama*, *Montgomery, AL*, Landmarks Foundation of Montgomery, Inc., 1992, p. 90.

6 Britton, *Bale o' Cotton*, p. 48.

7 Britton, *Bale o' Cotton*, pp. 58-9. Thomas Oliver describes the operation of the Munger outfit in substantial detail in *A Narrative History*, pp. 65-93.

8 Robert S. Munger, U.S. Patent No. 308,790, December 2, 1884.

Richard O'Connor is a historian with the Historic American Engineering Record.

David Neufeld

Trigger for Atomic Holocaust

Aircraft Detection on the DEW Line

The isolated antenna of the Distant Early Warning (DEW) Line are enduring images of the Cold War in Canada. Stretching across the 70th parallel from Alaska to Greenland, the DEW Line was the northern bastion of a huge air defence system built in the 1950s. In Canada, the system included 4 main stations, 18 auxiliary stations, and 20 smaller intermediate sites. Two stations, the BAR-1 Auxiliary radar station and the BAR-B I-Site, operated from locations in what is now Ivvavik National Park in the northern Yukon Territory. The cultural resource management of these sites provides an opportunity to evaluate the aircraft detection technology.

Royal Canadian Air Force officer T.H. Collins stands before a doppler antennae towering over the DEW Line Main Station at the Hall Beach in 1955. Photo courtesy Dept. of National Defence DND-CPU-PCN 1660.

This extraordinary arctic military facility detected transpolar aircraft activity for continental defence. Designed to alert defending fighters and give six hours warning, the rapid development of military aircraft soon cut the DEW Line's warning time in half. Once ICBMs supplemented Soviet bombers in the early 1960s, the warning shrank to minutes; and air and civil defence efforts became pointless. The DEW Line was limited to confirming attacks and triggering massive nuclear retaliation.

Air traffic monitoring in remote areas offered unique challenges to system designers in the early 1950s. Because air traffic was infrequent in northern areas, console operators spent long, tiresome periods without any contact. The extra staff needed to cover remote areas was expensive. To overcome these difficulties, designers equipped the DEW Line with two kinds of electronic detection gear, a powerful gap-filler radar and a doppler radio detection system known as the "McGill Fence," developed under the leadership of McGill University physicist John S. Foster.[1] The fence operated on the DEW Line and the Mid-Canada Line, another link in the air defence system on the 55th parallel.

Radar technician Bob Virgin at the console of BAR-1, April 1993. Photo courtesy Johnson collection, Parks Canada.

Transmitting and receiving gear connected to a set of 100-meter radio masts equipped each DEW Line station. Radio transmissions between stations emitted lobes of electromagnetic radiation reaching from the ground to 30,000 meters. Station recording devices detected passing airplanes when they disturbed the energy field. The system provided intrusion warning, tracked aircraft, supplemented radar sightings, and covered gaps between radar stations. The system was an innovative and inexpensive solution to the need for automatic air traffic notification.

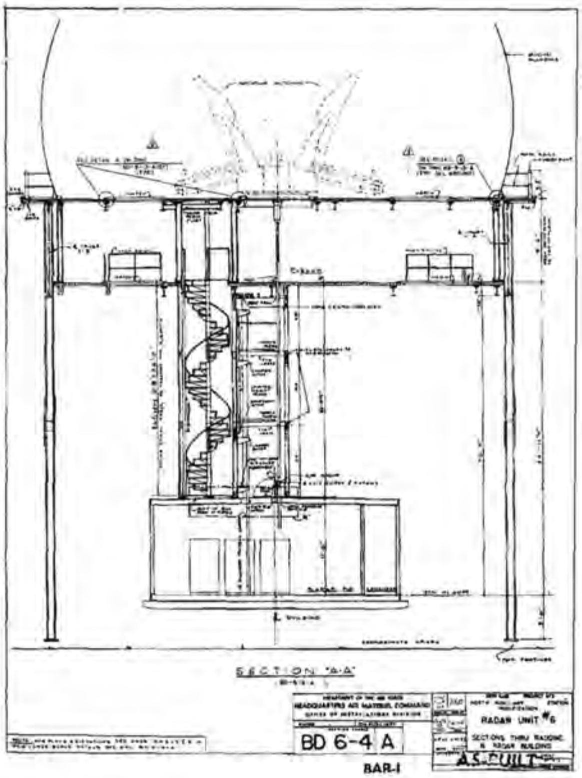
Although theoretically attractive, the "McGill Fence" was notoriously unreliable. Field reports on the "Fence" noted that operators were "cancelling the alarm without even inspecting the scope for target presence." Sam Lightman, a radar technician responsible for the doppler in the early 1960s reported, "We either got nothing, or we got geese. We never, ever got aircraft. It was a hopeless system. It was also a tremendously temperamental system, it was almost impossible to keep the damn thing running, I don't exactly know why. I think it was because the receivers were hideously sensitive and it was just awful."[2] As the need for aircraft detection diminished in the early 1960s, the doppler systems were taken out of operation. All DEW Line I-sites were closed in 1963. Two years later, the Mid-Canada Line was also abandoned. The large antenna and wire webs used for the "McGill Fence" on the BAR-1 and BAR-B sites were removed in the mid-1960s.

Besides the passive notification provided by the "McGill Fence," each DEW Line station was equipped with powerful long-range search radar. These units, capable of tracking aircraft to 30,000 meters and almost 500 kilometers away, provided overlapping radar coverage.[3] The rotating antenna was sheltered within the protective white hard shelled geodesic radome popularly attributed to Buckminster Fuller. Transmitting and receiving equipment and the consoles were housed in the building train immediately below the antenna tower.

USAF Captain Joseph A. Miller beside the radar array in the geodesic dome, BAR-1, April 1993. Photo courtesy Johnson collection, Parks Canada.

According to Sam Lightman, technicians had two sets of radars, "We had a six-degree radar and a three-degree radar. Inside the big geodesic dome was a huge rotating antenna ... And it had twin beams—one aimed at six degrees and one aimed at three degrees to the horizontal." The six-degree beam, also called the high beam, was designed to detect high flying airplanes. Lightman reported that in the year and a half he worked on the DEW Line, the high beam never detected anything. Lightman and his colleagues could talk with high altitude U2 planes, but never saw them. The three-degree radar, or low beam, was more effective. With the three degree beams, technicians could detect everything from commercial jets to police and military aircraft.

To meet the "empty skies" problem and keep console operators alert, an auto warning system, known as a radalarm, was installed. This device sounded an alarm whenever the radar detected an intrusion and was an important contributor to the staff reductions. However, it also suffered failings. Because ground clutter frequently triggered the alarm, technicians often turned off the sensitive equipment.[4]



Section drawing of BAR-1 radar tower and antenna. Photo courtesy BAR-1 DEW Line Collection, Parks Canada.

To preserve information on the aircraft detection systems of the DEW Line, Parks Canada has undertaken a significant collection program. Some 1000 kilograms of material were collected from the site when it shut down. A drawing set provides details on extant structures. A complete photographic record of the site was also made. As a full DEW Line radar console and associated equipment were previously collected, radar equipment collection at BAR-1 was limited to the actual console screen and surrounding panel. This equipment retains the grease pencil markings showing the last aircraft tracking completed before the shutdown.

Beyond this console panel, the park obtained a set of U.S. Air Force Technical Orders and DEW Line Instructions, though restricted volumes were not available. These cover the installation and maintenance of equipment installed on DEW stations. BAR-1 files covering actual maintenance schedules and breakdown reports are important complements to these manuals. Perhaps the most important element in the program was the oral history research. These limited interviews were made on-site while the operators were on the job. Although the line was closed, continuing contact with some of these individuals allows their participation in the project. An interactive report (CD-ROM) includes 200 images; indices of artifacts, files, and drawings collected; and a pair of essays describing the history and cultural resource management process of the site. A more detailed history of the site is in preparation.

Notes

1. D. Winkler, *Searching the Skies: The Legacy of the United States Cold War Defense Radar Program*, U.S. Air Force, Air Combat Command, June 1997, p. 83.
2. Report noted in Roy J. Fletcher, "Military Radar Defence Lines of Northern North America: an Historical Geography," *Polar Record* vol. 26, 1990, p. 270 and Sam Lightman interview with the author, June 6, 1995, Whitehorse, Yukon.
3. David Neufeld, BAR-1 field notes, conversation with radician George Bridger, July 18, 1993.
4. Telex of 27 Aug. 1986 in file AN/FPS-19, BAR-1 DEW Line Collection, Parks Canada and David Neufeld, BAR-1 field notes, conversation with Station Chief Ric Stephens, July 18, 1993.

David Neufeld is Yukon and Western Arctic Historian for Parks Canada.

National Historic Landmarks Related to the History of Science and Technology

ALASKA

Leffingwell Camp Site, Flaxman Island

ALABAMA

Redstone Test Stand-Marshall Space Flight Center, Huntsville
Sloss Blast Furnace, Birmingham

ARIZONA

Lowell Observatory, Flagstaff
C. Hart Merriam Base Camp Site, Flagstaff
Desert Laboratory, Tucson

CALIFORNIA

Room 307, Gilman Hall, Univ. of California, Berkeley
John Muir NHS, Martinez
Hale Solar Laboratory, Pasadena
Edwin Hubble House, San Marino
George H. Scripps Memorial Marine Biological Laboratory, La Jolla
Rock Magnetics Laboratory, Menlo Park
Unitary Plan Wind Tunnel, Ames Research Center Moffett Field

Grote Reber at his telescope, Reber Radio Telescope, Greenbank, West Virginia. Photo courtesy of National Radio Astronomy Observatory.

Mare Island Naval Shipyard, Vallejo

CONNECTICUT

Armsmear, Hartford
Edward W. Morley House, West Hartford
Charles H. Norton House, Plainville
Russell Henry Cittenden House, New Haven
Connecticut Agricultural Experiment Station, New Haven
James Dwight Dana House, New Haven
Lafayette B. Mendel House, New Haven
U.S.S. Nautilus (submarine), Groton

DISTRICT OF COLUMBIA

Army Medical Museum
Arts Club of Washington
Alexander Graham Bell Laboratory
Elliott Coues House
National Portrait Gallery
Old Naval Observatory
Smithsonian Building
David White House
Robert Simpson Woodward House

FLORIDA

Cape Canaveral Air Force Station, Launch Pads and Mission Control Center, Cocoa
Ybor City Historic District, Tampa

GEORGIA

Warm Springs Historic District, Warm Springs

IDAHO

Experimental Breeder Reactor No. 1, National Reactor Testing Station, Arco

ILLINOIS

University of Illinois Observatory, Urbana
Arthur H. Compton House, Chicago
Site of first self-sustaining nuclear reaction, Chicago
Kennicotts Grove, Glenview
Frank R. Lillie House, Chicago
Robert A. Millikan House, Chicago
Room 405, George Herbert Jones Laboratory, University of Chicago, Chicago
John Deere House and Shop, Grand Detour
Rock Island Arsenal, Rock Island

INDIANA

Indianapolis Motor Speedway, Speedway
Madame C.J. Walker Building, Indianapolis

LOUISIANA

Big Oak-Little Oak Islands, New Orleans

MAINE

Bowdoin (schooner), Castine

MARYLAND

Rachel Carson House, Silver Spring
Gaithersburg Latitude Observatory, Gaithersburg
Elmer V. McCollum House, Baltimore
Ira Remsen House, Baltimore
Henry August Rowland House, Baltimore
William H. Welch House, Baltimore

MASSACHUSETTS

Ernestina (schooner), New Bedford
Nathaniel Bowditch House, Salem
Elihu Thomson House, Swampscott
George D. Birkhoff House, Cambridge
Boston Manufacturing Company, Waltham
Percy Bridgman House, Cambridge
Reginald A. Daly House, Cambridge
William Morris Davis House, Cambridge
Reginald A. Fessenden House, Newton
Asa Gray House, Cambridge
Arthur D. Little, Inc. Building, Cambridge
Theodore W. Richards House, Cambridge
Count Rumford Birthplace, Woburn
Great Blue Hill Weather Observatory, Milton
George R. Minot House, Brookline
Arnold Arboretum, Boston
Boston Naval Shipyard, Boston
Ether Dome, Massachusetts General Hospital, Boston
Ellen H. Swallow Richards House, Jamaica Plain
Goddard Rocket Launching Site, Auburn

MICHIGAN

Herbert H. Dow House, Midland
Fair Lane, Dearborn
Parke-Davis Research Laboratory, Detroit

MINNESOTA

Mayo Clinic Buildings, Rochester

MISSOURI

Sanborn Field and Soil Erosion Plots, University of Missouri Columbia
Joseph Erlanger House, St. Louis
Missouri Botanical Gardens, St. Louis
Washington University Hilltop Campus Historic District, St. Louis

NEBRASKA

Captain Meriwether Lewis (dredge), Brownville

NEW HAMPSHIRE

USS *Albacore*, Portsmouth

NEW JERSEY

Lucy, the Margate Elephant, Margate City
Hadrosaurus Foulkii Leidy Site, Haddonfield
Abbott Farm Archeological Site, Trenton
Albert Einstein House, Princeton
Joseph Henry House, Princeton
Horn Antenna, Holmdel
Speedwell Village, Morristown

NEW MEXICO

Folsom Site, Folsom
Launch Complex 33, White Sands Missile Range
Los Alamos Scientific Laboratory, Los Alamos
Seton Village, Santa Fe
Trinity Site, Bingham

NEW YORK

James Hall Office, Albany
New York Botanical Gardens, New York
Jethro Wood House, Poplar Ridge
Locust Grove, Poughkeepsie
Vassar College Observatory, Poughkeepsie
George Eastman House, Rochester
Bell Telephone Laboratories, New York
Founders Hall, Rockefeller University, New York
Matthew Henson Residence, New York
Pupin Physics Laboratories, Columbia University, New York
General Electric Research Laboratory, Schenectady
Irving Langmuir House, Schenectady
John W. Draper House, Hastings-on-Hudson

NEVADA

Leonard Rock Shelter, Lovelock

Zero Gravity Research Facility. NASA Lewis Research Center, Cleveland, Ohio. Photo courtesy NASA Lewis Research Center.

NORTH CAROLINA

USS *Monitor*, Cape Hatteras

OHIO

Langstroth Cottage, Oxford
John B. Tytus House, Middletown
Rocket Engine Test Facility, Lewis Research Center, Cleveland
Zero Gravity Research Facility (B-2), Lewis Research Center, Cleveland
Thomas Alva Edison Birthplace, Milan
Huffman Field, Wright-Patterson Air Force Base, Fairborn
Kirtland Temple, Kirtland
Hawthorn Hill, Oakwood
Charles F. Kettering House, Kettering
Wright Cycle Company and Printing Offices, Dayton
Wright Flyer III, Dayton

PENNSYLVANIA

Charles B. Dudley House, Altoona
Humphry Marshall House, Marshallton
Pulpit Rocks, Huntingdon
Robert Fulton Birthplace, Quarryville
Mill Grove, Audobon
Gemeinhaus-Lewis David De Schweinitz Residence, Bethlehem
Joseph Priestley House, Northumberland
American Philosophical Society Hall, Philadelphia
John Bertram House, Philadelphia
Edward Drinker Cope House, Philadelphia
Hill-Physick House, Philadelphia
RittenhouseTown Historic District, Philadelphia
Stenton, Philadelphia
Wagner Free Institute of Science, Philadelphia
Edward G. Acheson House, Monongahela

RHODE ISLAND

Old Slater Mill, Pawtucket

SOUTH CAROLINA

Middleton Place, Summerville
South Carolina State Hospital, Mills Building, Columbia
Borough House Plantation, Stateburg

TENNESSEE

Rhea County Courthouse, Dayton
X-10 Reactor, Oak Ridge National Laboratory, Oak Ridge

TEXAS

Lucas Gusher, Spindletop Oil Field, Beaumont

VERMONT

Stellafane Observatory, North Springfield

VIRGINIA

Benjamin Banneker, SW 9 Intermediate Boundary Stone, Arlington
Gen. William Mitchell House, Middleburg
Cyrus McCormick Farm and Workshop, Steeles Tavern
Eight-Foot High Speed Tunnel, Langley Research Center, Hampton
Full-Scale Tunnel, Langley Research Center, Hampton
Variable Density Tunnel, Langley Research Center, Hampton

WEST VIRGINIA

Reber Radio Telescope, National Radio Astronomy Observatory, Green Bank

WISCONSIN

University of Wisconsin Science Hall, Madison
Thomas A. Greene Memorial Museum, Milwaukee
Soldiers Home Reef, Milwaukee

Listing from the National Register Database, courtesy John Byrne, National Register Database Manager.

Coxey Toogood

Managing RittenhouseTown
A National Historic Landmark

The Friends of RittenhouseTown was organized in 1984 to restore the site of the nation's first paper mill. They took on the management of five stone buildings in Philadelphia's Fairmount Park, remnants of the historic village of RittenhouseTown. Fourteen years later, after professional research and archeology, RittenhouseTown is a National Historic Landmark (1992), a site significant for its industrial history spanning two centuries.

RittenhouseTown is a charming cluster of 18th- and 19th-century buildings in a wooded glen in northwest Philadelphia. Five houses, a barn, a bake house, and a road along the Monoshone Creek are all that remain of the industrial village that, in the mid-19th century, included several mills and homes, a stone quarry, a Baptist Church, and a schoolhouse.

William Rittenhouse, the German-born founder of the paper mill, immigrated to America in 1689, after working 10 years as a papermaker in Holland. While living in Amsterdam, he married, started a family, and converted to the Mennonite faith. In 1690 Rittenhouse built the first paper mill in British North America. When this mill washed away in a flood around 1700, he constructed a larger mill farther downstream that survived into the age of photography.

The Rittenhouse mill followed the ancient practice of making paper by soaking rags in water and then pounding them into pulp. The fibrous material was then dried into sheets of paper. The mill was close to Germantown, an emerging textile center and good source of rags. The Rittenhouse family manufactured paper on the Monoshone until the early-19th century. After the Civil War, they began selling their land. At this time, the city of Philadelphia started purchasing RittenhouseTown village as part of Fairmount Park. The park commissioners demolished the mills and most of the village structures and ran scenic Lincoln Drive through its center.

Historic RittenhouseTown, in Philadelphia's Fairmount Park, is the site of the nation's first paper mill.

Despite these physical losses, the site retained enough integrity to be nominated as a National Historic Landmark, based on its significance as the birthplace of American papermaking, as the birthplace of David Rittenhouse, the first director of the U.S. Mint, and as a rural industrial village site. Board management decisions have focused on its papermaking history, because only one other place in the country tells the papermaking story, a museum in Atlanta, Georgia. Historic RittenhouseTown, Inc. aims to tell the story of this important industry and to serve as an interpretive model for other paper mill sites.

To accomplish these goals, the Board of RittenhouseTown, Inc., has considered whether to reconstruct the paper mill and fully restore the surviving buildings. Many members felt reconstruction of the mill was essential to understanding the site. Currently, a vision plan includes a partial reconstruction based on archeological remains and a photograph of the mill shot before its demolition.

The second mill stood across the stream from a large stone house built by William's son, Claus. Known as the Homestead, the house is RittenhouseTown's earliest surviving structure (1707) and the birthplace of David Rittenhouse. Until recently, the Board planned to restore the Homestead to its original appearance. A 1996 historic structure report on the Homestead, however, underscored the scarce documentation available on the building and the lack of historic fabric. Without sufficient record, preservation—rather than restoration of the Homestead—has become the preferred alternative.

Research changed the Board's direction on another occasion. The draft vision statement for RittenhouseTown called for all seven buildings to be restored to recreate a colonial village. An historic structure report in 1997, however, concluded one of the houses was built in 1840. Thus, the colonial emphasis was finally modified by factual information. The vision statement now calls for the preservation of the 18th- and 19th-century industrial village.

The Board has sponsored several other kinds of studies for RittenhouseTown. A professionally supervised dig exposed a corner of the paper mill's massive stone foundation. This archeology led to funding for an interpretive design study on the mill site. A master plan for RittenhouseTown mapped out the village's historical and archeological resources. A design firm researched and prepared an excellent exhibit time line for the visitor center, and a research historian prepared a handbook on RittenhouseTown's history. A landscape architect completed a study on the site's access problems, while a museum grant made recommendations for collections' management.

In the future, Historic RittenhouseTown will require additional studies, including a cultural landscape report for a planned wayside trail and historic structure reports for two houses currently leased to Fairmount Park. Some Board members have been impatient with research that has consumed needed dollars for restoration and interpretation, but the information obtained in this process has allowed the Board to answer critical questions about the site's future.

The Board hopes to expand the papermaking program and interpret the village of RittenhouseTown from the mill's origin to the present. Expansion, however, is currently limited by the site's rural characteristics and its setting. The village's septic system restricts the visitor center to one public toilet. More bathrooms can be added when a sewer line is installed, but estimates to run the line in the village top $400,000. Public access and parking are limited by the site's hilly contours and its proximity to Lincoln Drive, a fast-moving, but scenic commuter road. Public access also must be considered in the light of neighborhood concerns and the Board's effort to keep cars and buses from traversing the village. The future of Historic RittenhouseTown will thus need the continued cooperation of many diverse professionals, neighbors, community groups, and volunteers who together will determine the future of this National Historic Landmark.

Coxey Toogood is historian at Independence National Historical Park and Chairman of the Board, Historic RittenhouseTown, Inc.

Scott S. Sheads and Anna von Lunz

Rodman
Last of the Seacoast Muzzle-Loaders

The Rodman gun, shown here at Fort McHenry, was the last smoothbore muzzle loader used in American coastal defense during the late-19th century. Photo courtesy Ft. McHenry NMHS.

Fort McHenry National Monument and Historic Shrine has the largest surviving collection of Rodman guns in the United States. While the names Dahlgren, Parrot, and Napoleon are synonymous with artillery, few come close to the Rodman, the last of the smoothbore muzzle loaders to guard the American coast during the last half of the 19th century.

Thomas Jackson Rodman, an Army ordnance officer who graduated from West Point in 1837, developed the Rodman gun. Rodman's commission in the Ordnance Department enabled him to study cannon casting methods at the nation's leading foundries.

In February 1844, Rodman was one of several officers and dignitaries who witnessed the firing of the "Peacemaker," a large gun aboard the U.S.S. *Princeton* in the Potomac River near Washington, DC. The gun exploded upon firing, killing the Secretary of War and several others.

This experience prompted Rodman to investigate his own theories about gun casting. Discovering that current manufacturing processes produced structurally-weak guns, Rodman thought that casting solid guns and then boring them out caused structural stresses. Cooling guns from the outside caused the cannon to develop strata of different densities, making the tube more susceptible to bursting.

Rodman developed a method of casting the gun barrel around a hollow core or pipe, sealed at the bottom. The mold stood muzzle-up and a small pipe was lowered into the core. When a foundry worker released molten iron into the mold, water flowed into the smaller pipe. This water filled the inner core and ran off at the gun muzzle, away from the casting. Hot coals heaped around the guns exterior insured even cooling. As the iron cooled outward, each successive layer compressed down on the top of the layer under it. The result was a firm, tight casting without any dangerous cracks or air fissures. Rodman also reduced the stresses placed on the bore from gunpowder by increasing the diameter of the powder grains. This produced more uniform pressure on the shot, increasing its velocity during its passage through the bore.

After several unsuccessful attempts to convince the Army to try his process, Rodman applied for a patent in 1847. In 1849, he signed a production agreement with Charles Knapp of the Fort Pitt Foundry in Pittsburgh and continued to experiment on the process for the next several years. After a decade of experimental castings, the War Department ordered Rodman to cast a 15-inch smoothbore. Called the "Lincoln Gun," it was the largest gun produced in the U.S. and passed all trials at Fort Monroe, Virginia. The U.S. Army subsequently adopted the Rodman process.

In late 1864, the Army began replacing Fort McHenry's former Model 1842 seacoast guns with Rodmans. On June 30, 1866, five 15-inch Rodmans were mounted. In the next decade, several 8-inch and 10-inch guns were also mounted. In 1865, the Army breveted Rodman with the ranks of lieutenant general, colonel, and brigadier general for his meritorious service and placed him in command of the Rock Island, Illinois Arsenal, where he served until his death in 1871.

Rodman's new process revolutionized coastal armaments in the U.S. These smoothbore guns lost favor, however, as the superiority of rifled barrels became evident against older forts. As Rodman perfected his process, rifled artillery was being cast that made all smoothbore cannons obsolete. A pointed projectile could travel further and with greater accuracy, easily penetrating walls and thus making coastal forts "fortresses of the past." After the war, many Rodmans were converted to muzzle-loading experimental rifles by inserting 8-inch rifled liners. Fort McHenry's Rodmans were last fired on July 3, 1903, nine years before the Army deactivated the Fort in 1912 and 13 years before it became a national park.

With 14 Rodmans in its collection, the largest in the U.S., Fort McHenry NMHS faces the challenge of interpreting and preserving these mammoth guns for the public. The park presents a 30-minute program on one of the five mounted 15-inch Rodmans, which includes a sketch of Rodman's life, a review of his metallurgical achievements, and a discussion of the guns' operation and significance.

Fort McHenry has collected copies of primary and secondary archival materials on the Rodmans from the National Archives and the Rock Island Arsenal Museum and assembled them as the Historical and Archeological Research Project. To preserve the guns, every few years the park blasts the guns with walnut shells to remove old paint and applies a new layer. Because Fort McHenry lies 200 miles inland, salt corrosion is less of a problem than at other Rodman sites. Despite 120 years of exposure to pollution, this fine collection has weathered the elements.

Scott Sheads is a historian at Fort McHenry NMHS.

Anna von Lunz is a museum specialist at Fort McHenry.

The authors would like to thank Bob Healy, park ranger at Salinas Pueblo Missions NM and Don Steiner, park ranger, Fort Washington Park for their assistance.

From left foreground to right, three experimental 10-inch with 8-inch rifled sleeves (foreground), three 8-inch, and a 15-Inch Rodman fire a national salute. The Rodman guns at Fort McHenry were last fired on July 4, 1903. Note the cranes used for hoisting shells. This view is one of only four known photographs of the Rodmans being fired. Photo courtesy Ft. McHenry NMHS.

Conferences

The Information Ecosystem: Managing the Life Cycle of Information for Preservation and Access will be held March 8-12, 1998, at the National Archives in College Park, Maryland. Sponsored by the NPS Museum Management Program, the National Register of Historic Places, the Northeast Document Conservation Center, and the National Archives and Records Administration, the Conference focuses on:

- understanding who the stakeholders are in the information ecosystem from creators, donors, project managers, individuals, and groups as Subjects, to secondary users such as archival, museum, and library researchers
- comprehending the information life cycle and the value added at each stage of the life cycle
- evaluating information for potential future value
- selecting permanent and durable formats for electronic, textual (paper), and audio-visual information
- planning and designing information systems of long-term value that meet emerging national standards for systems, data content, data values, etc.
- understanding the issues involved in managing information from legal requirements, disposition strategies, and management techniques to performance improvement and problem solving
- learning how to effectively prepare information for secondary access via the World Wide Web and other outreach tools
- discovering how to search the information ecosystem

For course registration, contact the Northeast Document Conservation Center, 100 Brickstone Square, Andover, MA 01810-1494; tel: 508-470-1010; fax: 508-475-6021; email: <nedcc.org>.

—Submitted by Diane Vogt O'Connor

1998 National Aerospace Conference

As a precursor to the celebration of the centennial of powered flight in 2003, the National Aerospace Conference will occur at Wright State University in Dayton, Ohio, on October 1-3, 1998. As the Birthplace of Aviation and hometown of Wilbur and Orville Wright, Dayton is a fitting location for this conference. While the Wright brothers conducted their experiments in North Carolina, they researched, designed, and constructed all of their gliders and planes in Dayton. After the first successful flight in Kill Devil Hill, North Carolina, on December 17, 1903, the Wrights returned to Dayton to perfect their airplane.

Using the themes of the Evolution of Flight Technology, Flight and Public Policy, and Flight, Culture, and Society, the conference will identify and explore the wide variety of factors that have shaped the development of flight technology throughout the last century. A separate program titled *Our Youth/ Our Future,* will provide on-site learning experiences for students and teachers. The topics developed under the themes will be of interest to historians, industry experts, education specialists, and famous aviation/aerospace pioneers.

In addition to attending conference events, attendees will find many aviation-related sites in the Dayton region. Dayton Aviation Heritage National Historical Park includes The Wright Cycle Company building, the Huffman Prairie Flying Field, and the 1905 Wright Flyer III. Other area museums include the United States Air Force Museum, the WACO Historical Society Museum, and the Neil Armstrong Air and Space Museum. These sites and others, totaling 47, are part of the Aviation Trail, a collection of aviation-related sites that illustrate Dayton's unique place in aviation history.

For more information on the Conference, contact National Aerospace Conference, Conferences and Events, Wright State University, 3640 Colonel Glenn Highway, Dayton, OH 45435, or visit the website at <http://www.wright.edu/beyond/flight>.

—Submitted by Ann Deines

David P. Ogden

Cannon and Conversation
Preserving and Interpreting Seashore Technological Change

Gulf Islands National Seashore does not seem like a place where you would encounter great technological wonders. Yet, amid the sparkling white sands of the central Gulf coast lie the scattered remains of an army post affected by technological change. Fort Pickens, on Santa Rosa Island in the Florida panhandle, was constructed between 1829 and 1834 as part of the U.S. coastal defense system. Interpreting the technological significance of Fort Pickens has led to close cooperation between interpreters and cultural resource managers.

Cannons remained unchanged from the 15th to the 19th century. For more than 300 years, fortifications were designed in this unchanging environment. By the time of the American fortification program in the early-19th century, forts were only vulnerable to protracted army sieges. They were the perfect defense against naval enemies.

This changed during the American Civil War. By 1865, rifled cannon and ironclad warships had rendered masonry forts obsolete. In the 1880s and 1890s the U. S. replaced masonry forts with simpler reinforced concrete structures. While the structures were simplified, the weapons mounted on them were vastly more complex than the cannon of the pre-Civil War era. The weapons for these concrete forts, called Endicott batteries, represented a great technological leap. Weighing as much as 58 tons, these guns could fire projectiles that were twice as heavy and could go three times farther than the largest cannon in the pre-Civil War arsenal. Large carriages raised the guns over walls for firing and lowered them for reloading. The era of seacoast defense closed at the end of World War II. The development of aircraft and nuclear weapons rendered large coastal artillery obsolete. Most artillery bases were closed in the late 1940s, with the weapons and structures sold for scrap.

When Gulf Islands National Seashore was established 30 years later, America's seacoast forts had faded into obscurity. With a few notable exceptions, little was known of what had once been the core of our coastal defense. Efficient salvaging operations removed most of the material that made the sites understandable. Often, later fortifications built within original structures added to the confusion. These conditions presented formidable challenges for both interpretation and resource management.

For interpreters, little information was available on seacoast forts overall, and Fort Pickens in particular. Resource managers lacked the information needed to set preservation priorities and combat the corrosive effects of the marine environment. NPS historians addressed this problem by combing the National Archives to compile historic structure reports and a map file. These documents provided information for both interpretive and resource management needs. Early plans to restore Fort Pickens were abandoned when the park discovered that most of the damage was due to historic activities. Investigations also revealed that the Endicott battery in the parade of the old fort was a historic structure in its own right. The structure was stabilized instead, with restoration efforts directed to nearby Fort Barrancas. Explaining this resource management decision to visitors is an excellent way to drive home the idea of changing technologies.

Massive searchlight towers like this one at Fort Pickens in 1918 were important parts of the American coastal defense system. Visitors helped park staff understand the operation of these towers. Photo courtesy Gulf Islands National Seashore.

One interpretive solution added to the resource management challenges. Nothing makes a fort more interesting than a gun to go with it. The park collection contains several cast iron cannon, including a six-inch gun on a rare disappearing carriage. Sea air regularly assaults these weapons. For the most part, preserving them requires little more than maintaining a good coat of paint. It is seldom that simple, however.

The six-inch gun was mounted in firing position and held in place by a massive counterweight in a well beneath the mount, hidden from view. Sometime after the installation in 1976, water began seeping into the well. The corrosion went undetected for many years and was extensive when discovered. The conservation of this piece took three years and was done under contract by the Florida Research and Conservation Laboratory.

The 20,000-pound barrel was removed first, followed by 47,000 pounds of carriage and 10 tons of lead counterweight. Barrel and carriage were shipped to Tallahassee, where they were placed in an electrolysis tank. Following electrolysis, the components were sandblasted and then painted with rust inhibitor and industrial coatings. The gun and carriage were then returned to Battery Cooper and remounted, this time in the lowered position.

However, the guns alone could not tell the park story. The public is most interested in stories about people. We had plenty of stories from the Civil War at Fort Pickens, but the real story was much larger than that. The coast artillery had been at Fort Pickens less than 50 years ago. That means that some people who had been there might still be living, and they would have stories.

One day an interpreter encountered an elderly man in the fort who said he had been there during World War II. The interpreter asked him if he would mind giving an interview, and an oral history project was born. Over the next several years, park interpreters interviewed dozens of veterans. The veterans donated hundreds of photographs to the park collection, providing material for several exhibits, an illustrated talk, and a booklet published by our cooperating association. The oral histories put a human face to defense technology and solved a critical problem. Few studies of coastal artillery were written in the 20th century. As a result, the veterans were the only sources for some information.

My favorite example involved the searchlight operations. When one man told of his duty with the searchlight battery, park staff asked where they were. He responded that we had been driving past them every time we went to work. The lights were on retractable towers, so they could be hidden from prying eyes during the day and raised at night. To accomplish this required a steel tower and three blocks of concrete. One block was the base of the tower; one was for the light to rest upon in lowered position; the third block was the counterweight. The steel had been scrapped, but the blocks remained.

We had no idea what the mysterious trio of concrete blocks was—and likely would not have known for some time to come except for that one conversation. The man described the operations, including the night they accidently reversed the light and illuminated the navy base in the harbor instead of the Gulf of Mexico. He also had photographs, which he graciously lent for copying.

The cannon collection provides both the hook and tangible evidence of the evolution of the weaponry. The oral histories preserve what had been an intangible resource and add the human element to the story. It is this blending of interpretation and resource management that makes it possible to preserve and relate the unique tale of a technology that ended in our time.

David P. Ogden is an interpretive specialist at Gulf Islands National Seashore, Florida District.

The Western Reserve Historical Society is planning an expansion that will include a new museum of transportation and industry to open in 2001 at Cleveland's downtown lake front. This new museum will encompass about 165,000 square feet, including a large exhibition hall, special effects theater, learning areas, and public spaces. The core collection for this new museum is the Society's Crawford Auto and Aviation Museum, though the Society expects to acquire several large-scale artifacts, ranging from the World War II era Corsair fighter-bomber which won the 1946 Cleveland Air Races to a working 1937 Cleveland diner restaurant.

Plans for the museum are just being formulated, but senior staff on the planning team are committed to building a new kind of museum complex that moves dramatically away from traditional approaches to display and interpretation. Selection of external design firms, media producers, and fabrication companies began in the fall of 1997.

A specific site for the museum is still being worked out with the City of Cleveland, but it will be close to the Rock & Roll Hall of Fame and Burke Lakefront Airport, the city's active downtown airport. For information contact Ed Pershey, Task Force Director, Crawford Museum of Transportation and Industry, Western Reserve Historical Society, 10825 East Boulevard, Cleveland, OH, 44106: 216-721-5722, ext 228 or <pershey@en.com>.

William Gray Johnson, Nancy G. Goldenberg, Susan R. Edwards

The Japanese Village at the Nevada Test Site
A Relic of Nuclear War

Cold War material culture studies have focused on military developments representing 20th-century weaponry. This article describes a unique group of structures with an entirely different purpose, the Japanese Village on the Nevada Test Site. Located on the grounds of the main U.S. nuclear weapons testing facility, an international program constructed the village to study radiation effects and, ultimately, to aid the survivors of Hiroshima and Nagasaki. Resembling an "eastern version of a western movie set," it stands as a memorial to the only combat use of nuclear weapons.[1]

The Japanese Village stands on a gently sloping rise in an area known as Yucca Flat. The structures are on a stabilization area delineated from the surrounding desert by slight berms on three sides and an excavated revetment on the fourth. Two skeletal frame structures and a Hollywood-set style wall elevation are all that remain. A third structure and two additional elevations have collapsed. Constructed primarily of lumber with plywood floors, their original cement-asbestos board cladding is long gone. Each rests on wooden skids, intended to permit portability.

The rectangular structures simulate typical Japanese dwellings. The larger of the two originally had two stories, but its second story has since collapsed. The other has one story with a gable roof. Original construction drawings identify interior spaces as lobby, living room, kitchen, closet, and a room called a *toko*, a raised alcove for displaying hanging scrolls or flower arrangements. These room divisions roughly correspond to modules of standard tatami mats, the preferred flooring material. Nearby features include a concrete foundation that originally held a skeletal steel tower (subsequently moved to another part of the Test Site). A second 200' x 200' stabilization area, empty of structures, lies 750' to the east.

Recent photo of Japanese Village courtesy U.S. Dept. of Energy.

On July 16, 1945, the U. S. detonated the first atomic weapon, Trinity, near Alamogordo, New Mexico. Its successful detonation led to immediate plans for combat use; and in less than three weeks, a nuclear weapon was exploded over Hiroshima, Japan. Three days later, a second nuclear weapon fell on Nagasaki. On August 15, 1945, Japan surrendered, ending World War II. The death toll has been estimated at more than 200,000 between the two cities. Additional deaths within five years added another 130,000, with many more victims suffering long-term radiation effects.[2]

Japanese survey teams immediately began studying the effects of the atomic weapons on their urban populations. By the end of August, relief measures were underway as were efforts to investigate all aspects of the bombs effects. In 1947, the U.S. established the Atomic Bomb Casualty Commission (ABCC), a permanent medical survey-research organization with offices in Hiroshima and Nagasaki.[3] The ABCC continues its work as the Radiation Effects Research Foundation, a private nonprofit Japanese foundation supported jointly by the U.S. and Japan. It documents and analyzes the effects of nuclear radiation on the bomb survivors and their offspring.

Cooperation between the medical sections of these groups was excellent, but the groups working on physical damage did not try to reconcile differences between their measurements and calculations of the height and location of bomb bursts (i.e., the hypocenters). Such differences resulted in considerable problems for determining the radiation-dose calculations (dosimetry) of each survivor. In particular, the shielding effects of buildings were largely unknown, although records showed that many survivors were in their houses when the bombs fell. Thus, the ABCC determined that a study of the survivors who were in their

Historic photo of Japanese Village courtesy U.S. Dept. of Energy.

houses and the shielding characteristics of these structures could yield substantial information on survivor dosimetry.[4]

The survey group's recommendations led to the establishment of a program in 1956 known as Ichiban (the Japanese word for "number 1" or "best"). The program documented survivor location at the instant the bombs exploded, established air-dose curves, and analyzed shielding factors for houses. Ichiban included several nuclear weapon tests, many laboratory experiments, physical surveys in Japan, calculation studies, and a series of experiments known as Operation BREN (Bare Reactor Experiment, Nevada). BREN focused on determining shielding characteristics of Japanese-style houses and resulted in what we now call Japanese Village.

Historic photo of BREN tower under construction courtesy U.S. Dept. of Energy.

ABCC studies were used to develop these "analog" houses. Plans of rooms drawn during interviews with bomb victims and measurements of structures at varying distances from the bomb's hypocenters contributed to their design. Room sizes were based upon the dimensions of tatami mats, as was typical with Japanese dwellings. Given this uniformity, researchers found that three types represented 90% of all Japanese residential structures; a large two-story, a middle-sized single-story, and a small one-story. Studies comparing radiation-attenuation characteristics of Japanese building materials with U.S. products identified a cement-asbestos board known as "transite" as a suitable substitute for the traditional Japanese mud and oyster-shell stucco.

The Operation BREN concept developed from a need for information on neutron and gamma radiation fields and their ability to penetrate buildings. An open reactor was placed on a hoist car mounted on a tower. Three analog Japanese houses and three wall elevations were placed 2,250' from the base of the tower. Each house contained sophisticated dosimetry devices placed strategically throughout the rooms. These measured radiation rates and allowed researchers to calculate the dosimetry of bomb survivors. The BREN experiments were conducted during the spring and early summer of 1962. Upon completion, the tower was moved and used for other experiments; but the wooden structures and other features remain in their original location.

The tragic loss of life and long-term health effects suffered by the survivors of the Hiroshima and Nagasaki bombings are perhaps the main reason that an all-out nuclear exchange never occurred during the Cold War. Japanese Village stands as testament to profound tragedy and, conversely, international cooperation for humanitarian purposes. Data obtained from the BREN studies helped the Japanese survivors of Hiroshima and Nagasaki by providing information to their medical practitioners. This data was also used to determine health effects from radiation and, presumably, helped the U.S. to establish safety levels for radiation workers. Given its significance, Japanese Village was designated a National Register-eligible property. Its fragile nature led to Historic American Building Survey (HABS) documentation. Stabilization efforts were enacted, and the site still stands. However, security restrictions have limited access.

Notes

1. Commentary by John Rhys-Davies in *Return to Ground Zero*, New Dominion Pictures, Learning Channel Archeology Series.
2. R. Rhodes, *The Making of the Atomic Bomb*, New York, 1986.
3. J.A. Auxier, *Ichiban*, CEX-64.3 Civil Effects Study, 1964.
4. Ibid.

William Gray Johnson is an Associate Research Professor and Susan R. Edwards is a Staff Archeologist at the Desert Research Institute in Las Vegas, Nevada. Nancy G. Goldenberg is an architect and architectural historian at Carey and Company, Inc. in San Francisco, California. The authors thank the U.S. Department of Energy for funding the research that made this article possible.

Leah S. Glaser

Nice Towers, eh?

Evaluating a Transmission Line in Arizona

As tourists meandered down the Apache Trail, a historic road with beautiful views of Central Arizona's desert mountains, power engineer Bill Phillips, photographer James Eastwood, and I carefully searched for the perfect tower to photograph for a HAER report on the 115,000 volt (115kV) Eastern Mining Area (EMA) transmission line. As the visitors stopped and looked past the power lines to enjoy the view, Bill turned to them and playfully remarked, "Nice towers, eh?"

This photograph, taken in March 1996 by James Eastwood, shows a Salt River Project transmission tower and line crossing the Superstition Mountains in Arizona. Remote objects like these are significant cultural resources, representing the development of 20th-century electric power technology.

In the spring of 1996, I completed a Historic American Engineering Record (HAER) report on a long-distance transmission line in Arizona. I found Bill's lighthearted comment relevant to cultural resource management, material culture, and technological history. This project taught me that technological structures are more than a blemish on the landscape. They are valuable cultural resources with a crucial story about the impact of long-distance power.[1]

The HAER report stemmed from a planned programmatic agreement between the Salt River Project (SRP) and the U. S. Forest Service (USFS). Recently, safety questions were raised about the towers, built under the supervision of the U. S. Reclamation Service in 1907. Engineers determined that they would have to dismantle some of them. The structures, like many SRP facilities, are in the Tonto National Forest. Before removing the towers, however, SRP must comply with federal regulations requiring a HAER report for significant historical resources. The SRP/USFS agreement will involve a standardized procedure for streamlining the Section 106 compliance process. Rather than address resources on a case-by-case basis, this agreement will allow the review of several SRP facilities on federal land through a single, standardized process. The following recounts the research and sources I used for my report.

When first assigned this report, I had no idea where to begin. What did the towers look like? Where exactly were they? To compound matters, I knew nothing about electricity beyond a few recollections from my eighth-grade science class. What did frequency and voltage mean? What is loading? I found ample secondary sources on the history of electricity and electrical transmission, but no studies on transmission lines or towers. As I searched through the list of HAER reports in the Library of Congress, the lack of independent reports about power lines and the role of long-distance transmission dismayed me. Luckily, I had access to SRPs water and electricity library and archives. I joined the History of Technology listserve to solicit more references.[2] However, overwhelmed by conflicting information and the sheer number and variety of towers in the desert, I found it necessary to combine company records and historic photographs with several site visits.

I drafted Bill Phillips from the power department for aid. Bill knew about the variety of towers, where they were, how old they might be, and if they had been modified. I soon discovered that other towers dated from the 1920s. Thus, one long-distance transmission loop included a variety of tower designs reflecting the rapid advances in this technology over the years. The oldest, erected in 1909, were adapted from pyramidal shaped windmill towers. Yet in less than 20 years, engineers altered the tops and added new hanging insulators to address lightening problems and to deter large desert hawks who used transmission towers for perches. Towers built in the 1920s were rectangular and were varied in design according to their function and location on the line as intermediate, angle, or transposition towers.

When evaluating this transmission line, I had a problem addressing it as a single cultural resource. Not only is it made up of hundreds of independent towers, it is miles long, has often been rerouted, and has segments constructed over a period of 20 years. The 1996 National

Conference on Public History (NCPH) in Seattle conducted a valuable session on interpreting linear resources. Bureau of Reclamation Historian Christine Pfaff's discussions about boundaries were especially valuable to my research decisions. It made sense to deal with the line in segments and to discuss only representative towers that embody the integrity, character, and feeling of the line.

Once I learned how to evaluate this multi-structure resource, my research focused on its origin. The Internet proved valuable in finding sources. Annual U. S. Reclamation Service reports recorded that the U.S. Wind Engine and Pump Company in Batavia, Illinois, manufactured the towers. When I entered "Batavia" into the Yahoo! search engine for the World Wide Web, the town's webpage greeted me with the boast, "Batavia, Illinois, Windmill Capital of the World." Between the records from their historical society and a reference from a local windmill expert, I found ample information on the windmill manufacturers, including the Windmill Manufacturers Trade Literature Collection in Canyon, Texas. Old engineering journals in Arizona State University's science library (i.e., Electrical World) helped explain this adaptation of technological structures.[3] One afternoon, I even discovered a 1920s electrical supply catalog from Westinghouse in a used book store. This treasure details the forms and functions of each tower element and transmission wire, enabling me to match the exact insulator to those designated on the mechanical drawings in company archives.

David Nye's *Electrifying America* provided background on the effects of hydroelectric power on Salt River Valley farms and in mining towns. The Salt River Valley was one of the earliest and largest remote areas in the country to provide electricity to farmers before the Rural Electrification Act of 1936. Most mining operations were too far from hydroelectric sites to supply energy before advances in long-distance transmission. The mines had many uses for electricity—providing power for safe illumination, driving hoists, air compressors, ventilation equipment, mills, and tramming machinery. Small and powerful locomotives replaced mules for transporting minerals and equipment.[4]

The EMA transmission line stretches across the Superstition, Apache, and Pinal Mountains east of metropolitan Phoenix. It first conveyed power generated by Roosevelt Dam—the Bureau of Reclamations first large-scale work—to Phoenix and the rest of the Salt River Valley. The sale of power to local mines provided the revenue to expand the Salt River Projects (SRP) hydroelectric system and furnish valley farmers with electricity. The energy helped produce two of Arizona's most valuable economic resources, cotton and copper, during the early-20th century. Extant 115 kV towers serve as a testament to the federal government's role in bringing electric power to remote areas. They illustrate the rapid development in long distance, high voltage electrical transmission technology and tower design in response to society's economic needs.

Human use of natural energy resources, such as water, have interested western historians for some time. Thomas P. Hughes, David Nye, Mark Rose, and Ronald Tobey have written exhaustive accounts of electrification; but few have described the industrial and social impact of electrical technology outside urban areas. Transmission towers are as important as buildings, dams, or bridges. Long-distance transmission lines may intrude upon our natural landscape, but they are important cultural resources.

Notes

1. For a review of the impact of culture on tower design, see Eugene Levy, "The Aesthetics of Power: High-Voltage Transmission Systems and the American Landscape," *Technology and Culture* 37 (April 1996): 575-607.
2. To join the History of Technology listserve, send an email message to <LISTSERV@SIVM.SI.EDU>, no subject, with the message "SUBSCRIBE HTECH-L (YOUR NAME)." The list is home to informed historians, archivists, scientists, and engineers. Also see the Society for the History of Technology webpage for research links <www.umich.edu/~shotac/SHOT/index.html>.
3. The Hagley Museum and Library in Wilmington, Delaware has an extensive collection of trade catalogs. David Nye, *Electrifying America: Social Meanings of a New Technology 1880-1940*, Cambridge, MA, 1990, 204; Frederic Quivik, "Early Steel Transmission Towers and Energy for Montana's Copper Industry," *Montana: The Magazine of Western History* 38 (Fall 1988): 67-69.
4. Thomas P. Hughes, *Networks of Power: Electrification in Western Society 1880-1930*, Baltimore, MD, 1983; David Nye, *Electrifying America;* Mark Rose, *Cities of Light and Heat: Domesticating Gas and Electricity in Urban America*, University Park, PA, 1995; Ronald C. Tobey, *Technology as Freedom: The New Deal and the Electrical Modernization of the American Home*, Berkeley, CA, 1996.

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Billy Joe Peyton

To Make the Crooked Ways Straight and the Rough Ways Smooth

Documenting 19th-century Transportation Systems

With increasing public awareness of transportation's significance in American history, there is a growing interest in preserving important aspects of this heritage. Along with pioneering technologies, we are now studying more recent transportation systems associated with the automobile, aircraft, and space travel. As the millennium approaches, the information age will continue to take us beyond the bounds of distance and time. Preserving this heritage is important in the face of such rapid technological change.

Since 1989, the Institute for the History of Technology and Industrial Archaeology (IHTIA) at West Virginia University has researched America's transportation heritage, including bridges, aqueducts, and the engineers who built them. IHTIA's industrial archeology program documents, interprets, and—in select cases—preserves sites, structures, and artifacts. Theme studies of significant transportation systems are central to IHTIA's work in the history of technology.

Transportation systems have greatly influenced American economic development. Political leaders recognized the importance of internal improvements in the early-19th century. They touted the development of an integrated network of turnpikes and canals "to make the crooked ways straight, and the rough ways smooth," connecting the eastern seaboard with the "western waters" of the Mississippi basin. Given the limited capacity of turnpikes, shippers regarded canals as more efficient for moving large amounts of freight. Except for the Erie Canal and a few other waterways, however, most canals were unprofitable. Consequently, railroads became the preferred transportation alternative by the 1830s. The first trans-Appalachian railroads promised to open the nation's interior and make its abundant mineral and timber resources accessible to the world.

Time and the ravages of flooding have wrecked the upstream parapet of the C&O Canal's Conococheague Creek Aqueduct, built in 1834 at Williamsport, Maryland. Photo by John Nicely, courtesy IHTIA.

Of the three transportation routes built through the Potomac River Valley in the first half of the 19th century, none is more important than the National Road. This thoroughfare originated with a privately-built route from Baltimore to Cumberland, Maryland, where it connected with the publicly-funded Cumberland Road (built 1811-21), and then wound its way across the Appalachian Mountains to Wheeling, West Virginia. The National Road opened the Upper Ohio Valley to settlement and created important trade ties between previously disconnected regions of the country. It was the gateway to the West before the railroad reached the Ohio River. By 1860, it had become a local passage that eventually fell into disrepair until its rebirth in the early-20th century. Today U.S. Route 40, the successor of the National Road, is a popular heritage tourism route.

Work on the second pioneering improvement in the Potomac Valley began on July 4, 1828, when the Chesapeake and Ohio Canal Company broke ground on a water route from tidewater to the Ohio River. Built with public and private funds, financial problems plagued the C&O Canal from the beginning. Although it eventually opened in 1850 from Georgetown to Cumberland, the canal never reached the Ohio River. Boats plied the C&O Canal for 75 years, until traffic ceased in 1923. In 1938, the federal government turned the abandoned canal into the Chesapeake and Ohio Canal National Historical Park.

Construction began on the third, and most revolutionary, of the Potomac Valley transportation systems on the same day that the C&O Canal broke ground. In 1828, the citizens of Baltimore decided to build a rail line across the Appalachians. It took 25 years for the privately-built Baltimore and Ohio Railroad to reach the Ohio River. The driving of the last spike in late 1852 marked the completion of the nearly 400-mile-long B&O, America's first trunk line. Engineers regarded this line as the most daring feat of mountain railroad construction ever undertaken. The B&O operated for over a century before it merged with other railroads in the late 1960s to become CSX, one of the nation's largest carriers.

The National Road, C&O Canal, and B&O Railroad became training grounds for civil engineers who dreamed of crossing the mountain wilderness described by Benjamin Latrobe Jr. as a land of "singularly perplexed topography." Each presented a unique series of civil engineering challenges and responses that were both inventive and, like the mountains themselves, grand. Moreover, they represent three pioneering transportation systems built during America's first great wave of internal improvements. An abundance of surviving physical evidence provides an opportunity to preserve and interpret these examples of 19th-century transportation engineering through the techniques of industrial archeology.

IHTIA and the Historic American Engineering Record (HAER) have teamed up to study and document engineering works associated with the National Road, C&O Canal, and B&O Railroad. The National Road study includes the Little Crossings Bridge, the nation's largest single-span masonry arch when it was constructed over the Little Youghiogheny River in Maryland in 1815, and a triple-arch span Great Crossings Bridge built in 1816 over the Youghiogheny River in Pennsylvania. IHTIA is also preparing a monograph on the construction of the National Road east of the Ohio River. Future work may entail recording bridges west of the Ohio River in Ohio, Indiana, and Illinois.

This 1931 photo of B&O bridges at Harpers Ferry (1868 iron Bollman truss partially hidden at right, 1894 steel Pratt truss at center, 1931 steel deck-girder at left) depicts three distinct eras in U.S. bridge building technology. Photo courtesy NPS.

The C&O Canal has been the subject of many independent monographs, articles, and NPS-sponsored studies. Unfortunately, this research has largely ignored the canal's engineering significance. To fill this void, IHTIA is working on a project with HAER and the C&O Canal National Historical Park that places the canal's engineered structures within their proper historical context. Perhaps the most important of these structures are the 11 masonry aqueducts. These "works of art," as the company engineers called them, are among the finest surviving 19th-century aqueducts in the U.S. Conococheague Creek Aqueduct, built in 1834 at Williamsport, Maryland, was selected as the pilot project by a joint HAER-IHTIA team. Instead of employing traditional hand-rendered techniques, a HAER architect used photogrammetry and completed a set of measured drawings using AutoCAD. IHTIA staff members augmented the drawings with a narrative report on the construction of the aqueduct, along with photographs of the structure just after the devastating floods of 1996.

Besides its work on the C&O Canal and National Road, IHTIA is also involved in an ongoing effort to research the remains of the B&O Railroad between Harpers Ferry and Wheeling, West Virginia. This line, requiring 15 tunnels and some 170 bridges to complete, featured the most mountainous terrain ever traversed by a railroad at the time. IHTIA's goal is to augment the B&O documentation done by HAER in the early 1970s by focusing on tunnels and other previously undocumented engineering works and to produce a monograph on B&O bridges titled *Bridges Over Time: A Technological Context for the B&O Main Stem at Harpers Ferry.*

By virtue of its longstanding partnership with the NPS, the IHTIA will continue to document and preserve our transportation heritage in the Potomac Valley and elsewhere.

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For more information about IHTIA and its work, contact Billy Joe Peyton at 304-293-3589 or <bpeyton@wvu.edu>.

Randi Sue Smith

Collecting Slime
Cultural Resources in the Federal Fish Hatchery System

Although fish culture has had a major economic and cultural impact since the 1850s, it has received little attention. Fish, or aquaculture, includes propagation of fish and other aquatic species for food, recreation, endangered species restoration, and dam mitigation. Commercial concerns and governments at the federal, state, and local levels operate hatcheries; but the fish culture story is closely related to the history of the U.S. Fish and Wildlife Service (FWS).

Many people do not relate to fish because they lack fur and soft brown eyes and have a slimy appearance, but fish culture is important. Recreational fishing contributes approximately $69 billion to the economy annually and employs nearly one million people. Taxes on fishing equipment support scientific research, fish restoration, and habitat improvement. Hatcheries stock many lakes and streams with fish, and farmed fish is readily available in grocery stores. About 25% of the shrimp consumed in the world is farm-raised. Some species currently cultivated include trout, catfish, carp, bass, and porgies.

The destruction of the forests in the early-19th century resulted in erosion, silting, and flooding. These changes adversely affected fish resources, fostering the development of fish culture in the U.S. Fish culture is part science, part technology, and part art. In the early days, art was foremost because no one knew how to spawn, hatch, and grow fish. Trial-and-error methods eventually gave way to scientific studies of nutrition, genetics, disease, transportation, and stocking.

The first attempts at increasing fish populations involved transferring eggs, fry, or adult fish into depleted waters. By 1810, experimenters had introduced northern pike to Maine and New Hampshire and, by 1832, carp to California. At the end of 1852, two Cleveland, Ohio, doctors, Theodatus Garlick and H.A. Ackley, performed the first successful artificial fertilization of fish eggs in the U.S.

Massachusetts created the first of many state fish commissions in 1856 to report on fishery resources. The commission, discovering unrestricted fishing and depleted stocks, advocated private fish propagation. Over the next several years 10 other states established commissions. In 1870, the nation's oldest operating conservation organization, the American Fish Culturists Association (AFCA) held its first meeting. The AFCA (later the American Fisheries Society) and the state commissions pressured Congress to establish the U.S. Commission of Fish and Fisheries in 1871, the first federal agency devoted to natural resource conservation. The commission's primary duty was to determine the extent of any diminution in the number of food fishes on the coast and in lakes and to report on remedial measures.

The federal fish hatchery system began in 1872 when Livingston Stone established a Pacific salmon hatchery on the McCloud River in northern California to restock the depleted Atlantic coast. Although they were miles from the nearest railroad and worked in 105 degree temperatures, Stone and his assistants constructed the facility in 15 days. In the first year, they collected 50,000 eggs. Out of 30,000 shipped, about 7,000 arrived safely; and fewer than 300 grew to fingerling size. By the third season, the hatchery collected 5.7 million eggs.

This 1905 photograph of the Spearfish Fish Hatchery, now the D.C. Booth Historic National Fish Hatchery, shows the hatchery buildings on the left and the superintendent's residence on the right. The ice house overlooks these buildings on the ridge in the center of the photograph. Photo courtesy D.C. Booth Historic National Fish Hatchery.

More than 280 federal hatcheries, research stations, fish health laboratories, and technology centers have been established since 1872. The National Marine Fisheries Service still operates Woods Hole in Massachusetts, the first summer research station. The Fish Commission launched the *Albatross*, a state of the art

Interior of the Spearfish Hatchery in 1899. Photo courtesy D.C. Booth Historic National Fish Hatchery.

marine research vessel, in 1882. Sixty-five hatcheries, five technology centers, and other research facilities exist today. Of the 65 hatcheries, more than 40 are over 50 years old. Many retain old buildings and structures, including water supplies, ponds and raceways, and employee housing.

The National Register of Historic Places lists more than 20 fish hatcheries. The D.C. Booth Historic National Fish Hatchery, formerly the Spearfish Station, is listed as a historic district. Spearfish, in the Northern Black Hills of South Dakota, became a hatchery in the 1890s, in part because of its water supply and access to railroads. The first structures, including the hatchery building and raceways, opened in 1899. Extant structures include the 1899 hatchery building, the 1905 superintendent's residence, WPA-constructed stone garages, ponds, and rock walls. The hatchery stocked the lakes of the Black Hills with non-native trout. If the hatchery had not stocked the lakes early this century, tourists might not enjoy the area's popular trout fishing.

Five partners operate the site. FWS employees administer the site and manage the museum collection. The Booth Society, a cooperating association, runs the gift shop, sells fish food, hosts special events, coordinates volunteers, and maintains the superintendent's residence as a house museum. Since the 1950s, the nearby McNenny State Fish Hatchery, part of the South Dakota Game, Fish and Parks Department, has raised fish at Booth, a mutually beneficial arrangement. McNenny gets much-needed space; and visitors learn about fish production and feed the stock food purchased from the Booth Society. This reduces McNenny's costs and contributes to the preservation of the hatchery. The city of Spearfish provides six campground sites for hatchery volunteers and donates proceeds of a hospitality tax to the Booth Society. The fifth partner is the Fish Culture Section of the American Fisheries Society, which houses its Hall of Fame in the replica ice house and contributes funding.

The hatchery has always been open to the public. Approximately 175,000 people (including school groups) visit the site each year, with about 20,000 coming during the summer. Only the grounds are open during the winter, and local residents use them year-round. In the 1990s, Booth added underwater fish viewing windows, accessible sidewalks, and a new 10,000-square foot building for the preservation and storage of fish cultural resources. Facilities include processing space, a conservation lab, and collection storage areas.

The FWS fish culture collection dates from the 1870s. The collection traveled from site to site before finding a permanent home at Spearfish in 1979. The 1899 hatchery building, restored in 1979, houses a fish culture museum. The D.C. Booth collection includes nets, hatching troughs and trays, shipping containers, picking tongs, glass hatching jars, laboratory equipment, and a variety of other objects. One of the latest additions is a 1963 Studebaker dump truck, with original paint and only 27,000 miles, donated by the Alchesay-Williams Creek National Fish Hatchery in Arizona. The collection has grown in part because of federal budget cuts and program changes that reduced the number of hatcheries. As hatcheries are closed or turned over to states, the Booth staff works to ensure the preservation of potential museum objects. Caring for cultural resources is a new responsibility for the FWS. While most hatcheries have only a few museum quality items and the FWS does not require transfer to Booth, hatchery staffs are eager to find a safe home for their historic objects.

The cultural resources of fish culture exist on a larger scale than we realize. The challenge lies in locating and preserving them before they are lost. Increasing awareness within the FWS of these important materials is vital to preserving this heritage.

Randi Sue Smith is museum curator at D.C. Booth Historic National Fish Hatchery, Spearfish, South Dakota.

Michele Lyons

Interpretive Challenges in a Medical History Museum

The Stetten Museum's First 10 Years

In 1987, the National Institutes of Health (NIH) established the DeWitt Stetten, Jr., Museum of Medical Research to preserve and interpret 20th-century biomedical technology. The vision behind the museum belonged to Hans Stetten, the senior science advisor to the NIH director, who lamented the loss of so much medical history to the government's surplus dump. In its first 10 years, the Stetten Museum faced the institutional challenges common to museums created by larger organizations. Yet unique to the Stetten Museum are the interpretive problems posed by a collection often viewed by the public as intimidating devices used by scientists who speak an unintelligible language.

The Stetten Museum mounts exhibits in the main-floor hallways of the Clinical Center, the research hospital on the NIH campus in Bethesda, Maryland. The population of this working hospital includes scientists, hospital staff, patients and their families, and visiting dignitaries. Because of this mixed audience, we strive to make our exhibits simple, but with enough technical detail to challenge scientists, physicians, nurses, and technicians.

The Lazarow Micrometer Gasometer, from the collection of the Stetten Museum, extracted components of minute blood samples in the form of gas. Photo courtesy Stetten Museum.

The biggest hurdle we face in interpretation is our collection itself. There are very few "sexy" items in the collection. Most of our objects are instruments with little visual appeal. They are exciting not because of their beauty or provenance, but because of their impact on our health. Objects from the collection like spectrometers, centrifuges, and mercury purifiers are unfamiliar to most museum visitors. Even many of the more familiar objects need explanation: an early heart/lung machine, slide rules, microscopes, balances, an early CRAY supercomputer, and a positron emission tomography (PET) scanner. Thus, we must "speak" for our objects, informing the visitors why they are worth attention. Unlike a painting, which conveys a "thousand words," our objects need well-written labels to convey the excitement of medical discovery that they represent.

Health and medicine are relevant to everyone. Cancer, child development, mental health, aging, infectious diseases, genetic diseases, dental and eye diseases, and the mapping of the human genome are only some of the research conducted at NIH. Discoveries made at NIH, like the breaking of the genetic code, will influence our lives. Our challenge is to help the public appreciate the significance of the medical knowledge and practical applications generated at NIH.

The Stetten Museum tries to answer this question with exhibit development teams comprising the curator, exhibit designer, and scientific experts—often the actual people who used the objects to be exhibited. The curator's role on the development team is different from what it is in a more general museum because the curator cannot be a subject expert on every medical topic. Instead, the curator serves as the expert on how to create meaning for museum visitors. The team method impacts exhibit interpretation, particularly in the subject matter presented and the language used to present it, because the curator and the scientific experts must compromise their own voices in the exhibit. This process involves tension between scientists who seek accuracy and curators who strive for comprehensibility.

The difference between how scientists and curators interpret medical history is clearly shown by the language they use. Scientists easily write articles explaining their work to colleagues. Sometimes these explanations are so technical that only scientists in the same field can understand them. The curator, on the other hand, wanting the average tenth-grader to understand the exhibit, must do two things. First, the curator diplomatically limits the length of the text. Often the exhibit team is a great help in this, with the designer and other scientists pointing out space and attention limitations. Scientists often do not realize that the visitor may not need or want to know every step in an investigation. Second, the curator must make sure the words are understandable. For example, which do you use to describe a disease-causing agent: "microbe" or "germ"? The scientist wanted "microbe" for accuracy; the curator chose "germ" for comprehensibility. In the end, the meaning of the text was changed and cited "germ theory." When Dr. Marshall Nirenberg, the Nobel Prize winner who broke the genetic code, was told that the word "oligoneucleotide" should not be used in a subtitle because people wouldn't know how to pronounce it, much less what it meant, he innocently asked, "They wouldn't?" People who have devoted their lives to science often forget the rest of the world does not share their technical knowledge.

One key question that arises within almost every new exhibit team is "What is history?" Each group comes at the question with different attitudes: the museum staff are historians, but many of the scientists admit to hating history in school because it was "all dates." They liked something "more practical." This position, of course, rankles historians—what could be more practical than knowing how the present came out of the past? So we pose questions to the scientists: is something historical merely because it is old? If so, what is the cut-off date? How should we think about current endeavors such as the Human Genome Project to map our genes? If we create an exhibit based on recent history and current events, does that make it a public information exhibit or an academic historical exhibit, or a little of both? Does it matter?

This Serval Angle Centrifuge, now part of the Stetten Museum Collection, was a handy desk top model used for small samples.Photo courtesy Stetten Museum.

Usually the scientists and historians reach a consensus. The scientists realize that importance, not age, makes something historically valuable. They begin to see that history is not a story with a beginning, middle, and end, but an ongoing process. The line between history, current events, and future possibilities dissolves. Both scientists and museum staff usually agree that in our medical history museum, an exhibit without some historical context is a public information exhibit bound by today's understanding and outdated with the publication of new research. Nevertheless, we also realize that difficult scientific ideas often take much explaining. We have to make the exhibit as clear and simple as possible so that our general audience will understand the importance of the scientists' work.

As in other museums, our exhibits sometimes require a delicacy of interpretation. For example, our recent exhibit "Revolution in Progress: Human Genetics and Medical Research" describes some ethical issues raised by genetic research, particularly genetic testing, job and insurance discrimination, and genetic engineering of babies. The most difficult topic was pre-natal genetic testing because of one possible outcome of such testing: abortion. Abortion is perhaps the most highly politicized medical issue today. The exhibit team negotiated every word of this text, mindful of three caveats: we did not have security to deal with protesters; the exhibit would be seen by school children whose parents might not want them exposed to these issues; and as scientists and federal employees, the team members did not want to give the appearance of endorsing any particular moral decision. Instead, we wanted to stimulate the visitor's own thinking about the consequences of genetic research. With that in mind, we treated each issue in the ethics segment by outlining a situation and posing questions for the visitor to answer. For example, in the question about pre-natal testing of a fetus with a possible genetic disease, the word "abortion" was never mentioned.

In the past 10 years, the DeWitt Stetten, Jr., Museum of Medical Research has progressed from securing resources to refining its interpretation of NIH objects. During the next several years, NIH will construct a new Clinical Center with dedicated exhibit space in the new building. We look forward to the future with its opportunities for interpreting 20th-century biomedical research.

Michele Lyons is curator at DeWitt Stetten Jr. Museum of Medical Research.

Web site: <http://nih.gov/ed/museum>

Curtis McKay White

Mystery of the Notched Bar at Saugus Iron Works

Saugus Iron Works National Historic Site is the birthplace of the U.S. iron industry. Called "the forerunner of America's industrial giants," the Works was a center of invention and innovation, serving as a training ground for colonial iron workers and influencing the development of other industries. The site, a reconstruction based on the archeological work of Roland W. Robbins between 1948 and 1953, includes a blast furnace, forge, and slitting mill with seven functioning water wheels. The site also has an archeological collection containing tools, hardware, and scrap iron left by colonial iron workers.

Because illiterate workers practiced iron making in the 17th century, there are few contemporary references to the craft. To understand the complexity of iron making at Saugus, interpreters are dependent on the evidence uncovered by Robbins and other archeologists.

One piece of evidence was an iron bar uncovered by Robbins in April 1949. As he noted in his diary, "found three sections of metal that originally was one piece. It is (altogether) three feet long, pointed on one end, larger and half circular at the other end and one side is notched." Over a dozen of these broken pieces were found, but their purpose was unknown. For years, the museum displayed the only complete notched bar in a museum case with a label reading "use of the notched bar in the case floor remains a mystery." This was the case until recent research uncovered an answer.

This view of Saugus Iron Works NHS, the birthplace of the American iron industry, was taken in 1995 by Richard Merrill. Photo courtesy Saugus NHS.

While constructing the Works in 1643, company agent John Winthrop Jr. described a type of Irish bog ore that "yielded great store of Iron and wrought very well and gently, in the furnasse, and would make both gray motly or white sowe Iron." A modern reference from G. Reginald Bashforth's *The Manufacture of Iron and Steel* (1964) hints at the purpose of the notched bar: "normally, pig iron is graded according to its fracture. The type of iron produced is dependent on three factors: the raw materials charged; the temperature at which the furnace is operated; and the type of slag formed."

Winthrop's quote suggests that founders could control the furnace fire with air, iron ore, and gabbro (a fluxing agent used to lower the melting temperature of the iron), producing varying grades of cast iron. Each grade of iron had its own application. Gray cast iron, which is soft and suitable for castings, results from the fusion of small graphite flakes with the iron. Gray iron castings made at Saugus included pots, kettles, skillets, firebacks (large iron plates behind fireplaces), and salt pans, which fishermen used to extract salt from seawater. Because large amounts of salt were used to preserve fish, these pans contributed to the development of New England's fishing industry.

White cast iron is lower in carbon and silicates, harder, and more difficult to work with hand tools. It was made into pig bars and later refined and forged into wrought iron bars. In mottled iron,

This photograph compares historic and modern notched bars. The two top bars were found near the Saugus blast furnace during archeological excavations. The two bottom bars are from a modern blast furnace. Photo courtesy Saugus NHS.

tled, and that which has the greatest volume is gray.

The iron was perhaps tested with a notched bar. The notched bar mold was made by pressing a wooden pattern into the open sand of the cast shed floor. The mold was then filled with molten iron. The notches tested the fluidity of the iron and its ability to take detail in a casting. They also created a weak point, making the bar easier to break. The tapered bar gave the founder variations in thickness. When the bar cooled, it was broken at a notch similar to the desired thickness of the proposed casting, thus indicating the grade of iron.

Workers at Saugus may have been unlettered, but their tools and products give us useful clues to their craft. On a recent trip to a modern blast furnace that produces more than 10,000 tons per day, I observed rooms of computers and other test equipment. On the plant manager's desk I noticed two small notched bars. When asked how they were used, he replied, "The old-timers use them. It gives them a quick accurate reference so they can make adjustments to the furnace." The Saugus legacy lives.

Archeological excavations of the 1646 blast furnace. Photo taken in 1950 by Richard Merrill, courtesy Saugus NHS.

some carbon occurred as graphite, while the rest combined with the iron. An 18th-century reference describes its resemblance to "the spots on a dogfish or trout." Mottled iron was also refined and forged to make wrought iron.

By describing the surfaces of the cast iron as either gray, mottled, or white, Winthrop revealed that iron was tested by fracture. Due to different cooling rates, the thickness of a casting at any given point also influenced the way iron retained carbon. A 1775 treatise by Pierre Grignon, reprinted in *Sources for the History of the Science of Steel 1532-1786,* outlines the effect of mold thickness on cast iron.

> When cast iron that is by nature gray is received in a cold, humid, compact body, it congeals precipitately and becomes white, hard, and brittle, so that if a piece is molded in such a manner as to make it unequal in its thickness, even though it is cast from the same drop of gray cast iron, the thinnest part is white, that which is a little thicker is mot-

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Curtis McKay White is a park ranger at Saugus Iron Works National Historic Site, Saugus, Massachusetts.

Stephen A. Haller and Bartholomew Lee

Resurrecting the Presidio's Historic Radio Network

The "penthouse" message center at the Fourth Army Headquarters, the Presidio of San Francisco, just before World War II. The men at the typewriters are transcribing Morse code radio messages and routing the hard copy to staff departments through a mechanical conveyor belt system known as the Lamson message conveyor. Photo courtesy Golden Gate NRA.

A small, unassuming concrete building lies abandoned behind a chain link fence on a windy hill overlooking the Pacific in a remote part of San Francisco's Presidio. The hill was the site of the antenna farm for the Presidio's World War II radio transmitters, and the building was the Coast Defense Radio Station. The Perham Foundation and the California Historical Radio Society are working with the National Park Service to research the history of the Presidio's military radio network and preserve its associated artifacts and structures.

As headquarters of the Ninth Corps Area during the inter-war years, the Presidio was an important link in the Army's radio network from Washington, DC, to Fort Shafter in Hawaii and on to the Philippines. In 1921, the first dedicated radio buildings at the Presidio began broadcasting under the call letters WVY. The chief of the Signal Corps Engineering and Development Division, Major Joseph O. Mauborgne, approved the plans for these standardized structures. A Military Affiliate Radio Station (or "MARS" station), soon joined WVY. Formerly known as the Army Amateur Radio Service, MARS trained the military to set up emergency communications facilities with civilians and was an informal conduit for messages between far-flung service personnel operating as late as the Persian Gulf War.

In the early 1930s, the Army did not have an official program of monitoring radio transmissions from Japan; it labored under Secretary of War Stimson's admonition, "Gentlemen do not read each others' mail." "Reading the mail" later became a euphemism for monitoring radio transmissions, particularly radio teletype. However Mauborgne, a colonel destined to rise to the post of commanding general of the Signal Corps before World War II, was assigned to the Presidio. He monitored and recorded Japanese radio traffic as early as 1931 and passed the intercepted coded messages to the Signal Intelligence Service in Washington. These intercepts became part of the earliest grist for the code breakers' mill that solved the Japanese machine cipher known as "Purple" in 1940. These intercepts contributed to the stream of intelligence, code named "Magic," that allowed the Allies unparalleled access to the enemy's plans and greatly contributed to the victory in the Pacific.

By 1941, the Presidio had an official, but secret, monitoring station. On the eve of World War II, the Army finished a more expansive facility for Radio Station WVY and a dedicated Harbor Defense Radio Station. Testimony from the congressional investigation of the Pearl Harbor attack makes it clear that the Presidio was intercepting Japanese radio transmissions on the eve of the attack. During the war, the Western Defense Command, headquartered at the Presidio, communicated with Washington and units across the vast Pacific theater from its "Penthouse" operating room, reached by a set of spiral stairs from the Commanding General's offices. The Coast Defense Radio Station provided signal service to one of the most heavily fortified harbors in the United States. All these structures remain extant in the Presidio, which is now a National Historic Landmark district and part of Golden Gate National Recreation Area.

Recently, technical experts from the California Historical Radio Society, with information provided by NPS historians and curators, have produced a better understanding of the operation and significance of the Presidio's radio network. They have enhanced the collection and preservation of the post's historic radio artifacts, properly identified photographs of vintage radio equipment from the 1920s, '30s and '40s, and performed oral history interviews with veteran radio operators. These experts have provided a fuller assessment of the history, integrity and future adaptability of the structures associated with the Presidio's historic radio operations.

On April 19, 1997, the California Historical Radio Society, the Perham Foundation, the Military Collectors Radio Net, and the Boy Scouts of America worked with NPS personnel to restore native plants on the site of the Coast Defense Radio Station and antenna farm. After a morning of work, members of the Military Collectors Radio Net operated World War II vintage radios for sev-

The site of the Presidio's World War II Coast Defense Radio Station has recently benefited from collaboration in research and site rehabilitation between the NPS and radio historians. Photo courtesy Golden Gate NRA.

eral hours. This activity put the Presidio "back on the air" as it was during one of its most significant periods. It also helped develop a sense of stewardship of the site's natural and cultural resources. The research, the special events, and the resource preservation activities illustrate the value of partnerships between Golden Gate NRA and local organizations.

The Presidio Trust, a newly chartered government corporation charged by Congress with seeking tenants to rehabilitate the former military post, will manage much of the Presidio. The California Historical Radio Society, the Perham Foundation, and their allies have been seeking an operating area and public museum facility to house and display their collections of early radio equipment. They are developing a program proposal to place before the Trust for the rehabilitation and adaptive re-use of the Coast Artillery Radio Station site. Such a proposal has the potential to preserve the built environment, enhance the natural resources of the landscape, bring authentic historical programming to the Presidio, and provide an appropriate home for the historic radio collections of these community groups.

Stephen A. Haller is park historian at Golden Gate National Recreation Area.

Bartholomew Lee is a past president of the California Historical Radio Society.

National History Day

The annual theme for the 1998-99 National History Day program and competition will be Science, Technology, Invention in History: Impact, Influence, Change. Each year, up to half a million students across the country choose topics in history related to National History Days annual theme. After months of extensive research into primary and secondary sources, these sixth-to-twelfth grade students create imaginative exhibits, performances, video or slide tape documentaries, and papers. The students present their work at a series of contests at the district, state, and national levels; the contests are judged by professional historians and educators.

During the 1998-99 school year, students will be invited to explore an enormous range of topics. Some might investigate the invention of the Arabic system of numbers, while others might explore the impact of the invention of the atomic bomb. Still others might look at the influence of the railroad on U.S. communities in the late-19th century, or the ways in which 20th-century office technology has affected the work of women. The theme challenges students to use the lens of history to look at familiar objects like bridges and television sets, and famous people like Galileo and Einstein.

The National History Day program invites the participation of museum educators, teachers, and others interested in the history of science and technology. If you would like to assist with judging or other aspects of program development for the 1998–99 theme, or if you would like to get your students or school involved with the program, please contact National History Day at 0119 Cecil Hall, University of Maryland, College Park, MD 20742, 301-314-9739, email: <hstryday@aol.com>, or on the World Wide Web at <http://www/thehistorynet.com/NationalHistoryDay/>. The national office can refer you to state program coordinators.

In conjunction with its 1998–1999 school year theme, "Science, Technology, Invention in History: Impact, Influence, Change," National History Day will conduct a Summer Teacher Institute entitled, "Technology in History: Interactions in Everyday Life." The Institute will be held in the summer of 1998 at Case Western Reserve University in Cleveland, Ohio, and will involve 51 teachers, one from each state and the District of Columbia.

Institute topics and activities include discussions on Women, Farmwork and Technology; Industrialism and Factories; The Individual and Technology: Inventors, Engineers, Repairman; Consumer Technology: Advertising, Progress, Change; Teaching with Technology: History and the Internet; and trips to the nearby Henry Ford Museum and NASA Lewis Research Center. Opportunities for individual research will be built into the Institute, and teachers will learn to help students research topics related to the history of science, technology, and invention as they participate in the National History Day program. For information about the Institute, please contact the National History Day office.

Jack R. Bergstresser

Technological History as Green Space

Joliet Iron Works

The development of the steel industry after the Civil War helped launch the most active period of economic growth in American history. Improvements in blast furnace design, which greatly increased steel productivity, made this growth possible. In order to understand this heritage, it is important to preserve the rapidly disappearing physical remains of the steel era. Nevertheless, preserving fully-intact blast furnaces will be expensive and complex. The only successful example to date is the Sloss Blast Furnace National Historic Landmark in Birmingham, Alabama, which was saved from demolition in the late 1970s.

Preserving the ruins of important blast furnaces is a much more achievable goal. These sites have often survived as overgrown, forgotten nooks along the fringes of urban areas. They could easily be bulldozed, but they could also be saved as green space with trails allowing visitors to rediscover the site. As visitors wander the trails encountering each new set of foundations that mark the former base of a blast furnace, they are reminded of a rapidly disappearing industrial heritage.

One such model, now under development, is the blast furnace ruins of the Joliet Iron and Steel Company at Joliet, Illinois. The remains are in a wooded tract along the banks of the Illinois and Michigan Canal, which was designated as a National Heritage Corridor in 1984. The NPS, in cooperation with local preservation groups, has identified and is now preserving and interpreting several sites along the canal from Chicago to Des Plaines.

The Forest Preserve District of Will County, a state agency that manages several historic and natural sites in the county, is developing the Joliet blast furnace ruins into a bike and interpretive trail integrated into the Corridor. The district faces the challenge of preserving the natural harmony of this green space while simultaneously revealing the history of technology told by the industrial ruins: the foundations of two sets of blast furnaces representing two successive design generations.

Unfortunately, foundation remains do not convey iron production as readily as an intact blast furnace. The tools of the industrial archeologist, including surveying software and instrumentation, computer-aided design, and exhaustive historical research can provide help in developing an interpretive plan to overcome this problem.

Carefully crafted interpretive ideas will convey the sense that these quiet ruins were once a loud, hot, dangerous workplace and that the site is historically significant. The first Number One and Two furnaces were part of an early Bessemer Convertor steel mill built by Alexander Holley in 1873. Joliet was the ninth of a series of prototypical mills designed by Holley that helped launch the American iron and steel revolution. The blast furnace remains reveal much about the progress of blast furnace design in the late-19th century. One outstanding feature of this crucial sequence of improvements was the dramatic increase in the furnace size. The contrast in the scale between the Number One and Two furnaces, originally built in 1873, and the Number Three and Four furnaces, built after 1900, is striking.

To understand the site, visitors must discover what a blast furnace is, and they must visualize such a structure standing where only ruins remain. For interpretive planners, knowledge of the available information is helpful. Because new technology was continually perfected, blast furnaces did not remain static. To remain competitive, iron makers had to upgrade their facilities regularly. The company chronicled these improvements in engineering drawings, ground plans, and other documents generated as part of a renovation project. Professional trade journals also featured articles and photographs heralding the installation of new machinery and equipment.

The information necessary to interpret the ruins of a blast furnace plant is abundant, but it must be organized. At the Heritage Park in Joliet, Illinois, this organization process began with the production of a base map of the site. Developed in civil engineering software using measurements taken with a surveying instrument, this map shows the string of foundation remnants that stretch for nearly a quarter mile along the Illinois and Michigan Canal.

An accurate base map based upon readings gathered during the field work phase is essential to the industrial archeologist. Precise drawings of surviving foundations can often provide information not otherwise available. No matter how exhaustive company records and maps might be, they never tell the complete story. At Joliet, for instance, a substantial structure at the north end of the site was labeled only as the "Gas Engine House." The field measurements of the massive foundations inside the ruined walls of the building showed that three large Allis Chalmers internal combustion engines once chugged away 24 hours a day driving generators that made electricity for the rest of the furnace plant.

The base map was incorporated into a CAD program. Several historical maps of the site, including Sanborn Insurance maps and ground plans drawn by the plant engineers, were scanned and imported into the program. Drawings of equipment used at the site discovered during the research process were also scanned into the file.

With this data, it is feasible to call up on the computer screen a variety of map overlays depicting key aspects of the site. Zooming out and showing the overall site with a historical map overlaid upon the existing ruins is also possible. This depiction helps identify features that otherwise appear as meaningless piles of rubble. It also provides a map for laying out a hiking trail through the site.

Once the location for a wayside has been selected, zooming in on that particular area and viewing the map overlays and machine views atop the existing foundation ruins are possible. The design team can then edit the various layers, paring away extraneous lines and other information to create an image highlighting the location of machines. With a judicious selection of waysides on the hiking trail, the interpretive staff can trace the evolution of the modern blast furnace.

The work of the Will County Forest Preserve District and the Canal Corridor Association in interpreting the Joliet blast furnace ruins is important. The remains of America's steel industry continue to rapidly disappear. The chances of preserving more than a few examples are slim because of the enormous long-term cost involved. Still, preserving ruins found within green space sites is a cost-efficient alternative.

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IEEE Center for the History of Electrical Engineering Milestone Program

The IEEE Electrical Engineering Milestones Program honors significant achievements in electrical, electronic, and computer engineering. The Program is conducted by the IEEE History Committee through the IEEE History Center at Rutgers University. The Institute of Electrical and Electronics Engineers (IEEE) is an international organization with more than 300,000 members and the world's largest technical professional society. After approval by the IEEE, a bronze plaque describing and commemorating the achievement is placed at an appropriate site. Honoring these achievements fosters an awareness among electrical engineers of their professional history, increases public understanding of electrical engineering, and encourages the preservation of historically important materials and sites. The program also collects and distributes documentation of significant historical events.

As a grass-roots historical activity, the Milestones Program functions through the local IEEE Section, which nominates an achievement and provides documentation of its historical significance. After the nomination is approved by the IEEE History Committee and the IEEE Executive Committee, a plaque is cast and the Section conducts a dedication ceremony. This process increases awareness, both by the Section members and the public at large, of local heritage. Also, the documentation of the achievement helps to separate fact from local myth, and the Milestone process opens up channels of communication between the Section and other civic organizations, typically a local historical society. In the future, it is hoped that some Milestone nominations will include an industrial archeology component, thus further enhancing the Program's role in historical preservation and its contacts with other organizations concerned with researching and disseminating the history of technology.

Since its inception in 1983, the Milestones Program has honored 27 achievements. Among these are the Adams Hydroelectric Generating Plant at Niagara Falls which, when put into service in 1895, demonstrated the practicality of alternating-current power systems; Westinghouse Radio Station KDKA, which pioneered radio broadcasting in 1920; the MIT Radiation Laboratory, where radar was developed during World War II; the Atanasoff-Berry Computer, an experimental electronic computer built during World War II; and the ENIAC, a large electronic digital computer completed in 1946.

The Milestone Program, like the IEEE itself, is international; and quite a few Milestones have been dedicated outside the United States. These include the landing of the transatlantic cable at Heart's Content, Newfoundland; the Poulsen-arc radio transmitter invented by the Danish engineer Valdemar Poulsen in 1902; and the directive short-wave antenna (also known as the Yagi-Uda antenna), invented in Miyagi, Japan. On a number of occasions, the IEEE has collaborated with other engineering societies in promoting recognition and preservation of historic sites. For example, the Vulcan Street Plant, an 1882 hydroelectric station in Appleton, Wisconsin, was simultaneously named an IEEE Milestone, a National Historic Civil Engineering Landmark of the American Society of Civil Engineers, and a National Historic Engineering Landmark of the American Society of Mechanical Engineers.

Phyllis Ellin and Dan Riss

Notes from the Field
Industrial Preservation in Great Britain

The following are reports submitted by NPS historian Phyllis Ellin and conservator Dan Riss about their involvement with industrial preservation in Great Britain. First, Phyllis Ellin relates her experience as part of Countryside Exchange team, and next Dan Riss discusses a paper he presented at a conference in Wales.

In October 1996, I was part of a seven-member Countryside Exchange team that met at the Ironbridge Gorge in Shropshire, England. Designated in 1986, Ironbridge Gorge was the United Kingdom's first World Heritage Site and one of the few industrial sites recognized by UNESCO for its role as the birthplace of the Industrial Revolution. The site includes the village of Coalbrookdale, where Abraham Darby developed his process to manufacture iron on a large scale. Perhaps more famous is the bridge spanning the Severn River, the world's first iron bridge constructed in 1779. The Gorge is also dotted with several small settlements from the early industrial era, including Coalport, the home of Coalport china. The region's diverse mineral and timber resources, combined with transportation on the Severn, created an ideal incubator for early industrial development.

The Countryside Exchange originated in a Memorandum of Understanding between the National Park Service and the United Kingdom's Countryside Commission signed in 1986. Exchanges have taken place in both countries and in Canada. Local communities are selected voluntarily as case studies in various planning and resource management problems, and an international team with skills and interests matched to each case study is assembled. For Ironbridge Gorge, the Americans on the Exchange Team included myself; JoAnn Dolan, Assistant Director of the Forest Service's Mono Basin Scenic Area Visitor Center; and Larry Belli, Deputy Superintendent of Everglades National Park. The United Kingdom members were Tony Gould, a planning officer for Surrey County Council; Gordon Hewston, an ecologist with English Nature; John Jewitt, Senior Rural Officer with the Cleveland Council for Voluntary Services in Middlesborough; and Kate Sussams, a landscape archeologist with the Suffolk County Council.

Ironbridge Gorge was selected as a case study because it was in the process of developing a management plan for the area, as required for all World Heritage Sites. This process is a complex one, requiring participation and cooperation of many local governments, community groups, and private property owners. Under the guidance of the local Exchange sponsors, John Elvey of the Wrekin Council regional government and Jim Waterson of the Severn Gorge Countryside Trust, the Exchange Team spent a week examining the resources of the Gorge and meeting with a variety of the players and interested parties in the area. Issues considered included sustainable tourism and visitor management, interpretation of both cultural and natural resources and their interplay, forging a working partnership among agencies developing the management plan, and public participation in the process.

The Team's recommendations at the end of the week, presented at a public meeting and in a written report, attempted to address all those issues in a holistic way. The wide variety of resources scattered throughout the area prompted a recommendation that a more focused interpretive strategy be developed to emphasize the central story of world significance and to show how the varied sites in the area contributed to it. Such a story must include the critical role of the area's natural resources in the industrial story. We recommended that the inter-agency group formed to develop the management plan also try to integrate the land management policies across the World Heritage Site. Finally, we stressed the critical importance of effective communication with the public and acknowledgment of the Gorge's community history as part of the "cultural landscape."

In April 1997, curators, conservators, and historians met in Cardiff, Wales, at a conference titled "Industrial Collections: Care and Conservation." The conference, which was attended by representatives from the United Kingdom, Canada, France, Germany, and the United States, discussed problems in preserving, restoring, and displaying large objects such as mining equipment, locomotives, and farm machinery. Unlike most museum objects, much of this equipment is maintained in working order to enhance interpretation. A conflict can arise, however, between historians and conservators, on the one hand, and mechanics and restorers on the other. One side views objects as technological documents, while the other sees them as of little use unless they are working and moving.

In my talk, I discussed the issue of documentation as an area of conflict between restorers and conservators. Conservators want to document everything they can, and if possible leave everything "original" alone; restorers are anxious to get the machine working—even if parts need to be modified—and get documentation after the fact. I suggested that the two could move to the center if restorers would learn to document more, and if conservators would occasionally relax enough to allow changes to original surfaces and parts—if the changes were thoroughly documented.

The conference papers will be available as a publication of the United Kingdom Institute of Conservation (6 Whitehorse Mews, Westminster Bridge Road, London SE1 7QD). Another useful recent publication is *Larger & Working Objects, A Guide for Their Preservation and Care,* a publication of the Museums and Galleries Commission (MGC Publications, 16 Queen Annes Gate, London SW1H 9AA, price 11.25 pounds, and postage).

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Dan Riss is a conservator at the Harpers Ferry Center.

Bob Higgins

Preserving the History of Mining Technology in the NPS

The National Park Service preserves many sites and artifacts associated with the history of mining. These cultural resources reveal how mining shaped American development. The metals and minerals extracted from mines effect many aspects of our lives, whether we use them in the home (glass, nails, pipes), in industry (tools, machines), in communications (televisions, radio, telephones), or in transportation (automobiles, airplanes).

There are many ways to tell the mining story. To simplify interpretation, we can view mining technology in three parts or phases: extraction (or removal of material from the ground), processing (milling, refining), and transportation. NPS units contain evidence of changing technologies in all three phases.

Alibates Flint Quarry National Memorial in the Texas Panhandle is an excellent representation of mining techniques practiced by native Americans before European arrival. Southwestern parks, where early Spanish settlers extracted gold and silver, have the remains of mine openings and arastas for grinding. NPS units also contain many western mines from the late-19th and early-20th centuries, a period of rapid technological change. The copper mines of the Kennicott Mining Company in Wrangell-St. Elias National Park and Preserve, Alaska, and Calumet in the Upper Michigan Peninsula have wonderfully preserved machinery and structures from this period. Glacier National Park has a massive cast iron jaw-crusher and steam engine at the Cracker Mine.

The coal mines and structures (e.g., buildings, electric train cars, coke ovens, conveyor systems, etc.) in New River Gorge National River, West Virginia, and Big South Fork National River, Tennessee, are reminders of the dominance of coal in the American economy. Many diggings and structures dotting Colorado plateau parks and the six-story steel headframe on the rim of the Grand Canyon are silent testimony to the role of uranium mining during the Cold War.

The saltpeter (nitrate) works at Mammoth Cave in Kentucky supplied the chief ingredient of gunpowder until the War of 1812. Gold was mined within the C&O Canal near Washington, DC, from the colonial period to the early-20th century. Allegheny Portage Railroad NHS in Pennsylvania transported barges over the mountains with steam hoists and mined coal to fuel the boilers. The iron furnace at Hopewell Furnace NHS near Philadelphia operated from 1771 to 1883. The New Jersey side of Delaware Water Gap NRA is home to the Pahaquarry Copper Mine.

Mining technology within the NPS spans the continent in both time and place. Some mining features are the main reason for a park's creation, and others are but a side story of the area's history. Among the tools and equipment in park collections are hand and mechanical rock drills, conveyor belts, and 300-ton capacity trucks. Mining continues to supply the raw material for our economy, and its technology awaits discovery by park visitors.

Bob Higgins is a branch chief in the Geological Resources Division of the NPS Natural Resource Program Center in Denver. He is also coordinator of the NPS Abandoned Mineral Lands Program.

Beth Aukstikalnis

Teaching Edison History with Traveling Trunks

Thomas Edison taking a meal break at his West Orange Laboratory in September 1912 with six of his assistants, or "muckers." Photo courtesy Edison NHS.

Thomas Edison is a familiar figure to students around the country. In New Jersey, where Edison spent most of his career, the state history curriculum includes a science/technology component for fourth graders. Because educational programs at Edison National Historic Site (NHS) help teachers fulfill this requirement, their popularity has soared in recent years. More than 8,000 students take advantage of site programs each year, but the site cannot accommodate thousands more. To meet this demand, Edison NHS has developed an outreach traveling trunk for classroom use.

Edison opened his West Orange, New Jersey, laboratory in 1887. The laboratory complex contains his research library, chemistry laboratory, machine shops, and a stock room that Edison once boasted included everything from "the hide of an elephant to the eyeballs of a United States senator." Edison obtained over half his 1,093 U.S. patents in these buildings. The site also includes Glenmont, Edison's 29-room Queen Anne style home. Interpretive programs at the laboratory focus on Edison's invention process, while programs at Glenmont discuss the role of Mina, Edison's second wife, as "home executive, manager of a staff of up to 10 servants and hostess to such luminaries as Henry Ford and Herbert Hoover."

Edison NHS currently offers two on-site educational programs with a technology theme. "Idea to Product: the Edison Way," geared to elementary school students, examines Edison's invention process and includes such activities as model-making and brainstorming. A new program, "Impact and Technology" is designed for high school students. The traveling trunk, "Working for Edison," which a grant from the National Park Foundation made possible, is for fourth and fifth graders.

In developing the trunk, a committee of park staff and educators considered using one of the themes from the site's enabling legislation, but decided that these themes would not transfer well to the classroom because a site visit is necessary to communicate them effectively. As a result, the committee had to develop a new theme. Although the program would feature Edison and his technical contributions, the committee also wanted to include other themes, such as cultural diversity, women's history, and the impact of the industrial revolution. To cover all these topics, the committee decided to build the trunk around Edison's workers. Students would learn about Edison's life and work through his employees' eyes. At the end of a traveling trunk session, students could describe one of Edison's work habits, name three Edison industries, and identify three types of jobs at the laboratory or Glenmont.

Committee members chose student activities that addressed different skills and fulfilled the learning objectives. The committee drafted a master list of suggestions and voted for the top five choices. Each of the selected activities takes approximately an hour to complete. A teacher may conduct one activity or any combination of the five. The "Discovery Box" encourages students to experience Edison's era by examining historic objects ranging from men's soft collars to darning eggs. "Where do we go?" develops map skills by asking students to outline the path Edison traveled from Glenmont to the laboratory. The "Mental Fitness Quiz" challenges students to take the test Edison employees had to pass to work in the laboratory. The test questions focus on scientific problems and current events of the 1920s. "Invent-a-Something" borrows Edison's invention process from the on-site program and divides students into teams to create new inventions with Tinker Toys. In "Biography," students dress up in replica costumes to impersonate actual Edison workers. Biographical flashcards provide photographs and information about the workers. Discussion questions complete each activity. The trunk comes with a teachers' manual containing lesson plans for the five activities.

The trunk helps students grasp Edison's work ethic. They learn that Edison affectionately nicknamed some of his closest associates the "insomnia squad" because of the long hours they worked. Students also discover that Edison's con-

Edison employee Fred Ott, performing in the kinetoscope film, "The Record of a Sneeze." *Made in 1894, it is the oldest surviving copyrighted motion picture. Photo courtesy Edison NHS.*

tributions went beyond the incandescent light to include motion pictures, the phonograph, and the fluoroscope, an early X-ray device. Students learn about Anna Case, a singer who recorded for Edison's phonograph company. They see the world through the eyes of Fred Ott, an expert machinist who also starred in *"The Record of the Sneeze,"* one of the earliest movies. The servants who maintained Edison's home also place him in his era. The traveling trunk emphasizes that Edison did not work alone. From the 1870s through the 1920s, a diverse workforce helped Edison accomplish his goals in his laboratories and factories. They completed projects ranging from kitchen appliances to the storage battery and the motion picture camera, helping Edison shape 20th-century life.

Traveling trunks like "Working for Edison" can reach distant audiences unable to take advantage of on-site programs. Although the program has received positive responses from teachers, the trunk is a work in progress. Evaluation forms ask teachers to rate class activities and relate the students experiences and reactions. This information will help us revise the trunk to meet the needs of students. The "Working for Edison" trunk is available for loan by calling Edison NHS at 973-736-0550, ext. 60.

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