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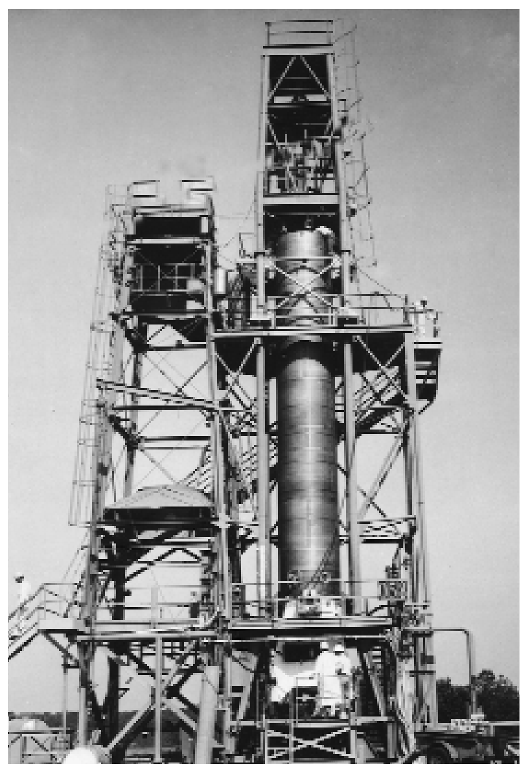
Small Steps and Giant Leaps

HAER Documentation of Static Test Facilities at NASA's Marshall Space Flight Center

On May 5, 1961, the eyes of the nation, and much of the world, focused on Cape Canaveral, Florida. The United States launched a Redstone rocket booster, sending a Mercury capsule containing America's first astronaut into space. On July 16, 1969, the world's attention again turned to Cape Canaveral (now called Cape Kennedy) where a mammoth Saturn V booster assembly was launched. The Apollo 11 mission was on its way to fulfilling the nation's commitment of landing a man on the moon and returning him safely to the earth before the end of the decade. The quest for the moon captured the nation's imagination and the astronauts became instant American heroes. Lost in the shadows created by this limelight were the brilliant and dedicated scientists and engineers who turned the theories behind sending humans into outer space into reality.

Almost 30 years later, the contributions of these unsung heroes of the early American space program were the focus of an intensive documentation effort by the Historic American Engineering Record. During the summers of 1995 and 1996, HAER conducted two documentation projects at NASA's George C. Marshall Space Flight Center (MSFC) in Huntsville, Alabama. Both of these projects focused on the documentation and interpretation of the static test stands and related facilities where liquid rocket engines and booster assemblies were developed and tested.

Throughout the summer of 1995, HAER documented the Redstone Rocket Test Stand. The development of the Redstone rocket was one of the military's programs to design and test liquid propelled missiles. This static test stand was also referred to as the "interim test stand" because it was constructed as a temporary facility to be used while the slow bureaucratic procedures for the funding and construction of a permanent facility were in process. Constructed by the Army in 1953, the interim test stand and observation and control tanks were very modest facilities due to fiscal constraints. Very little money was spent on construction, and the majority of construction material was salvaged from surplus equipment at the Army's Redstone Arsenal, which would later encompass the MSFC campus. The interim test stand was expanded on an "as needed" basis, again using salvaged material, and continued to operate through the transfer of the rocket research and development program from the U.S. Army to the newly formed NASA in 1960, and ended several months after Alan Shepard's flight into space in 1961. By the time the testing program moved to the facilities at the East Test Area, originally designed for the devel-



Historic photograph of the east elevation of the Interim Test Stand. Engineers and technicians are seen preparing the booster assembly for a test run in May 1957. Photo courtesy NASA-Marshall Space Flight Center, photographer unknown.

The static test tower in the East Test Area, Marshall Space Flight Center. The first stage of a Saturn I booster is on its side to the right of the static test tower. Photo by Jet Lowe, 1996.

opment of the Redstone booster, the next generation booster design, the Jupiter/Juno rocket, was nearing completion and ready for static testing.

The East Test Area was documented by HAER during the summer of 1996. Dr. Wernher Von Braun, director of the rocket development team, had recognized that the political process involved in getting large facilities built could be slow and cumbersome. Because of this insight the East Test Area was over-designed and planned for easy expansions to meet future needs. Even with the larger rocket engines already into the research and development phase, the transition to the East Test Area was seamless as a result of the forethought that went into the design of the new facilities. Subsequent modifications and expansions were made with relative ease as the space program expanded and the focus of its mission became clear. Operations at the East Test Area began with the testing of a Juno booster assembly with a maximum thrust of 150,000 pounds and ended with the testing of a single engine for the Saturn V booster with a maximum thrust of 1.5 million pounds. Adaptations to the East Test Area were swiftly made to accommodate rapid developments in liquid rocket propulsion.

Documenting these sites at MSFC presented challenges both common and unusual for HAER documentation projects. Most documentation projects undertaken by HAER which deal with science and technology have to go beyond simply recording the historic resource. These recording projects need to include a significant level of interpretation to explain engineering concepts to the general population. It is often necessary to explain a process, assembly, or operation of the resource being documented in order for the historic significance to become clear. Typically, the sites that HAER has documented in the past interpret an industrial process where raw materials enter the process, proceed through several stages, and a finished product emerges at the end. However, the documentation at MSFC involved interpreting a research and development process in which the end product was knowledge, which was then taken as "raw material" back to the beginning of the process. This type of process is more challenging to convey because it is a continual process of learning and testing new ideas. Although the association of these sites with such defining moments in the nation's history as the Apollo 11 moon voyage relieved us of having to convey their historic significance, it was still necessary to explain through words, graphics, and photographs a process that had no clear beginning or end, but was so critical to the success of the Man In Space Program. The relatively young age of the site assisted us in our endeavors. Both of the MSFC facilities that HAER documented were less than 50 years old. Normally the sites HAER documents are at *least* 50 years old and more often over 100 years old. The historical significance of the facilities was part of the reason for this deviation and enabled us to conduct interviews with many of the engineers and technicians who worked in these facilities and obtain first-hand accounts of the activities that occurred during the research and development of the rocket propulsion systems. Recording such a modern site has also provided a potential to expand our primary documentation to include historic motion picture footage. NASA filmed many of the static test firings as another form of monitoring for later analysis and through the generosity of MSFC, HAER was able to copy several of these tests onto video tape which will be included in our documentation package.

When HAER documents sites of historic engineering significance that are still in active use, we have the challenge of trying to capture the moment of significance amidst constant change. The young age of the facilities again helped. Within the disciplines of science and technology, evolutionary leaps forward occur rapidly. When we wait for sites to become historic, strictly from a chronological standpoint, they become much more difficult to understand and interpret as a significant cultural resource. Evidence of significant events or technologies are consumed by newer technologies and processes. Progress and innovation are the keys to success in these fields. However, these priorities are contradictory to conservation and preservation efforts. Although HAER's focus is on documentation and interpretation, we are keenly aware of the delicate balance between preservation and progress in the engineering fields. Practical considerations of efficiency, productivity, and the need to remain competitive, coupled with advancements in technology, often overshadow concerns of preserving our cultural heritage. Through our documentation we try to raise the level of awareness and sensitivity to our technological heritage, hopefully inspiring efforts in which conservation and advancement coexist.

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Engineering Methods in Historical Research

How does it work? This is a question frequently asked in preparing HAER documentation, especially when a site or structure derives its historical significance from function rather than form. Historians and delineators consult technical literature and solicit expert advice to bolster their understanding of unfamiliar technological artifacts. But what if the artifact is equally unfamiliar to an expert in that technology? When researching the Lower Bridge at English Center, Pennsylvania, built in 1891, historian Mark M. Brown noted that its appearance resembled both a suspension bridge and a truss. Upon asking three engineers to characterize its behavior, surprisingly, he received three different answers. Taking an unusual opportunity for in-depth engineering study, HAER solved this mystery. During the summer of 1998, Dario A. Gasparini, Thomas E. Boothby, Stephen G. Buonopane, and I analyzed and load-tested the Lower Bridge.[1] Our work shows how quantitative analysis can enhance documentation by providing information to reveal the designer's intentions, evaluate the success of the design, and place it in a context of engineering technology and creativity.

The Lower Bridge's design was appropriate to methods and materials available in 1891, and therefore foreign to the different circumstances of modern engineering and construction. According to Donald Friedman, structural engineer and author of *Historical Building Construction,* "Advances in analysis and design were so rapid, especially before the 20th century, that a few years' difference in the date of construction could make a tremendous difference in a building's structure."[2] This is no less true of bridges. Modern analysis, while capable of determining an older structure's behavior, must be informed by the original designer's knowledge and intentions. Period textbooks and design manuals tell only what the academic community thought about structures, but the question remains how much of this information was incorporated into actual conceptualization and design.

In the case of the Lower Bridge, records identifying the designer or describing the design process have yet to be found. Without direct documentary evidence, we had to "reverse engineer," or infer the designer's thoughts from physical evidence offered by the structure itself. Engineering is a subjective art, influenced by such inconsistent human aspects as skill, judgment, and creativity. While engineers use precise mathematical tools and objective scientific laws, they also make assumptions and approximations in predicting the behavior of complex systems. The effort of