Davidson Center for Space Exploration

U.S. Space & Rocket Center

Huntsville, AL

Created in coordination with the U.S. Space & Rocket Center and Gresham Smith

Photo courtesy of the U.S. Space & Rocket Center


The Astronaut Life
MENU
MENU
MENU

Photos courtesy of the U.S. Space & Rocket Center

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PROJECT **DETAILS**

Building: Davidson Center for Space Exploration

Location: Huntsville, Alabama

Owner: State of Alabama

Operator: Alabama Space Science Exhibit Commission (ASSEC)

Size: 75,932 square feet

Construction Cost: $22 million

Completion: January 31, 2008

Architectural Design: Gresham Smith

Construction Management: Turner Construction

Rocket Conservation and Display: EverGreene Architectural Arts

Metal Building Erector: JWC Specialties, Inc.

Structural Engineer of Record: LBYD Engineers

Civil Engineering: LYBD Engineers

Landscape Design: Gibson Landscape

Metal Building Manufacturer: American Buildings, a Nucor® brand

Exterior Cladding: Metl-Span

Awards/Certifications: 2010 American Institute of Architects Birmingham Chapter's People's Choice Award; 2010 American Consulting Engineers Council of Alabama's Grand Award; LEED Silver certified

Photo courtesy of Vincent E. Sagan, P.E., F.ASCE

PROJECT **DESCRIPTION**

The Davidson Center for Space Exploration (Davidson Center) is the largest and highest profile building on the U.S. Space & Rocket Center®'s (USSRC) campus in Huntsville, AL. (1) This monumental metal building was custom designed and constructed to showcase an authentic Saturn V rocket—one of only three that exist and the only one that was a test model for the Saturn V series of space exploration vehicles built during the late 1960s. (2) When it was fully operational, this rocket weighed 6.2 million pounds and was capable of generating 7.7 million pounds of thrust, making it the most powerful American

Photo courtesy of the U.S. Space & Rocket Center

launch vehicle of its era. (3) It is the only rocket to be designated as both a National Historic Landmark and a National Mechanical Engineering Landmark. (4)

In addition to the exhibit hall where the rocket is displayed, the Davidson Center includes offices, an entry lobby with a ticketing area, concessions and restrooms, a 360-seat theater for movies and presentations, a commercial kitchen that can serve groups of up to 1,400 people and enough banquet space to seat 1,000 people.

The building was named after Auburn University alumnus Julian Davidson, who directed the development of the U.S. Army's ballistic missile defense program and founded Davidson Technologies in 1996. (5) In 2010, the Davidson Center's architectural design won the American Institute of Architects Birmingham Chapter's People's Choice Award and the American Consulting Engineers Council of Alabama's Grand Award. (6)

History

During World War II, one of the most important rocket developers of the 20th century, Dr. Wernher von Braun, was in charge of Germany's rocket and missile development. (7)(8) As the war drew toward an end and Germany's defeat was imminent, von Braun and his missile and rocketry development team surrendered to U.S. forces.

In 1945, President Truman and the U.S. Joint Chiefs of Staff initiated Project Overcast—later renamed Project Paperclip—which was a top-secret program that authorized recruitment of up to 350 experts from von Braun's team who had specialized knowledge of value to the U.S. military. Von Braun and his team were brought to Fort Bliss, TX, where they lived in a secured compound and spent five years serving as consultants to the U.S. Army, U.S. Navy and private contractors.

In 1948, U.S. General Holger Toftoy, who had worked to bring von Braun and the majority of his team to the U.S., was able to obtain approval for the team members' families to join them in Texas. Toftoy had also helped orchestrate the transportation of 100 of the V-2 missiles designed by von Braun's team and 14 tons of their research documents from Germany to the U.S.

When the commander at Fort Bliss rejected Toftoy's proposal to expand and centralize the rocketry and missile research program, Toftoy needed to find a new location. He visited the Redstone Arsenal in August 1949 and learned the neighboring Huntsville Arsenal was for sale. He liked the site and in October 1949, he won approval to incorporate it into the Redstone Arsenal and transfer the von Braun team to Huntsville, AL. This catalyzed the economic, cultural and political transformation of Huntsville. The city's population tripled by the end of the 1950s with much of this growth due to an infusion of federal funds for the arsenal. (9)

On March 21, 1950, the von Braun rocket team moved to Huntsville and joined a group of U.S. rocketry specialists. Together, they created some of the world's first rockets and satellites to orbit the Earth, and ultimately, the Saturn V rockets that carried American astronauts to the moon.

While working on the Saturn V projects, von Braun began planning a permanent exhibition that would feature more than 1,500 rocketry and space exploration artifacts from the U.S. space program. He approached the Alabama Legislature and proposed creating a museum jointly with the U.S. Army Aviation and Missile Command and NASA. The U.S. Army donated land, and the state of Alabama created the Alabama Space Science Exhibit Commission (ASSEC) to provide oversight and direction for what became known as the U.S. Space & Rocket Center. (10)

The USSRC now has one of the largest collections of rockets and space memorabilia in the world. In addition to displaying Apollo program hardware and artifacts, the USSRC hosts exhibits about space shuttle and Army rocketry and aircraft plus special exhibits. For example, the Apollo 16 capsule on display at the Davidson Center has been on loan from the Smithsonian Institution for years. Outside and adjacent to the Davidson Center there are 27 missiles and rockets on display to illustrate how Army rocket technology gave rise to America's space program.

Community Impact

The Davidson Center serves as a major attraction for the USSRC, which is the top ticketed tourist destination in Alabama. Nearly 17 million people have toured this science center since it opened, with approximately 850,000 visitors arriving each year. Visitors have hailed from every U.S. state and 150 foreign countries. (11)(12)

As the official visitor's center for NASA's Marshall Space Flight Center and location for the world-renowned Space Camp®, the USSRC also hosts week-long residential and educational programs for students ages nine to 18, families with children as young as seven and adults. These programs use equipment adapted from NASA's astronaut program to promote knowledge of science, engineering, aviation and technology. The USSRC also hosts the Aviation Challenge®, which introduces students to military fighter pilot training, and the U.S. Cyber Camp® and Space Camp Robotics program.

According to Scott Spearing, assistant vice president for Projects and Infrastructure at the USSRC, up to 1,000 children attend Space Camp each week during the summer. "In recent years, we've had a waiting list of over

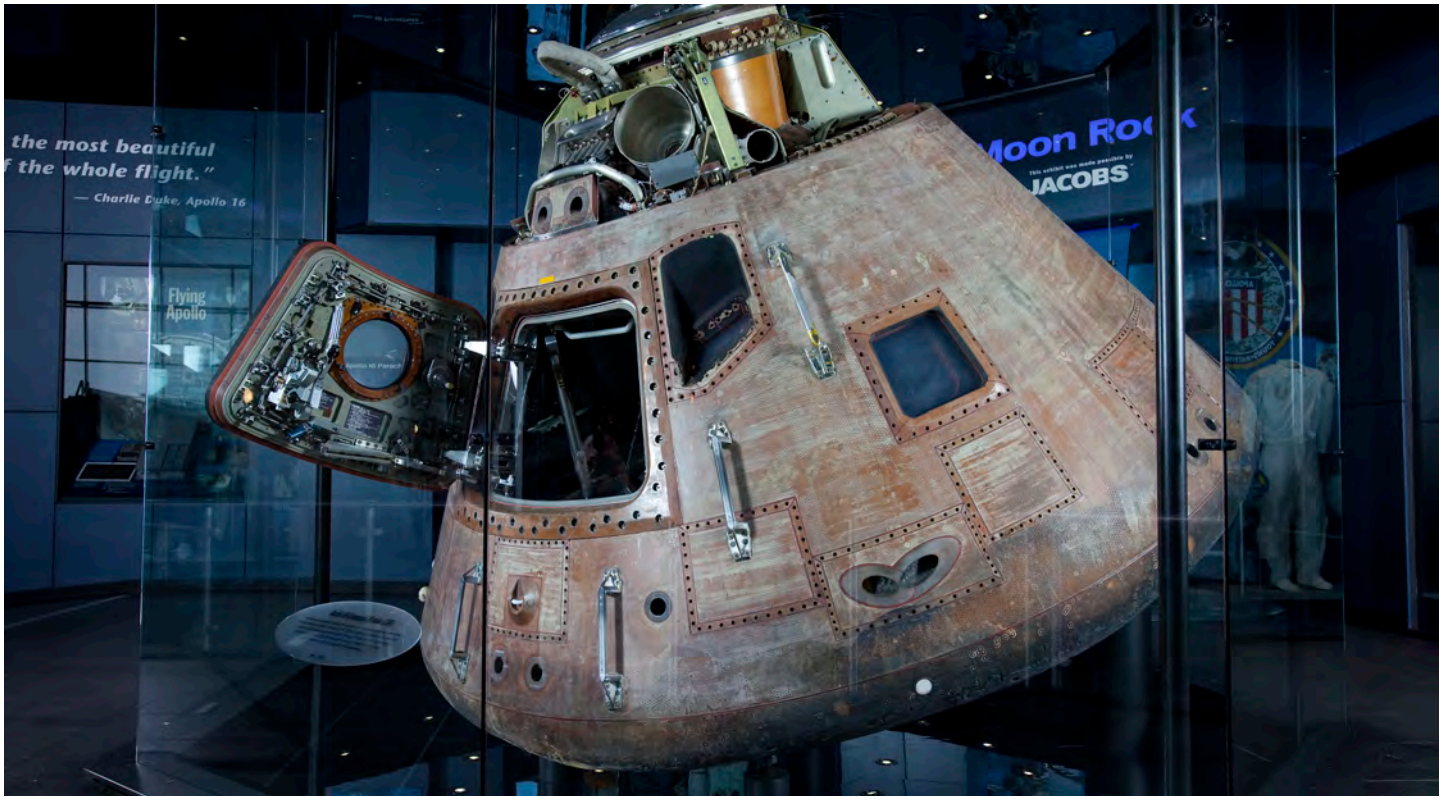


Photo courtesy of the U.S. Space & Rocket Center

1,500 kids for our summer sessions," he said. Space Camp operates year-round, with large school groups coming in the fall and spring months, as well as special programs like a Space Camp and Aviation Challenge program for blind and visually impaired students.

Planning & Design Priorities

Although the Davidson Center's main purpose is to shelter the Saturn V rocket (referred to as the USSRC's "crown jewel"), the Apollo 16 capsule and other priceless artifacts, the site's prominent location facing along I-565 highway provided a prime opportunity to build a magnificent structure that would become a beacon for the community. As the vision to construct this building began to cohere, it was clear that the essential first step would be to repair and restore the Saturn V rocket, which had experienced widespread finish and materials deterioration during the 35 years it had been displayed outdoors on its side.

EverGreene Architectural Arts (EverGreene) was hired to complete an expert evaluation of the rocket's condition, identify the specific causes of the deterioration and provide restoration services. EverGreene's team then made the necessary repairs, refurbished the rocket and oversaw its disassembly, relocation, reassembly and installation in the Davidson Center. (4)

Functionality

"The main reason a metal building was chosen was because we needed a very large and strong structure," Spearing said. As the largest rocket ever built, the Saturn V displayed in the Davidson Center's exhibit hall is 33 feet in diameter and 363 feet long with a fin span of 63 feet. (13) (14) "The first and second stages of the rocket are sitting on cradles that are anchored to the floor," he explained. "The rest of the Saturn V is suspended from the ceiling with cables. So, the steel structure is supporting both the building and the weight of several rocket sections, including the spacecraft-lunar module adapter (SLA), the command module, the service module and the escape tower. All these sections are aligned with each other and slightly pulled apart so people can view them separately."

Attractiveness

The Davidson Center was designed to attract tourists from near and far. Its architecture is distinctly different from the "blockhouse modern" style used by Huntsville architect David Crowe for the design of the original science museum building that opened in 1970. "Von Braun wanted people touring the original museum to experience what it was like to be in a building where the ceilings, floors and walls were all made from poured concrete," Spearing said. "There is nothing like this building elsewhere on Earth. If there was an F5 tornado, I feel I'd be safe inside it."

In contrast, the Davidson Center's design is transparent, spacious and spectacular. Its gigantic curtain walls face the I-565, which runs parallel to the building's north facade, providing an awe-inspiring view of the Saturn V rocket, worth 90 times the amount spent to construct the building. (15)

"In essence, we took a large metal [building] and made it into a museum, a billboard and an advertisement that everybody can see as they drive by," said former Gresham Smith architect Michael Mann in a 2013 project profile published by the firm. (16)

Flexibility

Julie Roquemore, senior interior designer for Gresham Smith, pointed out that creating such a large, wide-open building "resulted in a remarkably malleable interior space that is ideal for exhibitory while also being a flexible education and event center." The Davidson Center has a professional chef and catering staff who serve guests for occasions that range from family reunions, weddings and receptions to fundraisers, corporate gatherings, sit-down dinners and cocktail parties. Larger events are held beneath the suspended portions of the Saturn V rocket and more intimate gatherings at the INTUITIVE® Planetarium and other locations throughout the USSRC's campus. (17)

Cost Effectiveness

"The USSRC's Projects and Infrastructure Team is involved with major capital projects, and it must accomplish a lot while living within budgets," Spearing said. "We work with the state of Alabama's Division of Construction Management (DCM) because we are a state facility, and a small amount of funding is appropriated for USSRC educational programs that benefit Alabama students and educators. Beyond that, we are self-funded. Admission fees for the museum, planetarium and tuition for Space Camp, the Aviation Challenge and other programs provide the funds we need to operate. If we want to do something new, we have to find donors, and we have a 501(c)(3) foundation that plans and implements fundraising efforts. Donors often come to us. For example, parents of children who attend camp often contribute; and camp alumni, many of whom are now scientists and professionals, are also active donors."

Architect's Statement

In a 2010 Metal Architecture article, architect Jeff Miller said: "Just about everything related to the overall building design centers on the display of the [Saturn V] rocket. The sheer size of the rocket alone makes the building monumental, so the building was designed as a background, but with its own distinct visual homage to the Apollo space program." (18)

The Davidson Center's architecture uses insulated metal panels with a bright white exterior coating and a black matte interior surface to achieve a high-contrast backdrop for the Saturn V rocket, which is primarily white with black, red and yellow accents. According to Miller, a major advantage of choosing insulated metal panels to enclose the building is that they accomplish multiple design objectives at the same time: cladding, insulation and different interior and exterior finishes.

Roquemore added that the Davidson Center's design uses interior space and surfaces in innovative ways. "The floor features a diagrammatic graphic," she said. "Accent lights were installed above, on the sides and below to illuminate displays from all angles. There is a superimposed moon at the tip of the rocket that features the quote 'One small step for man; one giant leap for mankind.'"

Photo courtesy of the U.S. Space & Rocket Center

Photo courtesy of the U.S. Space & Rocket Center

PROJECT **CHALLENGES, GOALS & OBJECTIVES**

Simply housing the Saturn V rocket and related displays required the construction of a custom 65-foot-tall, 476-foot by 90-foot clear-span metal building. "Suspending the rocket from the structure was one of the most challenging aspects of this project," said Brad Yocum, Texas Division sales manager for American Buildings. "We needed detailed engineering specifications upfront to develop an accurate, competitive bid and then to produce the precise metal building components needed. The suspended rocket sections don't weigh the same at each point along its length. So, our engineers had to design for different point loads at each rafter."

Ultimately, engineers designed a 190-foot by 90-foot by 65-foot frame that was used for the main steel structure, plus 100-foot by 85-foot and 85-foot by 70-foot lean-tos that were added to the structural system. The building columns taper to a height of 20 feet; then they rise straight upward. The front part of the frame handles a standard load while the center section was engineered with a heavier frame to support the rocket.

Precise Construction Planning and Execution

Figuring out how and when to move and install the Saturn V was critical because the largest portions of the rocket are permanently landlocked. "The smaller parts of the rocket could be disassembled and moved out of the building if needed," Spearing said. "However, the first two stages are so large. Since everything is built up around them, you would literally need to shut down parts of the interstate to move them and they couldn't fit under the highway bridges."

"We had to leave one end of the building open during construction in order to get the rocket in," said Mike Johnson, president of JWC Specialties, Inc. (JWC), which erected and clad the metal building. (18) Once the Saturn V components were installed, JWC's team finished enclosing the building.

Photo courtesy of the U.S. Space & Rocket Center

Yocum said that building information modeling (BIM) was especially helpful for planning and executing these logistics. "We use BIM for every building," he explained. "This enables us to determine in a 3D environment whether or not something is going to work. BIM modeling has come to the rescue on certain projects where, for example, we weren't sure whether a particular piece of equipment was going to fit or if the interior of the building would be high enough."

Minimizing Movement

"Most people think buildings don't move," Yocum said. "However, when the wind blows, buildings do move a little. For the Davidson Center, we had a rocket that was suspended from the same structure that supports the building and we also had 17,000 square feet of glass curtain walls. So, this engineered metal building had to be strong enough to support the rocket and still be agile enough to avoid deflections that would break the glass panes or cause the rocket to sway." To achieve this balance, engineers limited frame deflections and provided longitudinal frame x-bracing between the columns.

Glazing

The high-bay architecture and grand-scale curtain walls bring natural light deep into the building while providing commanding exterior views. The windows have been tinted to limit heat gain and prevent ultra-violet rays from damaging artifacts displayed around the perimeter of the exhibit hall.

Acoustics

"We have acoustic dampers that run through the middle portion of the ceiling to absorb some of the sound," Spearing said. "Without these, the building's interiors would ring like a bell. Additionally, some of the exhibits have special sounds associated with them—including one that simulates the noise of an engine being test fired. Several people can stand in an alcove and experience what they would expect to feel and see if they were near the flight trench of a rocket being tested." (Flight or flame trenches are structures that redirect exhaust, heat and flames created by a rocket's engine to prevent damage to the rocket, its launch pad and the surrounding area.) (19)

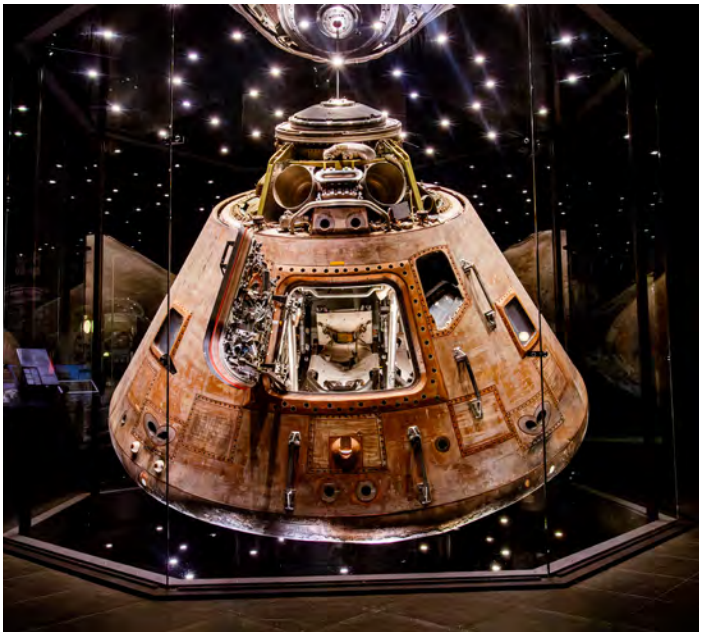
RELEVANCE FOR **STUDENTS**

"Often, architects want to make their own statement and that doesn't necessarily meet our needs," Spearing said. "I believe it's especially important for architects to pay attention to functionality—to address what the client needs and what the purpose of the building is. We have a complex that has been built over decades and we are trying to hold a theme together."

Spearing also emphasized the importance of a building being "producible" and noted that some design concepts presented to him and his team didn't meet this mark "When we've asked: 'How would you make this?' in [some] cases the answer has been 'We don't know, but we can figure it out.' That's not going to cut it," he said.

Since metal building technology has advanced and become more complex over decades, Yocum recommended that architecture students who want to learn more about metal buildings spend a week at their office and manufacturing facility.

"Years ago, a structure like the Davidson Center would never have been designed as an engineered metal building," he said.



Photos courtesy of the U.S. Space & Rocket Center

Practical Application

1. How did using a metal building optimize the use of materials and funds needed for the Davidson Center?

2. Generally, what characteristics and capabilities of metal buildings make them especially well-suited for the design of exhibit facilities?

3. What were the functional and aesthetic benefits associated with the architect's decision to use insulated metal wall panels? What additional benefits are offered by this choice of materials beyond those explicitly described by the Davidson Center's architect in this folio?

4. What do you consider to be the greatest design challenge for this project? Why? How did the team tackle this?

5. What do you think are the most distinct and valuable aspects of the Davidson Center's architecture? Why?

Review these MBMA web pages for more information:

- Aviation Gallery
- Design Resources

In addition to the Davidson Center, there are several other custom-engineered and fabricated metal buildings located on the USSRC campus. (21) These include:

- The Space Camp Operations Center, which was completed in May 2023. Panels on the front of this building are 3D-printed to simulate the lunar surface.

- Inspiration4 Skills Training Complex, a massive new building, will serve as a training center for Space Camp, the Aviation Challenge and corporate team-building programs. It will feature space mission simulations that place students in futuristic scenarios, a ropes course and climbing structures, astronaut training simulators, as well as a parachute simulator, an indoor drone flying range, an area for night-vision training and other equipment. An exterior aircraft display under a metal canopy will greet campers as they enter the building.

According to Spearing, NASA has also used metal as the main material for structures as monumental as the Vertical Assembly Building (VAB) at the Kennedy Space Center, which is one of the largest buildings in the world (by area) and also a national landmark. The VAB stands 525 feet tall and is 518 feet wide, with its footprint covering eight acres. It took 98,590 tons of steel to construct its frame and 4,225 steel pilings that were driven 164 feet into bedrock to anchor and support its base. (20)

"This is where the Saturn V rockets were erected," Spearing said. "There are four bays in the main part of the building and each one could house a Saturn V rocket. When you enter from the front end, you think: 'Wow. This is such a huge, tall building.' Then, when you get to the high-bay section, the ceiling just disappears. It's so tall that they've had clouds forming on the inside. This building had to have gigantic, open, interior spaces and has withstood countless hurricanes over the years."

Photo courtesy of the U.S. Space & Rocket Center

RESOURCES/RELATED READING

Related Reading

- Alabama Engineering Hall of Fame
- Design and Build with Metal
- Power to Explore: A History of Marshall Space Flight Center, 1960 – 1990
- U.S. Space & Rocket Center | U.S. Space & Rocket Center
- U.S. Space & Rocket Center - Encyclopedia of Alabama
- U.S. Space and Rocket Center | The Center for Land Use Interpretation

Video Resources

Over 50 videos highlighting metal building architecture, engineering, design and application can be accessed at www.youtube.com/mbmamedia. We recommend you begin your educational process with the following programs:

- Metal Building Systems 101
- An Introduction to Metal Building Systems
- How It's Made: Metal Building Innovations Are Revolutionizing Low-Rise Commercial Construction
- How It's Built: Metal Building Construction Raises the Bar for Low-Rise Commercial Structures
- Metal Building Wind Loads - Transverse

Additional Videos

- Davidson Center for Space Exploration Construction
- The Davidson Center for Space Exploration at the U. S. Space and Rocket Center, Huntsville, AL
- STS-129 HD Launch
- Window Walls vs Curtain Walls Differences Explained

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