National Aeronautics and
Space Administration

Marshall Space Flight Center's Journey
—From the Shuttle to the Future

A Final Liftoff of America's Space Shuttle Program

With the liftoff of the STS-135 mission onboard Atlantis from Kennedy's Launch Pad 39A, NASA celebrates the end of an era and the beginning of a new journey. The STS-135 mission is delivering the Raffaello multipurpose logistics module filled with the supplies and spare parts needed to sustain the International Space Station (ISS). This flight is NASA's 135th shuttle mission, the 37th mission to the space station, and the final liftoff of America's Space Shuttle Program

Paving the Way

The space shuttle has been part of the American identity, and its legacy is part of our experience for the past three decades. However, the end of the Shuttle Program paves the way for NASA to transition to the next generation of space vehicles. The agency is developing a new Space Launch System (SLS) and Multipurpose Crew Vehicle (MPCV) to travel to low-Earth orbit and beyond, including near-Earth objects, the Moon, Lagrange points, and Mars.

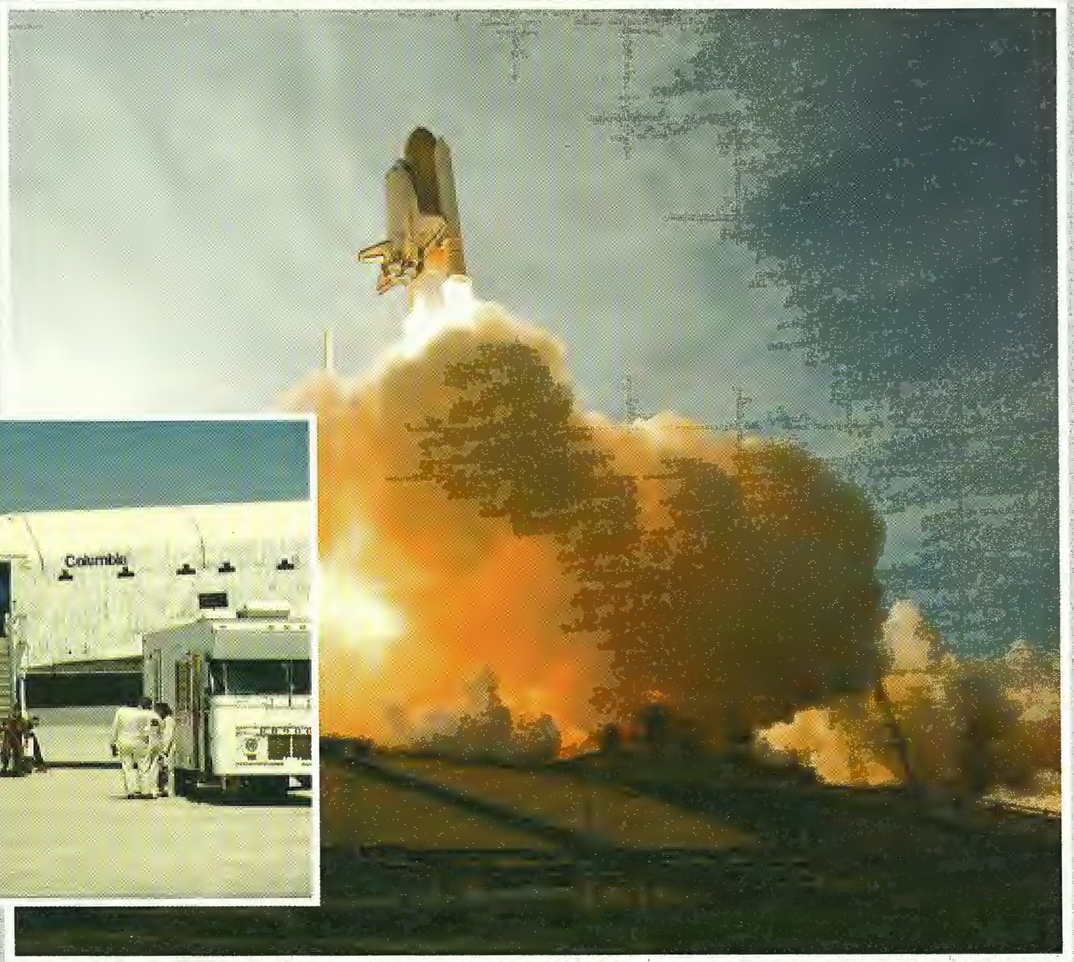
NASA Marshall Space Flight Center is responsible for planning the design and development of the new space launch system. The Center will maximize shuttle investments and advances in technologies to ensure America has access to space that is affordable, reliable, and sustainable. As NASA extends America's reach beyond Earth orbit, the Agency will partner with the commercial space industry to provide safe and cost-effective human access to the International Space Station.

Transforming the Shuttle Into a Safer, More Capable Spacecraft

As the world's first reusable spacecraft, the space shuttle first launched in April 1981. It was designed using the most advanced technologies available in the 1970s. But the shuttle that flew 30 years ago is not the same shuttle that flies today.

Marshall is responsible for the space shuttle's propulsion system, consisting of the main engines, the solid rocket boosters with their solid rocket motors, and the external tanks. Thousands of advances in technology and enhanced designs have been applied to the shuttle since it first launched, making it safer, more powerful, and more reliable. From the beginning, engineers at Marshall understood that improving performance and reducing vehicle weight would enable the shuttle to place greater payloads in orbit more quickly and at reduced cost.

The knowledge gained during 30 years of shuttle performance has provided a legacy of countless advancements and new technologies. These developments form a solid foundation for launching future missions of exploration and scientific discovery.



Improvements to Propulsion System

Reusable Solid Rocket Boosters: The space shuttle's two four-segment reusable solid rocket boosters (SRBs) provide the main thrust to lift the shuttle off the launch pad and up to an altitude of about 150,000 feet. Improvements to the SRBs focused on reducing weight and increasing safety and reliability. By creating a thinner casing, Marshall engineers were able to reduce the weight of each booster by 4,000 pounds. They narrowed the booster's throat and enlarged its nozzle to increase thrust and allow 3,000 more pounds of payload. Engineers recently tested a new design that increases the capabilities of these powerful boosters by 25 percent, providing new options for heavy-lift launch system designs. Motor upgrades from the shuttle's current boosters include the addition of a fifth segment, a larger nozzle throat, and upgraded insulation and liner.

Space Shuttle Main Engines: Developed in the 1970s, the space shuttle main engines (SSMEs) are the world's first reusable rocket engines. The shuttle is equipped with three engines, which are propelled by liquid hydrogen (fuel) and liquid oxygen (oxidizer). They operate during the entire 8.5-minute ride to orbit at extreme temperatures and pressures. Since these engines first lifted Columbia to space in 1981, Marshall has completed four major overhauls to the original design — tripling the safety, reliability, and performance of the engines.

The engine's main combustion chamber has been enlarged to reduce pressure on internal components without reducing thrust. A new simplified engine nozzle design eliminates the need for hundreds of welds — more than 500 feet of them — and reduces the potential for leaks. Additional improvements to the SSMEs reduce internal engine pressures and turbulence, decreasing stress on the engine and improving reliability and safety.

A recent upgrade includes an optical and vibration sensor system called the Advanced Health Management System. The system's high-tech sensors detect and track flaws in the engine's performance, enabling it to safely shut down if necessary. Monitoring systems such as this will be crucial to understanding the performance of new launch systems.

External Tank: The external tank (ET) is the fuel tank that holds the propellants used by the shuttle's main engines. The original tank used on the first shuttle launches in the early 1980s weighed approximately 76,000 pounds. A program to redesign the tank produced a 10,000-pound weight savings. The resulting lightweight tank, introduced on the sixth mission (STS-6) in 1983, made substantial improvements in shuttle performance. Since then, engineers have saved roughly 7,500 pounds by constructing the tanks from a stronger, lighter aluminum-lithium alloy and incorporating weight-saving design changes. The use of new materials required Marshall engineers to develop new manufacturing techniques to weld together the large panels that form the tank. Significant advances to the friction stir welding process improve the reliability and strength of weld joints in these alloys and reduce manufacturing time and cost. Designs for future crew and heavy-lift vehicles are incorporating these lightweight materials and manufacturing techniques.

30 Years of Accomplishments

The space shuttle has served America's science and research programs for 30 years. It has been used to transport people and payloads into low-Earth orbit for the purpose of building the space station, the largest structure in space. It has served as a platform to deploy planetary spacecraft to study Jupiter, Venus, and the Sun, and it enabled astronauts to visit the Hubble Space Telescope five times for servicing missions. In the orbiters' onboard laboratories, hundreds of experiments have been performed to help scientists study the effects of microgravity on materials, plants, animals, and human beings, providing untold benefits to life on Earth and preparing for humans to journey beyond the Earth's orbit.

In addition to numerous improvements to the space shuttle, more than 120 technologies derived from the shuttle program have benefited United States industry, improved quality of life, and created jobs. These benefits have been seen in the fields of engineering, medicine, communications, transportation, environmental remediation, public safety, and even consumer goods.

With the shuttle's final liftoff, we reflect on the accomplishments of this amazing vehicle and the generations of people who made it possible. We look forward to the journey ahead, reaching for new heights to reveal the unknown and make discoveries that will benefit all humankind.

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