The Marshall Star

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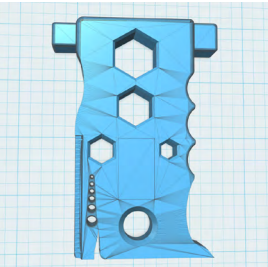

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The State of the Center

Marshall Space Flight Center Deputy Director Teresa Vanhooser talks about NASA's $18.5 billion fiscal year 2016 proposed budget as Marshall Director Patrick Scheuermann, center, and Johnny Stephenson, acting director of the center's Office of Strategic Analysis and Communications, look on during an all-hands meeting with employees Feb. 2. The proposed budget includes $2.09 billion for Marshall. "This is a strong budget for Marshall," Scheuermann said. "It provides stability for our workforce and the resources necessary to advance our deep space exploration programs." (NASA/MSFC/Emmett Given)

*See **State of the Center** on page 2*

Turning up the Temperature: Mini Models Fire Up for SLS Base Heating Tests

By Megan Davidson

It may be cold in upstate New York, but NASA engineers are turning up the temperature in Buffalo for a series of tests that will provide critical data on the heating conditions at the base of NASA's new rocket, the Space Launch System.

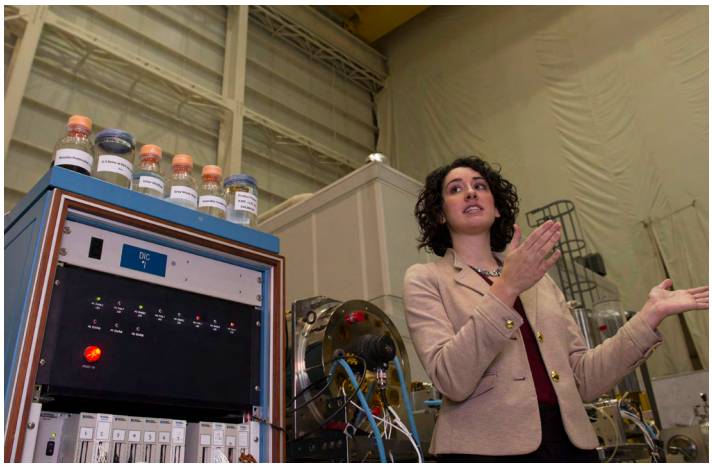
A team of engineers at NASA's Marshall Space Flight Center is working in close collaboration with CUBRC Inc. of Buffalo to design, build and test 2-percent scale models of the SLS propulsion system. That includes two five-segment solid rocket boosters and four core stage RS-25 engines, and a 2 percent, or 6.5-foot-tall, scale model of the entire rocket. The models are fired for short durations -- around 50-150 milliseconds per test.

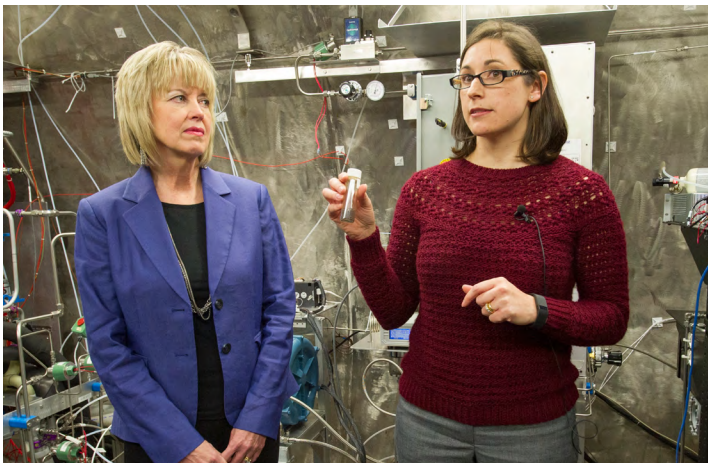
SLS will be the most powerful rocket ever built for deep space missions, including to an asteroid and eventually Mars.

*See **Base Heating Tests** on page 3*

State of the Center *Continued from page 1*

Jennifer Pruitt, lead design engineer for the International Space Station Urine Processing Assembly at Marshall, briefs a group of more than 20 social and traditional media representatives about her work to improve the recycling of water for astronauts. The tour of Marshall work supporting NASA's journey to Mars was part of agency-wide "State of NASA" events Feb. 2. The tour also included a look at oxygen recycling efforts, a Space Launch System Core Stage Simulator and a chance to talk with Marshall Director Patrick Scheuermann and Deputy Director Teresa Vanhooser. (NASA/MSFC/Emmett Given)





Dr. Morgan Abney, right, tells tour participants about her Environmental Control and Life Support Systems work to recycle more of the oxygen needed by astronauts aboard the International Space Station and on future deep-space missions. Marshall Deputy Director Teresa Vanhooser, left, joined Abney and others as they outlined a few of Marshall's programs critical to exploration objectives. (NASA/MSFC/Emmett Given)

Christopher Crumbly, manager of the Spacecraft Payload Integration and Evolution Office, gave visitors an insider's perspective on the Core Stage Simulator at Marshall and its importance to development of the Space Launch System. (NASA/MSFC/Emmett Given)

Base Heating Tests *Continued from page 1*

"There's a lot of complex work that goes into such a short-duration test," said Manish Mehta, lead engineer for the SLS Base Heating Test Program at Marshall, where the SLS Program is managed for the agency. "The timing of the propulsion systems and shock tunnel have to be precise. Although this test program has been technically challenging, there's no heritage data that we can fall back on to predict SLS base environments because this vehicle has never been flown before.

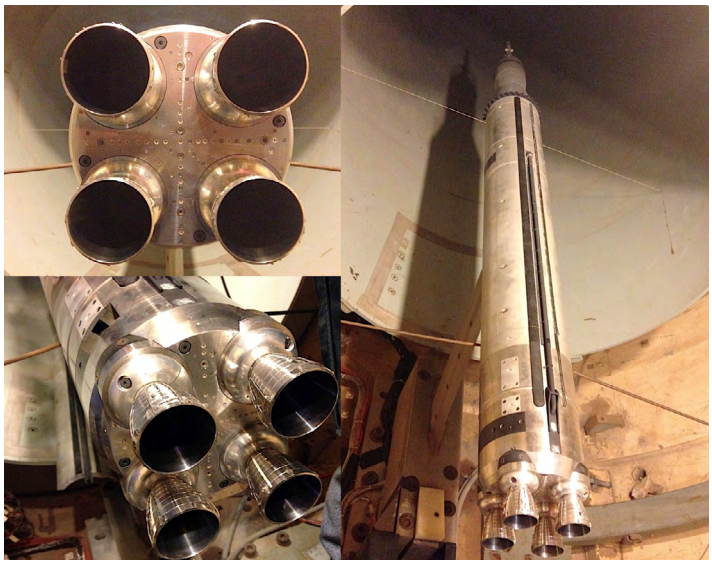
"There are four engines and two booster rocket plumes that are firing into the base," he said. "This results in highly complex flow physics, which is not something you can develop analytically and predict very accurately."

Testing of the mini models will provide data on the convective heating environments the base of the rocket will experience upon ascent for both planned and unplanned flight conditions. Data from the test series will be used to verify flight hardware design environments and set specifications for the design of the rocket's base thermal protection system. The system keeps major hardware, wiring and crews on future missions safe from the extreme heat the boosters and engines create while burning during ascent.

The models took about a year and a half to design and build to flight specifications and performance. For the test series, which began in August 2014, the replicas are loaded with propellant, pressurized with hydrogen and oxygen lines and ignited in one of CUBRC's shock tunnels. The shock tunnel replicates both supersonic and hypersonic flight conditions, matching what the rocket's environment will be like during ascent, including temperature, pressure and velocity.

"We like to say we're duplicating a flight test on the ground," said Aaron Dufrene, technical lead at CUBRC. "What's great about the design of these models is we can run them dozens, even hundreds, of times and reuse most all of the hardware every single time."

Testing for the core stage in normal ascent scenarios was completed first, followed by testing with the entire SLS model in early January. The full-stack configuration has 200 heat flux and pressure sensors within the aft section of the rocket to collect data on the base flow environment. More than 30 test cases have been performed, with about 85 total scheduled for the entire test series. The testing is planned to conclude early this summer.



A 2-percent scale model of the Space Launch System core stage RS-25 engines, in the pictures at left, and a model of the SLS without the twin boosters are used for nominal, core-stage-only testing at CUBRC Inc. in Buffalo, New York. (NASA/MSFC)

"That's why NASA historically started doing this short-duration testing technique," added Mark Seaford, a Marshall engineer who works on the test project. "Since you are testing at a much smaller scale, in this case 2 percent, the heating goes up at the throat of the nozzles. We can't run it for a substantial length of time or the hardware would be compromised under the heat. We really had to challenge ourselves in the design process to get the right materials to minimize that risk."

Read the full version of this story here.

Davidson, an ASRC Federal/Analytical Services employee, supports the Office of Strategic Analysis & Communications.

Marshall Center Observes Day of Remembrance Jan. 29

Lighting a candle during the Jan. 29 Day of Remembrance ceremony at NASA's Marshall Space Flight Center are, from left, Patrick Scheuermann, Marshall director; John Honeycutt, deputy manager of the Space Launch System Program Office; and former astronaut Robert "Hoot" Gibson. The observance in Building 4200 paid tribute to the crews of Apollo 1 and space shuttles Challenger and Columbia, as well as other NASA colleagues. (NASA/MSFC/Emmett Given)

Four Marshall Center Engineers Receive NASA Innovation Award

By Jena Rowe

Four engineers from NASA's Marshall Space Flight Center were recently selected as recipients of the NASA Innovation Award. Recipients were Larry Leopard, director of the Marshall Space Systems Department; Chris Singer, director of the Marshall Engineering Directorate; and Terry Rolin and Steven Peeples, both engineers in the Space Systems Department.

NASA's Office of Human Capital Management established the NASA Innovation Awards to recognize those individuals who exemplify the spirit of innovative behavior. The awards are separated into two categories: the "Champion of Innovation Award," and the "Lean Forward; Fail Smart Award."

Champion of Innovation Award - Larry Leopard; Chris Singer

The Champion of Innovation award is designed to recognize supervisors and managers who build a culture of appropriate risk-taking and who support and encourage creative and innovative behaviors from their employees. These individuals demonstrate excellence in leadership, vision, building relationships and being a professional role model for those around them.

Larry Leopard, director of the Marshall Engineering Directorate's Space Systems Department, received the Champion of Innovation award for continually challenging the status quo by taking appropriate risks to improve how the Space Systems Department accomplishes its work. He strives to set the example for creative and innovative behavior, and regularly encourages his employees to try new innovative approaches.

Leopard has championed a new, simpler cost-estimating tool to allow the department to quickly pursue new work without burdening employees who are supporting existing projects. This innovation has established a flexible, "yes we can" attitude throughout the Space Systems Department, empowering team members to take appropriate risks and develop their own creative ideas.

Chris Singer, director of the Marshall Engineering Directorate, received the Champion of Innovation award for his innovative approach to risk. As a young engineer, Singer worked on space shuttle main engines and often says that he learned as much from engine failures on the test stand as he learned from successes. Those experiences have allowed Singer to influence a shift in the risk posture within Marshall's engineering workforce from an operational oversight mode to a development mode.

Singer has advised teams that there is a time and place for everything and prudent risk-taking is part of great engineering, especially during vehicle development when innovation can have the greatest impact on vehicle affordability and sustainability. This change in how to approach risks not only provides engineers with hands-on experience with real hardware, but also helps NASA become more sustainable by exploring how these technologies and processes can improve the way we do business.

*See **Innovation Award** on page 5*

NASA Transfers Software To Army, Saving Taxpayers Millions

By Christopher Blair

NASA has transferred calibration and testing software to the Army, potentially saving the government nearly $4 million.

"NASA has been at the forefront of good stewardship with the taxpayers' dollars, and this initiative is no exception," said Gary Kennedy, NASA representative for the Metrology and Calibration Laboratory at NASA's Marshall Space Flight Center. "Sharing these procedures enhances the Army capability to perform more calibrations

*See **Software Transfer** on page 6*

James Johnson, left, executive director, Redstone Arsenal U.S. Army Test, Measurement & Diagnostic Equipment, accepted software from Patrick Scheuermann, director of NASA's Marshall Space Flight Center. The collaboration potentially saves the government nearly $4 million. (NASA/MSFC/Emmett Given)

Innovation Award *Continued from page 4*

Lean Forward; Fail Smart Award - Terry Rolin; Steven Peeples

The Lean Forward; Fail Smart award is designed to encourage, recognize and celebrate the spirit that propels individuals to take the risk to innovate -- unfortunately failing to reach the desired outcome, but learning from the attempt. These individuals exhibit the courage to depart from usual practice, have a determined will to succeed, demonstrate the ability to distinguish between productive and unproductive failures, and consistently share knowledge with others.

Terry Rolin, engineer in the Space Systems Department, set out to build a solid-state ultracapacitor to replace batteries that would avoid the use of hazardous chemicals, charge rapidly and be packaged in a way that was small but robust enough to survive aerospace environments. In addition, he proposed to build the device using nanotechnology and additive manufacturing techniques that had not been tried. After several failed attempts, Rolin collaborated with various materials experts to help characterize what was happening at the nanoscale level.

This collaboration began to pay dividends immediately. Rolin discovered heating the device at high temperatures to sinter the electrode ink was causing the shell to diffuse into the core. He needed to try something new. So he developed an electrode ink that would sinter at low temperatures but still be solderable in a way that commercial manufacturing would not be jeopardized. The formulation and processes used to create this ink are in the stages of a new technology submission for patent. If this spin-off technology leads to commercialization, it will help device manufacturers produce electrodes for a variety of devices at lower costs with less impact to their final components.

Steven Peeples, an engineer in the Space Systems Department, developed the idea for the Spherically Actuated Motor while building robots at home. It takes at least three actuators to make a robot arm or leg articulate enough to be useful. Peeples wondered, "Why can't a single actuator be built that operates like a shoulder or hip joint to take their place? Why hasn't NASA developed one of these?"

He began talking about the idea of the Spherically Actuated Motor with fellow engineers, managers and technicians regarding manufacturability, viability and reliability. These conversations led to awards of small amounts of funding. Now, a three-degree-of-freedom spherical actuator is under development that will replace functions requiring three single-degree-of-freedom actuators in robotic manipulators, providing space and weight savings while reducing the overall failure rate. This innovation will add new versatility to NASA robotic missions.

To learn more about the NASA Innovation Awards and the Marshall recipients, click here.

Rowe, an ASRC Federal/Analytical Services employee and the Marshall Star editor, supports the Office of Strategic Analysis & Communications.

Software Transfer *Continued from page 5*

in less time, which leads to better customer support and substantial savings."

NASA is transferring more than 2,400 automated calibration procedures. 1,700 were developed for the Space Shuttle Program with another 300 for general NASA use. Since 2013, 400 were developed at Marshall and are currently being used for NASA programs and projects including NASA's Space Launch System, a new deep space exploration rocket managed by Marshall.

Army officials touring the Metrology and Calibration Laboratory, known as the Marshall MCL, became aware of the automated software. Representatives from the Army's Test, Measurement and Diagnostic Equipment Activity recognized the time and cost benefits of NASA-developed software and formally requested access for Army calibration requirements. This transfer will reduce time the Army would have spent developing its own procedures.

NASA approved the request and held a transfer ceremony on Jan. 27 with Marshall Center Director Patrick Scheuermann and James B. Johnson Jr., executive director of the U.S. Army Test, Measurement & Diagnostic Equipment Activity.

"We currently have a couple of software programmers writing procedures," said David Hargett, chief of the metrology engineering division at the Army's Test, Measurement and Diagnostic Equipment Activity. "In a four-month window, they finished maybe 25. So, with access to this NASA capability, our numbers will increase to more than 2,400."

Senior metrologist Jeff Cheatham spent 12 years developing the procedures and emphasized the positive impact from using a standardized set. "Human involvement increases the probability of errors, so this minimizes that risk," he said. "Using automated procedures ensures recorded data has a high level of veracity or stability with minimal variability from technician to technician."

The MCL is part of Marshall's Engineering Directorate's Test Laboratory and Cheatham supports the lab through a contract with the Marshall Engineering Technicians and Trades

Jeff Cheatham, senior metrologist at the Marshall Center, developed 2,400 automated software procedures used to calibrate instruments for testing space vehicles and equipment. Marshall transferred this software to the Army for use in calibrating their test instrumentation. (NASA/MSFC/Emmett Given)

Services contract. The MCL assures NASA maintains the most technically advanced measurement concepts and processes. They measure and analyze data in mechanical, electrical, force and flow.

Other NASA centers have already benefited from Cheatham's procedures, as they are available to download through NASA Web portals. The Army will be the first non-NASA recipient. It is anticipated this could spark interest from other Department of Defense branches or other government agencies.

NASA's Metrology and Calibration Program has been at the forefront of repurposing space agency hardware, software and knowledge benefiting NASA projects. With Cheatham's help, equipment was relocated to various NASA centers, including Marshall -- a move saving NASA millions.

Blair, an ASRC Federal/Analytical Services employee, supports the Office of Strategic Analysis & Communications.

Alabama and Washington Students Selected for Winning Designs of 3-D Printed Tools for Astronauts

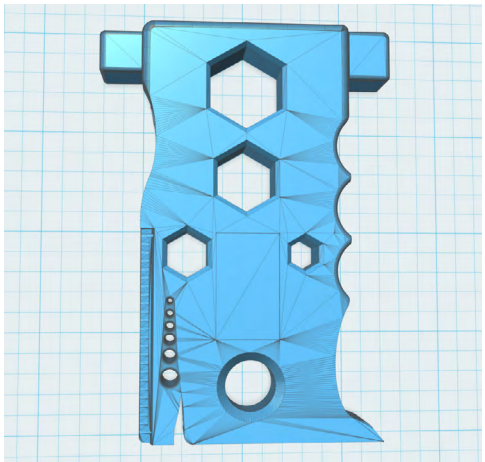
After young competitors spent three months designing and creating models for 3-D printed astronaut tools, a panel of judges from NASA, the American Society of Mechanical Engineers Foundation and Made In Space Inc. in California, selected the winners of the Future Engineers 3-D Printing in Space Tool Challenge.

The Future Engineers challenge asked competitors in grades K-12 to use their imagination to create and submit a digital 3-D model of a tool that they thought astronauts could use in space. The winner from the teen group, ages 13-19, is Robert Hillan of Enterprise, Alabama, who designed a Multipurpose Precision Maintenance Tool. Hillan will watch from NASA's Payload Operations Integration Center at NASA's Marshall Space Flight Center as his design is printed aboard the International Space Station.

"This challenge has been an amazing experience which taught me many educational skills that will greatly benefit me in the future," said Hillan. "It has given me an opportunity to put something on the space station, something I've always wanted to do, and I'm so grateful I was able to participate."

Sydney Vernon from Bellevue, Washington, won the junior group, ages 5-12, by designing a Space Planter. Vernon will receive a 3-D printer for her school.

"If an astronaut tool breaks, future space pioneers won't be able to go to the local hardware store to purchase a replacement, but with 3-D printing they will be able to create their own replacement or even create tools we've never seen before." said Niki Werkheiser, project manager for NASA's In-Space Manufacturing at the Marshall Center.



Robert Hillan of Enterprise, Alabama, won first place in the Teen Group in the 3-D printing challenge for his Multipurpose Precision Maintenance Tool design. He will watch as it is made on the International Space Station 3-D printer managed by Marshall. (Robert Hillan)

NASA Astronaut Barry "Butch" Wilmore holds a 3-D printed ratchet wrench manufactured by a 3-D printer aboard the International Space Station. (NASA).

Winners were selected after a panel of expert judges interviewed the four highest rated winners from each age group. The panel members were Werkheiser; Mike Snyder, head of research and development for Made In Space Inc.; and NASA astronauts Reid Wiseman and Yvonne Cagle.

This challenge tapped into the creativity and ingenuity of our nation's future engineers to imagine interesting solutions for potential mission-related problems. Models were received from 470 students across the United States. All winners and entries can be viewed at the Future Engineers Challenge site.

The Space Tool Challenge is the first in a series of 3-D printing challenges for students focused on designing solutions for real-world space exploration problems. They are conducted by the ASME Foundation in collaboration with NASA and were announced in June as part of the White House Maker Faire to empower America's students to invent the future by bringing their ideas to life. The next challenge will be announced in April.

The challenge supports NASA Human Exploration and Operations Mission Directorate's 3-D Printing in Zero-G International Space Station Technology Demonstration.

Marshall Center's 'Day of Remembrance,' Dawn Images of Ceres Featured on TW@N

On Jan. 29, NASA's Marshall Space Flight Center observed a "Day of Remembrance," honoring those who lost their lives supporting NASA's mission of exploration. Also last week, the Dawn spacecraft captured images of the dwarf planet Ceres. Both events were featured in the latest edition of "This Week @NASA," a weekly video program broadcast nationwide on NASA-TV and posted online.

During the "Day of Remembrance" ceremony, Patrick Scheuermann, Marshall center director; John Honeycutt, deputy manager of the Space Launch System Program Office; and former astronaut Robert "Hoot" Gibson joined Marshall team members in the lobby of Building 4200 to light a memorial candle.

The Jet Propulsion Laboratory manages the Dawn mission for NASA's Science Mission Directorate in Washington. The Dawn mission is a part of the Discovery Program managed by the Marshall Center, continued its approach to Ceres and captured its best images, to date. An animation was created, representing our highest-resolution views. The images were taken on Jan. 25, at a distance of 147,000 miles. Dawn is scheduled to become the first probe to visit a dwarf planet when it enters orbit around Ceres on March 6.

View this and previous episodes at "This Week @NASA" or at https://www.youtube.com/user/NASAtelevision.