National Aeronautics and Space Administration

Space Technology

Game Changing Development Highlights

July-August 2014

NASA Langley Technology Day Draws Huge Crowd
3D Printer Ready for Launch
Student Interns Join Space Tech for the Summer

Advanced Manufacturing's "Machine Shop in Space" Set for Launch

—Denise M. Stefula

The SpaceX-4 launch scheduled for September 20, 2014, will carry the first 3D printer to the International Space Station (ISS). The "3D Printing in Zero Gravity Technology Demonstration" test will serve as proof-of-concept for 3D printing in microgravity.

NASA's Game Changing Development Program team, which includes industry partner Made In Space, Inc., in support of the Advanced Manufacturing Technologies project, is at Marshall Space Flight Center (MSFC) readying for launch. Researchers are performing materials characterization and testing on parts identical to those that will be printed in space to ensure that the design parameters and materials are well understood when it comes time to compare the ground and space samples.

The 3D printers use acrylonitrile butadiene styrene (ABS) plastic—the same material Legos® are made of—as feedstock, and the printer deposits the plastic one layer at a time to build, or print, a three-dimensional object.

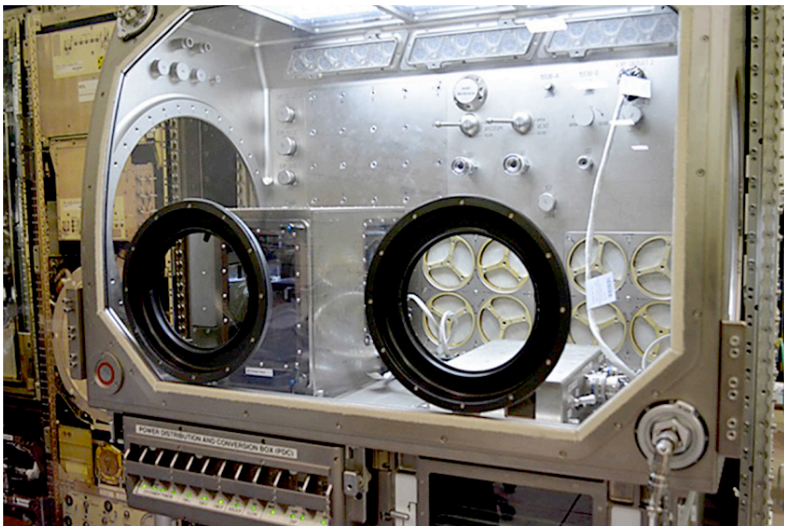
We checked in with Niki Werkheiser, 3D print project manager, for an in-depth look into the team's preparation for launching a technology demonstration that will inform what could become the very first "machine shop in space."

Q: What is the importance of this endeavor?

A: The capability of manufacturing needed parts on-demand during a mission, without having to rely on resupply from Earth, is critical to a sustainable existence off Earth. In situ fabrication and repair technologies provide risk mitigation for missions, as they provide crucial parts on demand.

Q: Tell us about characterizing the ground samples that the flight samples will be compared with?

A: The ground samples will be analyzed for tensile strength, compression resistance, and flexure. MSFC currently has multiple copies of coupons that will be printed on orbit for comparison. These samples will



3D print flight unit in the Micro Science Glovebox engineering unit (left) printing final ground control samples (right).

serve as the baseline for comparison—to show the difference between the material properties of objects printed on the ground and those printed on orbit.

Q: What is the desired outcome of this comparison?

A: The desired outcome is to show that parts printed on orbit are equitable to parts printed on the ground in terms of applications and utilization. Once that is established, the second phase of the tech demo will focus on demonstrating the meaningful utilization of parts printed on orbit, such as crew tools, experiment hardware, medical hardware, etc. Made In Space, Inc., is also using the design and operations data from the 3D print tech demo as feedback for developing its commercial Additive Manufacturing Facility (AMF), which will be the next generation 3D printer for space station.

Q: Tell us more about the MSFC prelaunch material testing activity. What is the process?

A: The MSFC materials testing activity will identify any effects of microgravity on the printing process. This will be accomplished by analyzing samples printed on the ground for properties such as dimensional variability, strength, general material characteristics, as well as behavior of the material based on the way it is layered (printed). The data generated from the ground prints will be compared with the data obtained from prints made on orbit. This comparison will determine if there are any meaningful differences between printing on the ground and in space that are a result of microgravity. If differences are identified and understood, the next generation of on orbit 3D printers will evolve to account for any microgravity effects. If it is established that the ground and space prints are equitable, then the second phase of the technology demonstration will focus on demonstrating utilization of the printed parts (such as crew tools, payload ancillary hardware, medical equipment, etc.) on the ISS.

Q: Tell us about the ground operations training going on…the various elements being trained in prior to launch, desired outcomes, etc.

A: Ground operations training involves making sure delegated parties understand the full capability of system commands and that those commands meet

Niki Werkheiser: The Importance of 3D Printing Technology

“Any remote location, whether it is the middle of the desert or the surface of Mars, presents a challenge in terms of obtaining the resources one needs to thrive. Analogous to the way the printing press evoked the Renaissance and generated a middle class by making information accessible to everyone, 3D printing will do the same by providing the individual with the capability to produce on-demand goods wherever and whenever they might be needed. This is particularly meaningful when applied to space exploration where the supply chain has been severely constrained due to the dependency on launching everything that might be needed from Earth. Later this year, history will be made by launching the first 3D printer to the International Space Station aboard the SpaceX-4 rocket.

This technology will forevermore improve the way we live and operate in space and ultimately provide the much-needed solution for sustainable human exploration. It will disrupt the traditional supply chain we’ve been constrained by throughout spaceflight history and present options never before considered. In addition to the obvious on-demand benefits, it becomes even more intriguing when one begins to realize that parts can be designed in a whole new way when they can be designed and produced in the microgravity environment and the significant structural constraints due to launch loads experienced when escaping Earth’s gravity no longer apply. With this technology, you can design the part you need both in and for the environment where it will be used.

the requirements for interfacing with space station systems. For example, Made In Space, Inc., will be able to turn the power, lights and printing operations on and off of the printer on the space station from their offices in Silicon Valley. Because this is a technology demonstration, we want to learn everything we can about how printing in space may differ from printing on Earth.

On the ground, Made In Space is printing thousands of times, extensively testing the hardware to see how it functions under a range of variables. Made In Space has already tested 3D printing on parabolic airplane flights, which provide small periods of microgravity, and successfully printed during those flights. That being said, there's no one-to-one comparison in terms of the environment, so NASA and Made In Space will be evaluating any differences encountered.

Q: What is the purpose of the remote commanding area and how will the team use it?

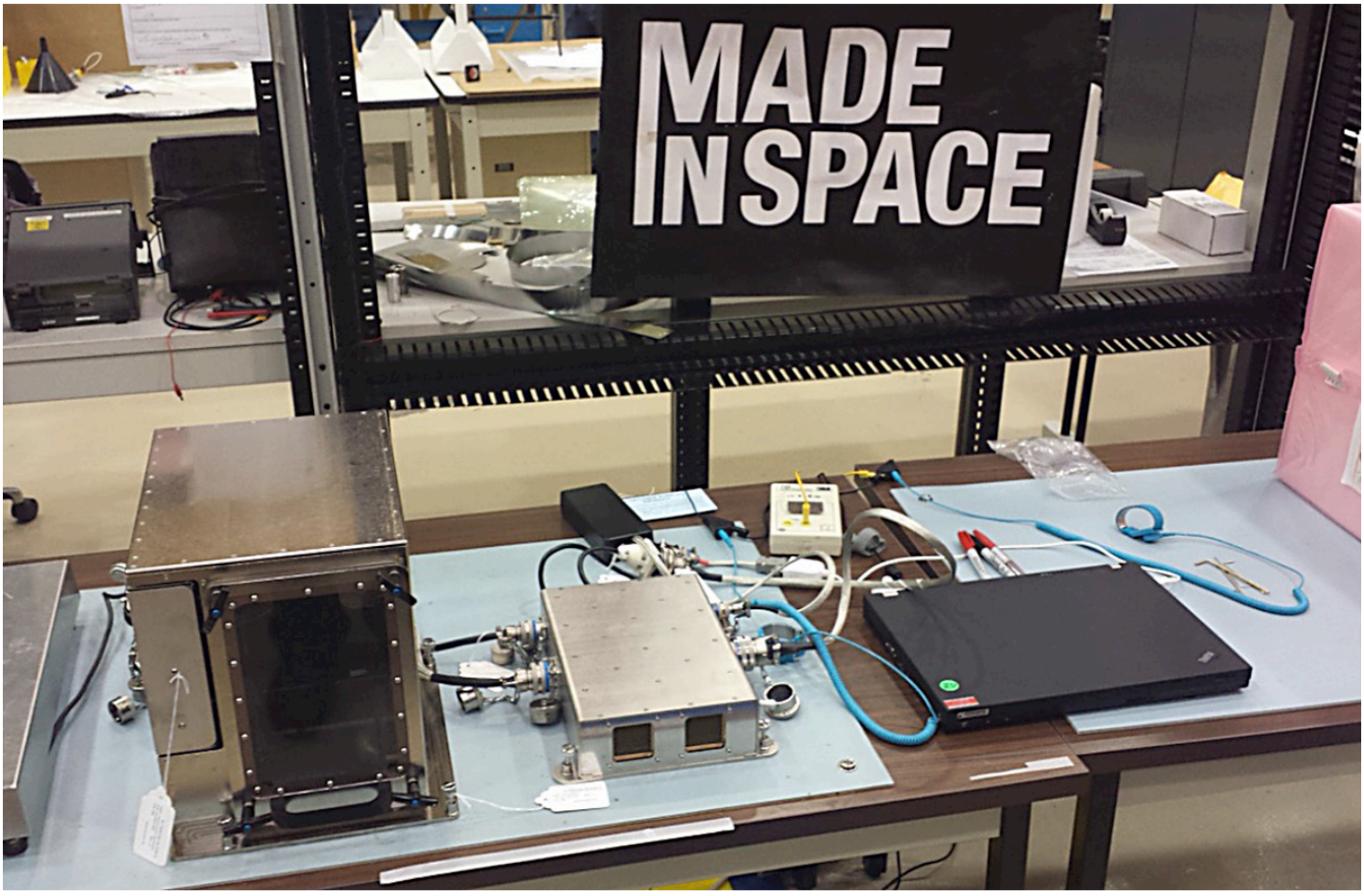
A: Though it is possible for astronauts to operate the printer on ISS, astronaut time is very limited, so the more we can operate remotely from the ground, the more we can print on-orbit. Additionally, Made In Space and NASA want to demonstrate the capability to quickly upload a file from the ground and print it on the space station. This will demonstrate that 3D printing of objects on ISS will not require a lot of crew time and, if need be, ground stations can send necessary commands to the hardware. Lastly, in the future, Made In Space plans to fly a commercial printer that will be accessible not only to NASA users, but to businesses, universities, entrepreneurs, researchers, etc.

Q: What's on tap for the future that you feel is interesting to share or an important benefit from the work on this project?

A: Of interest, we have an agreement with the European Space Agency to collaborate on the materials data for in-space manufacturing and we are also working closely with the NASA ISS Tools Office and payload users to identify parts that would be candidates for on orbit printing.

This project has illustrated how beneficial the SBIR program is; opportunities to collaborate reap important benefits. NASA and Made In Space have worked together as one team leveraging mutual strengths throughout the development of this project and as a result, a first-time flight capability has been developed ahead of schedule, within budget, and with minimal risk.

The Game Changing Development Program is part of NASA's Space Technology Mission Directorate.



3D print flight unit in the MSFC High Bay.

Flight Test Scheduled for Advanced Space Power Systems Project

In a set of three flight tests scheduled to begin in September, the Advanced Space Power Systems (ASPS) project will evaluate solar array components as well as the capability of the Earth resources, or ER-2 aircraft, to conduct solar cell measurement testing.

The ASPS project, part of Space Technology's Game Changing Development Program, seeks to define affordable, high-power solar cells for future deep space missions such as those that will use solar electric propulsion.

The testing, which is a collaboration between NASA's Glenn Research Center and NASA's Armstrong Flight Center, will be the first time advanced solar cells will be tested in the wing pods of an ER-2 aircraft.

The ER-2, flying at the edge of space, can scan shorelines, measure water levels, help fight forest fires, profile the atmosphere, assess flood damage, and sample the stratosphere.

ER-2 aircraft.

It's an ideal aircraft for testing advanced solar cells.

"The ER-2 design enables testing at higher altitudes, which means researchers can collect more accurate space-related data and can have a longer season available for testing," explained John Lytle, ASPS project manager.

Arc Jet Tour at ARC

Ames Research Center Engineer John Doe (left) provides a tour of the arc jet to NASA Chief Technologist Dr. Miller (right).

The arc jet, recently transported from Johnson Space Center, tests thermal protection materials and systems used in entry, descent and landing technology.

The device helps validate heat shield materials in an environment that simulates the high temperatures experienced during atmospheric entry.

The arc jet heats and expands gases (typically air) to very high temperatures and at supersonic/hypersonic speeds by a continuous arc between two sets of electrodes. The gases pass through a nozzle aimed at the test sample in a vacuum and flow over it, producing a reasonable approximation of surface temperature and pressure.

Seeing Thermal Protection Materials Under Bright Light

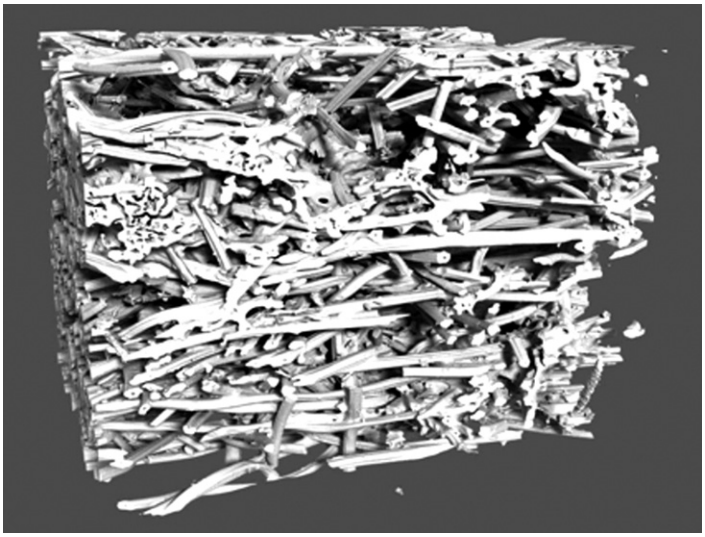
NASA scientists are using one of the world's brightest synchrotron hard X-ray sources at the Advance Light Source (ALS) facility at Lawrence Berkeley National Laboratory in California to build digital three-dimensional models of the internal structure of thermal protection materials. These materials enable survival of space probes during the fiery high-speed entry into planetary atmospheres.

"Visualizing the internal structure of a material improves our understanding and our models; it also opens the door to developing a new generation of materials that are more robust and lighter weight to support future exploration missions to Mars and other planets," explained Nagi Mansour, a scientist at NASA Ames.

The ability to acquire digital information at microscopic scales is extremely attractive to NASA's effort to expand its knowledge of lightweight porous ablators.

Recent missions, including the successful landing of Mars Science Laboratory and its Curiosity rover, the ISS resupply missions flown by the Space-X Dragon capsule, and Stardust—the fastest Earth atmospheric entry by a man-made probe, have all relied on Phenolic Impregnated Carbon Ablator (PICA), a NASA-designed, carbon fiber preform inpregnated in phenolic resin, as the thermal protection material for the heat shield.

Digital image reconstruction of a woven carbon fiber ablator backbone taken at the ALS facility is shown.



At 20 times magnification, a photorealistic rendering of the carbon fiber backbone of the PICA material enables detailed evaluation of the tortuous internal structure. Digital image reconstructions are rendered at the NASA Advanced Supercomputing Division from tomography data acquired at the Advanced Light Source, a U.S. Department of Energy Office of Science User Facility operated by the Lawrence Berkeley National Laboratory at Ames.

As part of NASA's Game Changing Development Program, the Entry Systems Modeling (ESM) project delivers cutting-edge customer-driven research in two areas: aerosciences and materials.

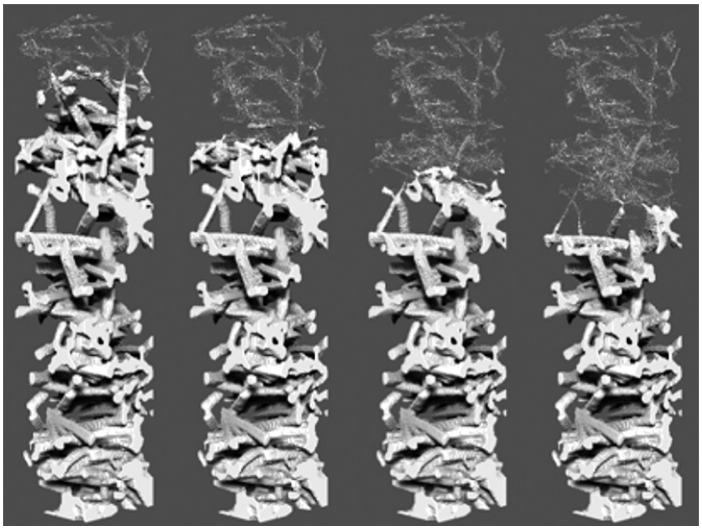
Experiments supported by the ESM project have been performed at the ALS to study the carbon fiber skeleton of the PICA material. High-end computing power at the NASA Advanced Supercomputing facility was used to produce photorealistic rendering of the internal structure of PICA using tomographic reconstruction methods. These digital images offer the ability to inspect the complex features of the material down to 1/1000 of a millimeter. Spectacular detailed images, as those shown for PICA and a weave material also being developed under the GCDP, are being studied and modeled under ESM.

As one the world's brightest synchrotron light sources, the ALS provides very high energy X-rays that enable reconstruction of micromillimeter scale structures with

NASA Supercomputer visualization expert Tim Sandstrom evaluates 3D images of virgin and oxidized FiberForm® microtomography rendering at his workstation.

incredible clarity through controlled environments. The test facility's capabilities, and the combined ingenuity of scientists teaming from both Lawrence Berkeley and NASA, enabled in situ investigation of material response under high enthalpy environments. NASA scientists are able to examine in real time the oxidation of individual fibers as well as the increase in the material's porosity. The resulting three-dimensional images make it possible to calculate the porosity, tortuosity, conductivity, and other properties of the porous material pre- and post-exposure to a harsh environment. Accurate, digital descriptions of the material provide ready-to-use computational grids for high-fidelity simulations of material properties.

ESM is also developing a computational platform called PuMA, for Porous Media Analysis, to enable simulations of the ablation process at the microscale. In addition to computing recession due to oxidation, these simulations will provide a means to develop spallation models at the macroscale. Digital descriptions of the material will also provide unprecedented capability to compute the conductivity of the material prior and after oxidation. The conductivity simulation will include the effects of radiation thus enabling assessment of in-depth heat due to radiation as the material decomposes and its porosity increases.



Simulation example of carbon fiber decomposition due to oxidation performed using a FiberForm® microtomography data set as the computational grid.

Summer Students

Nearly two dozen interns and seven volunteer students supported the Game Changing Development (GCD) Program office this summer. They ranged in experience and majors, but they all tackled their projects with the same amount of enthusiasm. Students were divided amongst the following projects: Additive Manufacturing for Small Satellites, Convective Heating Improvement for Emergency Fire Shelters, HIAD Antares, HIAD Flexible Systems/Entry Systems Modeling and Communications/Outreach. In addition to working their projects, the students attended tours, workshops, boot camp sessions and provided weekly updates as well as helped support the NASA Langley Technology Day. “The students have all become ambassadors of NASA in a matter of weeks by not only representing their technologies but also explaining NASA’s mission,” said Mary Beth Wusk, GCD Program integration manager and all-around champion of students.

Above: GCD intern Travis Moore assists with the "Capture an Asteroid" game at NASA Langley's Technology Day.

Above left: During NASA Days, a public outreach and education event held each year at Busch Gardens in Williamsburg, Va., NASA Langley interns Betsy (left) and Grace Wusk staffed the EVA Glove Box exhibit. The event was held Aug. 8-9 at the theme park, which draws thousands of visitors each day.

Left: Students man the Technology Day tattoo table in front of the Virginia Air and Space Center.

Below left and previous page: GCD summer interns visit an inflatable space habitat at NASA Langley.

Thanks to NASA Langley's David Bowman for photographic contributions.

Summer Students

Communications majors Laura Brady and Jordan Connell interned in the Game Changing Development Program Office. Here they share what it's like to be liberal arts majors and work at NASA.

Laura Brady, Christopher Newport University

As a Communications Major, I never thought that I would be able to find my place at NASA. However, after my time as an intern in the Game Changing Development Program this summer, I realized that I was completely incorrect.

Like most interns, my first day of internship was very overwhelming. The amount of acronyms and unfamiliar terms flooded my anxious mind. However, after my first week, I became more relaxed and discovered that NASA's welcoming and easygoing vibe fit perfectly with my personality type.

I was given the task to help coordinate NASA Langley's Technology Day at the Virginia Air and Space Center as part of the Technology Campaign that is being directed out of Headquarters. The event was set for July 15, so my team and I had only six weeks from the time we began our internship to plan out the details and recruit exhibitors. In order to properly execute Technology Day, we had to work as a cohesive unit and communicate with each other about every aspect of the event. About 1,400 people attended, and many mentioned how much fun they had.

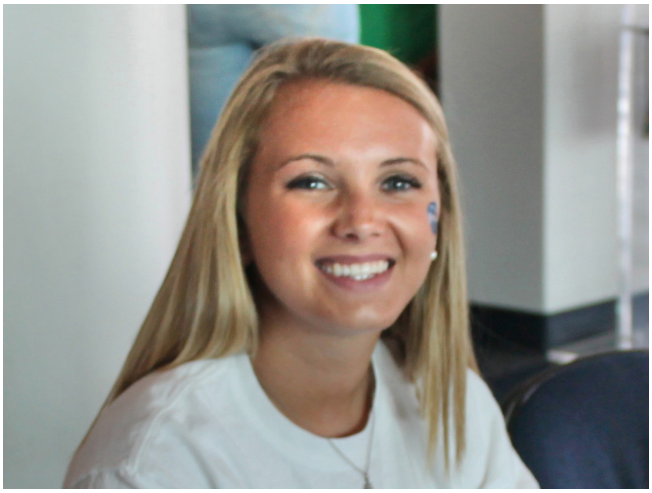
Through my internship at NASA, I have learned that working as a team is imperative to completing any project or task. A team needs every area of expertise and personality type to function properly. For example, my team for Technology Day had two communications majors, a business major, and a computer engineering major. Additionally, we worked with another mentor and intern who work in the public affairs and communications fields. Together, we successfully executed Technology Day using our knowledge of our specific disciplines.

In addition to Technology Day, I was in charge of coordinating the student luncheon and lecture with Dr. Michael Gazarik, the associate administrator for the Space Technology Mission Directorate, that was held on July 18. I had to communicate with various NASA employees in order to see this event through in a timely manner. To spread the word about the luncheon and lecture, I created a flyer, wrote the @LaRC advertisement, and created a web sign-up sheet to send out to all of the NASA student volunteers and interns. We had about 160 students attend and the event was very successful.

Coming into my internship, I had very little-to-no knowledge about space technology. Many of the new technologies seemed very foreign to me and some of the concepts were hard to grasp at first. However, through these past 10 weeks, I learned about the big picture of NASA and what the Agency's missions and goals are. I was also able to learn about the different projects that were exhibited at Technology Day. Without my internship at NASA, I would have never understood how interesting and amazing space technology is. It dawned on me this summer that I played a small role in a bigger mission to colonize Mars and further our understanding of space.

Overall, I am very grateful to have been given the opportunity to work at NASA this summer. I not only acquired on-the-job experience in my chosen field of study, but I also gained valuable life lessons in learning to work on a team and in turn, I became a better leader and communicator. I discovered that NASA has a place for every person, no matter if they are an engineering major, business major, or in my case, a communications major.

Jordan Connell, James Madison University

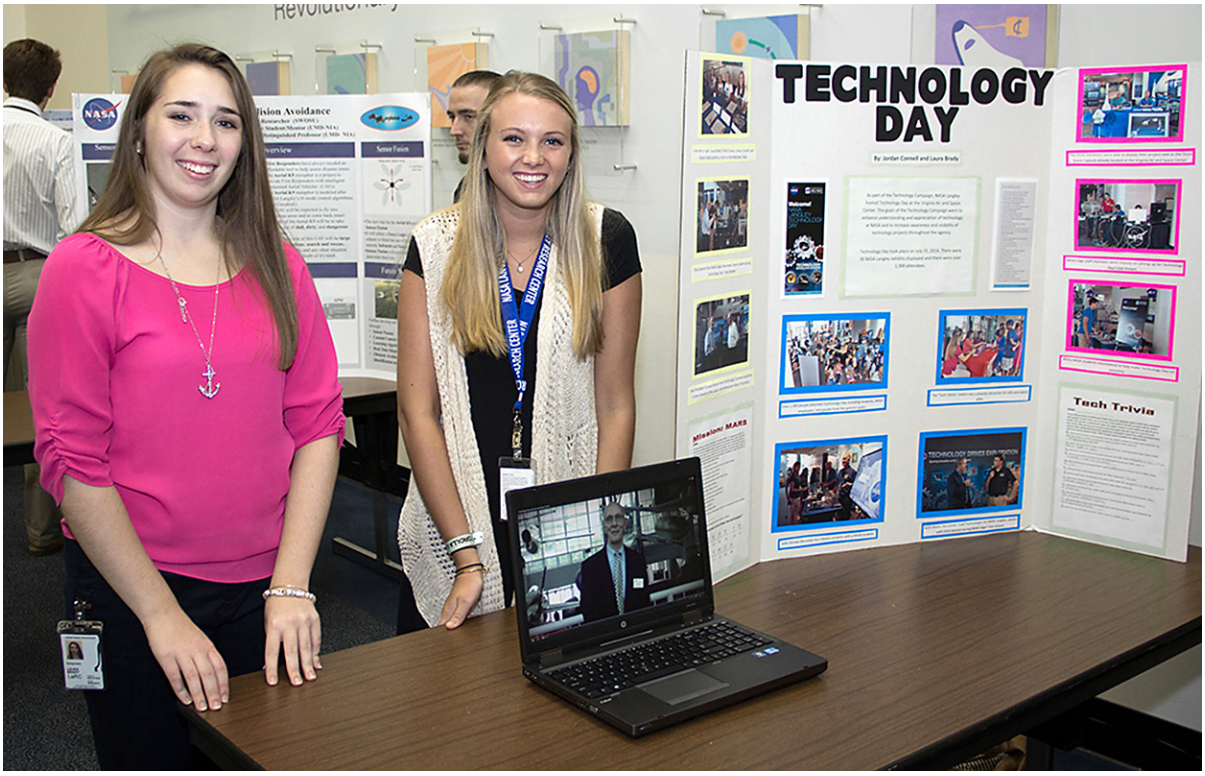


Like most interns, I was anxious and excited to start my summer internship at NASA Langley Research Center. As a communications major at James Madison University, I was nervous that I would not fit in at NASA, but after the first week I realized I was wrong. Everyone was very welcoming and I felt comfortable right away. I realized that not everyone who works at NASA is an engineer or scientist, and that there is a place for everyone here no matter what your background.

As an intern in the Game Changing Development Program, my project was to lead the planning and organization of NASA Langley's Technology Day at the Virginia Air and Space Center. Technology Day was led out of NASA Headquarters to promote space technology across all of NASA's Centers, and Langley was the first to hold Technology Day. This project gave me a lot of experience working on a team, as well as what it takes to organize an event of this size. I learned all the ins and outs of planning an event. Technology Day had 28 exhibitors and approximately 1,400 attendees. Overall, it was a great success for everyone involved.

I learned so much about space technology through the projects exhibited at Technology Day and this event sparked my interest further. Before I came to NASA, I did not know much, if anything, about space technology. I now have a better understanding of NASA's missions and goals and how essential these are to our future.

This summer was a great learning experience for me. I feel so lucky to have had this opportunity and to have met and worked with so many great people. I would do it all over again in a heartbeat.



GCD interns Laura Brady (left) and Jordan Connell present at the end-of-the-year poster session as part of their Langley Aerospace Research Summer Scholars (LARSS) internship. The two interns helped organize and execute the highly successful NASA Langley Technology Day.

AMSS Students Spend Summer Simulating Microgravity

Laura Brady
LARSS Summer Intern

Most summer interns at NASA arrive at their respective centers work for eight hours, and then go home. However, this was not the case for the Additive Manufacturing for Small Satellites (AMSS) student team at NASA Langley Research Center in Hampton, Va.

The team, comprising college students Taylor Dayton, John Mulvaney, Sam Holden, and Nicholas Asby, took its workday beyond the eight-hour requirement and traveled to a local neighborhood pool with a set of snorkels, flippers, a disassembled 3D printed satellite, and a timer.

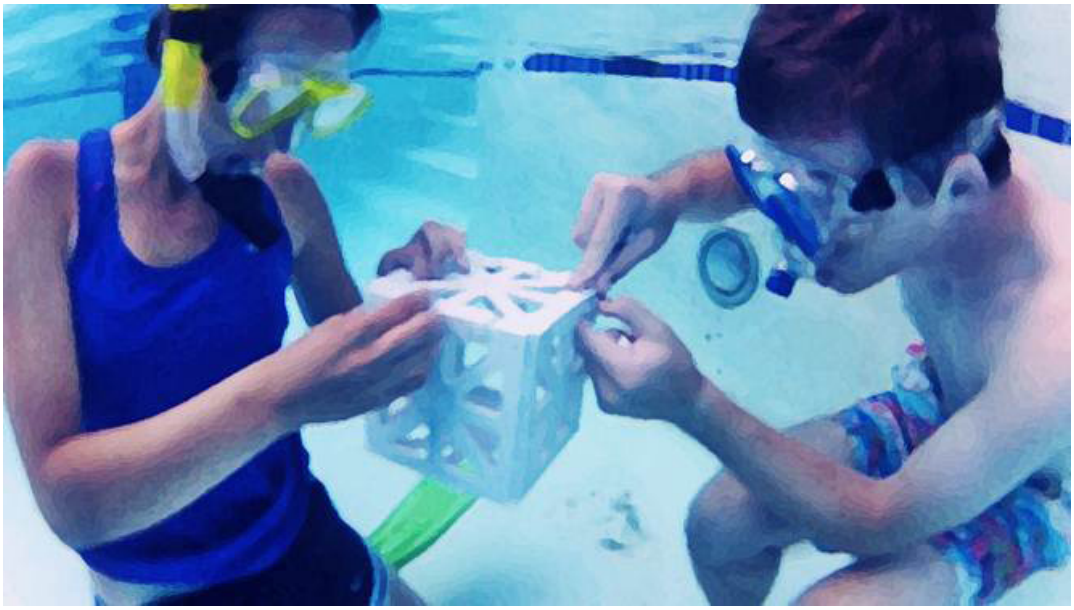
To simulate microgravity, two students took turns assembling the small satellite underwater while another recorded and timed their progress. The group also ran a duo assembly test where two students assembled the satellite together. As they did this, the team noted the different features in a microgravity environment.

This creative and new way of testing was anything but out of the ordinary for this innovative group of interns.

At the beginning of the summer, the team, led by Dayton, a Virginia Tech graduate student, was given the task to engineer a new structure for an existing, cube-shaped small satellite that would be simple to assemble and easily adaptable to other form factors. The challenge? Make sure the entire structure could be 3D-printed, assembled, and launched on orbit. The team worked closely with Dr. Steve Horan, the principal investigator for this project.

“We had concepts that we were kicking around for about six to seven months about what the structure would look like,” Horan said. “The students were able to come up with a better structure than what we could have come up with.” The original structure used 12 pins to connect the panels, which slowed assembly and disassembly time. The interns generated a more efficient design that uses hinges and clips.

With simplicity in mind, they wanted to keep the wiring in the small satellite to a minimum. Ultimately, the team was able to achieve this goal by embedding the wires using a printed channel and etched prototype board in the plastic. With this design, the satellite is less



GCD interns at NASA Langley assemble a 3D printed satellite at the bottom of a neighbornood pool.

AMSS summer interns John Mulvaney, Sam Holden, Nicholas Asby, and Taylor Dayton demonstrate microgravity

cluttered, it is easy to see where everything goes, and sensors can connect directly into the panels."

John Mulvaney, a junior at Virginia Tech, worked on the new design using Computer-Aided Design (CAD). He was given the task to develop a new approach to 3D-printed panel-to-panel connections for a small satellite structure. While working on the design, he ran into some conflicts with the printer.

"Basically, the designs look great on the computer—tolerances are perfect and every piece fits together. However, when we actually printed out the parts, the printers weren't as accurate as we expected, and we had to make changes to the design to accommodate the limitations of the print materials. With time, we learned how to properly dimension designs to work well with 3D printers."

Steve Horan mentioned that the students "have learned several ways of how not to do this."

To test out the assembly of their structure, they invited other interns to try to assemble the satellite with only a picture of the completed product in front of them.

Dayton noted that "some took as little as five minutes to assemble the satellite, while some took as long as 25 minutes." After this assembly test, the team redesigned the structure to make it more user-friendly.

When asked what was next for this project, Taylor said, "The satellite will need to be put through vibration testing to see if the structure is able to withstand the forces it would experience in a typical orbital science mission. We would also like to test the utility of the other form factors we designed, but were unable to print with the time constraints of our project."

Mary Beth Wusk, Game Changing Development (GCD) Program integration manager, worked closely with all of the GCD interns this summer and the AMSS students' hard work did not go unnoticed.

"The student team is composed of young, creative engineers, each bringing unique perspectives and ideas to the project. 3-D printing opens up so many doors to technology and these students have learned important aspects of designing, fabricating and testing 3-D printed hardware. The students have all become ambassadors of NASA in a matter of weeks by not only representing their technologies but also explaining NASA's mission," she said.

A 3D printer is set to launch around September 20, 2014 on Space X CRS-4. It will undergo a series of tests to ensure its suitability in space such as withstanding the forces of takeoff, electrical checks, and running through demonstration prints of 21 common objects. With this launch, the AMSS project will be one step closer to space.

NASA's Space Tech Chief Offers Students a Glimpse of the Future

Sam McDonald
NASA Langley Research Center

Image Credit: NASA/David C. Bowman

Michael Gazarik, associate administrator for NASA's Space Technology Mission Directorate, gave a group of students at NASA's Langley Research Center a sweeping overview of projects including hardware for entry, descent and landing on Mars, laser communications and robotics.

The man leading the charge to solve some of NASA's biggest and most vexing technical problems offered an invitation to bright young people.

Let's go places together—like Mars, for instance.

Michael Gazarik, the associate administrator for NASA's Space Technology Mission Directorate, spoke to a group of about 160 college and high school students on July 18, giving them insights, words of encouragement and a fast-paced, energetic look at the daring goals his team is pursuing.

NASA Administrator Charles Bolden created the Space Technology Mission Directorate with an eye toward tomorrow.

"If you look at where NASA is today, we're about to explore deep space, right?" Gazarik told the crowd inside the Reid Center at NASA's Langley Research Center in Hampton, Virginia. "We've finished building the International Space Station. We retired the shuttle. We're building a heavy-lift rocket called the SLS [Space Launch System]. We're building a human space freight capsule called Orion. We know those two things need a host of technologies not only to explore deep space, not only to survive in it, but to thrive in deep space. Not only to explore, but to pioneer in deep space.

"That's where we're headed."

NASA has sent science-gathering probes and robots past every planet in the solar system. Now, it's time for humans to pick up where the machines left off, Gazarik said. "To learn more about Mars, to learn more about Europa, to learn more about the other planets, there's more to go do," he said.

Progress toward sending astronauts on a mission to Mars continues. For example, teams in Huntsville, Alabama, are testing the world's largest composite cryogenic propellant tank. "This is about the next generation heavy-lift rocket replacing the standard aluminum tanks we have today. Why? Because it's cheaper. Because it takes less time to manufacture, and because it weighs less. That has advantages across the board."

Building better solar arrays is another key goal. Researchers are looking for ways to make space solar panels that are larger, more efficient and that can more readily fold up into a rocket's payload area. "The use of solar energy turns out to be one of the most efficient ways to move through space," he said. "That's where the investment needs to occur."

Navigating through space will require better time keeping, Gazarik said. Just like mariners in the age of sail, astronauts will rely on clocks to help them chart their progress through the void. Engineers are working to miniaturize atomic clocks that will allow astronauts to navigate precisely through the solar system.

Landing humans on the surface of Mars presents a complex and daunting set of problems for NASA. The Curiosity rover's arrival on the Red Planet in August 2012 represented the seventh successful Mars landing, Gazarik said. But there have been plenty of failures. "It's about a 50 percent probability being able to land successfully on Mars," he said. "The United States has a pretty good track record, especially when they use a group here at Langley….That group has been one of the common elements of successful landings on Mars. When they're not involved, it generally doesn't go well."

Why is landing on Mars so difficult? The planet's thin atmosphere provides enough aerodynamic and aero-thermal forces to rip a spacecraft apart if the approach isn't right. Slowing down from blazing speeds is also a major challenge.

To allow for a variety of landing sites and larger, heavier spacecraft, researchers are developing an array of technologies intended to slow a spacecraft as it hurtles toward the Martian surface.

"We've got to get these folks excited and passionate about NASA, passionate about space. This is what we need to do. We need to reach out."
—Michael Gazarik

Last month's first test of the Low-Density Supersonic Decelerator off the coast of the U.S. Navy's Pacific Missile Range Facility in Kauai, Hawaii, was a step in the right direction. An inflatable, doughnut-shaped apparatus, the decelerator created extra drag on a test vehicle as it shot down from the skies over the Pacific Ocean. A Supersonic Disk Sail Parachute, which was tested at the same time, did not work so well, however. That offered lessons, too.

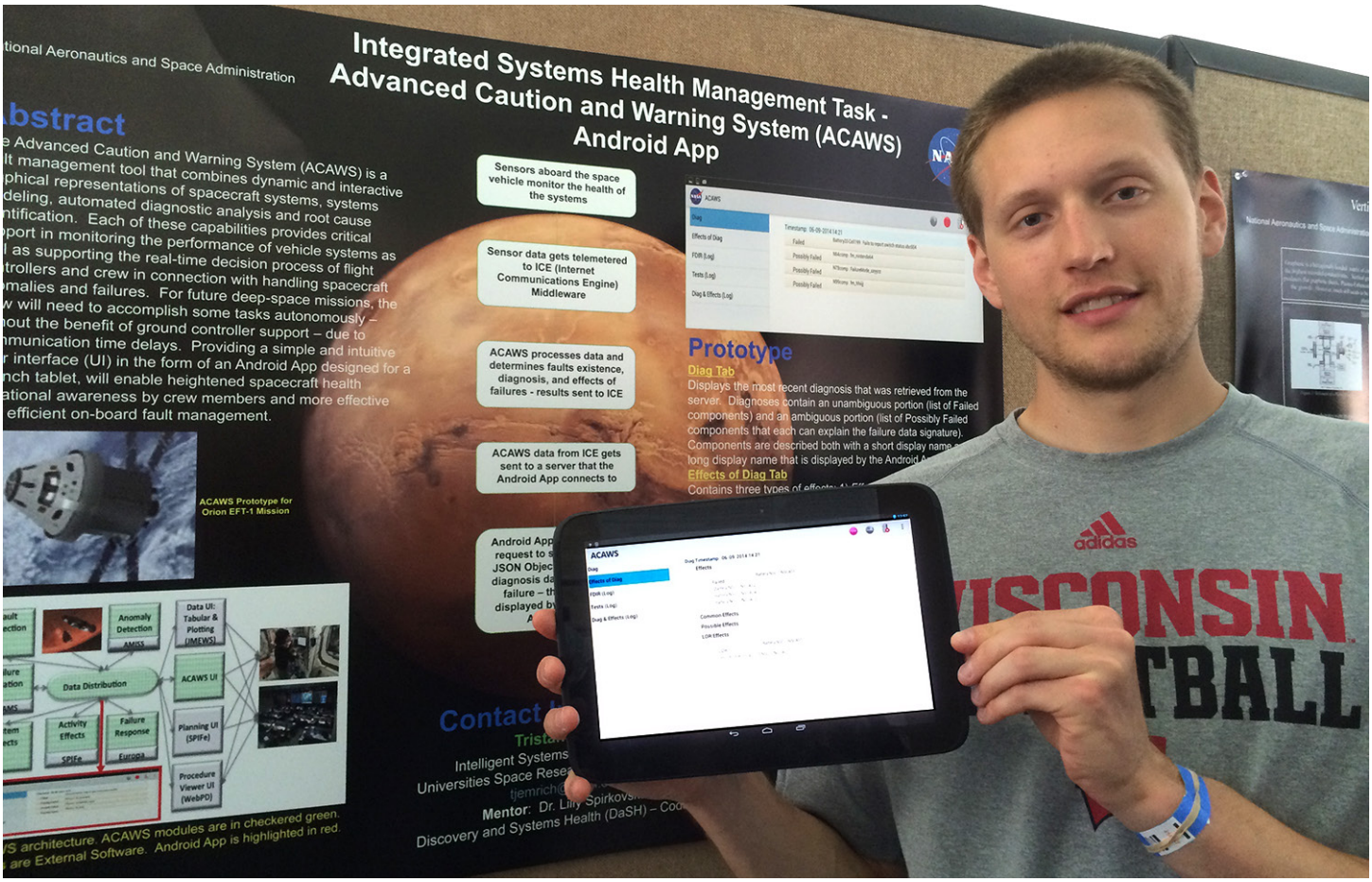
"It turns out that inflation dynamics of parachutes are really hard," Gazarik said. "We test to learn."

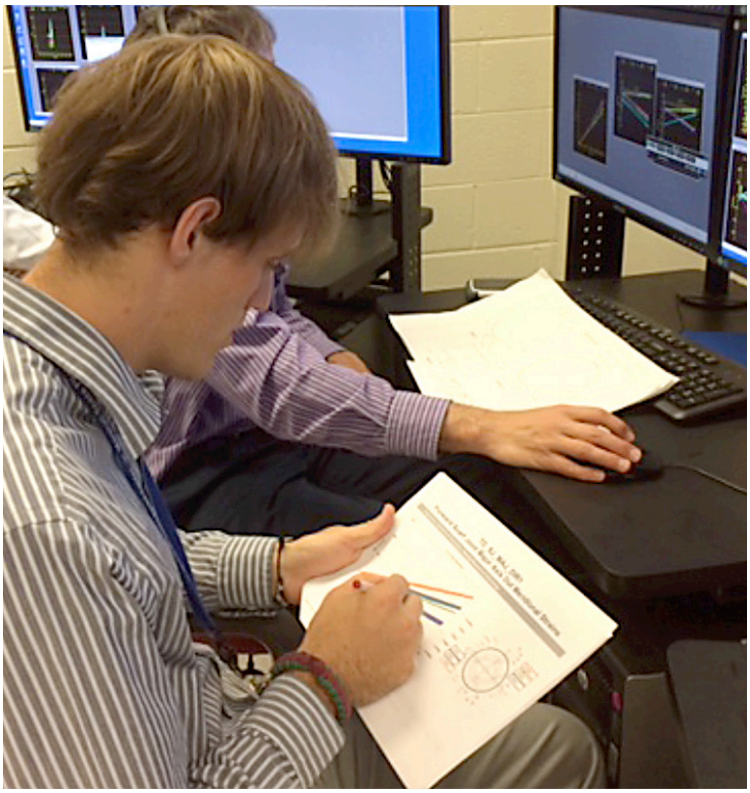
Gazarik's wing of NASA also focuses on robotic systems, lightweight space structures, space observatory systems and life support.

Afterwards, Gazarik said he hoped the talk ignited interest and excitement among young people in the room.

"A key part of this program is investing in the future," he said. "We've got to get these folks excited and passionate about NASA, passionate about space. This is what we need to do. We need to reach out."

Summer Students





Tristan Emrich (above), a student at the University of Wisconsin Madison, designed and developed an Advanced Caution and Warning System (ACAWS) Android app for a 10” tablet. The purpose of the app is to provide a simple and intuitive user interface that will enable heightened spacecraft health situational awareness by crew members and will enable them to make more effective and efficient on-board fault management decisions for deep-space missions.

The app’s user interface consists of five tabs that display ACAWS data retrieved from the server in real-time: list of diagnoses and effects, list of Failure Detection, Isolation and Response (FDIR) algorithms that run onboard the space vehicle, and a list of failed, passed and unknown fault detection tests that are conducted to find the root cause of a system failure.

Summer intern Anthony Christensen (left), from Boise State, spent his summer interning with the Composite Cryotank and Technologies Demonstration team at NASA Marshall. Here, he monitors secondary gauges during the testing of the 5.5-meter tank.

Third-Quarter Review

The Game Changing Development Program office Third Quarter Review was held July 22-24, 2014, at NASA's Glenn Research Center. A total of 27 project managers briefed 50 technologies either remotely or in person. Approximately 45 people attended in person and 33 remotely.

The purpose of the review was to discuss technical progress completed since the Mid-Year Review (challenges experienced, milestones met) as well as to provide a thorough evaluation of the FY14 execution budget needed to complete the end of year deliverables. Key metrics highlighting the projects' performances were gathered. Attendees also participated in tours of various facilities at NASA Glenn, including the Simulated Lunar Operations facility and Facility 6, where Nuclear Systems is testing its Technology Development Unit.

Nuclear Systems project manager Don Palac gives a tour during the Quarterly Review.
Image Credits: Mary Beth Wusk

GCD Employees of the Month

"Within our Game Changing team, members contribute to the STMD mission of 'building, flying, testing' in everything they do. Each month we are recognizing a GCD Employee of the Month, one who embodies the strong STMD 'can do' attitude."–Steve Gaddis, GCD program manager.

Amy McCluskey, GCD Communications Manager

July 2014 Employee of the Month

GCD Communications Manager Amy McCluskey joined the team two years ago and manages all internal and external communications for the Program Office. She creates, manages and staffs program and HQ exhibits for large-scale events.

"Amy does a fantastic job which was readily evidenced by the incredibly successfully LaRC Technology Day this past July. It was clearly an overwhelming success," said Program Manager Steve Gaddis. "She always goes above and beyond what is required. That is just the way she rolls."

And roll, she does. Amy's responsibilities also stretch from creating multimedia products to maintaining multiple NASA websites and coordinating outreach efforts for all GCD projects.

"I enjoy learning and communicating about the new technology NASA is investing in that will change the way we explore," says Amy. "I also like the camaraderie within the office. There is a genuine effort everyone makes to be friends in addition to being coworkers."

Outside the office, Amy likes going to the beach or attending one of the various local festivals for daytime activities. Evenings, you might find her out catching an act at the NorVA or dining at a waterfront restaurant. Amy also delights in traveling, a personal interest that transfers well to her job because she travels frequently to cover the numerous GCD projects and capture information to share with the public.

When alone, you might find Amy doing yoga or spending the day with a good book—or two, or three…. "I enjoy binge reading mystery and crime thrillers," she shared.

The most enjoyable time she spends is with her son, Elijah, especially watching him play soccer. "He's the apple of my eye," says Amy. "He's wise beyond his years yet also very funny and caring. If it was up to him, we'd have a house full of animals."

Asked if she has any pets, Amy replied with a resounding, "Do I!"

"I have a dog that was rescued from an animal shelter in Alabama that was damaged by a tornado three years ago, hence her name, 'Bama'. I also have three cats, which is truly three too many, but I love them anyway," says Amy. "Sandy and Daisy were both rescues, while Karina was a cat I had planned on only fostering until she stole our hearts."

Ah, our hearts do brim when we hear stories of pet rescues and adoptions. Amy, you and Eli are rolling with the right idea!

Mary Koca, GCD Configuration/Data Management Specialist

August 2014 Employee of the Month

As Configuration and Data Management Specialist for GCD since April of 2012, when Mary Koca starts her day, there is no shortage of things she may find herself getting into.

"Mary works tirelessly and is one of those behind-the-scenes people that without her the entire office would crumble," shared GCD Program Manager Steve Gaddis. "She does a great job and never complains. Seriously, she never complains. She is a real professional and great asset to the team."

While maintaining the GCD NX document library, Mary is also tasked with keeping current the baselines of all program documentation: project plans/agreements, continuation reviews, deliverables, closeout reports, memos coordination, and change requests, whether technical in scope or for scheduling or resources. She also facilitates the GCD Program Control Board and co-ordinates the L1 STMD Program Management Council.

Mary says she enjoys the challenge of defining configuration management requirements in a research/mid-TRL environment, one that provides exposure to new and emerging technologies. "I love to hear about the new and exciting game changing activities that the program supports or considers supporting."

What does Mary characterizes as most important about her work environment? Her coworkers. "I feel extremely fortunate to work with such a great group of individuals, genuinely good people who are dedicated, diligent, and exceptionally intelligent."

When off the clock, Mary participates in a number of outdoor activities: gardening, bicycling and kayaking, to name a few. First on her list of activities, though, is fishing. "I love to fish!" she said. "We moved here from Florida in 2012 and I still want to learn more about these rockfish/striped bass!"

Being relatively new to the area, when asked what her favorite local/cultural experiences are, Mary says there are too many to name them all. She and her husband Dave "love the fact there are so many wonderful things to do that are within a day's drive–from watching the Blue Angels on Virginia Beach to hiking the Blue Ridge Mountains and visiting the DC museums in-between."

Should you happen to be visiting Williamsburg one day, keep an eye out. You just might run into the pair on one of their occasional strolls up and down Duke of Gloucester Street.

"We're fascinated with the local history," says Mary. "This is where it all started. And the many parks this area has to offer really make for wholesome family living."

Along with her husband, Mary's family includes three grown children—Amelia, Erik and Kristine—and two grandsons—Hunter and Jackson. But don't mistake these two for empty nesters! Keeping up the tradition of threes, Mary and Dave's home is still a busy one.

"We have three adorable long-haired dachshunds: Lillie, Greta, and Cujo (don't let the name scare you—he's a little lover). But please don't say I'm one of those crazy people that replaced kids with pets after they all moved out!" said Mary.

We promise, Mary… just sounds like a whole lot of crazy love, Cujo and all.

Education *and* Public Outreach

Technology Day Puts NASA Langley's Work on Display for All to See

Joe Atkinson
NASA Langley Research Center

It's not often that the researchers from NASA's Langley Researcher Center gather in one spot at the same time to show off their work to the public.

But on July 15, a bunch NASA Langley researchers packed up their cutting-edge technologies, headed over to the Virginia Air & Space Center and did exactly that.

More than two-dozen exhibits filled the Air & Space Center's two floors as part of NASA Langley's Technology Day. The event put some of NASA Langley's coolest, most exciting technologies front and center for visitors to see and experience first hand.

The displays focused on everything from advanced radiation protection to small unmanned aerial vehicles.

At one table, children and adults took turns stuffing their hands into real astronaut gloves. At another, people craned their necks to hear a researcher described how the Hypersonic Inflatable Aerodynamic Decelerator could one day help people land on another planet.

After watching researcher Lucy Lee use a laser pointer, two erasers and a fish tank filled with water and cotton balls to explain how the CALIPSO satellite works, Deb Hicks, a Newport News resident and mother of two, said Technology Day was a can't-miss event for her family.

"My son has been obsessed with outer space and he's been reading a bunch of NASA books and space books, so he's been wanting to

People of all ages packed the Virginia Air and Space Center to get an up-close look at NASA technology. At left, Game Changing Development Program Element Manager, Jessica Woods-Vedeler, volunteered her time during Technology Day.
Image Credit: NASA/David C. Bowman

come," she said, gesturing to her 8-year-old son, William.

A few minutes earlier, William had tried out MindShift, a system that brings together biofeedback technology with video games. "I wish we could buy it at the store," he said.

For Hicks, who is also a sixth grade science teacher at Syms Middle School in Hampton, Technology Day wasn't just about her son's obsession with space.

"The fact that there's a lot of resources I can use in my classroom was an extra benefit to coming today," she said.

Across the center and down a flight of stairs, Michelle Munk of NASA Langley's Atmospheric Flight & Entry Systems Branch, discussed the Mars Science Laboratory Entry, Descent and Landing Instrument, or MEDLI, with curious guests.

Image Credit: NASA/David C. Bowman

Michelle Munk of NASA Langley's Atmospheric Flight & Entry Systems Branch, with Chris Karlgaard, hands a visitor a section of the MSL aeroshell with the MEDLI pressure transducer on it.

Munk said she was getting a great response from visitors, particularly educators.

"We've had lots of teachers who are interested who have students who are inspired by Mars exploration," she said. "So I actually have a couple of follow-up speaking engagements, probably, to schools."

Nearby, guests streaming past him, Keith Belvin, NASA Langley's chief technologist, said he was pleased with the turnout and the event as a whole. The museum put official attendance at 1,364 people.

"Today's been great," he said. "It's a really good turnout from both younger folks as well as adults coming out from the community."

Belvin said he'd talked to visitors who were impressed with the range of technologies on display. He emphasized that events like Technology Day give people a better sense of how their tax dollars are being spent.

"Often times we're able to take these technologies and license them with various businesses that develop commercial products," he said. "So telling that whole story, how their investments in NASA turn into real-world benefits, not just for exploration and science, but also for products that they use in their everyday life, is important."

But it wasn't just the taxpayers Belvin was happy to see; he was also pleased to see so many school-aged children trying out the interactive exhibits.

By engaging children and encouraging them to focus their studies on science, technology, engineering and math, he said, NASA is inspiring a new generation of innovators. And those innovators may one day bring their talents back to NASA, helping to keep it viable in an economically competitive world.

"Reaching young kids is really important right now," he said.

Aeris Nicholson, a 12-year-old who was at Technology Day with her dad, Ben, was certainly feeling inspired after perusing some of the exhibits. She was particularly interested in the exhibit that featured Orion, NASA's next space exploration vehicle designed to carry astronauts to deep space.

When asked if she imagined herself working at NASA one day, Nicholson answered without hesitation.

"Yes," she said. "Yes, yes, yes, yes."

For more photos from NASA Langley's Technology Day, see our Flickr galleries:
https://www.flickr.com/photos/gamechanging/sets/72157645742171324
https://www.flickr.com/photos/nasa_langley/sets/72157645752183363

Technology Day

Image Credit: Amy McCluskey

NASA Langley Chief Technologist Keith Belvin is interviewed by Chris Giersch of NASA Edge.

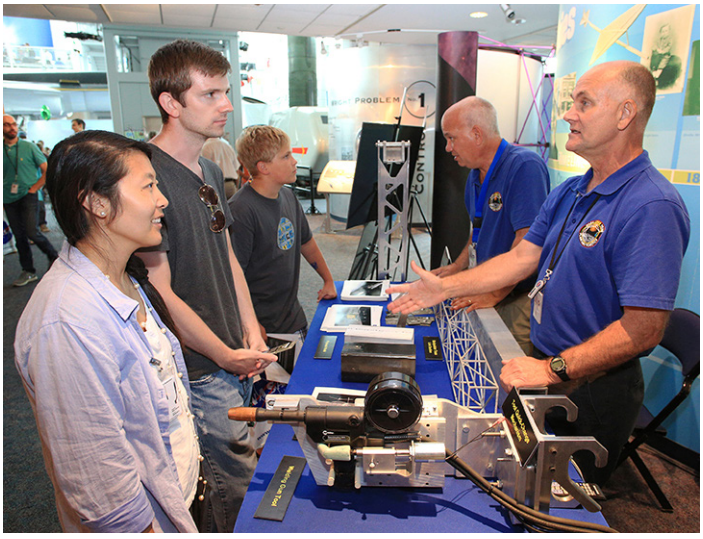


Image Credit: NASA/David C. Bowman

The robotics technologies always draw a good crowd. Here, NASA Langley engineer John Dorsey discusses his work on a robotic asteroid retrieval mechanism.

Image Credit: Amy McCluskey

It took a village, including NASA interns, and even employee family members, to pull off the successful event. Pictured from left to right are: LARSS intern Laura Brady, Eli Johnson, LARSS intern Jordan Connell and NASA student volunteer Kassie Fralick.

Take Our Youth to Work Day

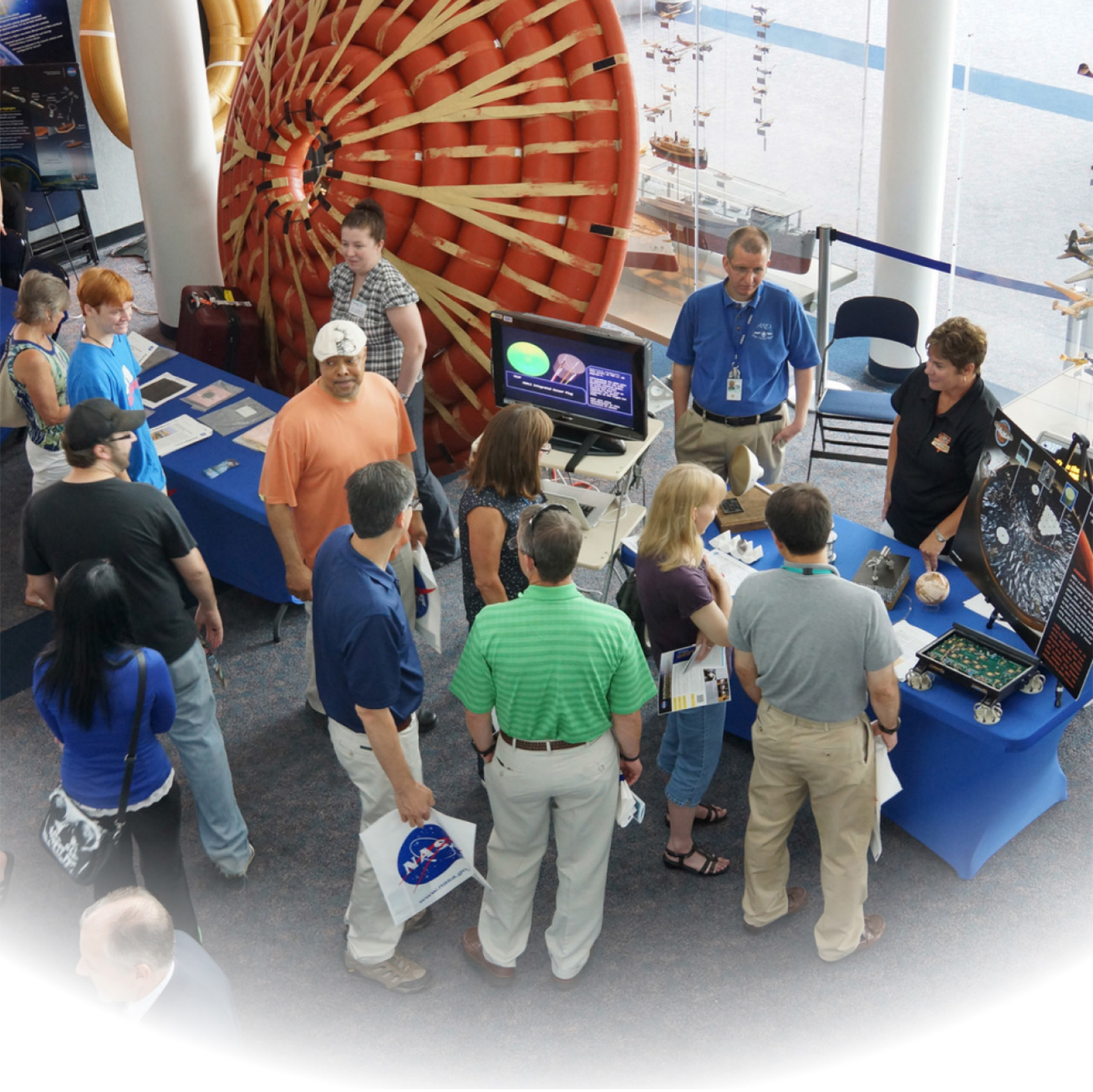
Mary Beth Wusk, Integration Manager for the Game Changing Development program (GCD) and Amy McCluskey, GCD Communications Manager, staffed the EVA Glove Box exhibit at NASA Langley's annual event, Take Your Youth to Work Day. The exhibit, which replicates what it would feel like to wear astronaut gloves in a space-like environment, was a big hit.

Image Credit: NASA/David C. Bowman

Cryotank Media Day

John Vickers (far left), project manager for the composite cryotank project, Dr. Michael Gazarik, NASA's Space Technology Mission Directorate, and Niki Werkheiser, project manager for the International Space Station 3-D printer, discuss technology projects with the media at NASA's Marshall Space Flight Center in Huntsville, Ala. Gazarik discussed how these technologies and others will enable deep space exploration.

Gazarik visited NASA's Marshall Space Flight Center in Huntsville, Ala., June 24 for an update on tank testing and to see an engineering unit that is identical to a 3-D printer that will soon head to the International Space Station.



Game On!

http://gameon.nasa.gov

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