National Aeronautics and Space Administration

Space Technology Game Changing Development

Monthly Highlights

November-December 2013

Slosh Team Readies for Important Launch

After a successful demonstration flight in September, the next Orb-1 mission is scheduled to launch on an Antares rocket on Dec. 18 as part of the NASA Commercial Resupply to Station contract.

The first operational delivery flight to actually carry supplies and experiments, Orbital Sciences Corporation's unmanned cargo freighter Cygnus will loft approximately 3,217 pounds (1,459 kg) of science equipment, spare parts and supplies to the International Space Station (ISS) for NASA.

Along for the ride with this payload will be the ISS Fluid Slosh experiment, a Space Technology Mission Directorate, Game Changing Development Program project dedicated to improving our understanding of how liquids behave *when there is little to no gravity.*

"Modern computer models try to predict how liquid moves inside a propellant tank," said NASA's Brandon Marsell, co-principal investigator on the Slosh Project. "Now that rockets are bigger and are going farther, we need more precise data. Most of the models we have were validated under 1 g conditions

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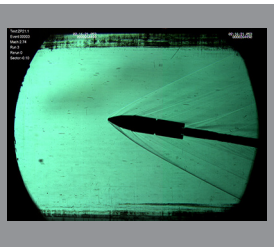
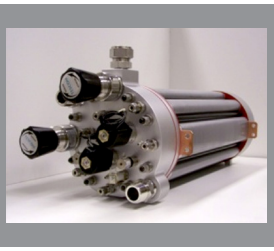
Image Credit: NASA

NASA's Brandon Marsell, co-principal investigator on the Slosh Project displays the Fluid Slosh experiment.



Slosh Launch

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on Earth. None have been validated in the surface tension-dominated microgravity environment of space."

The proposed research provides the first data set from long duration tests in zero gravity that can be directly used to benchmark computational fluid dynamics models, including the interaction between the sloshing fluid and the tank/vehicle dynamics.

To explore the coupling of liquid slosh with the motion of an unconstrained tank in microgravity, NASA's Launch Services Program (LSP) teamed up with NASA's Game Changing Development (GCD) Program, the Florida Institute of Technology (FIT), and the Massachusetts Institute of Technology (MIT) to perform a series of slosh dynamics experiments in the ISS using the Synchronized Position Hold Engage Reorient Experimental Satellites (SPHERES) platform. The SPHERES test bed provides a unique, free-floating instrumented platform on ISS that can be utilized in a manner that would solve many of the limitations of the current knowledge related to propellant slosh dynamics on launch vehicle and spacecraft propellant tanks.

"It was a complex and detailed process to bring this concept to fruition," said Charlie Holicker, an FIT student who worked on the physical design of the experiment and aluminum machining. "The data that this experiment will gather sets the foundation for all long-term space flight involving liquid fuels. It was an honor to be a part of something that will have such a great impact in the exploration of space."

Rich Schulman, an FIT student involved in the Slosh experiment since its beginning, said, "One huge benefit for the students working on this project is seeing firsthand the requirements for developing a payload for the ISS. Having gone through this process successfully, the students involved can effectively build future payloads or projects at the same standard."

Image Credit: NASA

Cygnus spacecraft shortly before attachment to ISS on September 29, 2013.

FOST Technology Receives Potential $750K Funding Award

NASA and its partners are currently developing a new generation of biologically inspired, forward osmosis (FO) membranes that have improved organic rejection over commercially available membranes. The new classes of membranes have superior organic rejection, specifically urea rejection, over commercially available membranes.

In October, Michael Flynn, lead for Forward Osmosis Subsystem Treatment (FOST) technology advancement at NASA's Ames Research Center, received confirmation of an award for development of FOST technology for use as a gray water recycling system. The award is through the U.S. Army Research Development and Engineering Command (RDECOM) and Tank Automotive Research, Development, and Engineering Center (TARDEC).

Under the Space Technology Mission Directorate's Game Changing Development Program, this activity has a potential funding of $750K for Next Generation Life Support's FO research over 2 years.

Legs Are Next for NASA's Favorite Humanoid

Sourced from NASA News Release

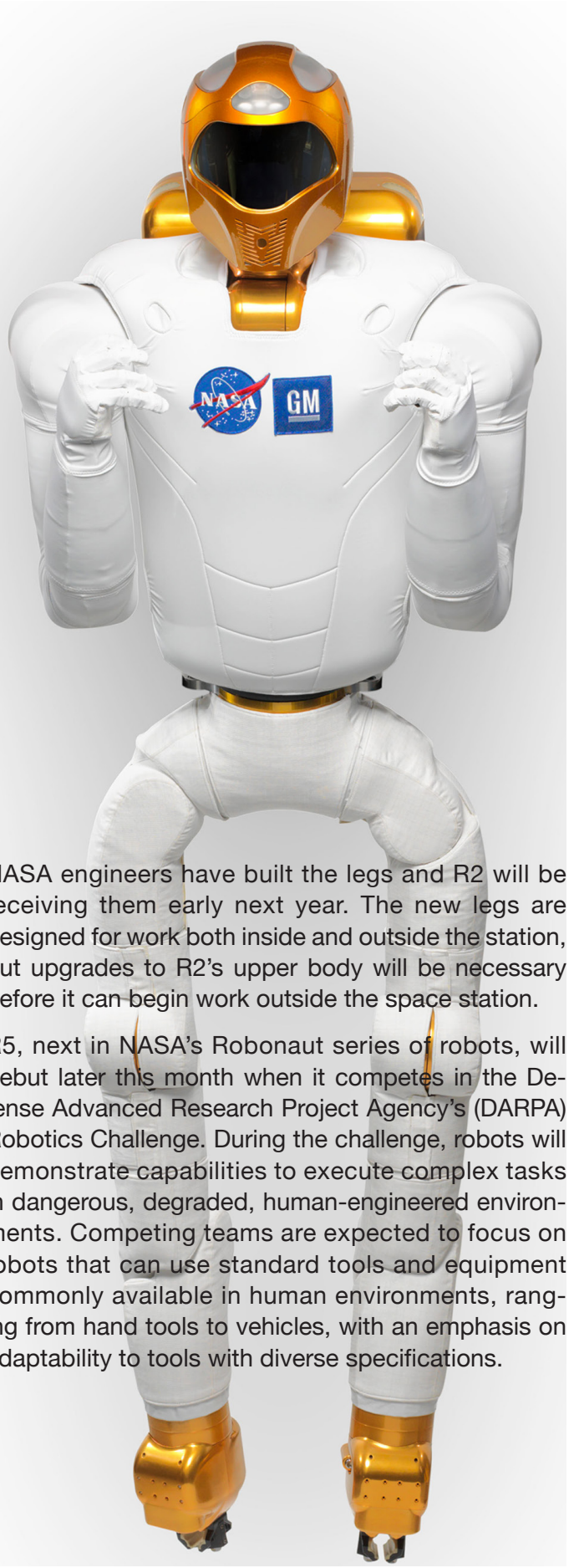
NASA engineers are developing climbing legs for the International Space Station's robotic crewmember Robonaut 2 (R2), marking another milestone in space humanoid robotics.

The legless R2, currently attached to a support post, is undergoing experimental trials with astronauts aboard the orbiting laboratory. Since its arrival at the station in February 2011, R2 has performed a series of tasks to demonstrate its functionality in microgravity.

These new legs, funded by NASA's Human Exploration and Operations and Space Technology mission directorates, will provide R2 the mobility it needs to help with regular and repetitive tasks inside and outside the space station. The goal is to free up the crew for more critical work, including scientific research.

Image Credit: NASA

NASA's Robonaut 2 is shown with the newly developed climbing legs, designed to give the robot mobility in zero gravity. R2's new set of legs are ready to head to space early next year.



NASA engineers have built the legs and R2 will be receiving them early next year. The new legs are designed for work both inside and outside the station, but upgrades to R2's upper body will be necessary before it can begin work outside the space station.

R5, next in NASA's Robonaut series of robots, will debut later this month when it competes in the Defense Advanced Research Project Agency's (DARPA) Robotics Challenge. During the challenge, robots will demonstrate capabilities to execute complex tasks in dangerous, degraded, human-engineered environments. Competing teams are expected to focus on robots that can use standard tools and equipment commonly available in human environments, ranging from hand tools to vehicles, with an emphasis on adaptability to tools with diverse specifications.

Next Generation Life Support Project Hosts Dr. Lind Seminar

Image Credit:

Dr. Mary Laura Lind.

NASA Space Technology Mission Directorate's Game Changing Development Program's Next Generation Life Support (NGLS) project hosted a seminar given by Dr. Mary Laura Lind of Arizona State University (ASU) in July. Dr. Lind is one of 10 recipients of the 2013 Space Technology Research Grant for NASA's Early Career Faculty efforts. The grants are designed to accelerate the development of technologies originating from academia that support the future science and exploration needs of NASA, other government agencies and the commercial space sector.

NASA seeks to dramatically improve state-of-the-art systems in water recovery and management for human health and habitation in space flight and travel, and Dr. Lind's research responds to this technology roadmap challenge under the Environmental Control and Life Support Systems.

During the seminar, entitled "Nanocomposite membranes to recover water from urine," Dr. Lind discussed results from the first year of research on improving water systems for space vehicles under the Early Career Faculty grant. The efforts at ASU are focused on developing advanced corrosion-resistant polymer membranes through which wastewater can be recovered and filtered for reuse.

The current water recovery system on the International Space Station uses a distilling and filtering process that recovers 70% of the wastewater generated. However, the remaining 30% of the water is brine that must be stored for disposal later on, and the current system is dependent upon resupply missions. Because NASA has retired the space shuttle fleet, the need to minimize use of ground-based resources is a higher priority.

Dr. Lind's research seeks to increase the amount of exploration wastewater that can be reused by developing a new class of corrosion-resistant molecular sieve inclusion nanocomposite (MoSIN) membranes that effectively recover water from urine and urine brine solutions through osmotic processes.

"We are currently using forward and reverse osmosis processes as part of an effort to develop an alternative water processor for spacecraft cabin water recovery. Advances in membranes will increase the performance of systems."

Current osmotic processes—both reverse osmosis (RO) and forward osmosis (FO)—offer the potential to increase water recovery from wastewaters consisting of raw urine, pretreated urine, and urine brines. Unfortunately, commercial RO and FO membranes have key limitations for water recovery processes. These membranes succumb to rapid degradation in the presence of acidic pretreated urine and urine

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Composite Cryotank Makes Cross-country Trip

NASA needs an affordable, lightweight vehicle for greater payload capability to enable future exploration missions. Composite Cryotanks could lead to rocket propellant tanks that achieve greater than 30% weight savings and 25% cost savings compared to the state-of-the-art Cryotank Technologies and Demonstration (CCTD) project has produced the largest automated fiber placement, out-of-autoclave, composite tank ever manufactured. The 2.4m composite cryotank represented a major element of the accelerated building block approach that has informed the design, fabrication and testing of the 5.5 meter article. The tank was shipped from Huntsville, Ala. to Kissimmee, Fla., to be displayed within the Boeing booth as part of the Defense Manufacturing Conference (DMC) exhibit. The DMC is the premier national conference that brings together leaders from government, industry, and academia aimed at addressing advanced manufacturing technology. This was an excellent public outreach opportunity for Boeing and NASA to disseminate the information about this exciting technology and start the dialog about future possible applications.The 2.4 meter tank also made a stop at NASA's Langley Research Center in Hampton, Va., for the Game Changing Development Program Office's Annual Review.

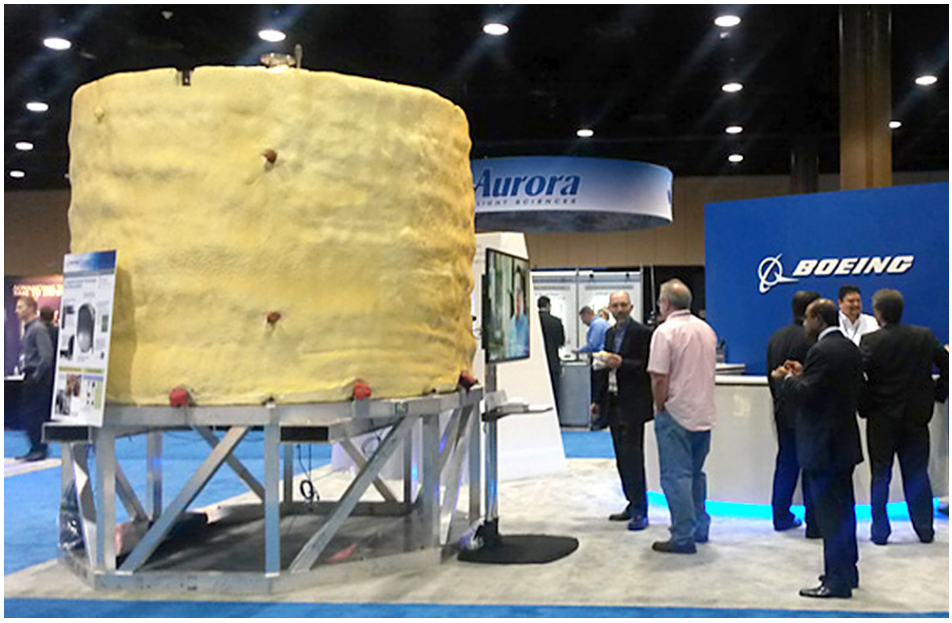

Image Credit: NASA

Composite cryotank at the DMC exhibit.

Dr. Lind

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brines, and they are not a sufficient barrier to small organic compounds commonly found in urine.

Dr. Daniel Barta, Project Manager of NGLS, was particularly interested in this funded activity. "We are currently using forward and reverse osmosis processes as part of an effort to develop an alternative water processor for spacecraft cabin water recovery. Advances in membranes will increase the performance of systems."

Dr. Lind's initial year of research holds exciting promise toward improving membrane technology. Investigations have included deposition methods of water-barrier polymeric thin films onto porous substrates through solution casting, spray deposition, and latex film formation. During the seminar, Dr. Lind described the optimized deposition methods and presented characterization data of thin film properties and water barrier performance.

"We can form water-barrier thin films of polymers on porous supports through solution and latex deposition methods," Dr. Lind said during her presentation conclusion. Year 2 research goals include synthesis of MoSIN membranes and performance testing with ideal, model solutions.

Advanced materials that successfully increase the reusable amount of water retrieved in space have the potential to decrease payload, extend the time humans can sustain activities beyond low-Earth orbit, and are a method of resource recovery crucial to the future of interplanetary travel.

Game Changing's 2013 Annual Program Review

Image Credit: NASA

The Game Changing Development Program held its 2013 Annual Program Review (APR) December 10-12 at NASA's Langley Research Center. Associate Administrator (AA) for NASA's Space Technology Mission Directorate Michael Gazarik, Deputy AA for Programs James Reuther and Deputy AA for Management Dorothy Rasco as well as other NASA stakeholders were in attendance. Project managers from across many different centers traveled to the APR to report on their project's major milestones, accomplishments, technology transfer and education and public outreach as well to give a look-ahead for FY 2014. In conjunction with the APR, the 2.4-m composite cryotank (shown in the background) was at NASA Langley for display. In addition to presentations, project managers shipped hardware and posters for the APR exhibit and participated in video interviews.

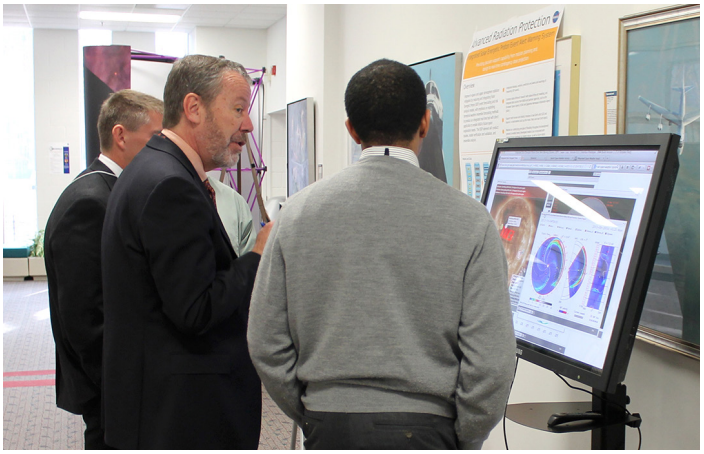


Image Credit: NASA

Members of the Advanced Radiation Protection team discuss space weather during the APR.

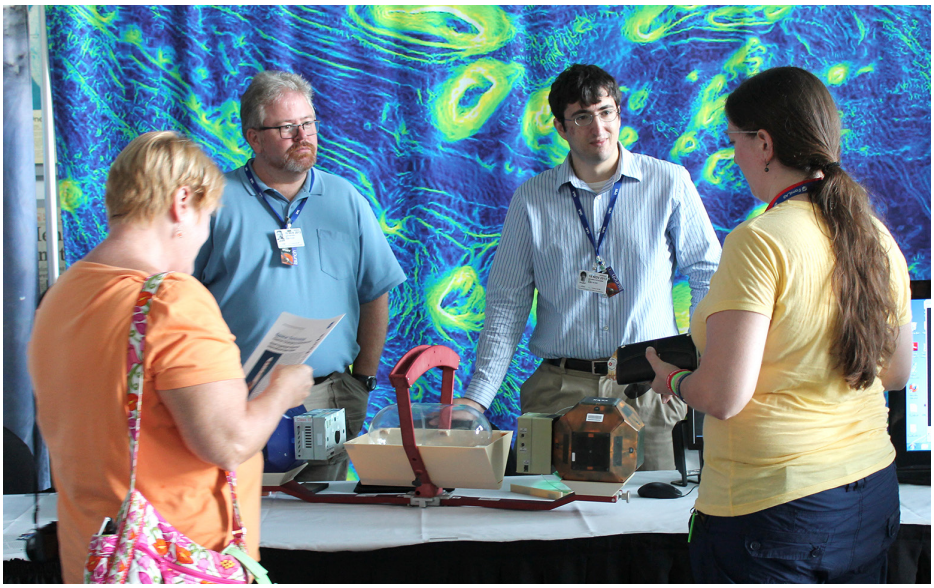
Image Credit: NASA

The 2013 GCD Annual Program Review kicked off Dec. 10 at the National Institute of Aerospace.

Image Credit: NASA

Project managers Bill Bluethmann (left) and John Lytle visit the exhibit tables during a break.

Game Changing Education and Public Outreach



Several Game Changing projects supported the Space Technology Mission Directorate exhibit during the Maven Launch at NASA's Kennedy Space Center in November. Members of the Slosh team (pictured) and In-Space Research Utilization staffed exhibits at the Saturn V building and Advanced Space Power Systems and Woven TPS sent exhibits. During the exhibits, NASA staffers engaged visitors about the mission of Space Technology that NASA is investing in that will get us to Mars. The event drew more than 30,000 people.

Image Credit: NASA

Members of the Game Changing Development Program Office participated in NASA Langley's annual chili cook off fundraiser for the Combined Federal Campaign (CFC). Team members Steve Gaddis, Arna Majcher, Jessica Woods-Vedeler, Bob Hodson, Parth Punjabi, Rob Lowe, Dawn Stewart and Amy McCluskey formed the Bazinga! Team and served "Big Bang Chili." The team raised $140 for the CFC.

Image Credit: NASA

Game On!

http://gameon.nasa.gov

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