

Mockup Helps Prepare Astronauts to Use Dexterous Robot on International Space Station

“The mockup has made it much easier for the crew to train and prepare to utilize R2.”

— Gina Young, Project Manager, Wyle

Wyle is a leading provider of high-tech science, aerospace engineering and information technology services to the federal government on long-term outsourcing contracts. Wyle’s Integrated Science and Engineering Group in Houston helped the National Aeronautics and Space Administration (NASA) prepare the Robonaut 2 (R2) dexterous humanoid robot for launch to the International Space Station (ISS).

While most current space robotic systems, such as robotic arms and exploration rovers, are designed to move large objects, R2’s tasks require more dexterity. Its mission is to work alongside astronauts, taking over repetitive and dangerous tasks. Its form factor and dexterity are designed such that R2 can use the same space tools and work in environments suited to astronauts.

One of Wyle’s responsibilities under this contract was building a one-to-one scale high-fidelity mockup of R2 for use in the simulation of potential missions. The exterior of the mockup had to duplicate the geometry and appearance of the actual R2. The limbs of the mockup had to be easily moved into the same positions as the real robot. And, the mockup had to withstand rough handling that it might receive during simulation and training exercises.

“The geometry is very complex and we were under time constraints to produce the mockup,” said Robert Stevenson, mechanical designer for Wyle. The parts have so many compound contours that it would have been very difficult to hold them during finish machining. One consequence is that they would have had to be thicker than on the real R2 which would have added to the weight of the mockup. The estimated delivery time for conventional machining for the mockup was 8 months and the cost was \$180,000.

“RedEye On Demand was a good fit for Wyle because of FDM’s ability to create complex geometries,” said Jeffrey Gangel, RedEye On Demand Account Manager. “FDM also provides the high level of accuracy needed to ensure that the many pieces required to build the mockup fit together during assembly. Finally, with the largest installed base of FDM machines and the largest inventory of FDM materials in the world, RedEye On Demand was able to meet the tight timeline for the project.”

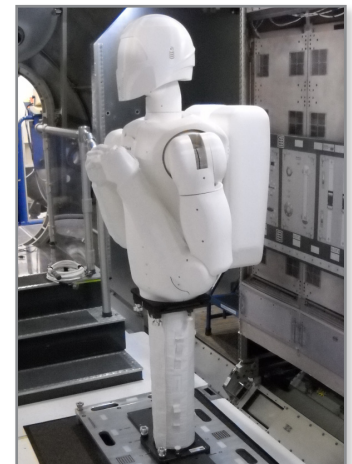
“Our manufacturing lead had used RedEye On Demand digital manufacturing services in a previous job and had good results,” Stevenson said. “I sent CAD models to RedEye for quotation and evaluated the mechanical properties of the Fused Deposition Modeling (FDM) materials on their web site. The ABS material met our strength and durability

How Did FDM Compare to Traditional Prototyping Methods for Wyle?

Method	Cost	Time
CNC machined tooling	\$180,000	32 weeks
FDM tooling	\$36,000	2 weeks
SAVINGS	\$144,000 (80%)	30 weeks (94%)



Actual R2 at Kennedy Space Center before it was carried to International Space Station on the last flight of Space Shuttle Discovery



R2 mockup in the US Lab mock-up at Johnson Space Center



Components for R2 mockup were made by RedEye On Demand digital manufacturing service.

requirements. RedEye was also very helpful in educating me in what I needed to do to get our CAD models ready for digital manufacturing." Fused Deposition Modeling is an additive manufacturing process that builds plastic parts layer by layer, using data from CAD files.

It took only two weeks and cost \$36,000 for RedEye to make all of the parts required for the mockup. The interior of the mockup is made from square tubing to provide strength. The mockup is positioned by tension in its joints like a mannequin.

"NASA was very happy with the mockup," said Gina Young, Project Manager for Wyle. "They liked the fact that it was produced on schedule, is light compared to the original and is strong enough to withstand the large amount of handling it has received. The feedback we received is that the mockup has made it much easier for the crew to train and prepare to utilize the R2."

The R2 flew to the ISS in February on the Space Shuttle Discovery's last flight. Initially, R2 will be deployed on a fixed pedestal inside the ISS for operational testing. Next steps include adding a leg for climbing through the corridors of the ISS and further upgrades to go outside in the vacuum of space.



Interior view of the R2 mockup

For more information about RedEye On Demand, call **866-882-6934** or visit www.RedEyeOnDemand.com

Worldwide Headquarters

RedEye On Demand

8081 Wallace Road
Eden Prairie, MN 55344
+1 866-882-6934 (US Toll Free)
+1 952-906-2725 (Int'l)
+1 952-906-2765 (Fax)

GoDigital@RedEyeOnDemand.com

European Headquarters

Materialise

Technologielaan 15
3001 Leuven
Belgium
+32 16 39.67.60
+32 16 39.62.75 (Fax)

GoDigitalEU@RedEyeOnDemand.com

Australasia Headquarters

RapidPro

3/17 Diane Street
Morningside, 3931
Victoria, Australia
+61 3 5976 3603 (Int'l)
+61 3 5973 6001 (Fax)

enquiries@RedEyeOnDemand.com.au

ISO 9001:2008 Certified

©2011 Stratasys Inc. All rights reserved. Stratasys, RedEye, FDM, Fortus, Dimension, and uPrint are registered trademarks and Real Parts, Fortus 360mc, Fortus 400mc, Fortus 900mc, RedEye On Demand are trademarks of Stratasys Inc., registered in the United States and other countries. *ULTEM 9085 is a trademark of SABIC Innovative Plastics IP BV. All other trademarks are the property of their respective owners. Product specifications subject to change without notice. Printed in the USA. CS-RE-Wyle-06-11



PARTS FOR PROTOTYPE AND
PRODUCTION • ON DEMAND