A stitch in time for NASA airplane techies

Aircraft of the future might be stitched together rather than fastened. NASA is preparing to test a structure built that way under a six-year-old project to make commercial airliners more environmentally friendly.

The Pultruded Rod Stitched Efficient Unitized Structure, or PRSEUS, will be set up in the Combined Loads Test System, or COLTS, at NASA Langley Research Center in Virginia to see how well it tolerates the bending and internal pressure of simulated flight. The month-long test is expected to begin in March or April.

"The upcoming test will prove that the PRSEUS concept is viable for commercial transport aircraft," said lead engineer Dawn Jegley. "This is the final step in our building block process, short of a flight vehicle."

The test article is an 80-percent-scale cross-section of a hybrid wing-body aircraft fuselage, and it contains three side-by-side compartments or bays like those in which passengers would sit. Boeing Research & Technology built the 30-foot-wide, 13-foot-high structure in Long Beach, California, and NASA was scheduled to fly it to Langley in mid-December aboard its Super Guppy widebody cargo plane. NASA developed the structure concept with Boeing and the U.S. Air Force Research Laboratory.

Unlike conventional aircraft, in which thousands of fasteners tie together structures, PRSEUS is made of carbon fibers stitched together by a device that operates like a large sewing machine. The fibers are then coated with resin and heated in a pultrusion process to make them hard like plastic.

PRSEUS is lightweight but damage-resistant, making it particularly suitable for a hybrid wing-body configuration, which produces greater lift and reduced drag compared with a conven-

A cross-section of a blended wing body, built at Boeing's facility in Long Beach, California, will be used to test stitched construction.

Boeing

tional airplane with a circular fuselage and wings, according to NASA.

"PRSEUS alone does not help with lift, drag or noise," Jegley said. "Combining it with the new shape of the hybrid wing-body is where we get the lift and drag improvements."

The structural testing at Langley is one of eight major technology demonstrations NASA is conducting under the Environmentally Responsible Aviation project. NASA launched ERA in 2009 to develop airplane technology that might cut fuel consumption, air pollution and noise. For aircraft that could enter service in 2025, ERA aims to cut aircraft drag by 8 percent, aircraft weight by 10 percent, fuel consumption by 15 percent, nitrogen oxide emissions by 75 percent and noise by 12.5 percent.

Jegley said that building an airplane to demonstrate these technologies in flight is an option for the future.

"We have discussed possibilities but no specific plans for a flight vehicle," she said. "It's just the next logical step."

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Space visionary

Retired Air Force Brig. Gen. Simon "Pete" Worden, director of NASA's Ames Research Center

Back when astrophysicist Pete Worden was an Air Force officer and the technical brains behind the Strategic Defense Initiative, members of his entourage liked to say that defending Americans from missiles was but one small piece of his plans for putting space to use. Since 2006, Worden has been marshaling the talents of supercomputing experts, entrepreneurs and Silicon Valley toward creation of a space economy in which people would live and work far from Earth. Worden, in fact, joined the Air Force to become an astronaut, but NASA did not select him. Ben Iannotta spoke to Worden by phone about his second career as director of NASA's Ames Research Center.

NASA has these capability leaders coming onboard. What would you say to one of them about Ames?

We've worked very hard to do things that are on the cutting edge but that aren't focused on a lot at the other centers, and that take advantage of our unique location. We're the IT leader for the agency. We've also become the partnership lead for the emerging private sector and international partners — sort of non-traditional partners. In aeronautics, we've always been the lead on more analytical things: end-to-end analysis, safety, air traffic management. On entry-descent and landing, if you want to go to space, you talk to Marshall and Stennis. If you want to come home, you talk to us. I've gotten excited about fundamental biology. I'm convinced that biology is every bit as important for our science and exploration missions as aerospace engineering. It's going to approach about 100 million [dollars] a year. My own personal area of interest is small satellites. We're seeing in the Technical Capability Assessment that we've come up pretty well.

What do you mean by fundamental biology?

If you look at what would [be required] on Mars to enable humans to live there and live off the land, I really would like a self-replicating programmable machine. It turns out that's called biology, and we're beginning to learn how to program biology.

I hit a computer command and an apple grows?

Eventually, yes. Let me give you an example of an experiment we're doing with the German space agency, called Eu:CROPIS [Euglena: Closed Regenerative Organic food Production In Space]. On the space station, we can't test variable gravity. We don't have a centrifuge. So in about 2017, the Germans are launching a small satellite that will rotate at variable speeds and simulate gravity. Gene expression differs in space for reasons we don't fully understand. So we have an experiment that we're putting on EU:Cropsis. Cyanobacteria convert sunlight and trace elements and carbon dioxide to sugar. We're going to engineer the cell wall so that sugar can be secreted. This is basically a mechanism where we can grow sugar and pharmaceuticals and so forth. So it's a programmable factory. We want to find out: Does it work in one-sixth gravity to simulate the moon, or one-third gravity simulating Mars?

How do you take advantage of your Silicon Valley location?

We have a research park with about a hundred partners and we team with them to produce new capabilities. A very interesting one is Made In Space. They work closely with us and Marshall Space Flight Center. They just produced and launched the first 3-D printer to go into space on the International Space Station. This is another part of being able to live off the land. If something breaks, you can build a part or a tool. A good bit of the venture funding is here. Another one is the spirit of innovation: It's OK to fail. The old saying at NASA that failure is not an option doesn't really apply in Silicon Valley. Failure is not only an option, but it's expected.

Do your Silicon Valley partners use the Pleiades supercomputer at Ames?

Yes. Pleaides is number 11 in size in the world but it's the largest sort of commercial endeavor. We work closely with Silicon Graphics — SGI. It is a public-private partnership to

Interview by Ben Iannotta

NASA

Pete Worden at the Ames Research Center's hyperwall, a liquid crystal display showing historic and predicted temperature maps of the U.S.

develop this capability. One of the interesting private sector partnerships is with this company right next door to me that you might have heard of, Google, I think they're called. We and Google and USRA [Universities Space Research Association] have got one of the three quantum computers in the U.S., the D-Wave machine. That's another example of a public-private partnership to move computing forward.

One of the points people have been making is that computational fluid dynamics tools aren't ready for supercomputing and quantum computing. Are you guys addressing that problem?

Absolutely. One of our key goals is to make sure the physics understanding matches the computational tools. The quantum computer came out of our physics-based modeling group. A lot of other methods are more sort of trial-and-error, whereas fundamental physics says, "OK, what are the physics we're dealing with?" We've used [the Pleiades supercomputer] to model some of the fluid flow and aerodynamics for [NASA's Space Launch System rocket] for example. We are running up against the computational limits for some of the problems we want to solve. The quantum machine offers one interesting approach to problems we can't solve with a conventional machine.

What kind of work can you do with quantum computing?

A quantum machine — and this is a very early first order machine — has a unique capability that a conventional machine doesn't. The classic problem is the traveling salesman. I'm a salesman and I want to go to a bunch of cities and spend the least amount of time on the road. I can program this on a [conventional] computer, but when I start to get more than about 30 cities, I double the size of the machine I need. That's called an exponentially growing machine problem. But a quantum machine has a linear scaling with complexity, because each bit can be all values between zero and one and is entangled in a quantum way with the other bits. You could have hundreds of sites and in principle solve them. We'd like to optimize thousands of airplanes flying simultaneously. That's part of [FAA's] Next Generation air traffic management system. Eventually a quantum machine would enable us to do that. Suppose I send a robot into a cave on Mars. If I try to program it for all possible things, it becomes impossible. But if I start us-

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ing a quantum approach, this provides a new level of autonomy. We do not yet have a quantum machine that we could send on a robot to Mars, but we might in 20 years. Some people would call it AI, I just prefer to call it complicated autonomy.

What are you doing in the area of climate change?

We have the NASA Earth Exchange, which is a tool that enables people who are doing the actual modeling to get access to this data in a way that it's calibrated and linked to other data sets. Also, the Pleiades supercomputer is used by the whole agency and the whole scientific community for models, to start focusing on site-specific climate prediction. If I go to a city and say, "We think the average temperature is gonna be 3 degrees higher in the state of California and you'll have 10 percent less rainfall," what they really want to know is: "What's it going to do right here in my area?"

Do you think climate change is an area that the new Congress might not be as interested in funding?

I spent a year as a congressional fellow when I got out of the Air Force. I like to think most NASA things aren't very partisan. I think we're looking forward to some broad support for what we're doing.

Do you think the emphasis on green and climate change will have legs beyond the Obama administration?

I think understanding the environment we live in is important no matter where we are. We can argue about what's causing changes, but the climate is constantly changing for a lot of reasons. The climate changes not only on this planet but on Mars and other places we're going to be. If you're going to live someplace, you need to understand and be able to predict at a certain level the changes. This goes far beyond politics or one person's or another's view.

Our job is to collect data, to help interpret it, and make it available. I think we do it pretty well.

Where do you come down on climate change?

My interest is climates on planets that might be orbiting the nearest stars. One of the things I learned as a scientist is that I should stick to areas that I'm really an expert on. So I'll decline to give you an opinion on that.

On small spacecraft and cubesats, what kind of deorbiting technologies are in the works?

One of the interesting things about cubesats is that most of them we launch to an altitude where they deorbit in short order anyhow. That said, we are looking at ways to accelerate that. We've worked with the Marshall Space Flight Center to deploy at the end of life a small solar sail that will slow it down and deorbit it. I think if we can make these things cheap enough that it may make it possible for us to take these small sats to higher altitudes and maneuver them even if you're out of fuel or you don't have a propulsion system.

Could you foresee ever having to deploy a nuke — a nuclear weapon — against an asteroid or comet?

We don't know. I would like to think that in the long run, if you have good enough sensor systems, you can find things years or decades out so that we can use much more conventional means to move them.

When you look back on the Strategic Defense Initiative, what were the impacts?

Starting to look at defenses was a key element in ending the Cold War and coming to a peaceful end. It had to be one of the more cost-effective initiatives. So I'm happy about that. As a side benefit, we developed a lot of very exciting technologies. The nucleus of the current small satellite effort, much of it came out of the strategic defense technology program. Not that we should do efforts in national security because of the technology. But we should certainly take advantage of those. If you recall, when I was there, we sent a probe to the moon — a low-cost probe called Clementine.

I remember that.

Now that I've been here, I've sent two other probes to the moon. [*Interviewer's note: He means LADEE, the Lunar Atmosphere and Dust Environment Explorer, and LCROSS, the Lunar Crater Observation and Sensing Satellite.*] I'm a moon mission expert now. So three times to the moon and they all worked.

The other piece of history I was curious about was your chapter as director of the Pentagon's Office of Strategic Influence. That always struck me as an odd choice for a technologist, but maybe not.

Obviously there's a lot of controversy. I will tell you that a lot of our interest was in cyber and information that goes over computers. Prior to that, I was the deputy director of operations at U.S. Space Command that had the cyber operations responsibility. I think the other thing is they were looking for somebody to look at things outside the box. But that was a short-lived job.

Can you paint a portrait of the interesting developments we'll see in the coming years?

We're at the beginning of a true space economy that's going to take us beyond Earth orbit. By the middle of this century, I expect us to be not only a multiplanet species, but a multiplanet economy. The second is biology. We are going to understand biology to make life incredibly better here on Earth, as well as to expand into the solar system. The third, and this is sort of my own pet area, is that this is the century we're going to start looking beyond our solar system. I loved the movie "Interstellar." It's time to start that — probably not using black holes, worm holes — but I'm very excited about the Kepler results.

It's science for the sake of science, but I guess what's wrong with that?

It's mankind's ultimate future. I think we're the universe's answer to entropy. And expanding into the solar system and beyond is, at least to me, the ultimate quest.

PUMPKIN CHUCKING—WHERE AERODYNAMICS, SCIENCE, AND GOURDS INTERSECT

Duane Hyland

In November, Team AIAA Greater Huntsville, composed of intrepid aerospace professionals, took to the fields of Tate Farms in Meridianville, AL, to participate in the "Pumpkin Blast 2014" competition, or as it's colloquially known "some pumpkin chunkin." At the end of the day, AIAA's band of "pumpkin chuckers" placed second in the event's Adult Division, and earned the event's Outstanding Spirit and Blastmanship award from the judges.

Team members, a mix of young professional, student, and professional members, were the Launch Crew: Brandon Stiltner, team's captain; Eric Becnel, Daniel Colty, and Michael Dunning. Team Members: Nathanial Long and Colin Moynihan. Other contributors were: Anthony Bartins, Ali Butt, and Tia Ferguson. Kenneth Philippart, chair of the AIAA Greater Huntsville Section, served as the team's program manager. Each team's propulsion device had to be capable of propelling a pumpkin weighing two to four pounds over a distance of at least 75 yards, with possible propellant systems including air cannons, catapults, slings, slingshots, or trebuchets. The team decided that a trebuchet, a medieval siege weapon used to fling heavy stones at the walls of cities, would be their "chunkin" device of choice. "Once we had an idea of what the trebuchet was going to look like, we went to drawing sketches in computer-aided-design CAD," explained team leader Brandon Stiltner. The analysis allowed for precision in the building process.

Each of the event's teams were provided with five pumpkins to "chunk," and 30 minutes in which to chunk them at a target some 95 yards distant. Team AIAA Greater Huntsville's longest chunk was 80 yards. Teams started the day with 350 points, from which the judges deducted one point per foot that the pumpkin finished away from the target. Teams earned bonus points if their pumpkins weighed more than four pounds, with the maximum weight limit being 10 pounds. Other bonus awards included 50 bonus points for using trebuchet designs, and another 50 bonus points for the team finishing with the day's longest "chunk, and another 50 points for winning one of the event's special awards. The starting points, minus deductions, combined with any bonus points, determined the team placement in the event.

Team AIAA Greater Huntsville also aided the next generation of engineers during the event. "When one of the youth division teams had a major equipment failure, our team grabbed their tools and spare lumber and without hesitation, helped the high school team repair their machine," said Philippart. "The event organizer, students and parents came up to us after the event and thanked AIAA for helping their kids. We couldn't have asked for a better way to give a favorable first impression of AIAA and a practical application of STEM in action!"

The best part of the process, according to the team, wasn't watching the pumpkins soar or the application of practical engineering skills, but rather the teamwork and camaraderie that resulted from working on the device and competing. Philippart is already looking toward next year, stating: "I have no doubt that through this competition, our section planted the (pumpkin) seeds for the next generation of AIAA leaders. They did AIAA and the Greater Huntsville Section proud!"

AIAA Huntsville chapter visiting the United Launch Alliance rocket factory in Decatur, AL