AIRLINES TO WATCH IN 2013

$7.95 DECEMBER 17, 2012

AVIATIONWEEK
& SPACE TECHNOLOGY

POWERING A320NEO
Testing Pratt's New Engine

OAK RIDGE
Big Science, Big Solutions

Exporting The JF-17

The McGraw·Hill Companies

AviationWeek.com/awst

Eureka Effect

Oak Ridge National Lab can serve as an extension of aerospace companies' in-house R&D

Anthony L. Velocci, Jr. Knoxville, Tenn.

Industry has long recognized the value of collaborating with government on applied research projects, especially in the pursuit of breakthrough technologies. Access to specialized skills and state-of-the-art facilities, not to mention risk sharing, are just a few of the direct benefits. Such cooperation has been instrumental in helping companies validate and commercialize advanced capabilities sooner than if they had been working alone.

For aerospace, in particular, these kinds of partnerships may take on even greater significance in the future. In the more challenging environment in which aerospace and defense contractors will be operating for years to come, companies will need to stretch scarce resources to satisfy research and development needs.

One organization that could play a pivotal role in helping companies fill R&D gaps—and sustain a higher rate of innovation than otherwise might be possible—is Oak Ridge National Laboratory (ORNL). Moreover, there is just as much opportunity for small manufacturers with no access to cutting-edge R&D tools as there is for larger enterprises compelled to more aggressively manage where to place their big-science bets.

Run by Battelle in partnership with the University of Tennessee, Oak Ridge is home to the U.S.'s largest concentration of open-source materials research, plus a state-of-the-art Manufacturing Demonstration Facility (MDF). Its primary mission is to push the envelope in the development and demonstration of energy-efficient manufacturing technologies and materials, and to disseminate these capabilities. Robotics, additive manufacturing and microfluidics also are discrete fields of expertise.

Of ORNL's 800 industrial partnerships, no more than 5% involve aerospace companies. Contractors historically have demonstrated little concern for energy usage in their calculus of manufacturing efficiency; hence the relatively small number, according to Craig Blue, director of the MDF. That sentiment was prevalent at an aerospace planning workshop organized by Oak Ridge and attended by executives of some of the industry's largest primes. Another hindrance to aerospace collaboration has been a popular misconception that government labs only pursue pure science rather than concrete objectives.

However, a combination of factors has led to an increase in aerospace participation. Companies are showing greater interest in more-innovative production methods to improve competitiveness, and Oak Ridge is doing more outreach to educate companies about the huge efficiencies to be gained through lower energy consumption.

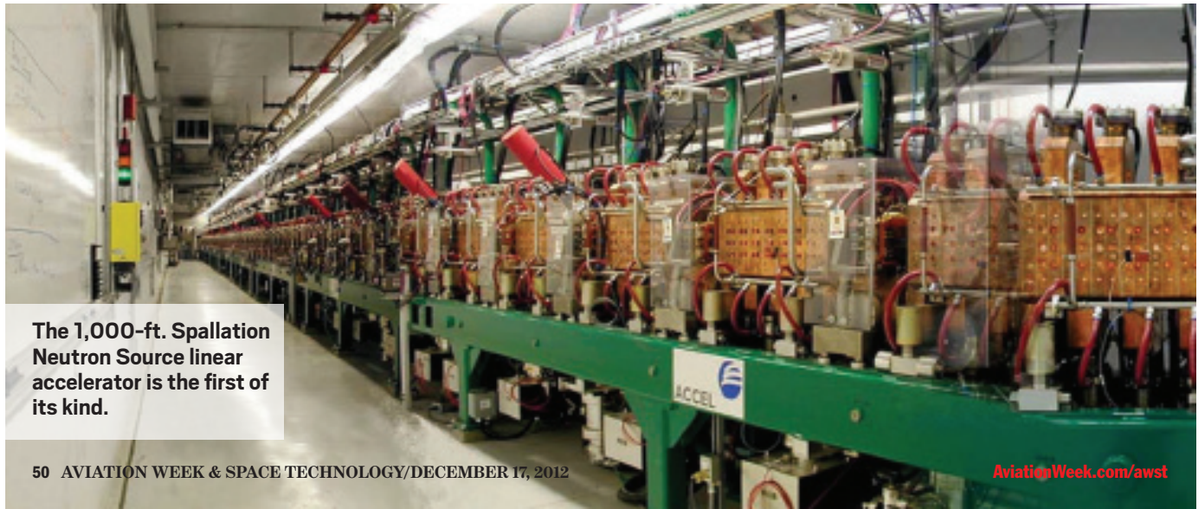
Word also is spreading that the MDF facilitates implementation of advanced technologies. "Our main purpose is to help companies by allowing them to come here and test processes and components that will be part of a larger system, with partners retaining their intellectual property rights," Blue says. "We have all the facilities under one roof to function as a beta test site—and basically serve as an extension of companies' own research capabilities."

In some cases, builders of the actual production equipment required to put advanced materials to work and implement innovative manufacturing processes—such as additive manufacturing—have referred A&D contractors to ORNL. This was the case with Stratasys, the world's largest developer of additive manufacturing machinery.

"The level of awareness within the aerospace engineering community about ORNL's mission and what it is doing to drive advanced manufacturing technologies has been low," Jeff DeGrange says. He is vice president of direct digital manufacturing at Stratasys, and a former Boeing engineering manager. "In the case of additive manufacturing, they don't understand the current state of the technology and how it can be applied to their function, which Oak Ridge is very good at doing."

He draws an analogy with information technology. When computers were in their infancy, DeGrange says, few people were able to appreciate how they could be tailored to business/manufacturing functions. "ORNL has the personnel and tools to help aerospace companies figure that out and put such applied research on a fast track."

One significant partnership Oak Ridge has with aerospace is a project involving Lockheed Martin. The two are perfecting near-net-shape manufacturing of new, low-cost titanium powders. Simultaneously, ORNL and Lockheed are developing accelerated component qualification. Implementation is underway.



The 1,000-ft. Spallation Neutron Source linear accelerator is the first of its kind.

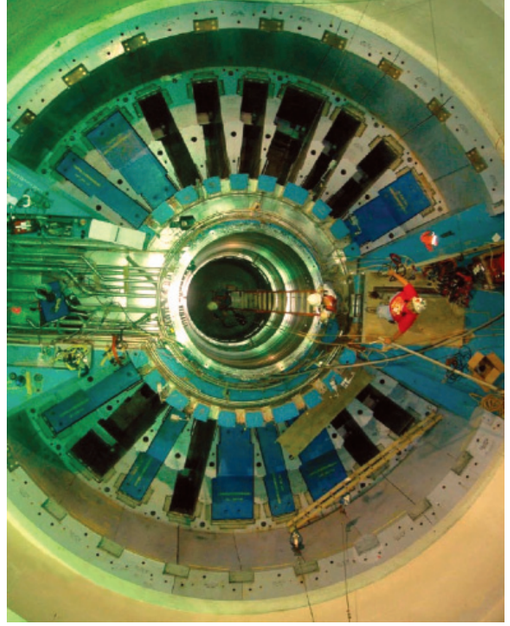
In addition to the growing number of partnerships with aerospace companies, some large enterprises are showing a greater willingness to collaborate with each other on precompetitive technologies to an unprecedented degree. To make such collaboration possible, partners must be able to resolve the sensitive issue of intellectual property (IP). Non-disclosure agreements (NDA) brokered by ORNL are proving effective, due in large part to the trusted relationships that Oak Ridge has built over the years with companies in a range of industries. "Oak Ridge has developed a very successful model for managing who owns what and respecting the needs of all stakeholders," DeGrange says.

Blue refers to ORNL as "a white-hat organization" in facilitating industry collaborations, whatever form they may take. "Companies must have confidence that their IP will be protected even as they open their black boxes," Blue says, emphasizing the importance of such openness. Without it, ORNL engineering managers explain, there would be little hope of accelerating the progress of advanced technologies, since there would be little or no learning from the failures of others in the partnership. "Very simply, we don't want to be repeating other people's mistakes."

Through the collaboration model the laboratory has assembled—with openness by all parties a key component—industrial partners say they have learned more about how to advance additive manufacturing in the last six months than they have in the last 10 years.

"It's about understanding basic physics and taking the black magic out of whatever the advanced technology happens to be," Bill Peter says. He heads the Materials Processing Group in the Materials Science and Technology Div. "Anybody can build parts. The real goal is the ability to produce a product and qualify it, and then transfer that fundamental knowledge broadly."

He adds, "We are able to take much of the risk out of applied research, including eliminating the need for companies to make the capital expenditures it would take to duplicate the tools Oak Ridge is willing to share."



The Spallation Neutron Source enables precise study of micro- and macro-cracking due to residual stresses from processing.

Supporting ORNL's mission and the aerospace partnerships it is seeking to expand are a set of extraordinary tools found nowhere else. These include, among others, the Spallation Neutron Source, the world's most intense neutron source that enables scientists to study micro- and macro-cracking phenomena related to residual stress during processing. It also allows ORNL to produce high-value parts in low volume as part of its applied research. And the lab houses the world's first commercial prototype superconducting magnet for designing mechanical properties into materials that cannot be accomplished in any other fashion.

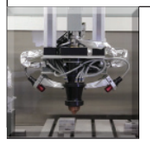
Oak Ridge's newest applied research capability, the Carbon Fiber Technology Facility, can demonstrate the scalability of low-cost carbon-fiber technology and produce quantities of low-cost carbon fiber needed for large-scale material and process evaluations and prototyping. The facility houses the only line in the world configured to do both carbon mat and tow, with the capacity to produce 25 tons per year from multiple precursors in various forms.

Much of ORNL's work involves potentially disruptive technologies that eventually will be rolled out to industry, such as the previously discussed additive manufacturing. The MDF already has demonstrated the potential of the process to reduce the buy-to-fly ratio from an average of 8:1 to 1:1—that is, 8 lb. of material to produce 1 lb. of aerospace-quality material. Essentially, MDF reduces the risk of developing and testing cutting-edge manufacturing technologies and components.

Additive manufacturing creates components directly from a computer model, adding material only where needed and providing greater design flexibility and decreased energy consumption. Currently there are approximately 20,000 parts flying and 200 part numbers—the product of polymer advanced manufacturing technology—on 10 different commercial and military aircraft. Each part weighs up to 75% less than comparable parts made by traditional means.

The ability to produce whole systems, although still in the research phase, is within sight, says Blue. An example is unmanned aerial vehicles built from the ground up by laying down material in open air, with sensors and electronics installed as the product is being manufactured. It is a print-and-build, no-parts-assembly-required process. "We are getting there quicker than we ever imagined," Blue says.

As U.S. aerospace and defense companies adapt to what almost certainly will be an era of constrained resources—given the sharp defense budget downturn and the struggling economy—government- and company-funded R&D is likely to be squeezed. While it is too soon to forecast the extent of the constraint, some industry observers believe it could be substantial. Observes Blue, "Oak Ridge is a national resource, and if ever there was a time when we could make a difference, I would think it is now."



Oak Ridge National Laboratory's expertise in additive manufacturing could soon greatly increase A&D contractors' manufacturing productivity. To see a video demonstrating some of ORNL's technologies, check out the digital *AW&ST* edition on leading tablets and smartphones, or go to **AviationWeek.com/video**