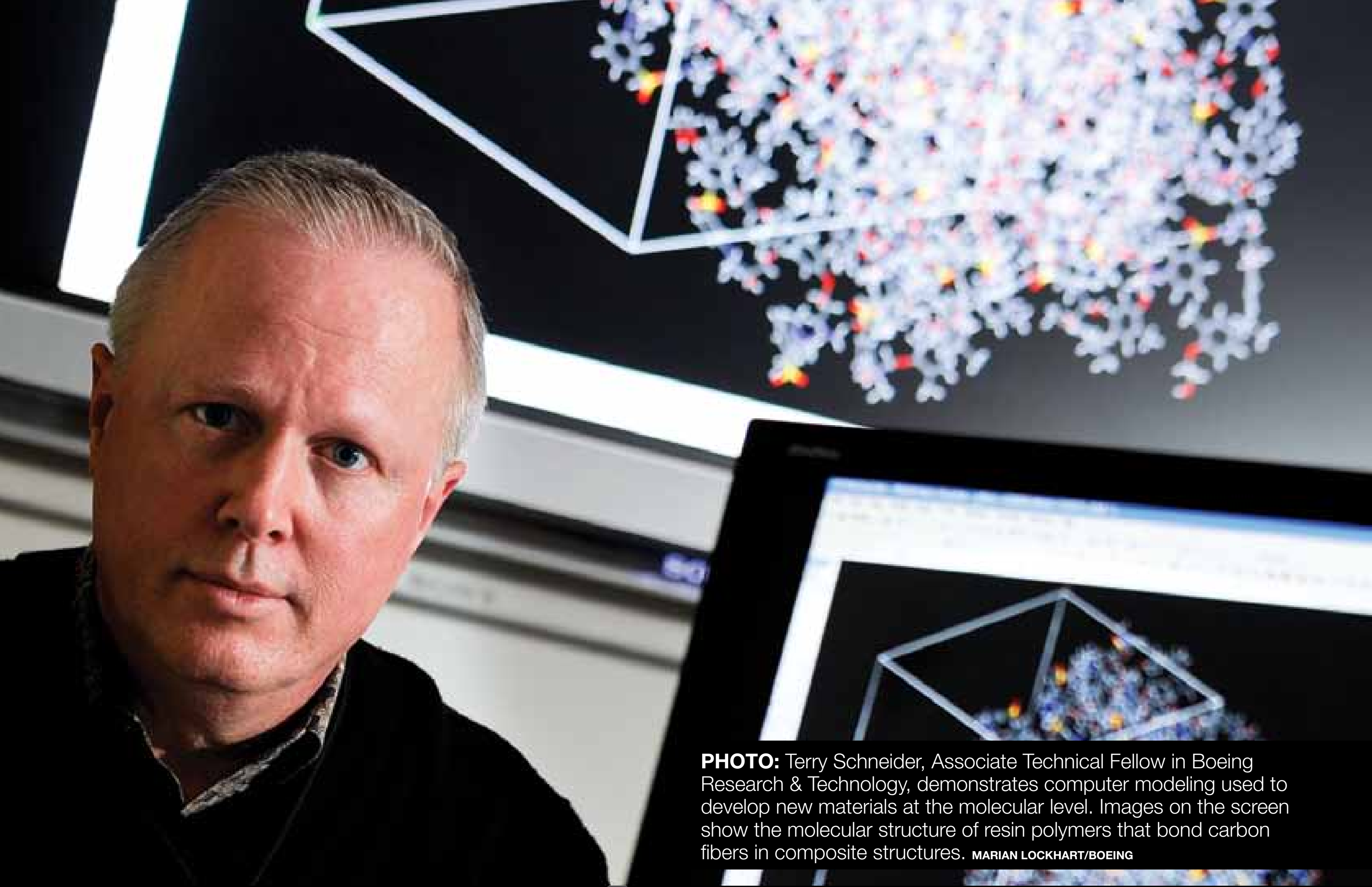

PHOTO: Terry Schneider, Associate Technical Fellow in Boeing Research & Technology, demonstrates computer modeling used to develop new materials at the molecular level. Images on the screen show the molecular structure of resin polymers that bond carbon fibers in composite structures. MARIAN LOCKHART/BOEING

Atoms **to airplanes**

New structures technologies, developed across Boeing, are helping accelerate product development **By Bill Seil**

Terry Schneider, an Associate Technical Fellow in Boeing Research & Technology, works in "atoms to airplanes" modeling, or the complete process of modeling an airplane computationally from a molecular level up to the full-scale, complete airframe.

One important goal of this work is to optimize the chemistry of polymers to increase the load-carrying capability of the carbon fiber in composites, which could significantly reduce the weight of next-generation composite structures.

"This is exciting work because we're able to rapidly assess hundreds of polymer candidates in a matter of weeks—a process that might take years in a lab," Schneider said. "We're also able to quickly determine their performance in large-scale laminated structures and screen for the best-performing candidates. This opens the door to huge cost savings in the future."

Work such as this demonstrates the benefits to Boeing generated by the company's enterprisewide approach to making research investments in key areas such as structures, a term that describes the physical airframe components of airplanes and other aerospace products. Critical aviation design issues—including weight, reliability and safety—all depend on the quality of research and planning that drives structures engineering.

Boeing has long been a leader in structures technology, and research conducted throughout the enterprise has steadily improved the design of structures and the materials used to make them. The challenge today is to increase the company's competitive edge by investing in research that generates maximum benefit for Boeing's range of products, both commercial and military.

That's why, in 2008, the company created its Enterprise Technology Strategy (ETS), which takes a coordinated, "One Company" approach to technology development. The strategy is built around eight technology areas, or domains, that support Boeing's many business programs and can create a sustainable technical competitive advantage that helps the company grow.

Among these domains is Structures, which has two broad areas of research. First, it looks at the methods, tools and processes that go into the design of new structures, as well as advanced structural architectures. Second, it develops new materials for use in aerospace products. Company-funded materials research, for example, has led to the development of commercial airframes made from composite materials, as used in the 787 Dreamliner.

Structures engineers refer to structures as "the bread and butter of everything that flies." And the Structures domain brings people together to ensure the best of technology—and the best of the enterprise—goes into Boeing products.

Like the other domains, Structures taps into research talent around the world, including teams at universities, corporations and aerospace suppliers. Advances in materials development have taken a major leap with the use of computer modeling at the molecular level, said domain leader Andy Bicos.

"With today's software, we can design materials on a computer and work with material suppliers, who produce it and send us samples," Bicos said. "We then test the samples to see how close to the designed properties the actual supplier-made material has come."

While many factors are considered when developing a new material, the ultimate goal is increasing performance while driving down weight and cost. Right now, composites are offering the greatest opportunity for improvement. But Bicos noted that metals can always make a comeback, depending on program requirements and technology advancements. The domain is continuing to look at new aluminum alloys that could be competitive with composites.

Research also is taking place to create structures that support additional functions. For example, designing health management systems into structures could help identify abnormalities before they become problems. Or aircraft wiring could be integrated into structures, rather than attaching it by brackets.

Rod Dreisbach, Senior Technical Fellow adviser to the Structures domain, said the potential of multifunctional structures, along with other new technologies, underscores the importance of the eight domains working together.

"The domains aren't independent silos," Dreisbach said. "As we find new ways to coordinate their activities, we'll greatly enhance their overall effectiveness."

Akif Bolukbasi, a Senior Technical Fellow who serves as Structures domain leader for Integrated Defense Systems, said the synergies resulting from the domain system are of great value to IDS. For example, research into composite structures conducted by Boeing Research & Technology and Commercial Airplanes has a number of possible applications in Integrated Defense Systems.

Good cross-domain planning and coordination helps develop research projects that address high-priority business opportunities and capability gaps, along with technical requirements, in time for Boeing to present a winning bid, according to Bicos. This approach reduces the chances of individual programs engaging in overlapping research. Ultimately, the domain comes up with a research portfolio that falls

"Our job is to find and put the best available structures and materials on airplanes. The domain is helping us to do that better and faster."

– Randy Coggeshall, Structures domain leader, Boeing Commercial Airplanes

PHOTO: Terry McClure, a quality assurance technician in Seattle, inspects the world's largest aerospace-grade structural component built using advanced out-of-autoclave processing technology. The successful Out-of-Autoclave Launch Vehicle Shroud Demonstration was a major step toward economically building the large-diameter composite structures needed for NASA's future development of heavy launch vehicles. GEOFF BUTLER/BOEING into "core technology" areas—needs that are essential to the company's programs (see sidebar below). In addition, the executive level identifies "key technologies," research given the highest importance.

Jerry Young, director of Structural Technology with BR&T, said the business units were working together prior to the introduction of the domains, but the new structure enhances this collaboration by creating more formal processes. The domains also give senior management a clearer picture of research taking place across the enterprise.

Engineers across Boeing are involved in important "computational materials" work—materials development done on computers, Young noted. In Southern California, engineers are using computers to develop new re-entry and ablation systems for space vehicles. St. Louis engineers are working with universities to simulate next-generation titanium and aluminum materials. Computer simulations of polymers and coatings are taking place in the Puget Sound area.

"This is the perfect laboratory because computers can simulate a material or experiment multiple times and the results will come out the same," Young said. "When you do this in the real laboratory the results may be consistent, except for one instance. Then you have to go back and find out why that happened." ■

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This article is part of a continuing series that looks at the Enterprise Technology Strategy and its eight Technology Domains. Here are the previous stories in the series.

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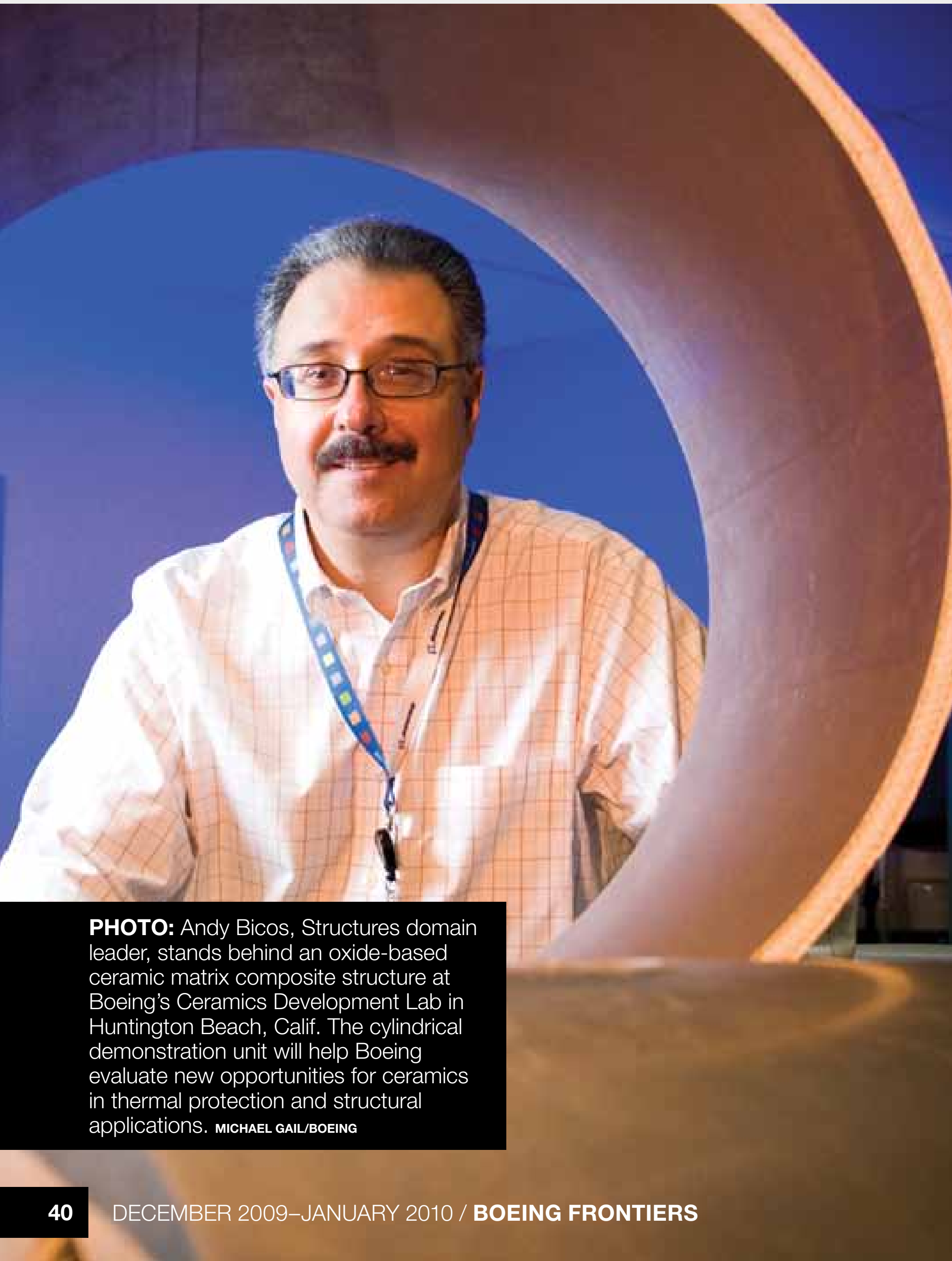

PHOTO: Andy Bicos, Structures domain leader, stands behind an oxide-based ceramic matrix composite structure at Boeing's Ceramics Development Lab in Huntington Beach, Calif. The cylindrical demonstration unit will help Boeing evaluate new opportunities for ceramics in thermal protection and structural applications. MICHAEL GAIL/BOEING

At the core of the matter

The Structures domain organizes its research activities around these core technologies:

- **Multifunctional structures:** Optimize the design of airframes and other structures by incorporating systems, wiring or other functionalities.
- **Advanced methods and tools for integrated design:** Develop next-generation analysis methods and tools, as well as enhancements to the current set of tools.
- **Performance-driven materials:** Discover, create and mature new material system product forms that enable breakthrough system performance at an affordable cost. Areas of research include next-generation composites, ceramic composites, advanced metals and emerging materials.
- **Structural concepts development:** Explore structural concepts that would achieve breakthrough weight and cost performance.
- **Rapid certification and qualification:** Develop and strategically implement innovative methods to accelerate and integrate material development, qualification, testing and structural certification in less time and with less cost compared with traditional methods.