

Performance

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Through its Platform Performance technology domain Boeing is developing and sharing new technologies for its diverse product line

By Bill Seil



PHOTO: A Boeing-designed advanced wing model, to be used in high-speed aerodynamics technology studies, gets one last inspection by Commercial Airplanes engineers before it is shipped to NASA for wind-tunnel testing. From left: Jeffrey Crouch, project lead and Senior Technical Fellow; David Witkowski, principal investigator; and Mary Sutanto, wing aerodynamics designer. JIM COLEY/BOEING

What do commercial airplanes, military aircraft and space vehicles have in common?

It's a question on the minds of Boeing technologists and engineers because, while Boeing produces a diverse range of products, some of the same technologies, tools and processes can be used in their design and production.

To become even more efficient and productive in the development and use of technology, Boeing last year formed a new Enterprise Technology Strategy, which takes a "One Company" approach to technology development. The strategy is built around eight technology areas, or domains, that are designed to create a sustainable technical competitive advantage and help the company grow. Among the domains is Platform Performance, which focuses on the Boeing products, or platforms, that have captivated and inspired the general public: jetliners, military aircraft and spacecraft.

"The Platform Performance domain is identifying and developing technologies that lead to significant improvements in platform capability and efficiency," said domain leader Don Leopold. He has more than 20 years of experience at Boeing as an engineer and manager of flight sciences and advanced product design. "We're also focusing on high-value processes and tools that can be used in conceptual and preliminary design. This includes providing rapid, multidisciplinary design, analysis and optimization capabilities that can be used to reduce development cycle time, risk and costs.

"In addition, work in this domain includes developing next-generation concepts and configurations that will help shape markets and capture new business," he said.

EXPERTS, UNITED

The domain brings together experts from across Boeing to develop technology plans that align with the company's business priorities. Leopold said this task requires a team effort that includes business development, programs, functions and technologists.

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— Don Leopold, Platform Performance domain leader, Engineering, Operations & Technology



To accomplish this, each of the eight domains works with enterprisewide teams. Team members include representatives from different business and functional units as well as representatives from support organizations such as Intellectual Property Management and the Boeing Technical Fellowship.

The Platform Performance domain team began by organizing research around six core technology areas that align with the company’s overall strategy and support the needs of the business units. The core technology areas are:

- Aerodynamics
- Propulsion integration
- Guidance, navigation and control technologies/architectures, and autonomous mission management
- Flow control technologies
- Integrated conceptual/preliminary design, analysis and validation
- Computational sciences

The team looks to adapt technologies developed for commercial airplanes for use in military products where possible. A well-matched transfer of technology will produce improved efficiency or mission effectiveness that is valued by the customer. In all cases of technology transfer between programs and different parts of the company, Boeing strictly adheres to export compliance regulations as well as to the obligations imposed by a variety of multilateral trade agreements.

In addition to technology developed by Boeing internally, Platform Performance, like the other domains, keeps a sharp eye on technologies being developed by suppliers, business partners, universities and other entities. In fact, an important element of the Enterprise Technology Strategy is that it includes a plan to leverage external technologies, and that this plan is consistent with a sound intellectual property strategy. The goal is to optimize the company’s internal investments by making the best use of available or emerging technologies from partners and suppliers—all of which supports the design and development of outstanding products.

The Platform Performance domain enlists core technology experts from throughout Boeing to help achieve domain objectives. The team also relies on business leaders, chief engineers and other experts to assist in understanding the company’s business priorities and capability gaps, and in assessing potential technology solutions.

“We’re looking at technologies that improve the overall capabilities of each platform,” Leopold said. “On the commercial side, performance metrics such as fuel efficiency, payload and range are key factors. On the military side, those same capabilities may be important, but due to the diversity of products, we also need to consider performance

PHOTO: Boeing Research & Technology Platform Performance researchers are developing and applying advanced computational fluid dynamics (CFD) to study powered nozzles and wing flow field interactions. From left: Roger W. Clark, aerodynamics technology manager; Pichuraman Sundaram (seated), CFD Associate Technical Fellow; and Dharmanshu Antani, computational sciences senior manager. **MICHAEL GAIL/BOEING**

metrics that are specific to a particular mission. Of course, both commercial and military customers are looking for the best value, so affordability is essential.”

GO WITH THE FLOW

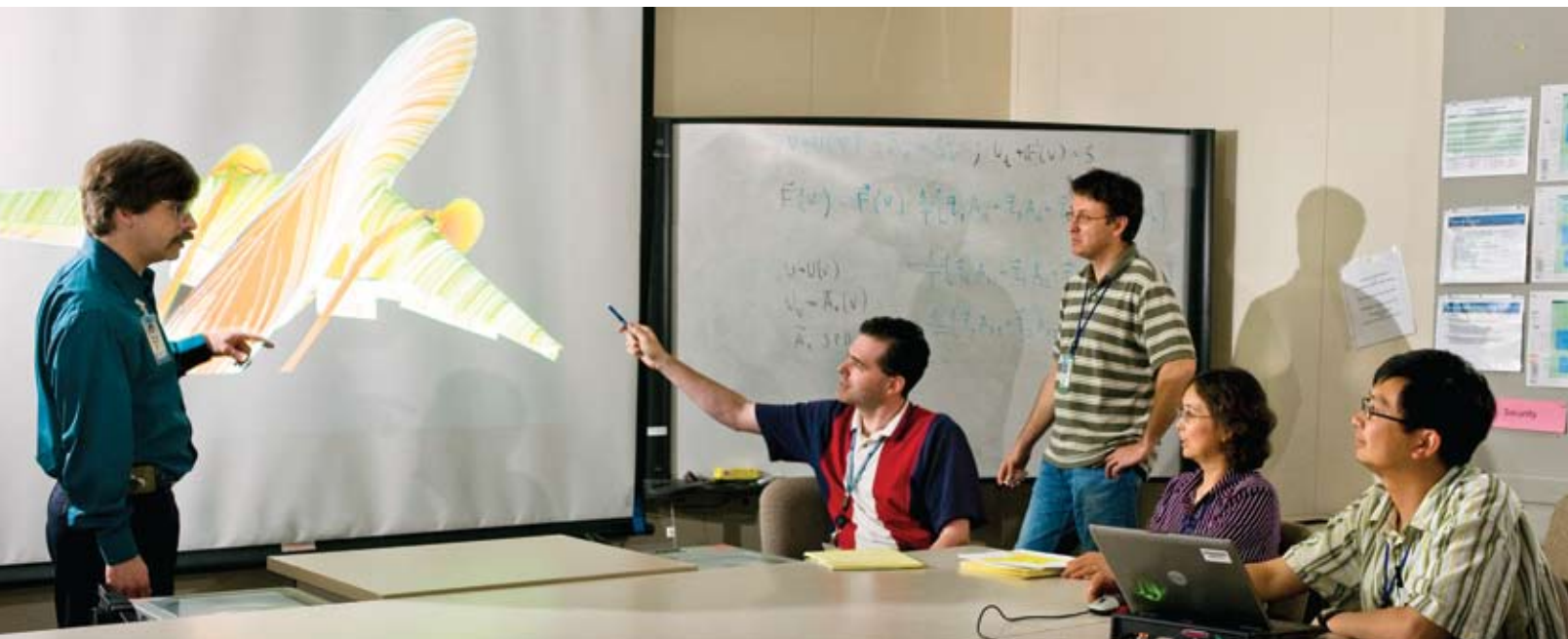
The 15 or so individuals involved in the domain’s Flow Control Technologies team are exploring ways to apply this relatively new approach to design. Flow control primarily uses air jets to modify the flow about a platform and improve its aerodynamic performance. It can be used to reduce drag, enhance lift, lower noise levels and, by doing the job of other hardware, lighten the weight of a structure—all of which increase a platform’s capabilities. Although this technology is still in early development, it is expected to play an important role in future platforms.

Bill Bower, Boeing Research & Technology leader for Flow Control Technologies and a Boeing Senior Technical Fellow, said this core technology team is currently focusing on three areas: designing and developing improved flow control devices; applying these devices to specific Boeing needs and testing their performance; and formulating modeling techniques to design flow control systems by computer.

“One of the technology gaps we’re focusing on is getting these flow control devices sufficiently lightweight and robust to operate flawlessly over many flight cycles,” Bower

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– Laurette Lahey, director of Flight Engineering for Integrated Defense Systems and IDS Platform Performance Domain leader



said. “This is a critical factor in the transition of the technology to products.”

In 2003, Boeing participated in a full-scale demonstration of flow control on a tilt-rotor aircraft. The airflow from this platform’s rotors impinges on the wing surfaces while the aircraft is in hover, resulting in a significant loss of lift. Flow control, however, reduced this loss. In addition, Commercial Airplanes is currently pursuing possible flow control applications in weight and drag reduction, lift enhancement and noise reduction.

While the Platform Performance domain continually looks for technologies to improve existing or derivative Boeing products, its greatest impact will be on the next generation of Boeing products, Leopold predicted.

Work within the domain also is being performed to ensure that Boeing programs have the right tools and processes. Wind-tunnel testing, a traditional development tool of the aerospace industry, can be costly and time-consuming. Before going to the tunnel, computational design and analysis methods can be used to develop better, more efficient designs so that wind tunnels can be used more effectively. This is especially important when adapting new technologies to a variety of products.

PHOTO: Commercial Airplanes Computational Sciences Core Technology Team leader Steve Sawyer (far left) discusses high-lift computational fluid dynamics results for a commercial airplane with Commercial Airplanes Enabling Technologies & Research engineers Timothy Mauery (left), Dmitry Kamenetskiy (standing), Pei Li and Emanuel Setiawan.

MARIAN LOCKHART/BOEING

THIS WORK COMPUTES

The domain's Computational Sciences team is developing and applying state-of-the-art computational fluid dynamics tools and processes that are particularly important in the design of future Boeing products. Computational sciences are of great value when integrating flow control and other new technologies.

Doug Ball, chief engineer of Enabling Technology and Research in Commercial Airplanes, said the domain's work in computational sciences has been particularly valuable in areas such as high-lift modeling, which enhances takeoff and landing performance. People in the Platform Performance domain also are working closely with people in the Environmental domain on the reduction of airplane noise.

"About half the noise produced by an aircraft coming in for a landing is produced by the engines, and about half is produced by the airframe," said Ball. "The landing gear alone accounts for 50 percent of the airframe noise. Computational methods are being developed to analyze the flow of air around the various elements of the landing gear to determine how noise can be reduced."

One of the most difficult challenges facing computational sciences is analyzing the airflow from the trailing edge of the wing to the leading edge of the tail's horizontal stabilizer.

"We can predict the flow pretty well when it's over a single surface," Ball said. "But when you look at the horizontal tail behind the wing and behind the engines, it becomes far more difficult."

Ball believes it may be decades before the computer hardware is developed to fully address this problem. But research carried out through the domain could make significant progress in this important area of study.

Laurette Lahey, director of Flight Engineering for Integrated Defense Systems and the IDS Platform Performance Domain leader, said her business unit has worked over the years to encourage collaboration among its diverse programs through a variety of approaches. This includes establishing horizontal integration leadership teams, which now operate as engineering functions, with representatives across all IDS businesses and sites. Commercial Airplanes, similarly, has used groupings called "themes" as a means of internal collaboration.

Today, the domain system has formalized such approaches to ensure collaboration. For example, Lahey said that while most IDS platforms are very different from Commercial Airplanes jetliners, the company's investment in computational sciences will enable early risk reduction and improve cycle time in both types of development programs. "Technology improvements developed for jetliners can certainly have applicability for heavy-lift military transports," she said.

Dennis Egan, director of technology for Commercial Airplanes, said platform performance is critical to the future of the business unit.

"The success of our products depends on developing technologies that allow highly efficient integration of the engines into the aerodynamics," Egan said. "The Platform Performance domain is working across the enterprise to ensure that we can draw on the best solutions available."

Egan noted that Platform Performance is one of the more mature domains in the company, thanks to the long history of collaboration Boeing business units have demonstrated in this area. The domain is working particularly well in the areas of flow control and computational sciences, he said.

"2008 was a year of discovery and the beginning of our journey," Leopold said. "We need to build on that foundation in 2009 by ensuring our technology plans stay aligned with business priorities and by realizing the enterprise's full potential. We'll be working on delivering results in support of Boeing's overall growth and productivity objectives." ■

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