



Bruno Darboux (right), vice president, Systems General Engineering for Airbus, and Pascal Gendre (left), senior expert, Modeling and Simulation for Airbus, explain how the aerospace giant uses simulation to manage and integrate the increasingly complex, distributed smart systems that comprise the modern jet aircraft.

Dimensions: What is the biggest challenge in the aerospace industry, and how is Airbus approaching it?

Bruno Darboux: Over the past decade, systems for large aircraft have become more complex. They have transitioned from a loose coupling of systems to a more tightly coupled situation. In the past, systems were designed so that they did their own job with limited information exchange (loose coupling) with other systems. They were somewhat standalone systems. This is no longer true. Now all of the systems onboard our planes are increasingly interconnected. And they share a lot of common resources — computing platforms and interface devices, for example — which makes everything tightly coupled and

quite complicated. Not only are the resources shared, but the functionality is spread across several systems.

Pascal Gendre: In addition, how a system interfaces with the real world has advanced. At Airbus, we now measure more physical phenomena, such as icing, EMI/EMC, thermal environments, material behavior and fluid–structure interaction, with more precision, and that helps interacting systems to optimize the overall flight experience. You can't fly an unstable airplane. But by using an advanced flight control system that interfaces extremely closely with the physical world, you can deliver optimum flight performances under safe conditions.



MASTERING COMPLEXITY

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BD: This complexity has compelled us to put heavy and costly processes into place to develop a new airplane. But heavy and costly are not viable from a business perspective. So we have introduced — and are trying to introduce more — ways of mastering this complexity by means of advanced system engineering methods. We have already started to deploy model-based systems engineering for the successful development of the A350, and want to deploy even more for our next product developments.

Dimensions: You mentioned safety briefly. The management of embedded software to ensure its safety is obviously critical for airplanes. What processes does Airbus have in place to manage embedded software?

BD: Guaranteeing the safety of embedded software is well under control thanks to compliance to aerospace standards. This includes external standards such as DO-178C and SAE ARP 4754A, along with our own internal standards. However, there are cost and lead time challenges associated with adhering to these standards. Full demonstration of compliance is very costly, so we don't want to repeat the demonstrations 10 times, because the software evolves with each design iteration. We need fast iteration loops. And, as the design matures, we have to fine-tune our software, even during the very late stages of development, including the flight test stage.



“We have already started to deploy, and want to deploy even more, model-based systems engineering.”

Various sections of Thai Airways International’s first A380 jetliner were joined at the Airbus Final Assembly Line in Toulouse, France, in November 2011.

Dimensions: So you can make software changes even that late?

BD: Absolutely. This is where the value of simulation software really comes into play. Tools for modeling embedded software, such as ANSYS SCADE Suite and ANSYS SCADE Display, allow engineers and designers to express the design specifications in a formal manner. These tools generate the actual flight software in an automatic way from the models. Using this method, we can produce software with a significantly reduced certification cost as well as reduce the number of very expensive test demonstrations. Software modeling and simulation has reduced our software generation time from typically two months to as short as two days during flight tests. That is a great improvement and time-to-market advantage.

Dimensions: How does simulation fit into the development process?

PG: Considering subsystem design as a start, each design team models its own environment to address the specific questions it has to answer and to find the solution for optimal performance. In the integration stage of development, we need to

combine extensive simulations in a single simulator called the “Iron Bird.” This simulator must accommodate several separate systems with their different physics and ways of interacting.

Dimensions: Because an aircraft is made of many models, how do these separate models come together?

BD: It’s obvious that each team needs not only its own model but also a representation of what’s around it. For example, the hydraulic system team needs a good representation of the engine performance and nacelle environment on the power side, and of the landing gear extraction/retraction sequences on the consumer side. This has driven us to develop an approach through which we can share models and assemble them into a larger system.

We then run end-to-end simulations, and, depending on the results, we simply tune the control logic, or possibly iterate on the architectural design.





Airbus at a Glance

- **Founded: 1967**
- **Headquarters: Toulouse, France**
- **Workforce worldwide: 58,000 (100 nationalities)**
- **Reach: 8,340 Airbus aircraft currently in operation**



PG: Whether you want to check the kinematics of control surfaces, study human factors in cockpit design, or design and calibrate an air conditioning or ventilation system, you need to use different modeling techniques, and you must simulate lots of different combinations of parameters.

The main point is to carry out much more of the integration work upfront using modeling and simulation during the tuning of the design, and reduce the number of test points during the final testing phase with the complete aircraft on the ground or in flight.

Dimensions: What is your vision of the best way to combine physical testing with modeling?

PG: We have experts who really understand how to interpret simulation results. Most of the physical testing with the real vehicle or mock-ups is aimed at double-checking that what the simulation delivers corresponds to reality. You can then use simulation to validate the aircraft behavior in the complete design and off-design envelope.

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Dimensions: What other challenges are you experiencing?


BD: At Airbus, we have very diverse, competent teams in-house, but also we have a lot of collaboration with the engineering teams of our suppliers. While we are responsible for systems architecture and integration, we contract out 95 percent of our systems' detailed design and equipment manufacturing. Five percent we do in house, 95 percent we buy. The suppliers bring technologies, supply smart design solutions, and participate as part of the integration effort. So we must exchange models with our suppliers to help us accomplish more simulation upstream and perform fewer tests on the final product.

PG: To exchange models, we need to rely on strong standards. We already have exchange standards in place like Airbus AP2633, but we cannot yet say we have a truly superior set of standards to do the job in an optimum manner. We are working on developing these standards, in an industry-wide effort; the MOSSEC initiative is an example. MOSSEC stands for modeling and simulation information in a collaborative systems engineering context.

Dimensions: What technological trends do you believe will play a big role in the aerospace industry in the next five or 10 years?

BD: Innovations are not so easy to predict. However, the fields for which we generate and capture innovations are the ones that add value to our airplane customers: superior passenger experience, continual improvement of airplane performance, and seamless fleet operations.

The trend in all this is clearly digitalization — making the most knowledgeable use of data to design the best solutions. Capturing the best data and routing it to provide the best real-time services to end users is also important.

Whether you consider multiphysics optimization or the setup of distributed functionality across onboard and ground computing platforms, it is clear that modeling and simulation bring much to our business. They allow us to reduce our development cycle and costs, bringing innovation to the market much faster. And thanks to modeling and simulation capabilities, we continually develop better products, like our new A320 Neo, which delivers an improvement of more than 15 percent in fuel efficiency. 

2015 ambition A350 XWB engine





A380 cockpit



Bruno Darboux has worked for Thales, ATR and Airbus. He was involved in numerous developments of civil and military platforms, in both engineering and program roles. He currently leads the definition of Airbus processes, methods and tools for systems development, and manages the teams that perform Airbus aircraft safety and qualification demonstrations.



After earning a Ph.D. in computational fluid dynamics (CFD) for aerospace, **Pascal Gendre** worked for Lacroix and Airbus. He employed modeling and simulation to develop products before devoting his efforts to developing modeling and simulation processes. He currently manages R&T projects for the modeling and simulation required for all engineering aspects of the aircraft program at Airbus.

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