Saab: New-generation aircraft benefits from model-based system engineering

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Vehicle aircraft systems require the complex design and installation of test rigs in test aircraft. Saab uses 3D data created with CATIA in Dymola – both from Dassault Systèmes – to model and simulate the functioning of its vehicle systems, reducing the risk that design errors will remain undetected until late in the development process.

Saab delivers world-leading products, services and solutions for military defense and civil security worldwide. Its Gripen fighter is the first of a new-generation, multi-role fighter aircraft that is the most complex and advanced plane Saab has ever built. The fighter is equipped with the latest technology, enabling it to perform an extensive range of air-to-air, air-to-ground, air-to-surface and reconnaissance missions. It can switch between fight mode, attack mode or surveillance mode and back, depending on the mission's evolution.

VEHICLE SYSTEMS COMPLEXITY REQUIRES EFFICIENT DESIGN

Engineering systems for the Gripen is a complex task, due in part to expensive equipment and testing procedures, long lead times, safety constraints and varying environmental conditions, including temperature, pressure and g-loads, plus weight and space constraints. All this can lead to a high level of interaction among systems – and among the different engineering domains that create them.

The Gripen is a small aircraft, compared to its peers. Vehicle systems such as the fuel system or environmental control system are highly integrated and optimized to fit into small areas. This presents development challenges if it becomes necessary to modify these systems or install new equipment or functions. "Our biggest challenge is producing aircraft as efficiently as possible without increasing development costs," said Ingela Lind, PhD, Technical Fellow at Saab. "This is why we use model-based development; it enables us to fully understand the benefits and limitations of the vehicle systems, how they interact with one another, and how to fit them together."

MULTI-ENGINEERING MODELING AND SIMULATION SOLUTIONS

To achieve cost-effectiveness, Saab has used model-based systems engineering to develop its complex vehicle systems. Where multiple disciplines must interact to function as a whole, the company relies on Dymola to model and simulate the vehicle systems. Saab chose Dymola for its multi-engineering modeling and simulation capabilities, which are based on the open Modelica modeling language.

Dymola presents a fast approach to system modeling, which makes it the ideal solution for Saab's projects. It also is easy to connect models from Dymola with models from other solutions, either in Dymola, in the other solutions, or in a standalone simulation environment.

Saab's most recent project involves using 3D CATIA data of fuel tanks in Dymola for real-time simulation. "The fuel-level reading of the tank depends on the orientation of the aircraft and the g-loads, which causes fuel sloshing in the tank while the plane is flying," Lind said. This needs to be taken into account when reading fuel sensors to determine the amount of fuel left in the tank. "With Dymola, we are studying the type of design adjustments that would need to be made to the tanks and sensor placements to get the most accurate fuel readings to the pilot and to ensure fuel feed to the engine in all flight conditions," she explained. "It is an interesting application that combines the 3D world with systems simulation."

Among many fault scenarios studied by Saab, one scenario concerns the piping attached to the fuel tank. During maintenance, if some of the piping was not securely attached because the connectors were not locked, the pipes could be dislocated by the pressure exerted during the refueling process. "Through simulation, we can verify that this fault will be detected and not destroy the entire aircraft," Lind said.

Using Dymola helps Saab find trouble spots that otherwise would not have been detected until the aircraft was finished. "With model-based system engineering, design errors can be detected earlier than if we were to use document-based systems engineering, where many troubles may only be detected when the first test aircraft has already been built," Lind said. "Dymola helps us verify that our designs are optimal very early in the design process. It also helps us reduce the costs and risks linked to verifying equipment during flight tests."

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