



Integrated software tools will allow the JSF to be designed and tested in a virtual environment

Grumman – soon to be merged with Lockheed Martin and already a member of the company's JSF team – will ground test a complete aircraft electrical system. This will include high-power, JSF-sized EHAs developed by Moog and Sundstrand starter/generators driven by both the engine and the thermal- and energy-management module (T/EMM). Being developed by AlliedSignal, the T/EMM combines the functions of auxiliary and emergency power-units and environmental-control system. Northrop Grumman will also be involved in a final J/IST ground demonstration planned for early 2000 at Pratt & Whitney, in which the F119 JSF engine will be integrated with the T/EMM, starter/generator, fan-duct heat-exchanger and thermally efficient fuel pump.

LIGHTER AHEAD

Lightweight, low-cost structures are key to achieving the JSF affordability and performance goals, says Kirkland. Lockheed Martin has several demonstrations planned involving technologies and processes for the design and manufacture of advanced structures. While its two concept-demonstrator airframes will incorporate some of the technology planned for the EMD design, ground demonstrations will investigate higher-risk approaches.

In producing the CDAs, Kirkland explains, the team was faced with the choice of building high-fidelity prototypes, and so freezing the design and technology earlier in the programme, or focusing the CDAs on those areas requiring a flying demonstrator, such as the propulsion system, while continuing to pursue technologies that could increase affordability and reduce cost. Lockheed Martin opted for the

latter approach, and its eventual PWSC will be evolved from the CDAs to incorporate design and manufacturing technologies that will be matured through ground tests.

One such effort is the Airframe Affordability Demonstration. This is a unique demonstration intended to reduce the cost and risk of the baseline airframe, Kirkland says, and will involve building a large section of the airframe – the



Animated mannequins enable Lockheed Martin to simulate and optimise JSF assembly

wing carry-through using the manufacturing processes planned for EMD. This project will "benchmark" the selected technologies and substantiate the cost estimates for EMD, he says. Higher-risk, higher-payoff approaches will be evaluated for possible EMD use under another project, the Composites Affordability Initiative.

Supporting Tech Mat projects include the Advanced Lightweight Aircraft Fuselage Structure programme, in which Northrop Grumman is participating. This has involved the "clean sheet" redesign of the centre-fuselage/inner-wing structure of the Boeing (formerly McDonnell Douglas) F-18E/F using fibre-placement and fibre-steering techniques for the low-cost manufacture of large-scale "unitised" composite structures.

Lockheed Martin, meanwhile, is progressing through a series of increasing complex demonstrations under the Simulation Assessment Validation Environment (SAVE) programme, a Tech Mat project to integrate software tools for virtual product-development. The effort is aimed at developing an infrastructure and methodology enabling various design tools to "plug and play" together, with an industry standard for "SAVE compliance" to be available for use in EMD, Kirkland explains.

FLYING AVIONICS

Perhaps the most costly of the unique demonstrations planned by Lockheed Martin is the Cooperative Avionics Testbed (CATB), a joint effort with Northrop Grumman to flight test the JSF avionics architecture. This is an industry-funded project, and involves the modification of Northrop Grumman's BAC One-Eleven testbed with the sensors, processors and software for the proposed mission avionics.

The majority of testing, however, will involve a series of increasingly realistic virtual avionics prototypes, culminating in an integrated hardware prototype. At the heart of the system is the Texas Instrument integrated core processor (ICP), which will handle all digital signal and data processing for the Northrop Grumman multi-function nose array (MFA), electro-optical/infra-red shared-aperture sensor and electronic-warfare system.

The ICP is to be available early in the programme so that software development can be carried out on the target hardware. It is being designed so that the software is independent of the hardware, and commercial processors will be used. A key demonstration goal will be to prove that new processor technology can be inserted without perturbing the application software, Kirkland says. Another will be to show that "legacy" software, from aircraft such as the F-22, can be reused in the JSF to reduce costs. The ICP and the MFA, an active electronically scanned array combining radar, electronic-warfare and communications functions, will be key elements to be flight tested in the CATB beginning in mid-1999. □