Forward-sweep technology
C

onvincing the sceptics that a high-
performance forward-swept-wing
aircraft will fly is the primary justi-
fication for building the Grumman X-29A.
But there is more to this aircraft than its unusual wing, and the principal benefit of the programme is likely to arise from its integration, for the first time in a single airframe, of several other tech-nologies.
These include a thin supercritical aero-foil section, an aeroelastically tailored composite wing, a close-coupled variable-incidence canard, relaxed static stability, triplex digital fly-by-wire, three-surface control, and discrete variable camber.

Forward sweep is by no means new, but previous applications have capitalised on its benefits for low-speed controllability and configuration design flexibility. On the Junkers Ju-287 of 1944, forward sweep allowed the wing structure to pass through the fuselage aft of the bomb bay, which could then be located near to the e.g. This minimised trim changes when the Ju-287 released the single large bomb that it was designed to carry. Similarly, the HFB 320 Hansa of some 20 years later used forward sweep to provide an un-interrupted full-height passenger cabin.

The justification is rather different for X-29, and is dealt with in detail elsewhere

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The objective of Grumman's X-29A flight demonstrator is to prove that the forward-swept wing is a viable and practical alternative to conventional aft sweep, reports Graham Warwick.

in this article. Basically, forward sweep
promises to generate transonic and super-
sonic drag, which can be traded in two
ways: by making the aircraft smaller for
the same performance, or by increasing performance for the same size aircraft. A high-performance fighter requires a much greater degree of forward sweep than previously possible. All-metal wings are effectively limited to 15° of forward sweep by the exponential increase in structural weight required to resist the unstable twisting characteristic of this planform.
The unidirectional strength and stiff-ness of carbonfibre can be used to control, or tailor, the aeroelastic properties of a forward-swept wing, allowing sweep angles consistent with supersonic performance.
The X-29 forward-swept-wing flight demonstrator had its genesis in Col Norris Krone's 1975 Master's Thesis, entitled "Divergence elimination with advanced

composites". This described the key to overcoming forward sweep's basic prob-lem of structural instability.
Then, in 1976, during studies aimed at the HiMAT highly manoeuvrable aircraft technology demonstrator, Grumman discovered the transonic manoeuvre potential of forward sweep. As a result, in 1977, the US Defence Advanced Research Projects Agency (Darpa) launched an FSW technology demonstration pro-gramme, with General Dynamics, Grum-man, and Rockwell receiving feasibility study contracts.

The flight demonstrator programme, funded by Darpa and administered by the US Air Force's Flight Dynamics Labora-tory at Wright-Patterson AFB, began in January 1981. The X-29A designation, the first X-series experimental aircraft for more than a decade, was allocated in September 1981. In December of that year Grumman received a $71-3 million contract for fabrication, ground test, and

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