R EPLACE control rods and bell-cranks with sensors and computers and the rigid connection between pilot input and aircraft behaviour is removed. The aircraft becomes more flexible. Instability can be made a virtue, with accelerometers and computers working together to mask undesirable effects and to provide the pilot with increased manoeuvrability. New control surfaces can be blended with existing controls to provide a new degree of superiority over the air.

On March 6 a development F-16 was returned to General Dynamics for modification to an Advanced Fighter Technology Integration (AFTI) testbed. When the AFTI/F-16 flies again in July 1981 it will be equipped with canards and a digital flight-control system. These innovations will decouple aircraft attitude and flight path, giving the pilot complete freedom to manoeuvre the AFTI/F-16 in six, independent, degrees of freedom.

The six degrees of freedom are: translation—fowards and backwards, side to side and up and down; rotation—pitch, roll and yaw. In conventional aircraft, a manoeuvre is a combination of some of the above. A turn is a blending of forward motion, roll and yaw. Pure motion along any axis is denied to conventional aircraft. The additional surfaces and intelligent control system of the AFTI/F-16 will allow the aircraft to exploit independently all translational and rotational modes of flight.

This unorthodox way to fly was first-tested on a YF-16 modified as a fighter control-configured vehicle (CCV). Encouraging results were obtained with this canard-equipped aircraft but its usefulness as a demonstrator was limited by the lack of a weapons system. The AFTI/F-16 will have the F-16's radar and nav/attack system and later flight-testing will couple the six degree-of-freedom flight-control system with the fire-control system to give automatic target tracking and manoeuvring.

Both the McDonnell Douglas F-15 and the General Dynamics F-16 were considered as Advanced Fighter Technology Integration testbeds. In December 1978, GD received a contract to modify the eighth full-scale development F-16. Heart of the conversion is the tripleplex digital flight-control system, based on Bendix BDX-930 high-speed computers. CCV control laws are stored in the computer and selected according to task. The digital flight-control system is a joint US Air Force/Navy development and has applications outside the AFTI programme. Such a system offers improved performance, versatility and reduced costs when applied to more conventional aircraft. There is also considerable Nasa participation in the project.

To maintain the same reliability as the quadruplex analogue F-16 system—with one less redundant lane—each path has built-in self-test. If a fault is detected, the affected control path shuts itself down. Redundancy management allows control lanes to monitor each other. The system can withstand two similar failures with a reliability criteria of one catastrophic failure in 10,000hr. Existing F-16 rate gyros, accelerometers and power systems will be used but with the fourth redundant system removed.

Provison for ±20° manoeuvring flap deflection does not require any mechanical changes. The same jack as used for the rudder provides ±27° movement on the vertical canards. Fairings for these jacks reduce intake area by 5 per cent locally, but 60hr of tunnel testing at speeds up to Mach 1.6 have shown no adverse effects. Full weapon-delivery capability is retained and flight-test instrumentation is housed in a dorsal spine. More than 1,000hr of windtunnel testing was needed to define the complex aerodynamic characteristics.

Particular attention has been paid to the pilot/vehicle interface. CCV functions are added to the sidestick, giving hands-on selection of modes. When a particular task is selected flight-control laws and displays are automatically reconfigured. Cockpit displays consist of two, interchange-able, multifunction cathode-ray tubes and a wide field-of-view (18°X20°) headup display. The latter is required to handle the increased manoeuvrability of the AFTI/F-16.

When the aircraft flies in July next year, it will be equipped with the digital flight-control system, canards and manoeuvre flaps. Flight-testing will last 11 months, during which time the integrated flight and fire-control system will be developed. Flight-testing of this system will begin in mid-1982 and will last 13 months, culminating with a demonstration to the US Air Force at Red Flag.

Further modifications planned include a helmet-mounted sight coupled to the flight-control system to provide “fly-where-look.” The present Westinghouse radar will be augmented by an electro-optical sensor/tracker pod giving a 2mil (2°/17°) root mean square tracking accuracy.

The Fighter CCV YF-16 pioneered the “new way to fly” between March 1976 and June 1977—with a nine-month break following a landing accident. The aircraft demonstrated direct lift and sideforce control, independent fuselage pointing and translation, manoeuvre quickening and gust alleviation. Principal changes were two intake-mounted vertical canards and the provision for symmetrical upwards deflection of the flaperon.

The CCV control laws were stored.