MARCONI
AVIONICS

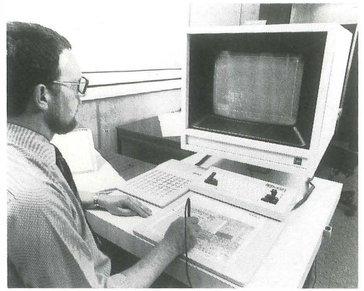
Combat Aircraft Controls Division

The problem of controlling an unstable highly agile aeroplane has been likened to a man kneeling on the bonnet of a car, holding a bicycle by the handlebars and steering it backwards while doing 60 mph. In these circumstances the bicycle is unstable and the resultant breakaway and destruction would occur in seconds, since the guidance corrections required to maintain the bicycle in a straight line would be so small, and be required so rapidly, that the human being would be unable to cope.

In future high agility combat aircraft, guidance instructions will need to be issued by high speed computers to the control surfaces many times a second to match the aircraft's behaviour precisely to the pilot's demands. Such computers and other associated equipments in the automatic flight control system are the bread and butter of the people working in the Combat Aircraft Controls Division (CACD). Modern flight control techniques known as "fly-by-wire" allow the aircraft designer to make the most of new ideas in aerodynamics, propulsion, materials and fabrication. Current combat aircraft designs have no reversionary controls of any kind and rely on systems specially designed to survive multiple failure for their safety. It is an exciting and complex business, the success of which is crucial to the operational effectiveness of future combat aircraft.

The Company has a long record of success in both analogue and digital advance flight control systems and has pioneered many new developments in multi-channelled safety critical control systems. As a result of the continuing expansion of the Company's flight controls business, CACD was formed in early 1980 to look after the design and manufacture of flight control systems specifically for combat aircraft projects, and moved into the new custom built Phase III building in September of that year.

The spacious Production Area of CACD.

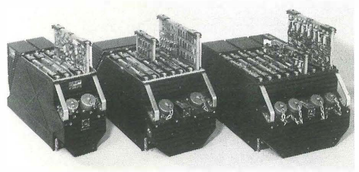


The Applicon CAD facility in use.

The Division currently employs 485 people on a variety of projects, with everyone working in air-conditioned accommodation and many of them equipped with modern computer aided design, manufacturing and management facilities.

Tornado

The Company is the prime contractor for the Tornado flight control system which consists of three major sub-systems; Command and Stability Augmentation (CSAS), Autopilot and Flight Director (AFDS), and Spin Prevention and Incidence Limiting (SPILS). This programme has been part of everyday life for CACD for over 10 years and completion of the major manufacturing programme of over 1000 systems should sustain the Division for several more years.



The CSAS, AFDS and SPILS family of computers.

The CSAS is a complete fly-by-wire manoeuvre demand system that provides the pilot with a three channel system for controlling the aircraft in pitch, roll and yaw as well as ensuring good handling in turbulence.

The digital AFDS provides automatic control of the aircraft in the pitch and lateral planes in a variety of operating modes. A flight director facility provides signals to the pilot's instruments to enable the pilot to monitor the autopilot performance when the aircraft is being flown automatically, and provides flight path guidance to the pilot via the head-up display for manual flight.

The SPILS is designed to prevent loss of control at high angles of attack and so allow more operating flexibility.

The Tornado entered service in 1981 and a total of over 40,000 flying hours have been achieved. The flight control system has earned high praise from air and ground crews alike for the effectiveness and reliability with which it performs.

Aeritalia Macchi Embraer (AM-X)

CACD is co-operating with Aeritalia GE in the design, development and production of the electronic flight control system for the AM-X which is a single engined combat aircraft especially designed to survive malfunctions or battle damage with a minimum of on-board equipment. The system provides fly-by-wire control of the tailplane, spoilers and rudder together with the mechanical elevators and ailerons. In addition automatic pitch, roll and yaw stabilisation is incorporated. The cordial working relationships established between the Company and Aeritalia GE on the Tornado AFDS programme are being continued on the AM-X and, following the planned first AM-X flight in 1984, should lead to a long and fruitful production programme.

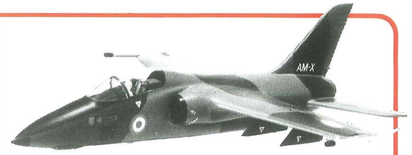
The equipment consists of two dual-redundant flight control computers based on 16-bit microprocessors organised for specially developed fail-safe software and driving seven aircraft control surfaces. A MIL-STD 1553B interface is provided.

To optimise hardware requirements, analogue computing is used for the actuator control loops, the pilot command paths and the rate damping computations. The Z8002 microprocessors in the flight control computers monitor the system performance and handle gain schedules, electronic trim and airbrake integrators.

Jaguar Fly-By-Wire Demonstrator

The Jaguar Fly-By-Wire demonstration programme is intended to prove the design concepts, hardware and software needed for advanced active control technology to be incorporated from the outset in the next new combat aircraft such as the Agile Combat Aircraft currently being designed by a tri-national industrial consortium.

The FBW Jaguar has an all digital quadruplex control system with no mechanical control runs or reversion of any kind. It is capable of surviving all probable failures and was the first truly practical digital active control technology aircraft to fly with its equipment made to production rather than development standards.

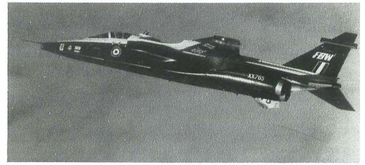


A model of the AM-X.

Four independent electrical channels relay instructions in the form of electronic impulses generated by four main high speed, mutually self monitoring digital computers. These are linked with a further two subsidiary actuator drive and monitor computers which lead to the six-lane failure absorption actuators.

The computers are programmed to ensure that any commands are kept within the limits of the aircraft's flight capabilities. These capabilities and the control response are optimised to give the best possible aerodynamic characteristics and handling for the pilot.

The avionics have been manufactured to production standards and provide a ready basis for future advanced flight control applications.



Jaguar fly-by-wire-demonstrator.

The FBW Jaguar first flew on 20 October 1981 and through a highly successful flight trials programme has already demonstrated that a full time fly-by-wire system can be implemented safely, and meet airworthiness criteria similar to those of other modern high performance aircraft.

CACD is now striving to exploit its success on the Jaguar FBW programme in an effort to win contracts on other programmes both in Europe and the USA.

In other fields the Division enjoys a good social life, well organised by the CACD Social Committee, and is not slow to show its prowess in the sporting arena. Ably led by the Divisional Manager, Ray Reese, who won the Veteran's 100m sprint and Mrs. Rosa Hargrave-Sutherland who won the Victor Ludorum, the Division recently won the Management Trophy at the Rochester Sports Day. In addition the Engineering Department has provided eight men (including the Technical Manager, Gordon Belcher) who between them have completed 14 marathon runs in 1982/83.

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