Flying the flight deck of the future

The increasing amount of information which has to be presented to the crew of a transport aircraft calls for a new approach to flight-deck instruments. Capt R. E. Gillman gives his impressions of flying a NASA 737 equipped with electronic flight-system and navigation displays.

When the National Aeronautics and Space Administration invited me to their Langley Research Centre at Hampton, Virginia, to fly in the Terminal Configured Vehicle, I did not really know what to expect. Certainly I had heard of the NASA/Boeing 737 which has a flight deck halfway down the cabin and from which the crew have no external vision, and it was clear that something pretty revolutionary was going on. But I was still surprised and intrigued to discover how advanced was the equipment now in daily use in this programme.

The project was started in 1970 by John Reeder, chief of the newly formed Research Aircraft Flight Division at Langley, as the result of growing concern about the congestion in terminal areas and the chaos created by bad weather. Clearly, much more sophisticated systems were needed to use the airspace more efficiently, and there was a great deal of work to be done on let-down aids if weather minima were to be effectively reduced.

The development of new guidance systems such as Microwave Landing Systems (MLS), navigation techniques and data links for communications generated an urgent need for complementary airborne systems and flight procedures. Fortuitously, after starting the Terminal Configured Vehicle Programme (TCV), NASA became involved in a DoT/FAA-funded SST technology follow-on exercise of which revolutionary flight-deck displays were a part. A Boeing 737 was fitted with an Aft Flight Deck (AFD) to house these and other systems.

In order not to prejudice the fidelity of the aircraft, the controls in the AFD were routed into the autopilot servos by a fly-by-wire system and a number of disconnect circuits were built in to facilitate transfer of control between the forward and aft flight decks. By this ingenious pick-a-back method, an endless variety of experiments with controls and displays could be mounted without further modifying the original aircraft.

Fig 1 Within the fuselage of the 737 is an experimental flight deck which can be given authority over the standard autopilot. "Brolley handles" replace conventional controls in order to make space for the electronic displays. The lowest of the three displays is used to programme the flight plan, and its associated computer automatically selects navaid frequencies as the flight progresses.

On arrival at Langley I was invited to fly the simulator before moving on to the aircraft. The conventional instrument display has been replaced by large cathode ray tubes (CRTs) and, in order to give the pilot a clear field of view, the control column has been split into two "brolley handles" which emerge from the facia. Pitching control is effected in the conventional way by pushing or pulling the handles, but for rolling manoeuvres they have to be twisted in the same direction.

I found it not too difficult to adapt quickly to these rather unconventional controls but the attitude displays were more of a problem. They were quite revolutionary and not self-evident; I found that I had to interpret what I saw and consciously think about my responses. It was pointed out that pilots had made the transition readily enough with a little practice, but I felt compelled to make the point that first impressions are the most important.

However, it is only fair to record that NASA is not currently offering a definitive display system; purely experimental, it is a complete breakaway from past thinking, and use of computer-generated symbols on the CRTs opens up a range of possibilities wider than anything that has gone before in display technology.

The upper CRT is known as the Electronic Attitude Director Indicator (EADI) (Fig 2). The basic attitude is indicated by the reference aeroplane, which is set up 5° from the horizon line to reduce clutter in the centre of the instrument, and the expanded pitch scale has a continuous line at 10° up and down, with a broken line indicating 5° of pitch.

An entirely new departure from conventional practice is provided by "gamma" wedges which move in relation to the horizon according to the equation \(
\frac{h}{\sqrt{v}}
\) and, by resolving the parameters of vertical speed and groundspeed, indicate the Flight Path Angle (FPA) in the vertical plane. Vital during the approach phase, this information currently has to be "guessed" from VSI reading, groundspeed or VASI indications.

To the left of the gamma wedges is a flight-path acceleration symbol. If the power is increased and the aircraft accelerates, the symbol will move up. Should the pilot wish to climb at a constant speed he has only to lift the nose.