

ground control, air navigation and air-to-air interrogation in the right proportions, the main function of the last mentioned being not to give the pilot last-minute warning of a pending disaster but to confirm to him all the time that sufficient separation for safety does in fact exist between his own and the nearest aircraft at his own flight level.

from V. H. King

(Decca Navigator Company)

IN areas of low traffic density it has been suggested, proximity warning indicators (or relative position indicators) could partially or entirely take over the present function of air traffic control in the sense that they may be used by pilots to determine the need to alter altitude and/or heading in order to secure safe separation from other aircraft and, at the same time, ensure the ability of aircraft to utilize optimum flight paths and altitudes with the minimum of restriction and delay. The North Atlantic has been mentioned as a typical area where this could be done.

The air traffic control system is not perfect and much has to be done to develop it to the stage when it can adequately cope with the present and future air traffic situations. The means to do this are now available in the form of high accuracy area coverage navigational aids and ground radar, and are becoming available in the form of improved data transfer systems, computers and ground presentation displays now in the course of development. Other refinements and improvements are also within reach. To discard the air traffic control system at this stage, or to relegate it to a passive role in the collision avoidance question in favour of a promiscuous form of individual pilot traffic control on the basis of airborne proximity warning indicators—which may have inherent limitations anyway—is not only a backward step but savours of a ‘return to the jungle’ approach.

The trend should rather be towards the improvement and extension of positive ground control to eliminate the possibility of collisions altogether, if possible. The traffic pattern should, therefore, be disciplined and orderly in the overriding interests of overall safety and appropriate to vehicles capable of closing speeds of up to 1000 m.p.h. Ideally, air traffic control should be exercised by unified civil/military centres to ensure that both main types of traffic are subjected to the same control. Given the tools, air traffic control can do the job which, after all, it was created to do. The part to be played by airborne proximity warning indicators—and, later, by developed airborne collision-avoidance systems—will then be, as it should be—not as a form of traffic control, but as a separation monitor and as a final safety factor to provide against human error.

Visual Avoidance in the Air

from Dr. Hentschel

By far the majority of air collisions occur in the vicinity of airports, in full daylight, and in clear weather; and in the majority of cases, distant planes are affected.

Dr. Morrel (11, 18) has told us that, in the majority of cases, when there is more than thirty seconds in which to take evasive action, such evasive action can in fact be successfully taken. This makes it obvious that the collisions which do occur are caused by the other plane not having been spotted in time. The statistics in Dr. Roessger's paper (11, 14) showed that forty-seven per cent of all planes which did not take evasive action did not do so because they had not spotted the other plane.

The question I should like to ask is whether we are doing all that can be done to aid the human eye in utilizing its own powers of sight and sighting. I know that research is being carried out into the possibilities of improving sighting methods, and I am aware that investigations are proceeding into the psychological aspect of the whole matter and the question of human shortcomings. We all know that it is easy to spot a jet aircraft at great range, because of the vapour trail and I believe that the avenue to pursue is to develop a smoke device which can perhaps give off coloured trails. Such a device might give the pilot the thirty seconds breathing space he needs to work out what action to take.

In view of the figures, which show that sixty-four per cent of all collisions take place in the vicinity of airports, such a device could at least be used compulsorily by all aircraft near airports.

from Captain J. D. Proctor

My impression is that very near misses are more easily avoided visually by manoeuvre in the vertical than in the horizontal plane; it is presumably easier for the pilot to perceive the near-horizontal plane in which the wings and fuselage lie and to avoid it than to perceive and avoid the vertical plane; also for comparable initial stick forces, perhaps vertical acceleration increases faster than horizontal acceleration. Dr. Morrel states that, if the intruding aircraft is on a collision course and has a relative bearing of about 075° or about 105° port or starboard, a turn the wrong way may be useless: perhaps, therefore, a rule should be made that intruding aircraft on or near the beam should be avoided by vertical manoeuvre not by turning.

The suggestion of coloured smoke from exhausts seems good since aircraft in the circuit are often hard to see against the background formed by the ground, or because they are under the nose of one's aircraft; the only objection I can see is that it might reduce visibility on final approach, when there is little wind.

In all areas A.T.C. should give to VMC traffic details of conflicting traffic since expected aircraft can be spotted at greater ranges than unexpected aircraft. Introduction of the terms Visual or Instrument Separation proposed by Captain Ayers would emphasize the importance of *cockpit* visibility regardless of general meteorological conditions. Use of the term *Contact* by the pilot to indicate that (in the appropriate circumstances) he can see enough of the ground to descend outside the instrument approach procedure without risk of hitting it, although he might at the same time request Instrument Separation, might reduce delays at airports.

An I.C.A.O. Panel on Vertical Separation has given data on the error to be expected in assigned altitude at various altitudes; no doubt the M.T.C.A. has data on the accuracy of E.T.A.s and on tracking accuracy from radar traces, and this Institute has useful data on navigational error; should not such data be used to calculate the risk of collision on airways, off airways, in control zones and

around airports between aircraft nominally separated by given amounts, laterally, vertically and longitudinally? If this were done, nominal separation standards could be specified for each area to give a specified safety standard; they might well be found to be quite different from those currently used. Such calculations might show whether the collision risk is less on airways or off airways. Publication of traffic density maps might help pilots avoid volumes of highest traffic density.

The magnitude of altitude error makes desirable height control for all automatic pilots, the standardization of altimeters and the investigation whether some other variable than pressure might more accurately be used to provide vertical separation, particularly at great heights.

Visual Awareness and Instrument Design

from W. H. McKinlay

(Smiths Aircraft Instruments Ltd.)

THOSE of us who are concerned with the development of flight instruments feel that the automatic pilot can be used to control the aircraft throughout the traffic pattern, and in fact, the major British system at present in service is particularly designed to provide this facility. The fact that the pilot is then free to concentrate more on events outside the cockpit has incidental advantages from our point of view, as the resulting visual reference provides by far the best method of detecting an automatic pilot malfunction should it occur in conditions of good visibility.

Although we do not at present provide full automatic landing, it is worth pointing out that we do provide control to the fine limits required for such an operation. Its introduction awaits a number of other factors, notably the provision of a radio guidance system superior to ILS during the critical final phase of the approach. We will also have to pay particular attention to safety. No electrical circuit is of itself absolutely infallible and we will have to consider what degree of multiplicity is necessary to achieve the required safety under realistic fault conditions.

The philosophy of design for safety will involve the complete control loop including, of course, any ground installation required, and this may call for international agreement. The safety aspect of the problem appears whenever electrical techniques are used in a role which directly affects the safety of an aircraft. If the collision problem is eventually solved electrically, the standard of overall system safety required will become more exacting the more aircraft operators have to depend on the equipment in congested air spaces. In the guidance and control field it is our experience that it is vital to work to a design philosophy which recognizes that equipment failures will sometimes occur, and which provides for the inclusion of failure warnings with duplication or even triplication where necessary. All this may sound pessimistic, but no amount of engineering detail can produce a higher degree of safety than is permitted by the basic conception of a system. Perhaps the systems currently being proposed for collision warning should be subject to this sort of analysis once they have survived the initial one of practical feasibility.