Avionics

ATC at Brétigny

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The automation of air traffic control has received considerable attention in recent years, both from an electronics industry struggling to cope with the complexities of the subject at a degree higher than ever previously envisaged, and from a general public increasingly aware of the dangers of congestion around the world's airports.

The solution of ATC problems depends largely upon the accuracy of the initial studies of the particular environment, in the establishment of air-traffic patterns and density, in predictable growth, and in assessing the effective reductions in controllers' workload that could be brought about by automation and, more significantly, in their ability to retain control in the event of failure of the system.

Now, with SSTs and their attendant control problems nearly upon us, with plans well advanced for major new airports, and with traffic density increasing all the time, the various organisations responsible for safety are turning increasingly to simulation as a means of checking their plans before committing themselves to the risk and cost of implementation.

The Eurocontrol Experimental Centre at Brétigny, France, was established in 1963 as an experimental ATC unit, with a brief to develop operational techniques compatible with future ATC installations and to investigate the applicability of advanced data-processing schemes. The organisation achieved its present level of simulation facilities in two stages, the first of which was the air-traffic simulator system of 1967, the second being the Experimental Data Processor. With the completion and acceptance of the second stage last May, Europe gained a simulation centre possessing all the facilities of ATC automation expected to be needed in the next decade.

The Experimental Data Processor was designed, installed and commissioned by the European Consortium led by Marconi Radar Systems and comprising Standard Electrik Lorenz and Sait Electronics. It is, in fact, a fully engineered and operational automated facility capable of full flight-plan and radar-data processing, flight-plan/radar correlation and a certain degree of flight-plan conflict detection. The data source at Brétigny is the air-traffic simulator, a Telefunken TR4 computer providing radar data and flight-plan information in exactly the same way as that from radar plot extractors and data links.

The possible applications of the EDP system are numerous. They range from the familiarisation of controllers in the use of automated equipment to feasibility studies for advanced future systems. The keynote of the system is flexibility. All hardware and software has been designed so that various equipment layouts and degrees of automation can be simulated, from simple flight strips to fully automated systems including conflict detection for aircraft in level flight.

Although the EDP functions entirely in a simulated environment, it has the same radar/flight-plan and controller/machine relationships as its operational counterparts, with the added advantage that, for experimental purposes, traffic samples and geographical areas can be selected for the investigation of specific problems. Further, when these problems are identified there is a far greater opportunity for analysis than would be feasible in an operational situation.

The equipment at Brétigny is one of Europe's larger real-time systems, with five interconnected computers and some 50 display units which can be arranged to represent a large number of different operational layouts. It can deal simultaneously with 60 active flight plans, the same number of filed but inactive flight plans, and up to 120 processed radar-plus-plan tracks. The performance of the system can be varied as previously described to suit the needs of the simulation exercise concerned, and in its most comprehensive operational state the Experimental Data Processor has three main processing functions. These are the handling of flight-plan data received from other centres and from local flight-information entry positions; the handling of primary and secondary radar data received digitally from up to three separate radar sites; and the display of processed data in accordance with the requirements of the system being studied.

Procedural control of flights is assisted by reference to flight-progress strips in the normal way, but in addition an entirely new "electronic strip-board" facility is provided whereby flights are listed under reporting points on a tabular display, giving a controller a continuously updated picture of traffic movements at the control points under his supervision.

The electronic hardware at Brétigny has been developed in a modular form comprising five main units:—

(1) The traffic-generator, based on a Telefunken TR4 computer and providing simulated traffic information to the rest of the system. This unit provides in effect the radar and flight-plan input.

(2) The main computer system, comprising two CII 10020 machines which process the radar and flight-plan data and provide information to peripheral computers.

(3) The peripheral computer system, consisting of two Marconi Myriad II machines which use main-computer information to form the display information to the controllers.

(4) The display subsystem, consisting of the display back-up and memory and the viewing units themselves. The viewing units are of both tabular and plan-position type (for message and traffic-display respectively) and are of modular design to enable the display facilities of the control consoles to be built up as needed.

(5) The controller input subsystem, comprising touchwire, keyboards, tracker ball (a manually operated marking device) and light-pen facilities. These are all handled by the peripheral computers and form the means whereby the controllers select the type and amount of data to be displayed on their screens, and communicate with the system in respect of flight data. The touchwire system, in particular, is a useful means of sequencing the input of complicated messages where the only alternative would be a complicated keyboard layout.

Flight plans are presented to the EDP system in standard format, describing aircraft identity, airport of departure, destination, time, route, level, speed and facilities. Each flight plan entering the system is checked for syntax and credibility; plans containing errors are rejected for correction. A correct plan is accepted, converted into an internal representation and used for calculations of estimated times of arrival at the route points and sector boundaries. A conflict search is performed against all other plans in the system, and if all is well the plan is then stored in the inactive file until a fixed time before the entry of the flight concerned into the area of control being simulated. When this time arrives the plan is transferred to the active list and its information used to warn (initially in the form of call-sign display) the controllers into whose area the flight will pass.

Having received a call-sign on his touchwire display, a controller then has access to the flight plan and can

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obtain all the information he needs before giving clearance to the flight. If the flight is found to be in conflict with traffic already in the system, a controller can study the effects of changes he might make against the other traffic, eventually arriving at a solution which can be used to amend the original plan.

During the flight the plan is "navigated," and may be correlated with the corresponding radar track. If this is done, and the true radar position shows a deviation from the expected plan position, warning messages are signalled to the appropriate controllers. Finally, a flight which is about to leave the area is retained as a flight plan for a period after its time of departure from the system, after which it is cancelled internally.

Radar data display within the EDP is entirely synthetic; no "raw radar" is handled by the system and all input information is digitised. The radar data-processing facilities accept digital information from up to three radar sites (primary, secondary or combined primary / secondary) and provide multi-radar tracking. Incoming plots are retained either as single plots or, where possible, used to form local tracks in local co-ordinates. Secondary radar returns can be used to initiate the tracking process automatically; tracks based on primary returns must be initiated by a controller input. Successive primary returns are tracked in the normal manner, using an extrapolation and best-fit process. Local tracks for a given aircraft may be formed at more than one radar, and the system forms a common track for the aircraft. This forms the basis for further processing, such as flight-plan/radar correlation and deviation warning.

Thus the system has two major sources of navigational information: long-term flight-plan data and the instantaneous radar fixes. These may be correlated either automatically or manually, depending on the characteristics of the radar responses.

Programming the Experimental Data Processor is a complicated business, and in an effort to reduce the degree of interaction within the software the various functions of the system have been re-arranged into separate program modules. These have no direct communication with one another except through the common use of a supervisory system.

Use of the EDP system is organised in the form of simulation exercises comprising preparation, simulation and analysis. The preparation stage involves the definition and generation of the traffic sample and the information needed for the exercise, while at the same time the operational staff are briefed on the objectives of the simulation. A magnetic tape is then produced which defines the exercise; this tape, in conjunction with the traffic sample, contains the information necessary to run the simulation. Then follows a comprehensive two-part go/no-go stage. The first part provides a check-out of peripheral equipment by means of standard test programmes, enabling a decision to be made as to whether or not the system is technically usable. The second part tests the validity of the information supplied.

Then follows the actual, real-time simulation, with the flight plans and traffic information being fed in at the appropriate time. There are updating facilities, e.g. the flight paths of aircraft as generated by the traffic sample can be changed to simulate pilot action, and the flight plans can be amended by the controllers themselves or from the flight-data entry positions.

The analysis stage is concerned with investigation of the recordings made by the system of its own and the controller's performance during the simulation phase. These recordings contain all the information relating to system and traffic loading, controller work-load and actions and flight-plan modifications. The result of the analysis could be, for example, that a particular mode of procedural control was unacceptable.

Analysis of the outcome of a simulation is the final stage in a process which will undoubtedly find many applications in air traffic control, enabling the full potential of automation to be realised, and providing the controller with the support he will certainly need to perform an increasingly complicated job efficiently and safely. ■