Elliott-Automation in Aviation

Farnborough 1962

CONTENTS

FARNBOROUGH 1962–4000 SQUARE FEET PRESENTATION OF 'ELLIOTT-AUTOMATION IN AVIATION'

Elliotts unique ability to approach aviation problems on a broad front

Elliott-Automation is dedicated to the task of promoting the concept of Automation over the whole range of technical activity.

In the military sphere, World War II gave a sharp stimulus to technological development in electronics, computing and control engineering. In the succeeding years, phenomenal advances have been made under the pressure of ever more exacting military requirements. In the industrial sphere the application of these same techniques lies at the very roots of our future economic wellbeing in what has been termed 'a Second Industrial Revolution'. To this extent Elliott-Automation has a sense of mission and purpose which transcends purely business interests.

By definition, Automation implies the use of a whole range of diverse techniques in varying combinations according to requirements; indeed we believe that the solution to the problems of the future can only come from an organisation which can approach these problems on a broad system basis. Yet a company which sets out to do this must be strong in all these aspects if its proposals are to be purposeful, free from bias and based upon solid engineering experience.

Elliott-Automation has, in fact, succeeded in building an organisation which encompasses the whole range of technology required and has created two Systems Companies – military and industrial – not only to make system proposals over a wide front, but also to give full expression to the creative ideas and concepts which spring naturally from the continual inter-action of so comprehensive a group of activities.

Commander H. Pasley-Tyler RN(Retd), Group General Manager, Elliott-Automation Limited, and Chairman, E-A Flight-Automation Limited

Part of the special 4,000 sq. ft. 'Elliott-Automation in Aviation' display in the Radar Area

The role in Aviation

In aviation, Elliott-Automation's breadth of engineering know-how has a particularly vital role to play: the ever-increasing performance of aircraft, the mounting density of air traffic, the simultaneous demand for greater safety, more reliability and greater regularity of operations are in turn creating the demand for more and more sophisticated and reliable equipment both in the air and for ground control.

Elliott-Automation's unique ability to approach the aviation problems of the future on a broad front is amply demonstrated in the special 4,000 sq. ft. exhibition at this year's S.B.A.C. Show at Farnborough. The products of no less than 24 Divisions and Companies of the Group illustrate activities in civil and military autopilots, air data systems, instruments, inertial navigation systems, airborne digital computers, airborne radar, communication and navigation systems, air traffic control systems, blind landing systems, precision gyros and components, relays, and automatic checkout equipments.

Our concept of Automation

A mistaken impression has been created that the introduction of Automation involves the wholesale elimination of the human being. Whilst there will undoubtedly be some re-adjustment of human tasks, our concept of automation is primarily aimed at providing a means whereby human beings can work with far greater efficiency and harmony. This is particularly true in aviation. The objective is certainly not to replace any part of the crew, but rather to make their task more manageable at a time when higher performance aircraft are becoming less forgiving of inattention and delayed reactions in emergency conditions. As more and more difficulties and complexities are imposed upon the pilot, automation techniques can play their part by relieving him of many routine yet vital duties, thus freeing him to concentrate on those aspects on which the human being alone must exercise his critical judgement ●

We cordially invite you to visit our 4,000 square feet integrated presentation of Elliotts comprehensive activities in the whole sphere of aviation

Towards all-weather operations

P. F. Mariner

By **P. F. MARINER**, *Assistant General Manager (Radar and Communications Group), Elliott Brothers (London) Limited*
and **R. W. HOWARD**, *Manager, Transport Aircraft Controls Division, E-A Flight Automation Limited*

Plane or Train

Is air travel safe, reliable and regular? Jet aircraft have so decreased potential travelling time and so increased travelling comfort that both time wasted and the physical inconvenience caused by delays and diversions are becoming important limitations.

Airlines throughout the world will say that 95 to 98 per cent of their flights arrive at their scheduled destination more or less on time. Statistically then there is less than a 1 in 20 chance of missing an appointment when travelling by air. On the face of it this doesn't seem too bad; but what does the frequent traveller remember about the winter months . . . long hours of waiting in Prestwick and Keflavik, overcrowded customs, buses and hotels at alternates such as Halifax, diversions to Frankfurt and Beirut and perhaps an unpleasant journey on a crowded 'special' train from Manchester to London. The 1 in 20 case leaves a lasting impression and the efforts he makes to avoid them are seen in many ways. For example, originating flights are more popular than transit flights which have had time to accumulate successive delays. Can it really be said then that the airlines schedules are sufficiently reliable?

The faster the travel, the more important is precision to the business man – and if this is provided his contribution to airlines business can increase enormously. All travellers on the other hand want increased safety; and both precision and safety can be met by the introduction of all-weather facilities – or must we seriously consider yesterday's travel by train, bus and ship – or channel tunnel?

Men and Machines

Several years ago an eminent politician predicted that there was little future for manned military aircraft. There was much speculation as to how this rather revolutionary thinking might affect the world of civil aviation. Would the application of military systems development to civil aviation ultimately lead to automated world transport? Fortunately the magnitude of the technical problems of the all-automation philosophy is now better appreciated, and thinking may be described as less advanced; but the necessity for furthering automatic systems applications cannot be questioned. This is particularly so in the case of all-weather landing.

The requirement for precision flying in a safe manner for long periods *en route*, and for accurate manoeuvring in airport control areas has already caused the stage to be passed where the pilot wishes to be in continuous manual control. In fact it is a paradox in the world of civil aircraft safety standards that such great effort must be exercised by flying crew to maintain their instrument ratings when so often hundreds of lives depend upon their proficiency. It is hardly fair to demand more difficult extensions to allow all-weather landings. On the other hand it is unlikely that automatic facilities alone will provide the complete solution to the problem. Over a period of 50 years aircraft and the traditional pilot skills have been developed to a degree of reliability which it is hard to assail with independent technical substitutes. It is known theoretically that failure survival automatic systems can give a total failure probability in landing better than 1 in 10 million; on the other hand it is known from practical experience that pilots with their aeroplanes achieve 1 in 1 million. It would be rash to discard completely this considerably proven achievement for an unproven automatic solution. In the same way pilot-control reliability should not be downgraded by permitting the automatic systems to make the first attempt at landing and then only allowing the pilot to take part when something fails. The obvious approach is to get the best of both worlds by having an experienced pilot in command and by using precise but in some respects limited automatic facilities to do the work, but not the thinking. There is no evidence for discarding the traditional skills of the human pilot, nor his power of decision. Airborne and ground automatic equipment must be developed therefore to parallel what is already achieved with clear and obvious improvements so that best use is made of past experience for the future.

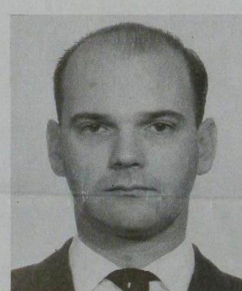
Little by Little

In the various countries where work is being done on all-weather landing the rational sections of the industry have settled upon similar philosophies to govern their programmes. The safety requirements demand in one form or another that the use of the facilities provided, both ground and airborne, shall not increase the overall likelihood of an accident. In fact a substantial decrease is desirable. It is more than apparent following the disasters in recent months that the low percentage of fatal accidents in the civil airlines is not good enough in itself. What is required is a low number of accidents – and ultimately no accidents at all. As the world's fleet increases this can only be achieved by better and safer equipment and facilities. But how does one better a record which already stands at lower than one in a million? The answer is by means of logical, step by step, evaluation of the development of facilities in a manner such that each step is so clearly acceptable that an unshakeable faith is built up in the system as a whole. In other words development shall continue as it has in the past by improving designs with proven techniques and where necessary by employing redundancy in an intelligent and selective manner.

Any breakthrough must be so apparently correct that long-term proof of high integrity is unnecessary.

The Vickers VC 10 is designed to have an all-weather landing capability

Photograph by courtesy of British Aircraft Corporation



R. W. Howard

The Jig Saw Puzzle

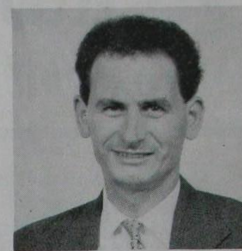
Having taken off, each aircraft must be directed through a complex of other aircraft paths to duly assigned altitudes. Then various facilities take the aircraft to the point where once again it must carry out the reverse operation hoping that all the Tommy Atcos know where it is.

Much of this jig-saw puzzle is being sorted out however. Data processing aids will soon provide the air traffic controller with more powerful means of handling the increasing traffic and for deciding just how each aircraft should proceed in orderly sequence through the complex traffic pattern regardless of weather conditions.

The Iceberg

The problems have been discussed and written about by many nationalities. The partial successes that have been achieved and the enthusiasm that they engender have tended to overshadow the enormous financial, technical and service problems which have still to be tackled. These equipment problems in turn may be small compared with the political and international operational problems on the ground when this battle really begins. One is reminded of the legendary story of the iceberg which looks so beautiful in the sunshine but is merely distracting attention from the monster below. Let us hope that the apparent lack of universal appreciation of the overall problem does not lead to a Titanic disaster ●

THE *PROBLEMS* OF SYSTEMS IN AIRCRAFT



H. Surtees

BY H. SURTEES *Director and General Manager, E-A Space and Advanced Military Systems Limited*

The systems concept

The concept of considering a complete system comprising aircraft, airborne equipment, weapons and ground-based support facilities, has received considerable attention in recent years. The objective of this concept is to optimise system effectiveness, a term which must be carefully defined for each aircraft requirement. While the effectiveness must not fall below some minimum standard, a balance must be made between safety, development costs, and maintenance costs. At the same time the requirement itself must be regarded as one of the parameters in this balance, at least until it becomes thoroughly clear as to what its unassailable essentials are. A start has been made in the military aircraft field where the airborne equipment is particularly complex, compact and varied in nature. The need to pursue the concept in the civil field increases as we move towards supersonic designs.

Earlier in time, a similar concept was required in the development of guided weapons due to the high density of varied equipment in the missile. The requirements of safety were not nearly so severe as they are in the design of manned aircraft. With certain notable exceptions the proper system balance was not achieved, particularly with respect to development time-scale and costs. However, the failure here only serves to emphasise the need to go further towards more complete acceptance of the conditions necessary for the systems concept to work.

The Technical problem

The problems which arise are, of course, technical and managerial, but it is not at all easy to draw a clear distinction between them. Inherent technical problems and the solution of them is the essence of development, and there will always be some which are unforeseen. However, many technical problems arise out of an almost unconscious resistance to the full acceptance of the idea of optimum system effectiveness when it conflicts with perfection in a specialist field. The airframe designer of a high performance aircraft is naturally loth to blemish it with antennae or to stiffen it to facilitate automatic control. The radar designer could improve his equipment performance if the antenna were larger or the radome less sleek. The control engineer would alleviate his backlash problems or his residual oscillations if the tailplane were smaller in area or more rigid, or both. There are many such examples of interaction between technical specialist fields. Whilst it is true that compromises must be made with care and considerable thought, these problems give rise to frustration because of the unduly long time required for their resolution stemming from a frame of mind not yet adjusted to the systems concept. It is clear that they must be resolved by a technical management group wherein a broad systems knowledge must reside. The bases of decision are the rates of exchange of system effectiveness with the main parameters in each specialist field.

Other problems, often technical, which should not arise at all are due to the fact that project management has not yet been applied as a science in itself. Again it is very often due to a failure to appreciate system problems right across the board. For instance, once the main characteristics of the airframe are derived from general performance requirements the structural design can proceed fairly rapidly, whereas the specification of equipment moves rather slowly in the initial stages due to intricate cross-connection between sub-systems and because it is the area requiring the most detailed integration from mechanical, electrical and electronic points of view. If then equipment considerations throw up the need for airframe changes to achieve optimum system performance, the change can perhaps only be made at high cost in money and time, and hence may not be made at all.

Let us consider the overall technical problem. There is a requirement with certain essentials arising from the task or tasks of the aircraft, and with certain desirable features which could be regarded as firm until assessment work has been done. It is thus an essential part of the organisation that the customer is immersed in the assessment phase. All possible means of solution to the overall system problem must be investigated to a depth which lays bare the problems to be solved in development, trials, production and service use. Development plans can evolve concurrently in order to couple system effectiveness with time-scale and cost. It is also wise at this point to draw up a possible equipment revision programme applicable in the life span of the airframe. It should be possible to reduce the results to the following:—

1. Two or three alternative system proposals.
2. The rates of exchange of effectiveness with main parameters.
3. Two or three alternative development programmes with the distribution in time of man-power and costs.

Decision is now required and the customer is fully informed. It should be possible to choose the system most likely to meet the need. However, the authority to decide is often diffuse and it is at this phase that much time may be lost. When the choice is made, the system proposal must undergo a further phase of assessment, leading to specifications of sub-systems calling for consistent standards of performance, safety, power supplies, packaging, reliability, accessibility, conditioning etc. The development programme and financial commitment programme is made firmer and more detailed, with special consideration to the phasing of environmental testing and flight trials of equipment in logical stages; this latter is rarely adequately planned. The efficiency of development depends critically upon the speed at which test and trials data is fed back to the designer and management; hence it is necessary to consider communications in the plan. Provided financial commitments can be made at the right times, the assessment leads smoothly into the development programme. The development programme is often regarded as something fixed; in fact it should be re-optimised at very frequent intervals, say once a week or once a fortnight. This is perfectly logical since unforeseen day-to-day problems arise and estimated times are found to be in need of correction, and as these facts come to light it would be surprising if the programme initially laid down remained optimum.

The Managerial problem

Let us now consider the management problem. A complex project, to be completed in the minimum time within budget, requires efficient day-to-day management and enthusiastic leadership from someone with a broad appreciation of the system as a technical entity. However, as aircraft systems become more and more complex, the number of interested authorities increases. A satisfactory solution to this conflict has not yet emerged. It is only necessary to compute the financial commitment per day for any project in order to realise how important it is to make decisions at the right time, and to react rapidly to the problems arising from day to day. One possible solution to this problem is to appoint a systems manager, supported by a team of systems engineers, for the day-to-day control of the project. This man must combine in himself the technical appreciation and the ability to apply the principles of management. His job would be to plan a project and to resolve day-to-day problems, to inform the customer of progress periodically and to provide the facts and figures on which major decisions by the customer can be based. The customer may take the form of a management committee or group in order to embrace all interested authorities. Experience shows, however, that decision-making is most efficient when such a management group comprises no more than six members ●

24 ELLIOTT-AUTOMATION COMPANIES & DIVISIO

are exhibiting at the 1962 SBAC Flying Display & E

E-A SPACE AND ADVANCED MILITARY SYSTEMS LIMITED
Chobham Road, Frimley, Nr. Aldershot, Hants.
Telephone: Camberley 1670
Director and General Manager: H. Surtees

E-A FLIGHT AUTOMATION LIMITED
Airport Works, Rochester, Kent. Telephone: Chatham 44400
Airborne Computing Division *Manager: B. A. Hunn*
Aircraft Engine Instruments Division *Manager: A. N. Haskett*
Automatic Test Equipment Division *Manager: H. Cook*
Aviation Service & Repair Division *Manager: F. J. Shields*
Flight Automation Research Laboratory *Manager: H. Hanbury Brown*
Gyro Division *Manager: A. R. Essex*
Inertial Navigation Division *Manager: R. E. R. Smith*
Military Aircraft Controls Division *Manager: W. H. Alexander*
Precision Test Equipment Division *Manager: H. R. Bristow*
Transport Aircraft Controls Division *Manager: R. W. Howard*

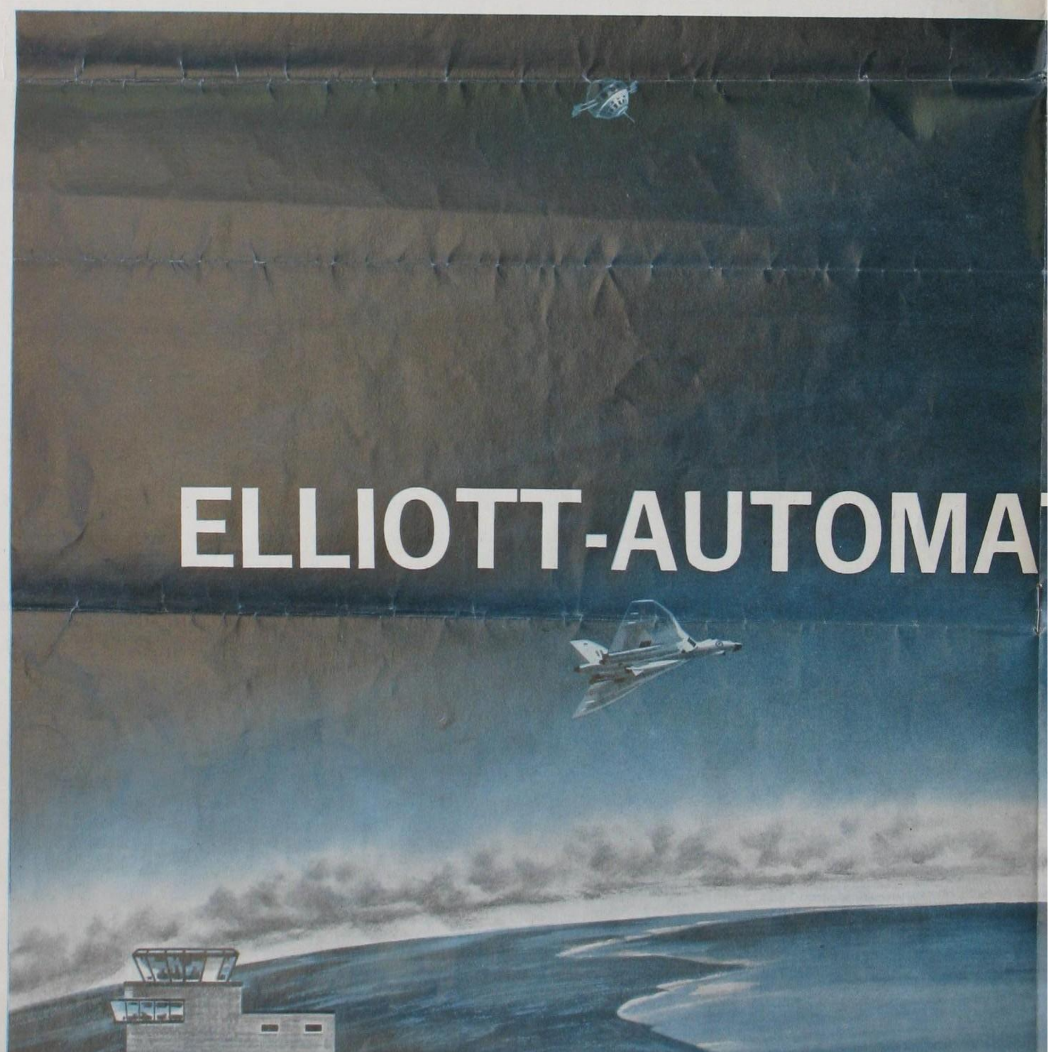
ELLIOTT BROTHERS (LONDON) LIMITED
At Elstree Way, Borehamwood, Herts. Telephone: Elstree 2040
Airborne Radio and Radar Division *Manager: R. E. Ford*
High Voltage Tube Division *Manager: A. I. A. Ray*
Radar and Communications Research Laboratory *Manager: Dr. E. Laverick*
Weapons Division *Manager: B. W. Patrick*

At Airport Works, Rochester, Kent. Telephone: Chatham 44400
Naval Weapons Division *Manager: G. F. B. Smithson*
Radar Fuse Division *Manager: A. R. Price*

At Century Works, Lewisham, London SE13. Telephone: Tideway 1271
Servo Components Division *Manager: R. F. Hamilton*

At 70 Dudden Hill Lane, Willesden, London NW10.
Telephone: Willesden 8070
Relay Division *Manager: J. Garnett*

At Chobham Road, Frimley, Nr. Aldershot, Hants.
Telephone: Camberley 1670
Radar Control Division *Manager: J. E. Engledew*
Trainer and Simulator Division *Manager: J. T. Archibald*



NS

Exhibition

E-A DATA PROCESSING LIMITED
Elstree Way, Borehamwood, Herts. Telephone: Elstree 2040
Aircraft Direction Division *Manager: J. Burrow*
Mobile Computing Division *Manager: J. P. Bunt*

ELLIOTT (TREFOREST) LIMITED
Treforest Trading Estate, Pontypridd, Glam. Telephone: Treforest 2211
Managing Director: S. H. Goss

The 4,000 sq. ft. Elliott-Automation display in the Radar Area outside the main S.B.A.C. Exhibition Tent at Farnborough

FLIGHT CONTROL SYSTEMS
AUTOPILOTS
INERTIAL NAVIGATION SYSTEMS
AIRBORNE DIGITAL COMPUTERS
FUEL MANAGEMENT SYSTEMS
NAVIGATION AND COMMUNICATIONS EQUIPMENT
AIR TRAFFIC CONTROL
BLIND LANDING SYSTEMS
SEAT RESERVATION SYSTEMS
SATELLITE CONTROL SYSTEMS
DIGITAL SIMULATION AND TRAINING SYSTEMS
WEAPONS SYSTEMS
ACCESSORIES FOR AIRFRAMES AND AIRCRAFT ARMAMENTS
TELEMETRY
AIRCRAFT INSTRUMENTS SERVICE AND REPAIR
AUTOMATIC PRE-FLIGHT CHECKING EQUIPMENT
HIGH-DUTY RELAYS
SERVO COMPONENTS

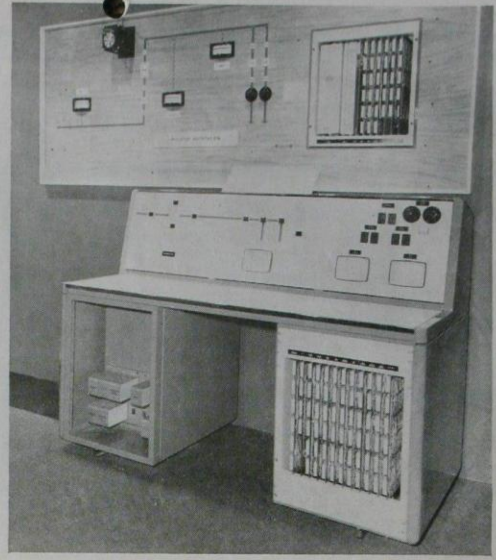
TION IN AVIATION

Farnborough 1962

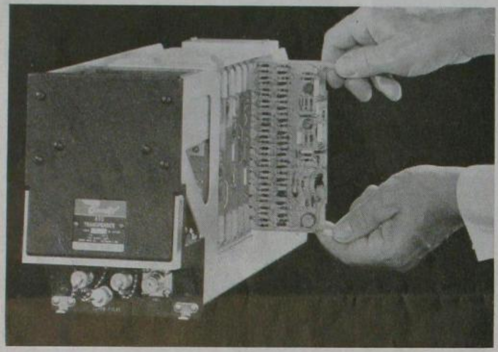
You are cordially invited to visit the integrated presentation of
"ELLIOTT-AUTOMATION IN AVIATION"
illustrating the comprehensive nature of Elliotts activities in the whole sphere of aviation, in a special 4,000 sq. ft. display in the Radar Area.

INDIVIDUAL ELLIOTT INSTRUMENTS AND COMPONENTS WILL ALSO BE EXHIBITED ON
STANDS 146-147

ELLIOTT



A digital coding and transmission equipment designed for an industrial application. A simulated outstation is used to demonstrate the equipment



Below: Air Traffic Control Transponder developed by the Bendix Corporation

MODERN COMMUNICATIONS & AERONAUTICS

At a recent dinner a leading figure in the Aircraft Industry referred to the technical strength of the Industry and the technical fall-out from the Industry because of its pre-eminent position in the development of new techniques which have afterwards benefited other spheres of activity. While this is true in many areas, in the field of air-to-ground communications this is not so and the Aeronautic business is in danger of falling behind the older and more conventional industries in the application of modern communication systems.

By **W. R. THOMAS, BSc., MIEE, AFRAeS,** *Joint General Manager, Radar & Communications Group, Elliott Brothers (London) Limited*

The large industrial plant of today has so many parameters requiring monitoring that it has been accepted that it has become impracticable to display all the values in parallel to an operator and expect an intelligent analysis and control function to be carried out unaided. Consequently increasing use is being made of digital transmission systems feeding information into a data processing installation which after performing an evaluation presents to the controller the minimum amount of data necessary for action to be taken and in particular of course presents any emergency or alarm information immediately. In a very large plant this evaluation may first be carried out at some intermediate stage from which reduced data is sent on to some central control room. Slow Speed systems using 60 bits a second transmission are already in use and development is in an advanced state on 600 and 1200 bits a second transmission systems to an agreed specification. These systems are being designed to operate into a 3KC bandwidth and be transmitted over radio links with speech facilities in the same radio channel.

Air Traffic Control

The modern aircraft is becoming increasingly complex. The introduction of more sophisticated control systems does not reduce the work load of the pilot. In fact modern radio navigation developments tend to present an increasing amount of information to the pilot rather than to some other crew member. The necessity for improving air traffic control systems will necessitate the continuous flow of data from aircraft to ground control points and this data will have to be in a suitable form for feeding into digital data processing systems. Consequently some automatic data communication system from air to ground is becoming an urgent necessity.

An automatic calling system that is available is the Selcal tone telemetry system which uses 12 different tones in the 300–1000 cps region to enable particular aircraft to be called. This provides a saving in time but information has still to be passed by voice.

With the increasing speed of modern aircraft, improved air traffic control is becoming essential. This, if it is to achieve adequate results, will require up-to-date reporting from all aircraft in the control zone. Some attempt has been made to go some way towards achieving this by the superposition of coded information on to the secondary radar transponder. But this can only be a stopgap in that the amount of information that can be transmitted is limited.

Automatic ground-air-ground communications

Work has been proceeding in the U.S.A. for some time on the development of an automatic ground-air-ground communication system, thus providing experience of what such a system could achieve, and we in this country are in danger of once again having to follow behind. This would be regrettable when one considers that in the ground industrial case we are not in fact behind the U.S. in the development of integrated data transmission and analysis systems.

It must be appreciated that in the development of such a system for use with aircraft there are no insurmountable problems to solve; it is not necessary to battle at the frontiers of physics. The task required is to translate the philosophy and to extend the technology to meet the aviation environment. After all one is only applying a modern guise to the age-old method of communication used by the native with his tom-tom. An integrated system can be designed with an airborne computer evaluating information from many measuring points in an aircraft, presenting the essentials to the pilot, and in parallel, on interrogation, transmitting relevant data to the ground, in digital form on one of the normal communication channels for analysis at the control centre. Agreement has to be reached that future economical and safe operation of modern aircraft requires a flexible, high-capacity, digital data transmission system, operating over the normal air-to-ground radio links, in order to enable adequate information to pass between ground and air without the need for human intervention ●

The Digital Computer approach in Aviation

By **A. St. JOHNSTON** *Joint Managing Director, E-A Data Processing Limited*
and **P. A. HEARNE** *Assistant General Manager, E-A Flight Automation Limited*

The normal instruments that pilots are familiar with are analogue in presentation. By that we mean that the instrument pointer has a scale and the pointer can take up smoothly any position on the scale depending on the circumstances. It was natural, therefore, that aircraft controls, as they became more and more automatic, continue to use analogue technique to carry out the calculations involved. This approach leads to the situation of 'one box for one function'. This is a perfectly reasonable situation when the number of functions – and hence of black boxes – is small. The pilot himself has always acted more like a digital computer in that he can switch his attention from one particular situation to another and usually carries out his operations sequentially using his one brain, sometimes from explicit instructions but more often from automatic reflexes and acquired behaviour patterns from his own memory.

Scope of the Computer

This method of operation is the basic way a digital computer works. It carries out one simple operation at a time, much simpler operations than a man, but as it does them thousands of times faster, a complex control operation can be built up in real time by using a series of instructions stored in the machine's memory. Naturally the computer also needs 'eyes, ears, hands and feet' to be able to be of use in a real life situation.

Remembering the 'one box for one function' situation, a digital computer, if fast enough and with sufficient memory capacity, can not only carry out a complex function but the same basic hardware can carry out any function that it is possible to specify in simple steps and, indeed, the one machine can spend milliseconds on one job and then switch its attention to another and hence gives the impression of being continuously in control of many complex situations at the same time.

The essence of using a digital computer is to be able to break down a complex operation into simple steps. Many routine situations fall to this approach and as routine operations are usually the boring ones, a machine may be more effective than a man. In a real life situation there are many functions, particularly emergency ones and really subtle ones, that cannot be specified as a series of simple steps. Here the man scores and will always score.

As the computer is so very much faster it is capable of doing jobs a man cannot do for sheer lack of time. This is why computers were first applied to complex mathematical problems. In fact neither the design of modern aircraft nor the use of nuclear power – certainly not the control of satellites – would have been possible without the use of mathematical computers.

The next major application field was to business data processing in which the machine's memory is extended by the use of magnetic films or tapes.

In both these applications the actual moment that the machine carries out its job is usually immaterial within a few hours and hence this type of use is called 'off-line'. There must be many thousands of computers operating in this mode in the world by now.

above P. A. Hearne
left A. St. Johnston

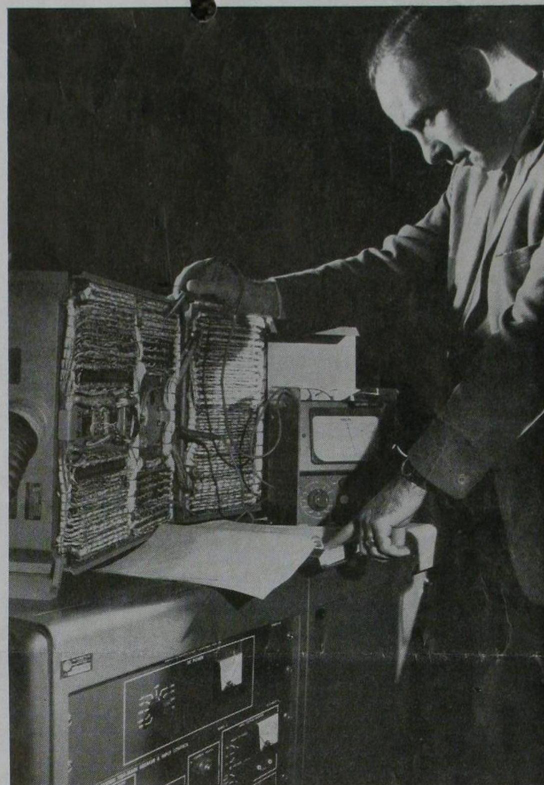
A vast number of more interesting computer uses are possible if a digital machine can be used 'on-line' where it is computing moment for moment in real time. The earlier computers used valves whose mean free time to failure was such that preventive maintenance routines were necessary. This meant that a machine was deliberately taken off the air at least once a week for valve testing.

New fields of application

The coming of transistors with failure rates perhaps a thousand or more times better than their equivalent vacuum tubes, means that preventive maintenance of this type is now quite unnecessary. Transistorised computers have run thousands of hours without failure in some cases. This has opened up many new fields of application. The 'on-line' use of digital computers in process control, in power stations, chemical plants and so on, is now well established, although not widespread. Component failures are still very real and in situations where the utmost system reliability is essential, two machines are necessary. Often, however, this need not mean that one is 100 per cent redundant and hence inefficient, as in many cases the two machines can both be doing useful and different jobs and if one fails the top priority job is held by whichever machine is working.

However, it is the use of the stored programme technique rather than its reliability, that is the key to the widespread application of the digital computer. Not only does it mean, as has been said earlier, that often a single hardware design can be used for scientific, business, process control and defence operations, as has been the case with the 803, but also that changes can be made to what the machine does, as experience is gained in the job, without hardware re-design.

Digital computers are being applied to airline seat reservation, air traffic control, communication network switching and many classified operations.



Testing the VERDAN Airbo[rne] Digital Computer

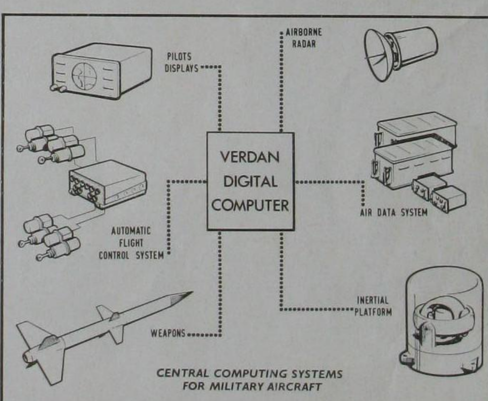
Digital computers are being used increasingly in the aircraft and missiles themselves with many advantages to the airframe and system designer. Perhaps the chief of these is the flexibility which allows the developments and changes in aircraft role to be accommodated easily and rapidly by reprogramming rather than expensive hardware changes. This is especially valuable today when one single type of aircraft may be required to carry out many varied types of mission. Such flexibility is demonstrated in the extreme by the Autonetics VERDAN computer, used in Polaris submarines, U.S.N. aircraft carriers, A3J aircraft, Hound Dog missiles and Dynasoar space craft.

An Hypothetical Aircraft System

The illustration below of an hypothetical aircraft system shows an aircraft with an inertial navigator, air data transducers and radar system. These all act as sensors for the Verdan central digital computer which takes in their information and computes the outputs to the pilot's displays, autopilot and weapon groups. These outputs could include, for example, steering and position information via the displays and autopilot, weapon release, etc. Along with flexibility go increased accuracy, and the real gain of a common digital language between the aircraft system and the 'computerised' air traffic or air defence systems on the ground.

Exciting New Developments

But it is the fact that the computer uses repetitively only a limited number of types of components and circuits which leads to the most exciting possibilities of all. This limitation of circuit types is ideal for the application of micro-miniaturisation techniques when, for example, complete flip flops can be made on one crystal chip. Computers using such elements are already in the design stage and promise orders of increase in reliability yet with a much smaller weight and size ●



CENTRAL COMPUTING SYSTEMS FOR MILITARY AIRCRAFT

The implication of SPACE TECHNOLOGY

The giant aerial at Goonhilly Downs in Cornwall, which is being used to track the 'Telstar' communications satellite, is steered by instructions from a National-Elliott 803 Computer. (Photograph by courtesy of H.M. Postmaster General)

Space programmes are well advanced in the USA and USSR—can we afford to lag behind?

Space programmes are well advanced in the U.S.A. and U.S.S.R., but in Europe, and particularly this country, our efforts have been limited so far to a high altitude rocket research programme and a restricted U.K.-U.S. co-operative satellite programme, both of which are aimed at making certain scientific measurements which will provide much useful information about various spatial phenomena but will not contribute appreciably towards the advance of Space Technology in this country.

One must ask the question, is it important to build up experience and 'know how' in Space Technology in this country? The answer is undoubtedly in the affirmative if this country wishes to remain abreast of the frontiers of technical progress. Because any new sphere of activity such as Space Aeronautics forces and leads the development of new techniques and processes which then spread, revitalise and influence many other established industries. In addition new industries can develop from the application to other fields of advances made in the process of Space Development. Space Technology is providing the driving force in the U.S.A. for research work into such things as new materials for the construction of satellites and for bearing surfaces running in a vacuum; microminiaturisation of electronic units; miniature stabilised platforms; the development of long-life microwave tubes, capable of running for two or more years; high standards of reliability in mechanical and electronic components; nuclear batteries and many others. All of which will have considerable impact on other fields of activity in due course.

This article was written by W. R. Thomas, BSc, MIEE, AFRAeS, Member of the B.S.D.C. Technical Committee, Joint General Manager (Radar & Communications Group), Elliott Brothers (London) Limited

The ELDO Organisation

Some progress has been made by the U.K. along the Space Road by initiating the setting up of the ELDO organisation which will provide a launching vehicle in 1966/67, but plans for the use of this are still vague.

There are, undoubtedly, a number of useful experimental uses such as the launching of an astronomical satellite into an orbit to allow measurements to be made from a space stabilised-platform free from the earth's atmosphere, but the most profitable satellite programme to follow has already been highlighted in America—namely that of establishing a Communications Satellite System.

Profitable in three ways: (1) it demands the solution of a number of advanced technical problems (2) it provides a highly desirable step forward in communication facilities for many parts of the world with a consequent benefit to civilisation and (3) it is the one satellite programme with a reasonable prospect of providing a financial return on the investment.

Communication Satellite programme

Britain and the British Commonwealth are pre-eminent in the field of International Telecommunications by virtue of investment at the right time in radio telephone systems and long distance submarine cables. We shall lose this position if we do not make an immediate decision to launch a Communications Satellite programme designed to meet the needs of Europe and the Commonwealth.

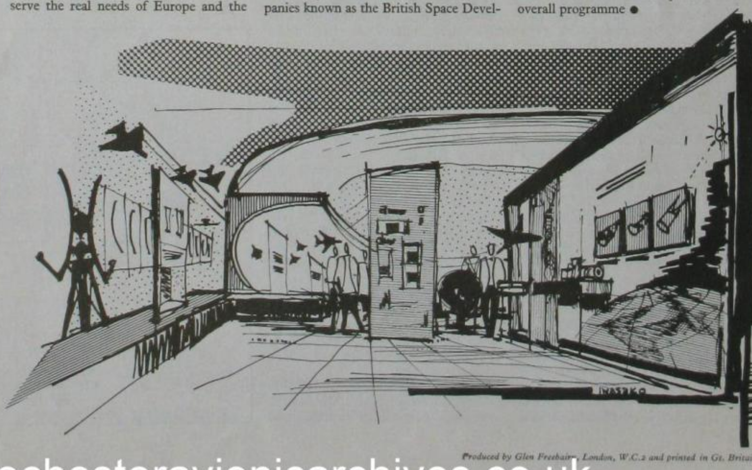
The earliest such a system could be in operation is 1970 and it is undoubtedly true that an American system will be in operation before this time. So how can a European/Commonwealth system be justified. On two principal counts: firstly the need to acquire the techniques as described above, and secondly the fact that the planned American systems do not serve the real needs of Europe and the Commonwealth. The nature of the American economy and approach to the problem has led to a conception of broad trunk routes similar to and supplementing the present cable routes round the world. There is, however, a large latent demand for adequate communications facilities between a large number of users throughout the world, whose individual requirements are small, *e.g.*, for a few telephone circuits. It can be shown that there is more traffic in volume to be collected from this large number of widely scattered sources than from the traditional trunk routes and that it amounts to the equivalent of several hundred telephone circuits all round the world. Many of these small users have traditional associations and connections with Europe and wish to communicate with Europe.

Two-way Telephone channels

The design of a system to meet this requirement is likely to culminate in a technical solution different in detail to that of the American system. Such a system has been proposed in outline by the British Post Office in conjunction with the Royal Aircraft Establishment. In this system, 12 station-keeping satellites go round in a circular equatorial orbit of approximately 6,000 miles providing 600 two-way telephone channels. The system has been studied by the consortium of British Companies known as the British Space Development Company and detailed proposals are being made to the Government for a development programme which could be carried out by B.S.D.C. in that through its member companies it can provide all the various types of experience necessary to bring the programme to a successful conclusion and achieve an operational communications satellite system utilising the ELDO launcher vehicle.

The Go-Ahead is urgent

The development of the Goonhilly Downs tracking station provides a good starting point for the ground station equipment but there are many problems still to be solved to achieve the quality and reliability of service needed. Even greater problems have to be solved in the satellite itself; the Go-Ahead is urgently needed. As usual; the requirement is an allocation of funds by the Treasury to start the programme; but in this case with the undoubted knowledge that it is an investment that will pay off in hard cash and not just in some intangible form of security. Co-operation with our partners in ELDO is essential, but if the commencement of the communication satellite programme has to await agreement with all these countries then much valuable time will be wasted. Certain specific development tasks should be started with limited expenditure which would save time and money in the overall programme ●



The special Elliott display at Farnborough incorporates an illustration of developments in Space Technology

Produced by Glen Freebairn, London, W.C.2 and printed in Gt. Britain