Computers and the Airways

To keep tab on scores of take-offs and arrival times, altitudes, speeds, types of aircraft, changing weather, flight progress, and to execute the paperwork associated with these factors, the human air-traffic controller must co-ordinate mind and muscle almost beyond the limits of human efficiency. While no system can eliminate the human factor, a logical solution is to take as much as possible of the burden from the mind and hands of the man and put it on the machine.

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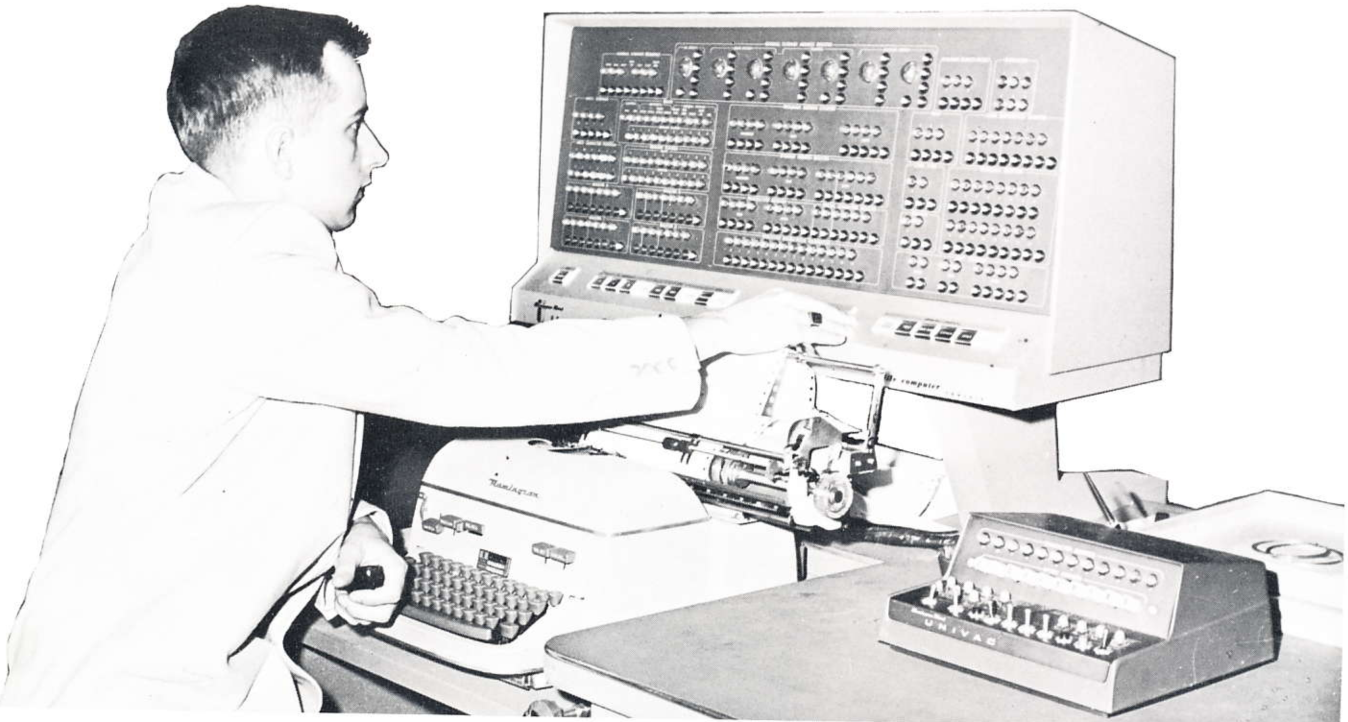
In air-traffic control and navigation, the Federal Aviation Agency plays the major role in determining the feasibility of particular equipment systems. Various systems have been, and will be, undergoing intensive checkouts at the FAA's National Aviation Experimental Center in Atlantic City, New Jersey. Recently, the FAA awarded a contract in excess of $3 million for installation of a new computer system at Atlantic City for use in a test model of an air-traffic control system.

Other systems are being tested in actual commercial operations. For example, an advanced radar traffic control system (ARTS) was installed by the FAA in the Atlanta, Georgia, airport early this year. Although the FAA is considering other systems similar in concept to ARTS, much of the FAA's thinking in the general field of tower air control automation will be shaped by the results of the Atlanta operation.

ARTS is one of the first computer systems to be installed in an attempt to relieve the terminal air-traffic controller of some of his clerical work. While no system can completely replace human air-traffic control, experience with congestion in air-terminal areas has convinced both the FAA and the aviation industry that merely adding human controllers is impractical. More controllers would lead to smaller control sectors which, in turn, would result in more sectors, and thereby create tremendous communications and sector co-ordination problems.

But the mere insertion of computers in air-traffic control systems does not automatically solve the problem, either. For one thing, there is the problem of the most practical display of data. For another, how can the controller continually update the computer without interrupting his control function? And what happens when there is a failure somewhere in the electronic system?

Tentative answers are already



The control console is the nerve-center of the FAA *Univac* File-Computer installations. The inquiry typewriter is an important element in the system's input/output facilities. All photographs for this article were made at the Cleveland Control Center.

available, but only operational experience will truly indicate the feasibility of these answers. For example, one solution might be found in the use of transmitter-receiver units, called beacons, aboard aircraft. These can provide automatic inputs to an air-traffic control system. The beacon is designed to transmit a coded reply whenever it receives a specific radar signal from a ground station. Studies of the use of airborne beacon signals are, in fact, one of the FAA's top priorities. One result has been the inclusion of beacon data in the Atlanta ARTS system.

Basic Procedures

Consider for a moment some of the basic procedures in controlling aircraft today. As a plane taxis down the runway and awaits takeoff clearance, controllers already are fitting this flight into the overall pattern of air traffic in the vicinity of the tower. Computers help the human controllers to project the positions of the various incoming and outgoing flights. This becomes particularly urgent as the visibility ceiling lowers in bad weather.

Once the plane is airborne and in its proper flight route, it is watched along the way by officials in the various FAA Air Route Traffic Control Centers. Computers in these centers display flight progress data and estimate times when the plane will arrive over specific fix points.

Finally, our plane nears its destination and is transferred to local airport controllers. Again, a controller directs the aircraft to an appropriate holding pattern, depending on the overall status of air traffic in the area, and gradually brings the plane into the correct landing maneuver. The controller again relies on a computer to help him sort out and keep track of the various flights under his control.

The impact of the computer is only beginning to be felt in air-traffic control, but its role in this field may prove to be most significant, and for good reason: It can help make air travel safer and more reliable.

Major Program

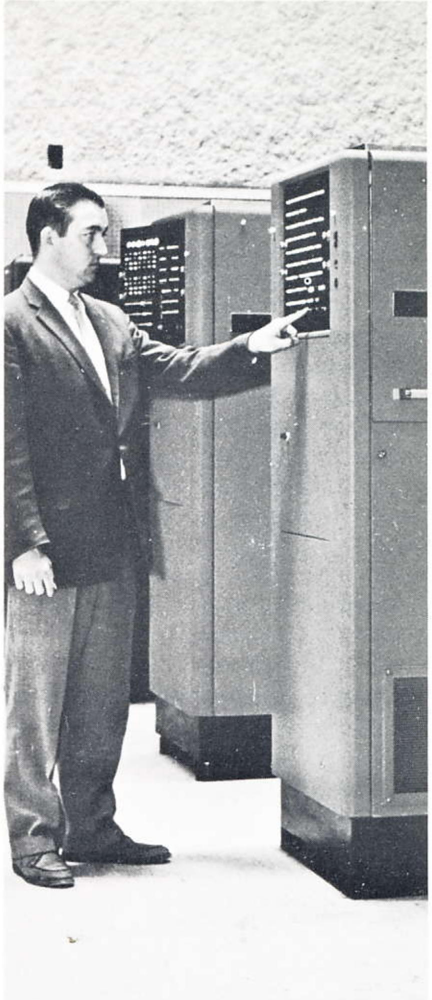
The Federal Aviation Agency is engaged in a major program of consolidating and automating its Air Route Traffic Control Centers from coast to coast. The FAA expects to have 21 of these centers by the end of next year; eventually all will be equipped with data-processing equipment. Control centers at Pittsburgh and Detroit have been eliminated as part of the plan for consolidation of control areas. The new Cleveland Center, actually located in a new $10 million facility at Oberlin, Ohio, now combines the functions of the old Pittsburgh and Detroit facilities.

The Cleveland Control Center is one of the five FAA centers now equipped with computers. The others are New York; Boston; Washington, D. C.; and Indianapolis. All except New York have the UNIVAC File-Computer. And all five are new facilities, built along similar lines with similar equipment. This type of structure, costing about $2 million without equipment, eventually will become standard for all FAA control centers in the country.

The five new centers, though bearing the names of large cities, actually are located in rather remote areas, except for the Indianapolis Center which is located in that city. The New York Center is housed at MacArthur Field, Islip, Long Island; and its controls area includes a vast area of the North Atlantic. The Boston Center is located at Nashua, New Hampshire, well to the north. And Leesburg, Virginia, is the site for the Washington, D. C., Center.

The computer systems in these centers are for the most part similar. The UNIVAC File-Computer Systems, for example, perform four functions to relieve air controllers of considerable computational and clerical work. They receive and store flight plans, compute estimated times of arrival, assemble and print-out flight progress strips for display at control sectors, and transmit flight plan information to other FAA control centers.

The UNIVAC system at Oberlin, as an example, consists of a central computer, a general storage system of six drums with a total capacity of 1,080,000 characters, and an input/output system. As many as 10 drums can be attached to the central computer, to provide maximum storage of up to 1,800,000 alpha/numeric characters. Input/output equipment provided with the Oberlin system includes high-speed paper tape, inquiry typewriter, magnetic tape, and a high-speed printer from which flight-progress strips are displayed in two colors. The colors can be used to distinguish flights by their route direction.



A portion of the system's control units.

Volume

Each of these major FAA centers controls hundreds of flights each day. The volume of incoming information is normally fantastic, since each route has several check points at which pilots transmit their positions, and this procedure results in at least as many calculations for each incoming flight as there are check points. Under these conditions, it would be a time-consuming operation for a controller to handle several flights at once; a computer does this work far more reliably and at high speeds.

Traffic control along major air

routes can be demanding, particularly in poor weather, but the task of controlling a great variety of aircraft over such busy terminal areas as New York, Washington, or Atlanta can be formidable. The job becomes almost too much for human capacities during "rush hour" periods and under low visibility conditions. At such times, individual air controllers have been known to handle as many as 27 incoming, outgoing, and over-flights in one hour. This is nearly two times the peak 15 per hour established by the FAA as a human capability limit.

Average traffic congestion, already near saturation at such terminals as New York's John F. Kennedy Airport, is certain to grow worse in areas still below saturation. This outlook, plus such disasters as the collision of two jet airliners over New York in December 1960, led the FAA to study the feasibility of such automated systems as the UNIVAC 1218 ARTS system at Atlanta.

The Atlanta system accepts flight data from a radar-beacon combination, converts it into digital form, and displays it on the controller's scope in alpha/numerical characters. Such information as position, identification and altitude is shown. Experiments have also been made with techniques for displaying marks on the controller's scope to indicate the future position of each flight, based on known speed and heading.

The Atlanta system, developed under a $643,000 FAA contract, consists of two UNIVAC 1218 computers and various peripheral equipment. The system can accommodate up to 100 flights simultaneously. Each aircraft and its altitude is designated by coded beacon signals transmitted from the aircraft. One of the 1218 computers is used to process radar data and information received from the aircraft by beacon code; the other computer is used to generate information for display.

ARTS was designed primarily for airport terminals, such as that at Atlanta. A similar system providing for beacon information display only will be installed shortly in the FAA's High Altitude Positive Control Facility, located at the Indianapolis Air Control Center. This system is called SPAN, for Stored Program Alpha/Numeric Beacon System.

Despite the bright outlook for computers in the nation's effort to solve the air-traffic congestion problem, there still remains the related problem of uncontrolled aircraft. Many of these uncontrolled flights show up in airspace where controlled flights adhere to instrument flight rules. In 1954, only about 15 per cent of the nation's aircraft were controlled. This figure climbed to about 25 per cent by 1963. Yet, this relatively low percentage of controlled flights is already straining the nation's air-control systems. If the proportion of these flights continues to rise, it may well be that the only salvation for the airlines will lie with computer technology.

The men in this rank of controllers are receiving over telephones flight information for processing through the *Univac* System.

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