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Secretary of Transportation, John A. Volpe
Administrator, John H. Shaffer
Associate Administrator for Manpower, Bertrand M. Harding
Editor, Clifford Cernick
Associate Editors, Thom Hook and Theodore Maher
Editorial Assistants, Carol Lencki and Don Braun

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Dawn of a New Era for FAA

Since the early 1960's, FAA has been working to define, design, develop and implement a computer-assisted air traffic control system. Now, this program is paying off at an increasing number of ATC facilities around the country and sharing the benefits are FAA employees, the aviation community and the traveling public.

Probably the most visible and tangible evidence of the progress being made are the automation wings either completed or under construction at 18 of the 20 air route traffic control centers in the en route automation program. The three-story automation wings will house the basic computer elements of the automated system and will also provide space for medical facilities, classrooms, additional offices and storage areas.

Concurrent with construction of the automation wings, the FAA has been pushing ahead with installation of computers and peripheral systems in existing space or in the new automation wings as that space becomes available. A total of 14 centers now have basic computer systems installed and are using them for flight data processing. In addition, 14 centers have received computer update equipment (CUE), permitting controllers to exchange data directly with the computers, and nine have this equipment in actual operation.

Radar Digitizers Going In

Another key element in the en route system—the radar digitizers which translate returns from primary and secondary radar into digital language that computers can understand—also is being installed at the long-range radar sites serving the centers. The agency expects to have this equipment delivered to all of its operational sites by early 1972.

Deliveries of Computer Display Channel equipment also began this spring with the first unit going to FAA's National Aviation Facilities Experimental Center (NAFEC) at Atlantic City. This is the third major element in the en route system and will provide controllers with a readout of such vital flight data as aircraft identity and altitude directly on their radar displays.

Even more impressive than the progress being made in the implementation of the en route system is the speed with which the terminal system is being installed. Deliveries of ARTS III (automated radar terminal system) began last December, less than two years after the initial contract for the purchase of this equipment was let. By the end of the year, the agency expects to have 26 systems delivered with 15 of these achieving initial operational capability.

In addition to providing controllers with new automated tools to assist them with the air traffic management function—and the purpose of automation, it should be emphasized, is to help the controller, not replace him—the FAA also is implementing other system improvements including construction of new towers and other facilities and the installation of such hardware items as radars, radar displays, communications equipment, navigation aids and instrument landing systems.

An outstanding example of new facility construction is the control tower commissioned last month at Chicago O'Hare. Stretching 200 feet above the surface of the world's busiest airport, the new tower provides controllers and maintenance personnel with a comfortable and functional working environment. It also houses the first operational ARTS III system to be accepted by the agency.

Deliveries have also begun on the ASR–7 (airport surveillance radar) with the first 13 units scheduled to be installed and checked out by the end of the year. Featuring solid-state components, integrated circuit design and modular construction, the new equipment will be a boon to the controller and maintenance technician alike. It also will ease siting problems for Facilities Installation personnel since each channel of the dual-channel equipment is self-contained in its own transportable van.

New ILS On The Way

New instrument landing systems (ILS) also are on the way as a result of a contract let two years ago for 99 full and partial solid-state systems. The first unit was delivered to Oklahoma City for check out this spring and the remaining units are scheduled to be delivered within the next 12 months. The agency also has contracted for an additional 49 units with delivery of these scheduled to begin before the end of the year.

Other recent contracts cover such hardware items as 200 radar bright displays for the centers, 34 bright radar indicators for FAA tower cabs (in addition to 88 previously ordered), 285 transceivers and associated equipment to provide automatic emergency backup communications for the centers, and 120 weather radar reporting units. Much of this equipment already is moving into the system, making life just a little more pleasant for both controllers and maintenance technicians.

And because little things do mean a lot, the agency also is proceeding with a myriad of minor—but nonetheless important—programs to improve the overall working environment of FAA employees in centers, towers, flight service stations and other facilities. These improvements—typified by the recently completed refurbishing of the Cleveland center—range from better lighting and improved air conditioning systems to installation of carpeting and acoustical ceilings.

The result of all these efforts to modernize and automate the ATC system will not be a finished product, however. In order to keep pace with the continually increasing traffic volumes, the system must constantly evolve to new and higher levels of technological application. Some of the more immediate tasks already outlined for the automated system include predicting impending traffic conflicts and suggesting ways of resolving them, providing flow control advice in congested traffic situations, and assisting with the pre-planning and sequencing of arrivals at airports. Another important objective is the use of data link to provide automatic communications between pilots and controllers.

Beyond this point, the air traffic control system is almost certain to employ the techniques and tools now being applied on the forefront of space exploration including use of satellites for communications, navigation and surveillance purposes. But whatever the future direction of ATC, one thing is certain: the human element will become more—not less—important in the systems concept. For the men and women who install, operate and maintain the ATC systems, the prospects are both challenging and exciting.

John H. Shaffer

JOHN H. SHAFFER
Administrator

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The Cover: The future is here. As modernization and expansion continue at FAA facilities across the country, traffic control centers are beginning to resemble this sweeping view from the glass-enclosed visitors' balcony.

At Indianapolis, a controller double checks the content of a flight strip, using a keyboard that is part of CUE-Computer Update Equipment. Directly in front of the controller is the high-speed printer that produces new or changed flight information strips.

AUTOMATION'S "ABC'S"

Confused about air traffic control automation? Is your mind boggled by all that talk about hardware, software, digitizers, fail safe and all the rest? Join the crowd.

Yet, ATC's automation is not too hard to understand. It's simply harnessing the computer's fantastic memory and lightning-fast calculating ability to the routine tasks of air traffic control.

The FAA is now "computerizing" its 20 en route centers as well as its busiest airport terminals. When initial operating capability is reached at the last site by the end of 1974, the system will interconnect centers and towers throughout the nation in a giant automatic data network.

Let's look first at automation of air route traffic control centers, a program officially referred to as "NAS En Route Stage A." This portion of the total job will be completed in two phases. Phase 1 saddles the computer with drudgery gladly relinquished by controllers: the mountain of daily paperwork involved in processing, printing, distributing and updating flight plans.

When a pilot files a flight plan, the information is "fed" directly to the computer from remote locations or via a keyboard entry device in the center and the electronic servant takes over. About 10 minutes before each flight is set to take off, the computer retrieves the appropriate flight plan from storage and prints it out on a flight strip printer at the sector position which has initial responsibility for the aircraft.

As the plane moves through the center's airspace and control of the flight is handed off from sector to sector, the computer automatically prints out a flight strip at each position, in advance of handoff. Information on the aircraft is automatically sent to the next center's computer along the route of flight or to equipped terminals if the aircraft is approaching destination.

Should a controller wish to "tell" the computer about changes in an aircraft's flight plan, he can do so by entering information on a special keyboard located at his control position. (See "CUE Has Nothing to do With Show Biz," Page 11.)

The second phase of center automation calls for bringing the vital information about each flight right on to the radar scope. The controller now has this information, in the form of flight progress strips lined up on a rack beside him. But he must remember which strip applies to which blip on the scope—a process calling for heavy concentration and constant verification. He must also prepare plastic markers called "shrimp boats" that he manually keeps in association with the displayed radar target.

Youngsters and grownups alike were given some insight into "automation's ABC's" during recent open house tour for FAAers at newly-completed O'Hare Tower in Chicago. Here Don Vogel (left) does the explaining. Vogel was chairman of the technicians-controllers committee that planned the open house.

At Chicago-O'Hare, where the first operational ARTS–III has been installed, a computer processes information from aircraft and provides it to traffic controllers instantaneously. The data processing subsystem handles information which identifies the aircraft, its altitude and its speed.

Here again, computer "magic" steps in to help the controller. Through an electronic process that converts digital information into letters and numbers, a bright tag containing all necessary flight data appears on the scope attached to the blip for each aircraft being controlled.

A controller hands off an aircraft to another controller simply by making a keyboard entry to the computer, causing the identity tag to transfer to the new screen. The tag continues to blink until the new controller acknowledges the handoff.

Part of the information on this tag is vital data that is missing from the present radar picture: altitude. When Phase 2 is completed, there will be continuous readout of the plane's altitude directly on the scope. How is this done? Most large aircraft are equipped—or will be equipped—with a "black box" known as a 4096-code altitude reporting beacon transponder. The transponder is directly tied in to the plane's altimeter and automatically transmits altitude data by means of selectively timed pulses of energy. If the aircraft does not have an altitude reporting transponder the altitude entered by the controller is displayed.

(The agency is considering action which would require 4096-code altitude reporting transponders on all

At Washington National, controllers can quickly scan the BRITE (Bright Radar Equipment—Tower Equipment) screen, which can be seen clearly even in a well-lit tower cab. The screen, which can be utilized to provide return from equipment like the new ASR-7 surveillance radar, is mounted on an overhead rail which can be moved as needs dictate.

aircraft operating in controlled airspace above 10,000 feet as well as in area positive control airspace and in designated terminal areas.)

What about tower automation? This segment of FAA's total automation effort is referred to as ARTS. (See glossary on inside back cover for a description of the various ARTS systems.) The system known as ARTS-III is designed to provide tower controllers at major and medium hubs with the same kind of basic assistance center controllers will get, as described above. This includes flight data processing, automatic handoff capability and alphanumeric display of vital flight information.

ARTS III, in the initial phase, will tag and track aircraft that are beacon transponder equipped. Computer programming required to perform this function for all aircraft with ARTS III equipment will be introduced later.

(A full discussion of the ARTS system in operation will be found in the article, "A Controller Looks at ARTS," on Page 12.)

ROBOTS WON'T TAKE OVER

Many FAAers have asked this question: what effect will introduction of automation have on the agency's air traffic employment picture?

The answer: the computer was never intended to replace the controller—and won't. Landings and takeoffs at the 311 airports with control towers are expected to climb to more than 89 million in 1975. By 1981, the total is expected to be about 170 million. (The 1971 figure is expected to be around 56 million.) This tremendous anticipated growth in air traffic will require more operational employees to man ATC positions and more maintenance personnel to look after additional equipment.

What the agency is implementing is a semi-automated system with the computer handling clerical and coordination tasks which now account for up to 70 per cent of a controller's time. This will free him to devote full time, attention and energy to necessary traffic planning, basic decision making and the sequencing tasks only he can perform.

New Wings For Aviation

Artist's drawing shows how a typical air traffic control center will look when new automation wings and other installations are completed.

New wings are about to be provided for FAA's men and machines.

The wings are not for airplanes; they are additions to existing buildings at 18 of the nation's 20 Centers.

Recognizing that the air traffic control system can be no better than the people who man it, FAA has inaugurated a two-phase Center Modernization and Expansion Program.

Phase 1 calls for addition of a three-story wing at each center to house the latest in computers and other electronic equipment, space for a medical clinic and office and classroom facilities for on-site training. This phase is already in progress.

Phase 2 will incorporate the latest advances in electrical and mechanical systems to provide the most harmonious atmosphere for the comfort and well-being of the personnel who control America's aircraft.

Phase 2 calls for refurbishing of the control rooms, addition of brighter, more eye-appealing surroundings and carpeting of the floors to reduce noise. (See "Creature Comforts," Page 20.) Plans also call for installation of acoustical ceilings and walls, better lighting and repainting of consoles and other controller work areas in "relaxing" colors. Other portions of the Phase 2 program involve redesigned, more efficient air conditioning systems, larger locker rooms and rest rooms, convenient conference rooms and "ready" rooms where controllers relax before they go on duty.

Major effort under Phase 2 will begin later this year with construction starting at Los Angeles and Houston centers in November and at the Oakland center in December. Work on Phase 2 will be begun at the remaining centers under a program stretching to October 1972.

Computer hub in Atlanta Center's recently completed expansion program is nerve center of the center's automated operation. Shown is M.L. Johnson, Systems Engineer.

Current ARTCC Automation Wing Completion Schedule

3/71	Atlanta* (completed)	10/71	Cleveland
6/71	Oakland		Boston
7/71	Los Angeles		Salt Lake City
	Albuquerque	11/71	Chicago
8/71	Washington, D. C.	1/72	Kansas City
	New York**	3/72	Jacksonville
	Denver		Indianapolis
	Seattle	4/72	Minneapolis-St. Paul
9/71	Fort Worth	5/72	Miami
	Memphis	1/73	Houston***

* Wing extension scheduled completion: 1/73.
** Seven bay expansion to existing building.
*** Three bay expansion to existing building.

Radar Comes of Age

For the first time in more than a decade, a new airport surveillance radar is coming into use.

The unit, designated ASR–7 and built by Texas Instruments of Dallas, will provide FAA's air traffic controllers with a much more reliable view of aircraft operating within 60 miles of the transmitter. In addition, the new surveillance radar is expected to require fewer adjustments and less maintenance than the ASR–3B's, –4's, –5's and –6's now in use.

The original contract, worth about $7 million, called for the delivery of 13 ASR–7's to FAA plus seven more destined for use by the Air Force and Navy and for foreign nations under the the Mutual Aid Program. The 13 have already been built. Contracts for 23 more for FAA and five additional ASR–7's for the Air Force have just been signed, and these will be delivered at the rate of two a month beginning in March 1972.

Lewis Roth, chief of the Terminal Radar Branch in FAA's Facility Installation Service, says the ASR–7 has five major advantages over its predecessors:

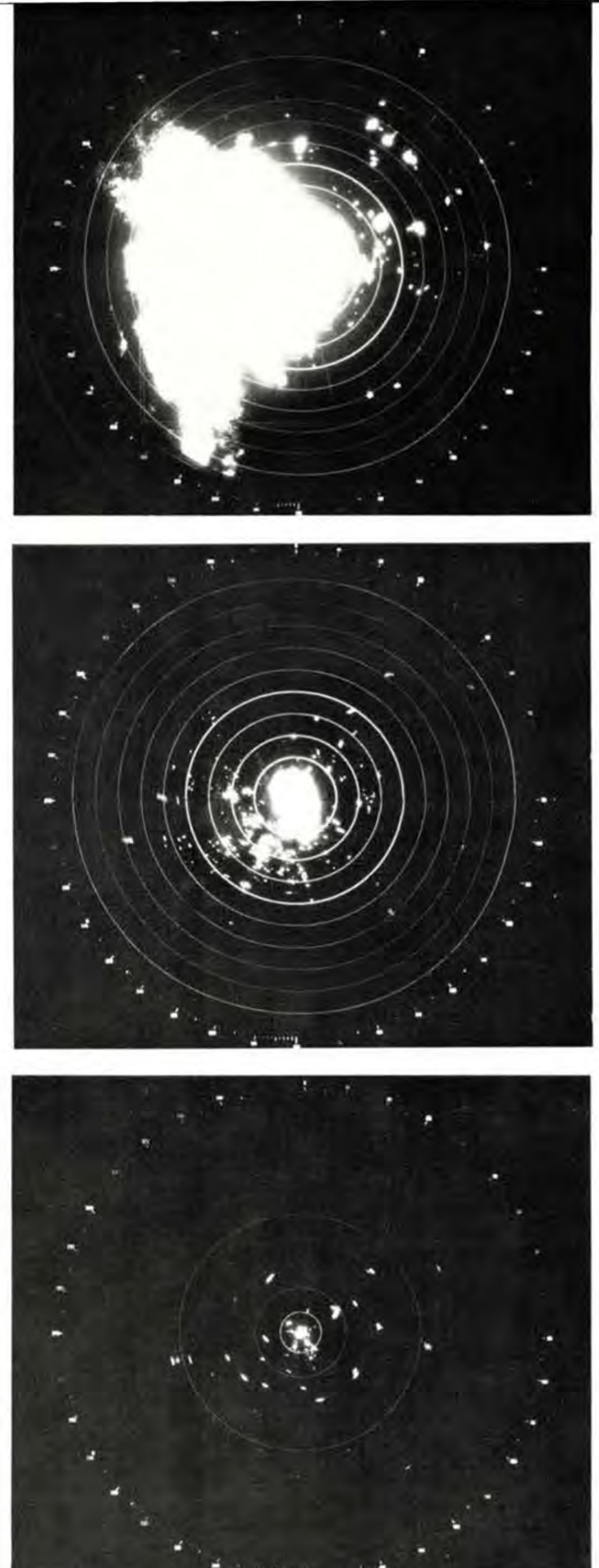
1. The ASR–7 is an all solid-state design, and this will result in reduced maintenance requirements. Expectations are that with the use of easily replaced, plug-in printed-circuit boards, it will take about 30 minutes to get the surveillance radar functioning again if a circuit should fail. Moreover, the solid state design should give the ASR–7 a mean time between failures of about 2,300 hours.

2. It contains Log-Fast Time Constant (FTC)—Antilog receivers to improve the set's performance in bad weather conditions. By eliminating weather clutter from the scope, the ASR–7 enables the controller to do a much better job of handling air traffic during storms.

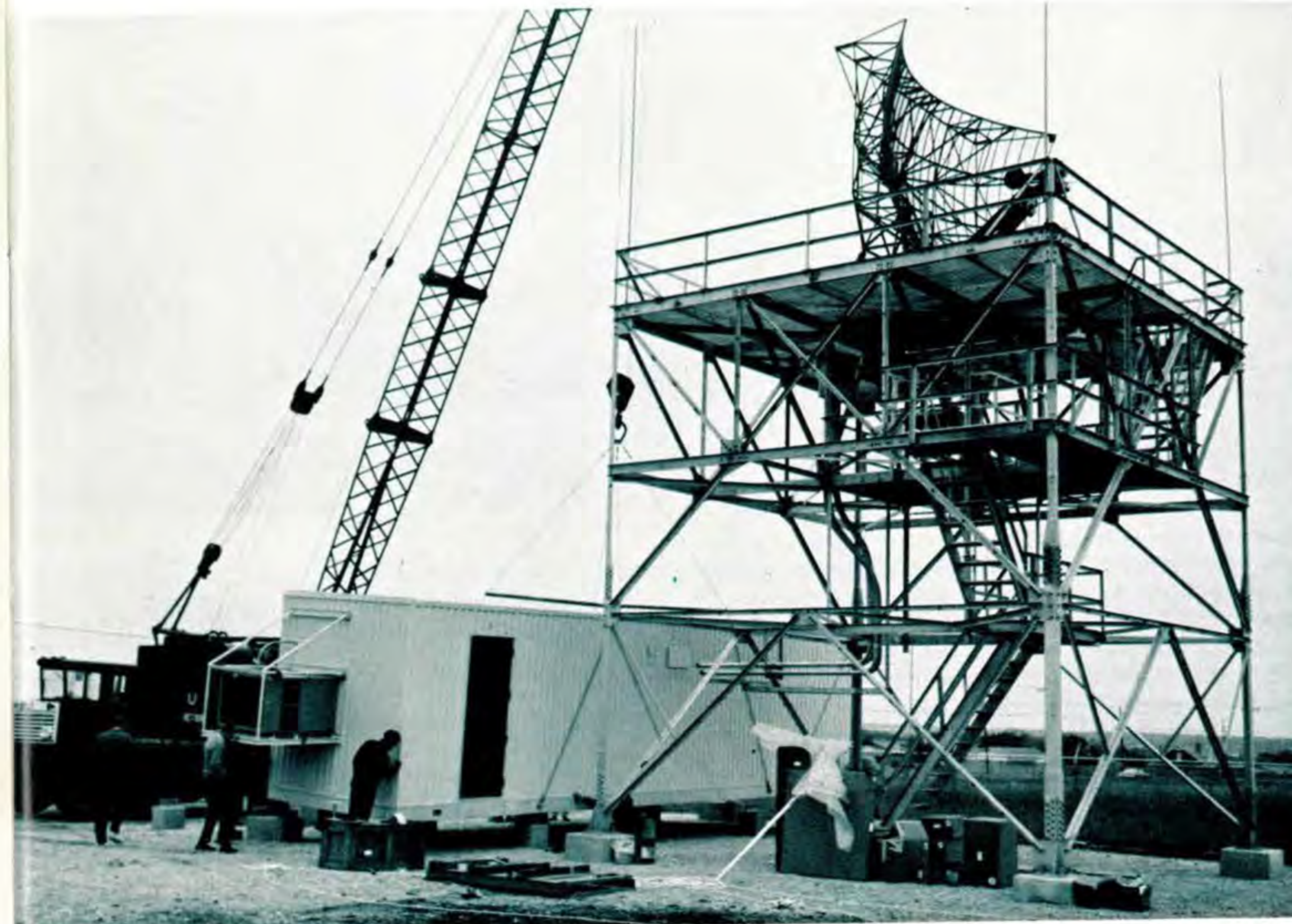
3. It features a video enhancer to enable the traffic controller to get a sharp image of the aircraft and weather in his area.

4. The gain control device in the ASR–7 provides improved control of sensitivity and thereby allows the controller to get amplification of weather and traffic conditions.

5. A single-channel radar is housed in each of two 10-by-40-foot structures that make up the ASR–7 system. (See illustration.) The electronic equipment is installed in the structures at the factory in a controlled environment and the structures are then erected at the airport site, minimizing the need for adjustments. Because the two structures are easily transportable by truck or by air, the entire ASR–7 system can be quickly transferred to another airport if necessary.



ASR–7 improvements are evident in this series of photos. At top is the normal picture showing weather clutter. Using the Log-FTC-Antilog feature with the normal video picture means much of the weather clutter is eliminated (center). The Log-FTC-Antilog element used in conjunction with the Moving Target Indicator (MTI) channel removes weather and ground clutter (bottom).



ASR–7 Radar, now in use for technician training near Richardson, Tex., will cover the Dallas-Fort Worth area. One of two transportable vans comprising the system is shown during installation by the supplier, Texas Instruments Inc.

ASR–7's have already been installed at six sites, Roth reports. They are now located at Huntsville and Mobile, Ala., South Bend, Ind., Boston, Dallas and Oakland, Calif. None has been formally commissioned but the Dallas unit is already being used as a training installation for maintenance personnel and the remaining ASR–7 systems are currently undergoing test and checkout.

Before the end of 1971, the remaining seven surveillance radars in the original order will be installed. Two will be located in the Chicago area—one at O'Hare International and the other will cover the area south of Chicago. Subsequent installations will be at Washington National, Los Angeles, Lexington, Ky., Erie, Pa., and Columbia, S. C.

The Lexington, Erie and Columbia units were originally destined for Kennedy International, Newark and Atlanta. But zoning and other problems at Kennedy, Newark and Atlanta necessitated the switch of the ASR–7's. These three airports are definitely programed to receive the advanced surveillance radar system, however.

With the first 13 ASR–7 sites firmly decided, FAA is currently putting finishing touches on which of the nation's airports will start getting the 23 follow-on ASR–7's after deliveries begin next March. Almost all of the sites have been picked and they range from New York to California and Minnesota to Louisiana.

Roth indicates the ASR–7 is the forerunner of an even more advanced airport radar, the ASR–8. FAA briefings to industry on specifications will be held in the very near future, with the contract award scheduled for May 1972. First production deliveries of the ASR–8 will begin in the late summer of 1974 and the first of these advanced units will be in service at a high density airport starting in December 1974.

Overall, Roth indicates, the FAA will have a first year buying program for eight ASR–8's. These will be augmented in future years as Congress votes the money required. One of the first of the ASR–8's will be installed at the FAA Academy in Oklahoma City for training purposes and the nation's highest density airports will get the rest of the first batch. In subsequent years, FAA hopes, the ASR–8's will begin replacing older ASR's at terminals across the country.

In the ASR–8 transmitter, several new features will be requested when the industry briefings take place. One will be the requirement for a klystron amplifier. The klystron is expected to provide a more stable output signal than existing ASR's (including the ASR–7) which utilize magnetrons (radar transmitter tubes). The klystron will be much more reliable than magnetrons. It will have an operating life of more than 20,000 hours—10 times that of magnetrons.

Tied in with the ASR–8 production program is FAA's work on a new ASR antenna, which will employ a dual-beam passive horn. In operation, this will result in the addition of a beam positioned just over the conventional beam. FAA's objective in sponsoring development of the dual-beam antenna and the ASR–8 is to lessen the problem of ground clutter and to improve the detection of small general aviation aircraft flying at low altitudes. Other advanced performance features will be included in the production ASR–8, Roth states.

The new ASR–7 and the later ASR–8 will work in conjunction with the Air Traffic Control Radar Beacon Systems (ATCRBS) already in use at most U.S. airports

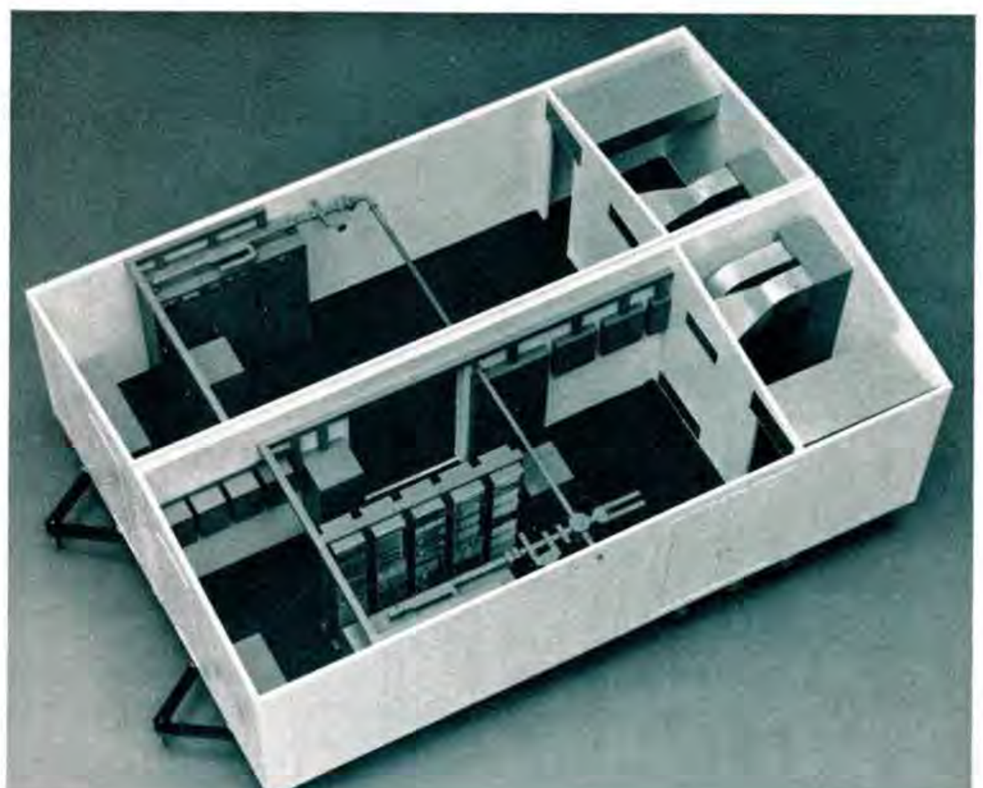
Learning the intricacies of the ASR–7 radar installed at Dallas are (left to right) Wayne Mattern, Columbia, S.C. Airways Facility Sector, Joe Arguello, instructor from the FAA Academy at Oklahoma City and Virgil Mills and Clarence Rogers, both from the Lexington, Ky., Airways Facility Sector.

to provide information to the new ARTS III automated radar terminal system which FAA is just putting into service.

Summing up th philosophy behind procurement of the new surveillance radar equipment, Roth declares:

"One objective is, naturally, to make life a bit easier for our air traffic controllers, especially with the constant buildup in air traffic. But our real purpose in designing and acquiring all of the advanced electronic equipment is to enable the air traveler to reach his destination safely and on time."

Model shows equipment configuration after two ASR–7 vans are co-located and bolted together. Radar channels A and B will operate at most terminals through a common antenna. The 10-by-40-foot vans can be moved when necessary by truck or aircraft.



CUE HAS NOTHING TO DO WITH SHOW BIZ

Computer message looks like this (left) to William D. Kinzie, controller at the Indianapolis Center, shown at the keyboard of the Computer Update Equipment console. If message shown on the screen is correct, it is entered into the computer merely by pushing a button.

On the Broadway stage, when an actor gets his cue, he knows the next line of dialogue is his. At the nation's en route air traffic control centers, the controllers are also getting their CUEs.

The CUE's being acquired by the FAA are known as Computer Update Equipment. Technically and financially they represent a comparatively small portion of the central computer systems now being acquired to make air traffic control procedures more efficient.

When the Cleveland Center received the first NAS Central Computer Complex in December 1966, it marked the inception of an extensive FAA program to use as much automation as possible in air traffic control. Since that time, the number of air route traffic control centers using basic computer systems has risen to 14. At these 14 ARTCC's, the computers process flight information and distribute the data to the traffic controllers.

First center to receive the CUE subsystem was the Washington Center (in October 1969). By June of 1971 CUE's will also be installed at Jacksonville, Chicago, Indianapolis, Boston, Los Angeles, Fort Worth, Kansas City, Oakland, Denver, Houston, Seattle, Atlanta and Minneapolis. Before the end of 1971, CUE's are due to be in operation at the remaining six ARTCC's—at Miami, Albuquerque, Memphis, New York, Salt Lake City and Cleveland.

Essentially, the CUE subsystem is a typewriter keyboard attached to a small, rectangular message display (which is used to display answers to controller questions). Associated with these two basic components are a quick-action keyboard (which serves to alert the computer system to an upcoming "conversation") and a high-speed printer.

Using CUE to pick the computer's brain is a simple assignment. The traffic controller, for example, may want to inform the computer that a flight will be arriving later than scheduled. He may seek to tell the computer—and other controllers—that it was advisable to reroute a flight because of turbulence or that the aircraft involved had to climb or descend from its assigned altitude to avoid other air traffic.

Once the controller types out his message or query, it is temporarily stored at his position and written electronically—letter by letter—on the rectangular screen. This provides the controller with an opportunity to review his message for accuracy and to make certain it says exactly what he wants it to. Once he feels the message conveys his ideas, he pushes the entry button. The message is then erased from the viewer and transmitted to the computer.

If the answer is needed immediately, it is sent either to the small screen or to the high-speed printer.

Without the CUE system, the controller's access to the computer complex and his instructions or queries must be handled manually by intermediaries. These intermediate steps not only require additional time—which is always at a premium in controlling aircraft—but also introduce the possibility of error. Changes in flight information which might require several minutes to get into and out of the computer without CUE can be handled almost instantaneously with Computer Update Equipment.

CUE provides the traffic controller with better information more quickly because the computer system in a large traffic control center can store and instantly recall more than two million letters or four million numbers. In the time it would take a piston or turboprop transport to fly across a 100-yard football field at 300 miles per hour, the computer could perform more than 100,000 calculations.

A CONTROLLER LOOKS AT ARTS

By Philip F. Jones
Controller, Atlanta Tower

The author *of this article, Philip F. Jones, is an ARTS-qualified GS-13 journeyman controller at the Atlanta Tower. Jones, 31, attended Athens, Ga., High School and North Georgia College, then served a four-year hitch in the Navy as an air traffic controlman at the former Naval Air Station in Sanford, Fla. He joined the FAA as an Air Traffic Control Specialist in October, 1962 and was assigned to the Crestview-Oskaloosa, Fla., FSS. His other experience before coming to Atlanta in July of 1968 included four years at the Daytona Beach Combined Station-Tower and more than a year at the Jacksonville Tower. He therefore is thoroughly familiar with both "pre-ARTS" and ARTS operation and recently received an outstanding rating for his proficiency.*

I hope I never have to control traffic again without ARTS.

Occasionally, it's necessary for ARTS to be taken from controllers temporarily requiring us to go back to the "old way" of controlling traffic. What a difference!

Without ARTS, controllers are always under greater tension and pressure. We must rely on mental association and repeated communication with aircraft to make sure the planes we're controlling correspond with observed blips. Sometimes controllers exchange information across the room via the intercom. There's a lot of flight data to be kept in mind, particularly when controlling several aircraft.

Controllers' eyes are constantly moving back and forth from scope to flight strips. In the interval between a look down at the strips and back to the scope, there's always the chance of temporarily losing track of a particular target, especially if the controller has a number of aircraft in trail. So he must get positive identification, through voice communication, a time-consuming process.

With ARTS, it's an entirely different matter. Controllers no longer have to keep looking down at flight strips and back to the scope—all the data is right there on the scope. This data appears on a small alphanumeric tag that travels right along with the blip representing the aircraft. There's absolutely no chance for mis-identification since each tag is unmistakably attached to the appropriate blip.

And there's no need to communicate verbally with other controllers to get data on other aircraft. With ARTS, this is done without a word being spoken. When I see other targets on the scope for which I need information, a flip of the quick-look switch can show me any radar position in the room. The tags tell me all I need to know—and there's no need for time-consuming conversation and no possibility of misinterpretation.

Symbols on the tags indicate whether the blips represent arrivals or departures. Numbers and letters denote flight number, beacon code, altitude and ground speed. If I want to know where any aircraft I'm tracking will be in a minute from now—or two, four, or eight minutes from now—I activate a control on the console and that information appears in the form of an extended line.

Using the proper modes, the beacon system—an integral part of ARTS—has a capability of simultaneously identifying over 4,000 different aircraft. The beacon system also provides altitude information direct from the aircraft transponder.

Data on scheduled airline departures and arrivals is fed into the computer several weeks in advance. Thirty minutes before each arrival and ten minutes before each departure, the stored data appears automatically in alphanumerics on the appropriate scope.

Information on flights whose data are not stored in the computer—such as non-scheduled or general aviation flights—is obtained through voice contact, and fed into the ARTS system by punching it out on an alphanumeric keyboard similar to a typewriter keyboard.

Aircraft handoffs between controllers within the facility are completed without a word being spoken. When a plane is being handed off, a conspicuous dotted line appears alongside its blip. Using the track ball to bring the bright slew dot over the target causes the dotted line to disappear, signifying radar contact and acceptance of the handoff. This totally eliminates verbal exchanges between the receiving controller and the handoff controller.

Without ARTS, there's more strain . . .

and the chance of briefly losing a target.

With ARTS, all data is right on the scope,

so time-consuming tasks are reduced, and

control decisions and skills increase.

It's far better than the old system.

ARTS relieves the controller of a number of time-consuming tasks, freeing him to make vital control decisions. It also gives him time to make observations that improve his skill as a controller—such as rates of climb and performance of various types of aircraft.

The advantages of ARTS are sharply brought home to controllers when the system is suspended for "debugging," program changes, or other reasons. Recently, it was discontinued for about ten minutes while I was controlling seven aircraft. It was back to the flight strips—and I had to concentrate about three times as hard under the old method.

ARTS gives controllers the ability to handle a much greater volume of aircraft without greater difficulty. I certainly wouldn't want to go back to flight strips and quick glances.

ARTS III Partial List of Operational Dates*

10/71 Chicago-O'Hare

2/72 Philadelphia

3/72 Washington National, Boston, Detroit, Denver, St. Louis, Pittsburgh, Cleveland, Minneapolis, Seattle/Tacoma

4/72 Miami, Honolulu, Santa Anna, El Toro Marine Corps Air Station

5/72 New Orleans, Cincinnati

6/72 Houston, Las Vegas, San Diego, Miramar Naval Air Station, Columbus, O., Indianapolis, Dulles International, Norfolk

7/72 Oklahoma City, Tinker AFB, San Juan, Los Angeles

8/72 Kansas City, Dallas/Fort Worth, Love, Phoenix

9/72 San Antonio, San Francisco/Oakland, Memphis

*These dates are not necessarily for commissioning. The need for additional space will involve some TRACON relocations, such as Los Angeles, into larger quarters, adding to the time of operational readiness before commissioning.

Atlanta Tower's IFR room as it looked during the "early days" of the introduction of ARTS.

ARTS also stands for . . . .

A Real Tough Struggle

When you talk about ARTS' "early days" you go back less than a decade, but a bunch of fellows in Atlanta will tell you, "Those were real pioneer times, pardner."

You can count the members of the exclusive "Atlanta ARTS Club" on the fingers of both hands. But what they lack in numbers, they made up for in dedication and concentration. This handful of technicians remembers back when ARTS was little more than a welter of concepts, theories, ideas and goals. And these ARTS "old-timers," hand-picked by the agency from sectors in various parts of the country, are still fairly young in years.

For example, Roger E. Blythe, an ARTS Technician in Depth who got in on most of the early developmental efforts, is only 37. The others, for the most part, are in the same general age bracket.

Besides Blythe, ARTS "pioneers" include Charles T. Bauman, H. L. (Joe) Anglin, Walter M. Ferguson, Kenneth A. Wood, Charles H. Coburn and Gerald H. Spikes.

"These fellows certainly deserve a lot of credit and recognition," said Monroe Harrison, the present chief of the Atlanta maintenance hub. Harrison wasn't among the early ARTS developers in Atlanta, but one of his predecessors—Fred Loundes—was. Loundes was sector manager in Atlanta when the ARTS project was launched there.

The technicians have received a group citation for what was undeniably an outstanding job of translating the faint stirrings of a research and development effort into a highly sophisticated air traffic control system.

Harnessing modern computer technology to the demanding job of controlling air traffic didn't happen overnight. And it wasn't easy. A veritable jungle of difficulties, problems and uncertainties faced the small Atlanta group when it was handed the ARTS project for field development. It was true that they were buttressed by representatives of large major computer firms who would furnish the hardware, but these representatives were themselves just getting started in this complex new field.

ARTS came into being through a grueling process of trial and error. "No sooner did we get one problem solved than we had to tackle another one," Coburn recalls. "We just kept doggedly at it. At times, we got so absorbed in working out ARTS problems that we lost all track of time. We wouldn't want to quit when

Associated with the early development work on ARTS at the Atlanta Tower are these Airway Facilities employees (from left) Charles T. Bauman, Roger E. Blythe, Fred Loundes, H. L. (Joe) Anglin, Walter M. Ferguson, Kenneth A. Wood and Charles H. Coburn. The photo was taken shortly after ARTS was introduced and most of these employees are still at Atlanta.

we were making headway."

Techniques never applied before had to be developed to get the job done. "For example, the slew ball on the radar console wouldn't work right," Spikes said. "We found a way of fixing it. Another major problem we tangled with was getting the proper registration of alphanumeric tags on the radarscopes. We had to work out a process for reducing the letters so they were sharp and readable. It had us all baffled at first, but gradually we licked it."

Initially, controllers were somewhat skeptical about ARTS, Blythe recalls, and had to be resold on its merits after each bug was eliminated. This is all in the past, of course. Now, it's like pulling teeth for ARTS technicians to "retrieve" the system for program changes or debugging.

"You can build all the little black boxes you want, but they're not worth a dime until the controllers accept them," Blythe says.

Despite the long hours of grappling with complex electronic problems, members of the group were virtually unanimous in declaring they derived tremendous personal satisfaction out of the job of perfecting ARTS. One member said he got special satisfaction from the fact that Atlanta sector personnel demonstrated they were able to maintain the ARTS system after it was developed.

ARTS "old-timers" aren't relaxing now that the spadework on the system is about completed. They are taking an active part in the job of seeing that the system functions smoothly. The evolutionary process of technical refinement goes on. And they're looking to the immediate future—the time when ARTS will make possible automatic handoff of traffic between centers and towers. Automatic metering and spacing of air traffic looms on the horizon.

"When you look at the job these men have done, it makes you proud to be associated with technicians of their çalibre," Harrison said. "And I'm talking now about everyone who has played or is playing a part in the ARTS system."

DIRECT LINE

This is your direct line to the top! Your questions will get answers. Here are the ground rules: all questions must be signed, the column should not be used to take the place of formal grievance and appeals procedures and questions should not be operational or technical matters. Send your questions to DIRECT LINE, FAA, 800 Independence Ave., S. W., Washington, D.C. 20590.

Q. Upon entrance into Government work, I did not know the value of Standard Form 57. I completed the form accurately, but without detail. Is it possible to submit a revised form to include numerous items of prior experience, responsibility, and management and completely replace the original form, or is there a better procedure?

A. You may, at any time, submit a revised Personal Qualifications Statement (SF–171) for inclusion in your Official Personnel Folder. Complete this form (a replacement for the SF–57) and forward it to your servicing personnel office with a note asking that it be placed in your file. Every time there is a significant change in your qualifications (training, education, and/or experience), submit an SF–172, Supplemental Experience and Qualifications Statement, or a whole new SF–171 if you prefer. Your original SF–171 (or 57) will remain a permanent part of your official personnel file.

Q. In my facility, trainees on duty at night do not receive night differential payments. We start getting this premium pay only when we become operational. Is this legal?

A. Yes. Under the Government Employees' Training Act, there is a general prohibition against the payment of premium pay (overtime, night, Sunday, and holiday pay) to employees assigned to training. Agency officials directly concerned with training programs and the selection of employees for training, may assign employees to training during overtime, night, Sunday, or holiday hours when clearly dictated by the urgent needs of the agency. This may be done even though employees will not receive premium pay for those hours. The Civil Service Commission has authorized a few exceptions to the above restriction (Section 410.602, FPM Supplement 990–1). The agency will make full use of authorized exceptions to the restriction when they are clearly applicable. (Reference 3550.10, Section 8.)

Q. I am a GS–5 teletypist at a flight service station. Why was my position not upgraded when the controllers at the facility were?

A. All positions are classified in accordance with standards issued by the U.S. Civil Service Commission. Each standard recognizes differing grade levels based on the complexity and difficulty of work. For air traffic control specialist positions, one major factor in determining complexity and difficulty is the volume of air traffic. Thus, as volume increased, the controllers in your facility were reclassified in accordance with the standards. A similar volume relationship is not recognized in the teletypist standards, and therefore your position was not affected.

Q. What is the FAA position on "coffee breaks?" What regulations are applicable?

A. The FAA has issued no official policy on this matter. It is, however, general practice in most organizations to authorize brief periods of rest twice during the working day.

Q. I received a four-day suspension. One of these days was a holiday. This does not seem fair, since I received, in effect, an extra day of suspension since I could not be paid for the holiday or given another day off in lieu of the holiday. Do you agree?

A. Yes. In fact, corrective actions were ordered in February to reimburse you and any others who may have been similarily penalized by having a suspension bracketed around a holiday.

Q. Eligibility for a Quality Step Increase Performance Award includes substantially exceeding one's performance standards for a period of at least six months. If an employee is rated on his EAR, Part II, block as EXCEEDS REQUIREMENTS in all Key Result Areas–does this mean he has substantially exceeded such according to the foregoing criteria?

A. Not necessarily. Performance which warrants the rating of "exceeds" does not automatically meet the "substantially exceeds" criterion. A supervisor who believes an employee has earned a Quality Step Increase must submit written justification showing how, in the supervisor's judgment, the employee has substantially exceeded the performance standards for the past six months *and* certify that he expects the performance to continue at that level. The key is the supervisor's judgment based on identifiable activities that support that judgment under the review of higher management.

IT STARTED AT JACKSONVILLE

Being first has its element of pride and its share of headaches—whether it means being at the top of the American or National League in baseball or serving as the pioneer automated air traffic control center for the Federal Aviation Administration.

At the Jacksonville, Fla., Center where FAA has installed the prototype of the National Airspace System En Route Stage A as the forerunner of an automated system designed for all 20 continental centers, the pride is evident. But so are the problems.

"We realize it is a tremendous responsibility," says James E. Pound, chief of the Jacksonville Center, "but the controllers consider it an honor to run the pilot program and they have been doing a great job."

Hardware, in the form of the IBM 9020A central computer complex, began arriving at Jacksonville in June 1966. The final piece of equipment, the Systems Maintenance Monitor Console, reached the installation in March 1969.

"We had our share of delays getting into operation because all of the equipment didn't come in at the same time and some deliveries were delayed because of the higher priorities for military equipment for use in Vietnam," declares A. S. "Gus" Hall, chief of the NASPO field office in Jacksonville.

The Florida center's development program has been moving forward in two specific areas:

- Automatic Flight Data Processing, which involves accepting and storing aircraft flight plans, printing and distributing flight plan information, calculating and updating flight data and transfering the data within the center and to adjacent centers.
- Radar Data Processing, which provides automatic tracking, flight information in the form of alphanumeric flight data blocks on the scopes of the air traffic controllers and automatic radar handoff.

According to Roy C. Sheppard, data system officer, the Jacksonville Center is particularly proud of its work in flight data processing. "Our controllers were skeptical at first," he reports, "but since October 1969 the program has received almost unanimous praise.

Heart of automation at Jacksonville is this intricate computer complex—a scene not unlike that at other centers throughout the country as the NAS Stage A en route system is implemented.

Today our controllers keep asking for more assistance from the computers."

Just how important and helpful those computers are to the men in the Jacksonville Center is evident when the automatic flight data processing equipment is shut down for maintenance, repair or development work during light traffic periods—after midnight and on weekends. "We usually hear loud protests when the controllers have to fall back on their old mainstay, manual flight progress strips," Sheppard indicates.

The automated system is currently in use 16 hours a day from Monday through Friday but the traffic controllers have told Jacksonville Center officials they would prefer to have it remain in service non-stop, seven days a week.

The desire became a partial reality on two weekends in February as the Jacksonville Center prepared for extraordinary air traffic—tied in with the Daytona 500 auto races and the Apollo 14 moon shot.

With automatic flight data processing, much of the routine and drudgery has been removed from air traffic control. Once a pilot files his flight plan by telephone from a flight service station or an airline or military operations office, or once flight data is augmented by the U.S. Weather Bureau, the flight plan is fed into the computer at the center.

The computer then takes over the humdrum assignment of distributing the information to all the controllers along the plane's flight path.

To Ernest L. Webster, a journeyman controller at Jacksonville, the system is a tremendous improvement. "I don't have to make as many phone calls and do all the manual passing of information down the line. Before automation, I had to call the next sector to give the controller update information and he would have to do the same for the next controller. Now the computer handles all of the update information and life is a lot easier."

As an aircraft passes through a sector handled by an automated air traffic control center, the controller updates the flight plan by "typing" the data on a key-

Controllers at work on newly-installed equipment during early phase of implementation of NAS En Route Stage A at Jacksonville Center.

board input to the computer and checks the accuracy on a readout panel. The characters are written in alphanumerics electronically. The controller then corrects any errors in his information and punches the "enter" button. The computer assimilates the information, adds it to the flight plan and sends the revised package to the next center.

At the receiving center, a print-out machine automatically types on flight strips information which tells a controller where the plane is, its altitude, its destination and the points it will fly over en route to its final destination.

Being first with the prototype does not mean that Jacksonville Center will be the first to receive production versions of the NAS Stage A automated equipment. FAA plans call for Jacksonville to continue work with prototype units until June 1973 even though delivery of production equipment will begin to other centers in 1972.

Aside from the advances for the air traffic controllers, the Jacksonville Center has also witnessed an expansion (from 40 to 115) in the number of airway facilities technicians. Four men from Jacksonville were among the first 14 technicians to be taught Stage A computer techniques at IBM and at the FAA Academy in Oklahoma City.

They have returned to Jacksonville to form the nucleus of a group of technicians capable of maintaining three different methods of operation around the clock—flight data processing equipment, radar data processing and the traditional manual system.

Says George B. Leonard, AF sector manager, "The introduction of automation equipment here at Jacksonville has sharply increased our workload. We have to maintain three different types of computers, including the Central Computer Complex, which by itself is large enough to handle all the transactions on the New York Stock Exchange and still have computer time to spare. The changeover to automation has been a tremendous challenge for the technicians."

Meanwhile, the number of visitors who want to see

All 20 FAA air route traffic control centers are scheduled to receive automated equipment to handle the growing fleet of airline transports and general aviation aircraft under the National Airspace System En Route Stage A project. Prototype has been in use at Jacksonville Center since 1969.

IBM 9020 system console is checked out in the data processing section of the Jacksonville Center by George Leonard, Airway Facilities chief, and Wilbur R. Smith.

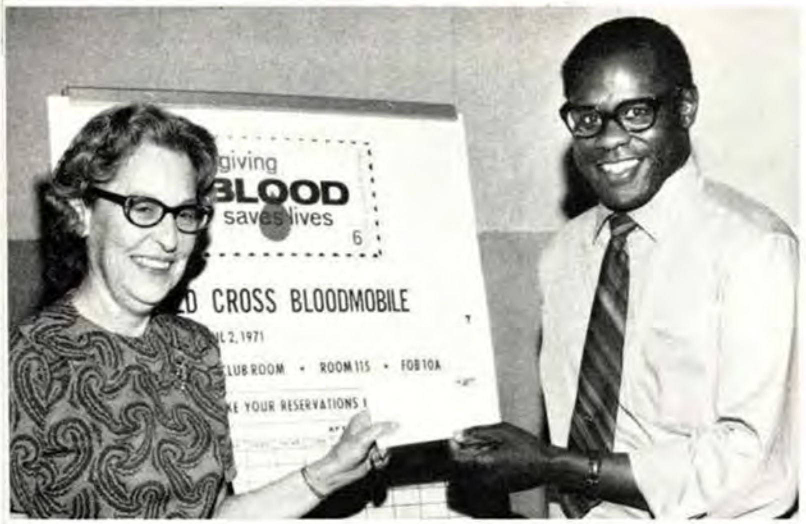
the nation's first civil automated center is constantly growing. After talking to the technicians and controllers, the visitors discover the total dedication and enthusiasm the men at Jacksonville feel for the NAS Stage A En Route Program.

Learning to operate an automated center has brought the men at Jacksonville their share of headaches. But they are truly proud of their achievement and this pride will be transferred to the other 19 FAA traffic control centers beginning in 1972.

FAA FACES & PLACES

DEANS RETIRE—Stanley E. Beaver, with the longest continuous agency service (since 1925), was FSS communicator at Youngstown, Ohio Municipal Airport. Charles M. Carnes, making "goodbye-for-now" call, was tower chief there 24 years.

HAIL TO THE CHIEF—Sounds like a man's name, but Gene Sims has been named to head the Cuyahoga County Tower, near Cleveland. She's an ex-Marine sergeant and the first woman to be made a tower chief. Proven ability got her there.



FIRST DAY ISSUE—Cancellations of the special six-cent blood donor's stamp were given to all donors on Red Cross Bloodmobile Day at FAA Headquarters, where 91 pints were collected. Wanda Kirkpatrick, co-chairman of the FAA blood donor program, presented the tribute to electronics engineer Reuben Powell.

PAT ON THE BACK—Denver FSS Specialist Pruett B. Helm receives recognition and a certificate of honor from the First Lady as the DOT/FAA "Outstanding Handicapped Employee" of the year. In a separate ceremony, Administrator Shaffer also presented Helm with a plaque and certificate honoring outstanding work despite a severe handicap.

ADVERTISING ARTS—The license plate (custom ordered) on Howard Burch's car says he works with the agency's ARTS program at the Atlanta Tower.

IT HAPPENED IN MONTEREY—Controller John L. Skinner gets an Outstanding Flight Assist Award from Leo Yuckert, Monterey tower chief (left) for saving a pilot from an imminent crash into Skinner's office. The pilot took off with full flaps extended and went into a stall attitude. The plane was headed out of control towards Skinner's office when he radioed the pilot to dump flaps, lower the nose and return over the runway. Plane and pilot landed safely.

WORKSHOP SESSION—Some of the 28 Accident Prevention Specialists who completed a recent course at the Aeronautical Center in "Developing Personal Effectiveness" were (from left): Ray C. Raney, Southwest Region; D. Copadis, Eastern Region; Joe Harrington, Central Region; William J. House, Jr., Education Specialist; Rene Cardona, Southern Region; Paul S. French, Eastern Region; John J. Karp, Southern Region and Herb H. Schaff, Southern Region.

SURPRISE PIN—A ruby 30-years of service pin from Paso Robles, Calif., Flight Service Station Chief Barra L. Boyte (left) catches controller Lynn E. Scott unawares. Scott began his career in 1937 as an Army radio operator. He served 16 years in the Southwest before coming to Paso Robles.

POP AND PILOT—An Airline Transport Pilot certificate which Frank Walley, III (center) earned three months earlier is presented to him on his 23rd birthday by his father, Frank, Sr., an air carrier operations inspector at New York ACDO, while facility Chief Richard Kleinert (right) looks on. Young Walley had to wait until he attained the minimum age.

MINORITY RECRUITMENT ENCOURAGED—Use of a "smoke hood" in a post-crash aircraft fire is explained by Ernest B. McFadden, Chief, Survival Equipment Branch, Civil Aeromedical Institute, to placement officials from Southern minority colleges touring the FAA center in Oklahoma City. At far right is Herbert Scurlock, FAA's Equal Employment Opportunity chief.

HEADS-UP DISPLAY—Under evaluation at NAFEC, this all-weather instrument approach equipment over test pilot William Stephens' head projects flight information through the glass plate in front of him. With the system, a pilot on instrument approach sees the runway immediately upon breaking into the clear without shifting his eyes.

FAST WEATHER INFORMATION—Students from Albuquerque's "Freedom High" watch EMT specialist Jimmy James make adjustments to an Automatic Data Interchange System (ADIS) high/low tape converter in the teletype room at the Albuquerque FSS. They toured FAA facilities in connection with their studies of aviation. The aviation class is taught by ATCS Ed Dover.

We call the little things that mean a lot...

THE CREATURE COMFORTS

All of us appreciate good lighting, attractive surroundings, improved acoustics and good chairs to sit on. Here's the heart-warming box score on ever-increasing FAA creature comforts—and they're getting better and more comfortable.

Walls and ceiling are tinted light tan. Gold carpeting covers the floor, complemented by the buff and tan consoles. Sound-absorbing material girdles the room. The low ceiling is layered with acoustical tile.

Long air ducts, nestled behind four rows of purring consoles, quietly sap the heat out of tubes, connections and motors.

These pleasant surroundings at the Cleveland Air Route Traffic Control Center typify the agency's modernization and construction program, begun in 1969. Environment specialists, interior decorators and human engineers have been hard at work benefitting the eyes, ears and nerves of employees in centers, towers, flight service stations and maintenance and administrative facilities.

More than $41 million has already been ploughed into center automation wing construction, several telephone company and cafeteria wing expansions and the Cleveland control room, with modernizing all center control rooms yet to come. Funds are available to complete these modernizations; however, funding for eight new radar rooms and seven relocations hinges on forthcoming Congressional appropriation. Money is available for 54 new control towers. Plans for fiscal 1972 call for four new towers, relocation of 20 old ones and modernization of more than 40 others. Also projected is relocation and modernization of eight domestic and international flight service stations.

Among the facilities that got a head-start in the current improvement program was the Cleveland Center.

"One of our biggest problems was noise," said Cleveland controller Glenn Cullen. "When traffic was heavy, you could hear a lot of talking, echoes and background noise. Even pilots sometimes complained that they were picking up the racket on their radios."

"The heat used to be pretty bad," recalled Constantine Limber, another Cleveland controller. "Once we measured the temperature near the radar sets and at the watch supervisor's desk. It was 93 for us, 73 for him. We'd sit there with our ties undone and would have liked to have worked in our T-shirts. Since the room was rebuilt, there's been less than a three or four degree difference across the floor—it's a lot more comfortable."

Ten million dollars have already been spent on noise reduction at agency facilities. "And there's continuous research going on aimed at still further improvements," said Ed Richardson, chief of the Industrial Hygiene Branch in the Office of Aviation Medicine.

Controller Ken Wolfe in Cleveland is among those gratified by noise reduction. "To me, it's a tremendous improvement," he said—quietly.

The thrust for expansion and better working conditions has grown out of the agency's own technical progress and the hyper-thyroid growth of commercial and private aviation. Flight control operations have more than doubled at the 20 traffic centers in the last 10 years. Air traffic has doubled at airport towers. Activity at flight service stations has nearly tripled.

Detrimental effects of the technological cascade were reflected in a 1969 report by the Research and Development Service:

"Technological progress, unfortunately, almost always adds new sources of noise, eye strain and tension to the already impressive accumulation of distractions. Constant use of radio communications and the steady grind of computers and automatic typewriters have created serious acoustical problems."

Today, studies and improvements continue in air conditioning, radar scope lighting, floor coverings, headsets, microphones, tower glass and shades, and even sunglasses.

In the radar room of the Washington National Air-

Modernization at the Washington, D.C. tower produced this tangle of obsolete chairs consigned to the surplus property custodian. They've been superseded by the new chair, authorized for all air traffic control facilities.

Standard chair for FAA's Air Traffic Control Facilities provides beefed-up structure and cloth-covered seat for hours-long stint at the controller's console. Older, plastic-covered chairs were uncomfortable and contributed to skin problems.

A new working environment—such as is shown above—is coming into being at FAA computerized facilities.

Ring out the old. The Los Angeles, California, Flight Service Station, circa 1967, provides all the necessary working tools, but lacks modern appointments and convenience. The facility now occupies new redesigned quarters.

Among the Nation's most modernistic Flight Service Stations is the Miami International Flight Service Station shown here. Automation and a better working environment are in store for these facilities.

Less than a year ago, the Cleveland Center looked like this—modern equipment and competent men, surrounded by greying walls and ceilings, drab colors, and noisy, reflective floors.

A clean sweep of uncluttered space in the new Cleveland Air Route Traffic Control Center stretches below the glass-enclosed visitors' balcony. Air ducting (center) draws hot air pockets away from the working positions. Similar ducting is tucked behind the consoles on either side.

port tower, used as a "guinea pig" for such studies, Jim Krantz looked up from his scope and remarked on improvements: "Before the changes were made around here, I was almost embarrassed to show people where I work."

Now there are fabric-covered chairs and glowing plastic panels and strips to illuminate radio frequencies and other vital information. There is also a rich red carpet and noise-dampening materials on walls and ceiling. New air conditioning prompted this appreciative comment from controller "Butch" Freed: "Now the radar room seems more like an office than a furnace." Coffee is brewed and food eaten in a new lounge, not in the radar room as before.

A track-mounted radar screen in the tower cab shows air traffic in a narrow range, allowing controllers to get critical information with a glance upward, instead of a contortion backward to the screen's former location.

In the glass-walled control tower cab, green-tinted roll-down shades shield controllers' eyes against the sun's brilliant glare on the nearby Potomac and its riverside runways. Soundproofing cuts noise which bounces off the special glass. The air conditioning, however, still has to struggle to conquer the blazing heat of a sunny summer day.

Not surprisingly, at least one improvement at Washington National led to a new problem. The attractive red carpet in the radar room produces static electricity. Until adequate humidification is built into the air conditioning, frequent spraying of the carpet with water remains the only way to hold down snapping blue sparks which sometimes travel an unpleasant route along a controller's headset.

In Miami, many intractable problems have been swept away in a single stroke. A gleaming new building houses the country's busiest domestic flight service station.

"Space was our biggest problem," said Miami specialist Bill Ross. "There simply wasn't enough and the floor plan was poorly arranged in the old building. There was too much internal traffic. Now, I'd say the station is ideal. We've got plenty of space and the floor is well-arranged. The inside is roomy with good visibility and it's very accessible to pilots."

"We can display all our airspace now, which we couldn't do before," added specialist Paul Duey, pointing to a huge board. "We've got almost a complete wall here for weather and flight information. It's an edge-lighted sheet of clear plastic, and information marked on it with colored grease pencil shows up bright as neon. The presentation is better, pilot understanding is improved and our specialists don't have to refer to nooks and crannies all over the room to provide a full briefing."

Subdued lighting accents wall displays and apparently adds the unexpected advantage of hushing the staff, according to Assistant Chief Bill Brown. "We have about 20 operating positions in one room. At first we were worried about combined noise. It hasn't happened," Brown said.

Murray Smith, chief of the Facilities Systems Division in the National Airspace Program Office (NASPO), said the environmental thrust will continue unabated.

"We're going to modernize and expand our center facilities to cover agency needs through 1980," he commented. "A piecemeal, year-by-year, start-and-stop approach just won't do. More is at stake than mere practicality. FAA employees are entitled to be proud of the place where they work."

Environmental systems, even in equipment rooms, are being designed to cater to the needs of people as well as machines.

Quieter. Cooler. More attractive. Cleaner. Machines and people work best in such an environment. But machines don't have to get up in the morning. . . .

The New FSSs

The Flight Service Station and the International FSS at the Tamiami, Fla., Airport is housed in a distinctive new building.

A new glassed in wing, resembling a tower cab, and automated flight planning services are in the cards for a number of Flight Service Stations.

The modernization program is getting underway at NAFEC where a life-size mockup of a "dream station" is being built.

FSS expertise from the field is being called upon to plan the mockup and when the stage-set facility "goes operational," specialists from the field will be called in to test and evaluate the plan in real-life situations. Although the mockup will be used to plan large, busy stations, it is being constructed in such a manner that components can be used to plan stations of any size.

When the mockup is approved, a field prototype will be built to check the feasibility of the plans on a day-to-day basis in the field.

By use of the mockup, various plans for modernizing a station or building a new station can be evaluated. It will be configured to house the latest state-of-the-art communication equipment, including improved ground to air communications systems, better interphone service within the station and improved direction finding equipment.

Also to be tested are various noise suppressant materials—such as carpets and acoustical tile. Various configurations for positioning equipment will be tried out in order to further reduce the noise level.

Automation equipment also will be built into the mockup. Several uses and packages are currently being studied. At this stage there are definite plans to test a computer than can retrieve and display weather and flight plan information. A flight plan also could be filed through the computer and sent automatically to the pilot's destination.

With this kind of equipment, the specialist can call up all the information a pilot needs for a given flight on a TV-like screen merely by pressing the appropriate buttons or typing a code on a keyboard.

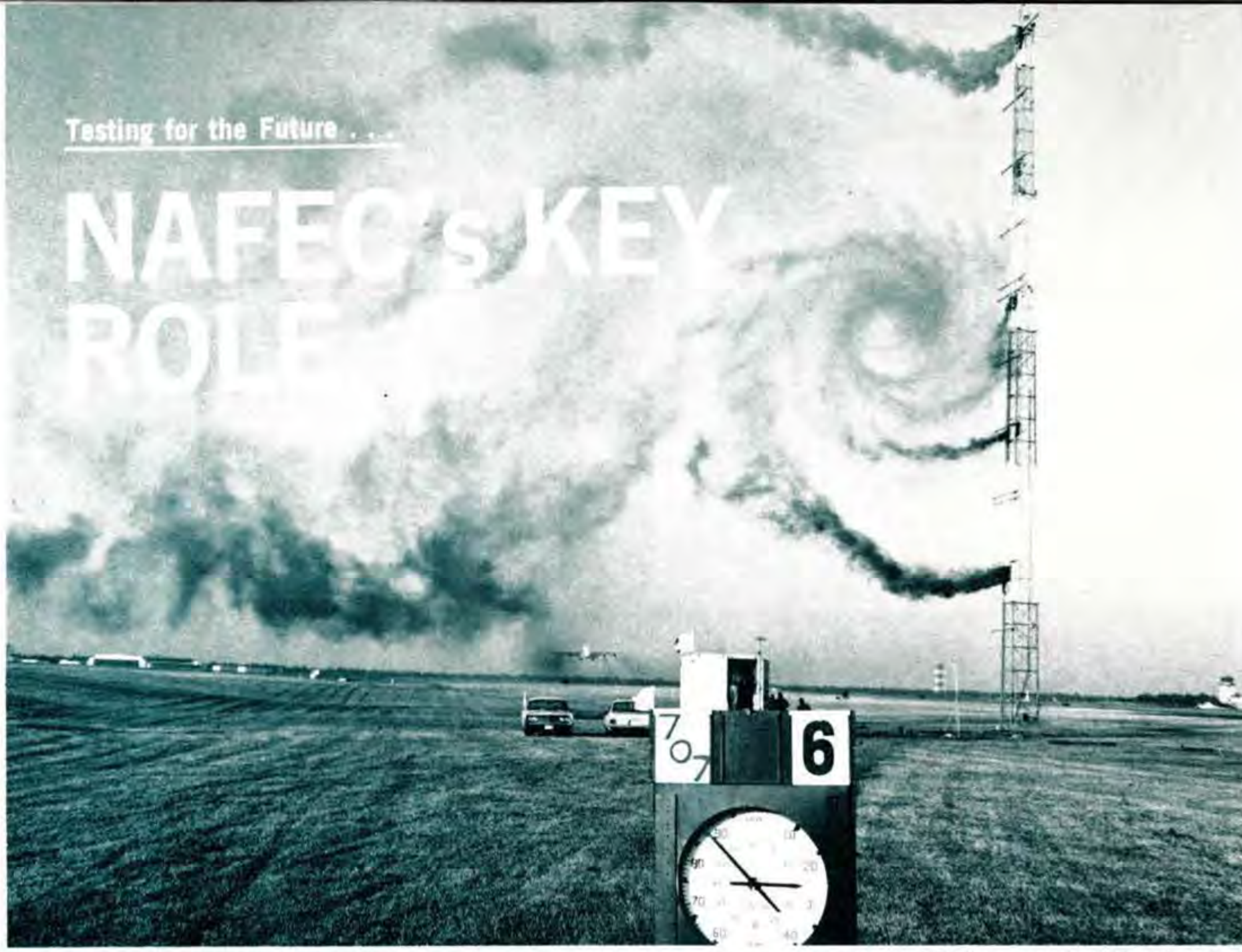
These are some of the improvements being looked at in NAFEC to make sure the agency's oldest service facilities continue to be an integral part of the total air traffic system.

Acoustical material on the ceiling and walls and carpeting on the floor substantially reduce the noise level in the new Flight Service Station at the Tamiami, Fla., Airport.

Night-time Airport Advisory Service is provided by specialists at the Tamiami FSS. Low consoles in front of the big windows give specialists an unobstructed view of the field.

Testing for the Future . . .

NAFEC's KEY ROLE



Color from smoke grenades is used at NAFEC to measure wingtip wake vortices after a Boeing 707 has passed within 50 feet of the tower. The clock indicates that 25 seconds after the airliner passed, dangerous turbulence awaits the unwary plane to come.

Projects never before possible at the National Aviation Facilities Experimental Center are now under way in its new Digital Simulation Facility. These include work on a Collision Avoidance System, Automated Radar Terminal System and controller human factors studies.

To get the real feel of NAFEC, one can't begin to catalog the 210 test and evaluation projects generated by Systems Research and Development Service and by the National Airspace System Program Office. One could interview several dozen program managers and turn out a Tom Swift-like library on the amazing items being "wrung out" to promote aviation safety. Some 1,800 FAAers in 150 occupational specialties have a hand in projects described in about 100 technical reports published yearly. Much of the work implements the NAS En Route Stage A System.

NAFEC is in high gear to meet the challenge of forecasted aviation growth in the next decade, under the leadership of Center Director Cecil A. Commander. But, iceberg-like, what you see on a quick tour is but a fraction of the work underway. Some of what you see will be proven and be a contribution to the system and some will be disproven—that's the mission of the vast 5,054-acre complex at Atlantic City Airport.

Inside the building complex, Public Affairs Officer Edwin Shoop pointed out batteries of area housewives operating radar target generators. With the new Digital Simulator Facility, each can "fly" five planes as easily as one. In another part of the building, 18 developmental controllers brought in for three-weeks of training work traffic in 10 sectors duplicating Cleveland and New York Center sectors.

"Because of vastly increased air traffic flows," Shoop explained, "developmental controllers can't fully utilize real-life scopes, so they train here and return for only 80 hours of additional on-the-job training. In this way, they can qualify much quicker for check-out to a higher grade."

In another room, Research Psychologist Ed Buckley, Controller Frank Willett and Cameraman Ernest Reid were completing the last of three 60-minute black and white films of radarscope traffic. The films will be used at Oklahoma City to give aptitude tests to potential controllers, since spotting conflicts on a screen will quickly provide a measurement of innate skill.

We also saw the revolutionary 11-sided tower cab mockup that will be used when Dallas-Fort Worth Regional Airport opens in 20 months. Project Manager J. Roy Bradley pointed out that two separate teams

Eleven-sided tower mockup is used at NAFEC to develop equipment configuration in project headed by J. Roy Bradley (far left). Giant tower cab will be ready when airport of tomorrow opens 20 months from now, in April 1973, with runways 8 and 9 miles long and a separate team to control traffic for each.

High-speed motion pictures (at 500 frames per second) record tests of several configurations for occupant restraint of belts and harnesses proposed for general aviation fliers. Dummies in fuselage are catapulted to a stop at 25 Gs in aviation safety studies.

Simulators depict individual aircraft "flown" by Atlantic City area housewives to generate radar traffic duplicating air traffic control problems. Developmental controllers elsewhere work the traffic in ten sectors duplicating parts of New York and Cleveland Centers. —*Photo by Thom Hook.*

will man the cab—one for the nine-mile-long runway and another for the eight-mile-long runway parallel to it. Bradley also showed us the prototype for 54 VFR six-sided towers designed for three-man operation, for which Congress has appropriated $10 million. NAFEC is also working out better control console arrangements.

Driving around the airport, we saw the tall tower used in last spring's accelerated test program to measure characteristics of wakes generated by large aircraft. Colored smoke grenades made the deadly vortices visible as the test jet flew close by. Films recording the tests were analyzed and data published. Devices to detect the presence of these invisible "upsetters" are to be tested at NAFEC this summer, and a study contract to determine feasibility of a turbulence prediction system is to be let at the same time. Valid separation standards were established after hundreds of flights were made at NAFEC.

Not all NAFEC work is airliner-oriented, however. On our way around the airfield perimeter, we spotted an electronic gear-packed trailer. Project Manager Bill Sullivan and a crew were working on a new pilot warning indicator for general aviation. The device was pointed at a light on the tower 4,500 feet away and signals picking up the infra-red radiation were being recorded in the trailer. Their tests will find whether the device, mounted on small airplanes, will help safety by keeping a pilot from overrunning another aircraft in the pattern, thanks to the warning light flashing on his panel.

Further along, Shoop pointed out the economy approach light system for general aviation, a system now approved for the Airport Development Assistance Program (ADAP). We also examined NAFEC's test set-up for developing data on a variety of seat and lap belts and shoulder harnesses to improve survivability in crashes. Life-like dummies are catapulted to a sudden stop at nearly 25 times the force of gravity. High-speed films are made of the tests, at 500 frames per second. Unofficially, work seems to indicate stiffening of fuselages, and retrofit is possible on belts supplementing the normal lap belt.

Far off the end of an airport runway we saw test stands for Instrument Landing Systems, where tests are being conducted on the STAN (Standard) 37 Experimental ILS Localizer the British are considering for all-weather use.

"For ILS, we think microwave is very promising," said Ed Shoop.

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1 *Reloading 16mm black and white film, NAFEC Cameraman Ernest Reid gets set to make a motion picture from radar scope situation programmed through the new Digital Simulation Facility. Three films, containing programmed air traffic conflicts, will be sent to the FAA Academy and used to test controller aptitudes.*

2 *Classes of 18 developmental controllers are brought in for three-week courses in working air traffic in ten sectors duplicating those of New York and Cleveland Centers. From Cleveland are (front to back): developmental controllers M. Russell Smith, Simpson P. Matthews and Instructor Richard W. Roy. Training utilizes NAFEC's Digital Simulation Facility.*
Photo by Thom Hook.

3 *Looking over a scale model of a proposed three-man, hexagonal VFR Air Traffic Control Tower are (from left): Project Manager J. Roy Bradley, Jr.; Tamiami, Fla., Tower Controller Joe Baughn; Bill Cooper, FAA Southern Regional Office, Atlanta; and Bob Shinn, NAFEC experimental machinist. Model shown is used to discuss new method of bringing stairs into tower cab.*

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He pointed out that the Modular Microwave System (MODILS) was evaluated last October. SRDS Program Manager Al Stein had indicated that MODILS is the agency's candidate for Short Takeoff and Landing (STOL) service—permitting landing with a 7½ degree glide slope as against the conventional 2½ degrees, and requiring only 2,000 feet of runway instead of the 10,000 needed for conventional transports.

"Microwave is beautiful," said Shoop. "The system has used Very High Frequency for 25 years, and it's been tough to get all the kinks out of it. Microwave is highly versatile and seems to be very promising for reliability and accuracy."

Other work in terminal navigation is the study of airports environment—where buildings can cause signal deflections and interference noise on localizer beams used by planes making instrument landings. Midway in testing at NAFEC is the Andrew Alford Traveling Wave Loop antenna, which eliminates side radiation and concentrates signal transmission down the runway center line. A by-product of this work is a handbook to be published which field engineers can use to predict signal performance in the face of known building obstructions.

NAFEC also is working on improving signals for problem VOR (Very High Frequency Omni Range) antennas. Parasitic aluminum loops are under test which surround the VOR, uptilting the signal and controlling it vertically. Also, a standard VOR antenna will be replaced next month when a stacked five bay antenna array with built-in heaters is delivered as an experimental VORTAC. This is a candidate to solve problems of snow and ice covering VOR. Later, the antenna will be tested on a 75-foot tall tower at NAFEC.

"Black box" work includes a test-bed utilizing a Collins computer to develop single-frequency communications to link the ground and the pilot. NAFEC engineers are also working on improving displaced threshold lights, a cockpit fog simulator so flight inspectors can measure the visibility or non-visibility of visual aids under varying degrees of fog and an Airport Surveillance Radar (ASR) beacon antenna for terminal and en route use that eliminates reflections and false targets.

The past research and development allocations favored in-house over industry in a 65/35 ratio. In the future industry will be doing 80 percent of the effort. NAFEC will be busy proving or disproving the technological input, "wringing out" the candidates to find those that will be adopted for the betterment of air safety.—*By Thom Hook*

Checking various indicator lights with trainees Shirley A. Butler and Sterling Foxworth is James R. Howell (right), Shift Supervisor, General Computer Operations Section.

The proper procedures for mounting input tape is explained by Harold J. Vandeslice, Shift Supervisor, NAS Computer Operations Section to trainee Gladys Bradbury.

Addressing computer trainees at the graduation ceremony is Center Director Robert J. Cannon. New operators in the front row are Gladys Bradbury, Eloise E. Beck and Bonita A. Achee.

Unraveling the mysteries of the IBM 7265 System Console to trainee Arline Spence is Dominick P. Messina, Shift Supervisor, NAS Computer Operations Section.

The computers at NAFEC are buzzing as FAAers in dead-end jobs are helped . . .

A STEP UP THE LADDER

Computer managers at NAFEC swung a two-sided sword recently when they beefed up their staff and at the same time helped employees stuck in dead-end jobs start a new career.

Here's what happened.

Trained computer operators were needed to run the center's bank of computers. There was a shortage all-around, and, of course, no one wanted the administrative computer, which cranks out the paychecks, to stand idle.

Also, operators were needed for the program to test and evaluate the 9020 used in the NAS Stage A air traffic control automation program. New operators were also needed to operate the Sigma Five computer which runs the digital air traffic control simulator.

When the number of applicants for computer operator jobs fell far short of the number of jobs that had to be filled, NAFEC managers took a hard look at their own employees. As a result a special school was set up to train and upgrade a group of promising employees.

After taking the six-month course the 20 graduates, including 13 women and 12 minority group employees, were presented special certificates to launch them on their new careers.

At the same time they became eligible for a grade raise to a GS–5 and with their new knowledge will be able to move up the ladder to the GS–7 level.

And the NAFEC computers?

They're buzzing right along, doing their thing, cranking out the payroll and helping to make air travel better and safer for everyone.

Explaining some of the uses of the data plotter is Vincent Mazza (center), Shift Supervisor, General Computer Operations Section. Trainees looking on are Joyce Wideman and Russell Turnure.

Spotlight on Airports

Airplanes and automobiles are not unlike: they get caught in monumental traffic jams, travel warily or not at all in bad weather and demand safe and certain direction at all times. Airplanes, however, are far more restricted in their choice of departure and arrival points and their pilots are far less adventurous in deciding what conditions are suitable for travel.

Traffic decongestion and all-weather flight guidance, therefore, are high on the FAA priority list for increasing airport capacity and maintaining the commitment to public safety. The agency's Systems Research and Development Service is currently engaged in an intensive series of studies and tests aimed at these goals.

Recognizing that rising costs and rapid development of land complicate the seemingly simple solution of constructing new runways and airports in or near cities which have dense air traffic, SRDS is studying new concepts in airport design that will safely permit closer spacing of aircraft on landing and takeoff, and afford better layout of runways, taxiways and terminals. More efficient ramp and gate arrangements are under scrutiny to unclog the flow of passengers, cargo and aircraft service personnel. Dual lane runways to expedite the stream of incoming and outgoing aircraft are key features in the re-thinking of airport patterns.

To meet the requirements of larger and heavier aircraft, such as the wide-body jetliners, SRDS is determining dynamic wheel loads and their effects on existing runways. When the results are verified, the research data will be used to recommend any required alterations in runway construction.

Of particular concern to SRDS are dangerous wake turbulence and runway overshoot incidents. Smaller aircraft using the same airports as jetliners can be subject to intense air disturbances caused by the exhaust of powerful jet engines and jetliner wingtip vortices. On rare occasions an aircraft approaches the runway too high or aborts a takeoff and runs out of concrete before stopping. New runway patterns and more prudent flight operations will help to eliminate the former, while arresting nets and runway grooving—currently under study—can effectively neutralize the latter.

The agency is currently expanding the number of weather-penetrating instrument landing systems from today's total of 300 plus fully-equipped runways and others partially equipped, to approximately 635 systems by 1978. Of this total, 420 will be located at air carrier airports, 135 at air carrier secondary airports and 80 at general aviation airports.

These ILS's, which use VHF and UHF radio signals, will be superseded beginning in the late 1970s by the microwave Instrument Landing System. Under the executive direction of the FAA, a joint committee drawn from the Departments of Transportation and Defense and from NASA is working on a five-year development plan for the microwave ILS.

The precision and versatility of microwave transmission enhances ILS by:

- Providing high-integrity pinpoint signals in space insensitive to the interference resulting from dense air traffic.
- Permitting all-weather flight operations with an extremely high degree of safety.
- Serving airports where site restrictions preclude the use of the conventional ILS.
- Offering low cost systems for use at small airports.
- Extending instrument approach and landing service to vertical/short take-off and landing aircraft.
- Generating curved approaches to handle more traffic and aid noise abatement.
- Allowing closer spacing (down to 2,500 feet) of parallel runways designated for instrument flight rules.
- Offering an internationally acceptable replacement of VHF/UHF systems to meet world requirements until at least the year 2000.

FAA's several approaches to airport traffic—encompassing new physical patterns, additional landing safety measures and manipulation and outfoxing of weather and its results—promise to raise airport capacity and efficiency as aviation continues to move ever more people in a growing number of airplanes from place to place across the country.

Stretching nearly 200 feet in the air, a new $5 million air traffic control tower has started handling traffic at O'Hare International, the world's busiest airport. The TRACON room, administrative offices, equipment room, computer complex and training facilities are all housed in 25,000 square feet below ground.

Fish-eye camera lens provides an unusual view from the cab of the new tower. Old tower is almost dwarfed by the maze of aircraft in the terminal area.

A group of controllers from the Chicago Center looks on as Controller Don McCoy points to the alphanumerics on one of the new flat-face scopes in use at the new O'Hare control tower.

Maze of wiring in the equipment room is described by O'Hare Controller Tom Sacco (right) to members of his family and friends. In all, more than 2,000 persons visited the new O'Hare installation during a two-day open house.

O'Hare—Symbol Of The Future

Just before the new $5 million air traffic control tower at O'Hare International became operational in May, FAA conducted an open house to let friends and families of FAA tower personnel get acquainted with the new facility.

More than 2,000 welcomed the opportunity to learn where and how the Chicago O'Hare air traffic controllers will handle the landings and take-offs of almost every aircraft type—from light planes to 747s.

Tower Chief Dan Vacurevich feels the two-day open house was a complete success, thanks primarily to the efforts of a special employee committee headed by Don Vogel. Other committee members who planned and carried out the open house were Pete Salmon, Sylvester Vanhandel, Bob Hake, Bob Mischke, Roger Petre, Bob Pywowarczuk, Jim Rowan, Walter Rusch, Norm Oleson, Bob Wheeler, Bill Weyenberg, Chuck Worth, Bob Schwank, Jim Wulffen, Owen Weber, Ron Huffman, Jim O'Malley, Hal Shrake, Walter McCollum, Chester Anderson, Bud Yelk and Don McCoy.

The planning group for the open house was made up primarily of controllers and technicians. But the planners got substantial help from various O'Hare secretaries, wives and girl friends, who volunteered to serve refreshments to tower visitors.

Immediately after becoming operational, the new O'Hare tower also started serving as the home of the first ARTS–III automated radar terminal system to be accepted by FAA.

Building for the 21st Century

The new Lambert Field control tower, St. Louis, is 120 feet tall and since November 1969 the $1.4 million facility has been utilizing modern electronic equipment and radar indicators. Automated Radar Terminal System is slated to be installed.

New multi-purpose building for the FAA Aeronautical Center at Oklahoma City started this Spring and will be completed by September 1972. It will house administrative services (distribution, printing), data services, the U. S. Coast Guard Institute, procurement and a sizeable vending machine area.

Meeting the challenge of aviation's burgeoning growth, the agency's Ten-Year Plan calls for building 136 air traffic control towers at a cost of $56.7 million dollars in the 1972-1981 time period.

Three sky-piercing major towers have joined the score of high- and medium-density towers of the I. M. Pei-type design. O'Hare Tower, just dedicated, will be the agency's tallest structure when its ASDE (Airport Surveillance Detection Equipment) Radome goes up to 196 feet. However, Tampa International's tower cab floor (175.4 feet) will be one story above that of O'Hare (166.7 feet) if the radome isn't taken into account.

St. Louis' 120-foot Lambert Field Tower is another of those impressive concrete shafts, and like the others will have Automated Radar Terminal System ARTS–III equipment. In all towers, new equipment is reducing controller paperwork and voice communication, materially improving coordination between the control and adjoining facilities. The ultimate capability of these towers will make possible better radar vectoring, improved safety and significant time-saving to aircraft operating in their control areas.

The towers are meeting the needs of expanding airports, where buildings—such as hangars and terminals—have sprouted and obstruct the "view from the top" needed by those controlling planes. Runways also have been extended to accommodate larger aircraft and the taller, more efficient towers answer the needs of providing greater visibility.

When the Dallas-Ft. Worth Airport opens 20 months hence at its eight-by-nine-mile airport site, traffic will be controlled from a huge 11-sided tower cab, a mockup of which is being perfected at NAFEC. (See NAFEC's Key Role, Page 24.)

Prefab-type towers are also in tomorrow's picture. By July, the agency will have constructed three unique factory-fabricated towers at Owensboro, Ky., Parkersburg, W. Va., and at Columbus, Ohio. The cab floor of the new towers, factory-made by the Air-A-Plane Corp. of Norfolk, Va., is 54 feet above ground. Cabs are roomy and attractive and utilize the latest in ATC equipment.

From contract signing to "key-in-the-door" takes less than 12 months. Another tower, ready to go up at 54 approved sites is being developed by Facility Installation Service. Controllers were brought in to evaluate a mockup at NAFEC and determine living and working arrangements, consoles and the like. Procurement action has started and the VFR towers will go up during the next 30 months.

In Oklahoma City, a multi-purpose building started this spring (March 1971) and will be completed September 1972. A computer complex will be in the basement, and the three-story $7 million building to be leased annually for $825,842 will also house administrative services functions; procurement and the U. S. Coast Guard Institute correspondence course personnel.

Construction also started in March on the new six-floor building to house FAA's Western Region Headquarters. Despite the fact that it is only four miles southeast of Los Angeles International Airport, there will be parking for 559 automobiles and provision for another 180 cars to park there in the future.

These are but a few of the major structures going up now, in connection with FAA expansion and modernization plans.

Southwest Region and NAFEC personnel man a full-scale mockup of the world's largest tower cab at Atlantic City where the new configuration is being tested. The 11-sided Undecagon-shaped, 620 square-foot cab will be the first of its type ever to be used by the agency. The 180-foot tower and cab is scheduled to go into operation April 1973 when the new Dallas-Fort Worth Regional Airport is opened. The tower will cost in excess of $2 million.

Construction started this spring on a new $6,109,550 six-floor building that will be the home of FAA's Western Region Headquarters at Hawthorne, Calif. It is expected to be completed by January 1973 and the agency will occupy all but one-and-a-half floors. There will be parking for 559 automobiles.

Artist's rendering of one of three modular turnkey air traffic control towers under construction for Parkersburg, W. Va., Owensboro, Ky., and Columbus, O. Facilities are in operation in less than a year from letting of the contract, with the building being prefabricated and then installed at the site.

When the Manpower and Personnel Information Systems go into operation FAA Managers will literally have...

DATA ON DEMAND

Congress votes a pay increase stipulating various increases for the different GS grades . . . legislation is passed that alters the retirement age and length of service requirements . . . authority to upgrade a group of employees by waivers to the Whitten Amendment is granted by the Civil Service Commission.

Management has to know promptly what the pay raise will cost . . . how many people become eligible to retire . . . and how many employees are affected by the CSC decision.

These questions are fed into the Manpower and Personnel Information System (MPIS), and answers that would have taken hundreds of man-hours to find are available almost immediately.

At the same time an opening develops in the Western Region for an engineer with a speciality in power plant design. In the Personnel Office, an operator types out the job requirements on a typewriter-like keyboard positioned in front of what appears to be a television screen but is actually a cathode ray tube (CRT).

The query is flashed across FTS telephone lines to a computer in Oklahoma City, and almost instantly the screen in front of the Los Angeles operator lights up. There are 100 employees who meet the general requirements.

The personnel specialist then wants to know how many of these have worked wtih foreign governments and how many speak either French or Spanish. Again the answer flashes back on the CRT. Only seven employees meet the specific requirements.

The field has been cut down to a manageable number and the operator presses a button and the records of the eligible candidates are typed out on a hard copy printer in the Personnel Office that night.

A search that might have taken weeks is finished in only moments. Of equal importance, the information is accurate and up-to-the-minute.

Situations like this will be typical once the MPIS goes into operation in the spring of 1973. The new system will insure that all employees are automatically considered for all vacancies for which they have the basic qualifications. The long delays frequently occurring in today's personnel selection process will be a thing of the past.

Robert McGuigan, MPIS Technical Director, called the FAA's system, "the best available today and far ahead of those generally used in government or industry."

Of course, a system like this takes time to implement, but progress has been steady. This month a third generation IBM 370/155 computer is scheduled


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1 *Checking a personnel form that will be displayed on a television-like screen when the Manpower and Personnel Information System becomes operational are Harold Metcalf (left) from the Office of Budget and Lionel Driscoll, Office of Headquarters Operations.*

2 *Reviewing a typical computer command sequence are MPIS Development Team Members Ann Gettman and H. A. Watson, both of the Office of the Associate Administrator for Manpower.*

3 *Typing out a computer query on the cathode ray tube keyboard is Helen Lewis while Robert McGuigan, MPIS Technical Director, looks on. Both are from the Special Staff, Office of the Associate Administrator for Manpower.*

to be installed at the Aeronautical Center where it will be put through a testing and debugging program. Also at the Center is a hand-picked, full-time team of computer system analysts and programmers engaged in programming the computer.

Simultaneously System Managers at Headquarters, the regions and centers are working with MPIS Development Teams to develop "predefined processes." These canned routines simplify the operation of the equipment. For instance, by typing the appropriate "shorthand" code word or words, the operator can call up a specific personnel action form. This is displayed on the screen and the operator can then fill in the details on the typewriter-keyboard of the CRT.

When finished, the operator hits the transmit button and the new information becomes part of the "data base" or the computer's memory providing there are no mistakes in what has been written. If there is a mistake that can be detected by the edits built into the system, the computer will return the copy to the screen, and the error will be identified to the operator by a flashing light or some other device.

System managers are also working out local procedures governing the flow of information to the system. For example: working out the mechanics of feeding an Outstanding Performance Award into the system so that it becomes part of the employee's permanent record.

Although the system is expected to be mechanically ready to go in the spring of 1973, it will take a full year to completely load the computer's data base.

Basic information on each employee will be loaded from the Personnel Statistical System and the Executive Selection and Inventory System currently in use. But the Personnel Statistical System contains only about 25 items for each employee such as date of birth, sex and so forth. Added to these facts in the new system will be about 350 others. For instance, a training history of each employee will be included in the computer's memory.

Agency managers concerned with the program emphasize that agency employees are not being reduced to a series of numbers in the MPI system. Person-to-person consultation will continue as in the past, but unlike the past now all employees having the qualifications for a particular job may be considered.

The new system promises greater efficiency, less red tape and a taming of the "paper blizzard" that has often hampered efficient personnel administration.

It also promises that managers, with up-to-date reliable information at their fingertips, will be able to make decisions on the facts as they are today.

A QUICK LOOK AT TOMORROW

The scene: the Twenty-First Century. Unmanned space vehicles have already made landings on Mars and Venus. Non-polluting automobiles are commonplace. Television and newspapers as the world knew them in the 1970s have been superseded by facsimile devices installed in each home. Vertical take-off and landing aircraft and the supersonic transport are in regular service. Prototypes of nuclear-powered aircraft have already flown. Electronic highways move automobiles automatically and safely at 75-100 miles-per-hour speeds between cities up to 200 miles apart while the driver keeps his feet off the accelerator and his hands off the steering wheel.

Ships, trains and materials-handling equipment move to their destinations on cushions of air.

With all of these advances in communication and transportation, however, men will be required to monitor (and if necessary over-ride) the computers that make the advances possible.

To the FAA, which will be responsible for the safe operation of all the new types of civil aircraft (and civil spacecraft?) that will be in service in 2000, the next 25 years will be a period of electronic buildup and preparation.

Projections made in December 1969 by an Air Traffic Control Advisory Committee to Secretary of Transportation John A. Volpe indicate:

- A growth in the number of U.S. aircraft of all types from 136,638 in 1968 to 526,700 in 2000.
- A jump in the number of flights per year from 35.7 million in 1968 to 157.4 million in 2000.
- A sharp increase in the number of terminal area operations (take-offs or landings) from 128 million in 1968 to 519 million in 2000.
- A quadrupling of the number of planes airborne at peak hours from 12,800 in 1968 to 54,400 in 2000.
- An increase in the number of itinerant flights by all types of aircraft from 24.3 million in 1968 to 110.3 million in 2000. Included will be more than 53.9 million flights in 2000 under full IFR (Instrument Flight Rules) and 56.4 million flights in 2000 under VFR (Visual Flight Rules), CVR (Controlled Visual Flight Rules) or IPC (Intermittent Positive Control).

Obviously, the electronic equipment and manpower used by FAA in 1971 cannot begin to cope with the number of aircraft and increased aircraft operations envisioned for 2000.

There are several proposed solutions to reduce noise and increase the capacity of the nation's airports. Among them are the use of dual lane runways, closely spaced parallel runways, curved approaches based on scanning beam microwave Instrument Landing Systems, a two-step glide slope, cutting back power during climb, retrofitting four-engine jets with quiet nacelles and adding terminal automation capability to the upcoming ARTS III program by the use of command control sequencing and data link format.

To assure adequate separation of aircraft, several new devices will have to be perfected. One is the PWI, a Pilot Warning Instrument or Proximity Warning Indicator, mounted in the aircraft to show other planes in the immediate vicinity. A second is an airborne Collision Avoidance System which will not only warn of other aircraft but provide command signals on appropriate evasive action to be undertaken. Still another is a data acquisition system that provides the ATC center with identity, position and altitude information on all aircraft in a segment of airspace and then advises planes of various hazards and recommends appropriate evasive maneuvers. This system is known as Intermittent Positive Control (IPC).

Several approaches have been suggested to improve air traffic control techniques. They include scanning beam microwave Instrument Landing Systems for landing and terminal navigation, improved VOR/DME for en route and terminal navigation with wide implementation of area navigation, automatic IPC, a discrete addressed ATC Radar Beacon System that includes an integral data link, increased capability of the National Airspace System/Automatic Radar Control terminal system and a coupling of the control function to aircraft via data link.

By 2000, therefore, it is quite probable that FAA's traffic controllers will be handling aircraft movements with systems and techniques that are now merely mental concepts.

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ATC AUTOMATION GLOSSARY

*(*Obviously, no attempt is made here to include every term encountered in ATC automation—only the most common ones. To cover all the terms in depth and to go into a more detailed technical description of their meaning would require more space than is available in this publication.—Editor.)*

NAS EN ROUTE STAGE A—The term for the system of automation applying to the en route (ARTCC) portion of the total automated system.

ARTS–An acronym for "Automated Radar Terminal System." ARTS applies only to the terminal (tower and combined station-tower) portion of the automated system.

ARTS–I—The initial ARTS system which was implemented at the Atlanta Tower beginning in 1963. That ARTS system, the first to go into operation, was commissioned in 1966.

ARTS–II—This is a scaled-down, non-tracking version of ARTS–III, designed for installation at the less-busy terminals.

ARTS–III—The advanced system for terminals. This system makes possible positive identification of radar targets on terminal displays through alphanumerics. The alphanumeric presentations provide the identity, altitude, speed, range and other data on aircraft entering or leaving the terminal area.

IBM 9020–A AND 9020–D—The two basic computer units used in the national automated system. They differ only in the types of computing and storage elements, the "D" model having three times the capability of the "A." The busier centers such as Chicago, New York, Cleveland, Washington and Fort Worth will get the "D" models.

DATA ACQUISITION SUBSYSTEM—A key element of ARTS–III. It receives signals from beacon transponders in aircraft, sorts them out, converts them into a suitable digital format for computer readout and transmits them to the data processing subsystem.

DATA ENTRY AND DISPLAY SUBSYSTEM—This equipment, a component of ARTS–III, generates alphanumerics and other radar information for presentation on bright displays in the terminal control room. The subsystem has a keyboard device (see CUE) which permits controllers to communicate with the computer element.

COMPUTER DISPLAY CHANNEL—This NAS Stage A equipment reviews the information provided by the central computer complex and determines what data the controllers want displayed. It then generates alphanumeric characters and map data for presentation to the controller on the new 22-inch bright displays.

CUE—An acronym for Computer Update Equipment. The typewriter-like keyboard for CUE provides controllers with a means of communicating changes and others information to the computer.

HARDWARE—Computer equipment—the physical components of the automated system.

SOFTWARE—Computer programming—the intricate instructions "fed" to the computer in the process of telling it what job it will do.

FAIL SAFE—This refers to the concept of building sufficient capacity into the computer to assure that all functions will continue to be performed at the rate required for safe operation even though some modules may be inoperative.

FAIL SOFT—The condition which exists when failures in a computer have occurred to the extent that full fail-safe operation is no longer possible, but operation is still available on a limited basis—with less than full capability.