AERA

A FLIGHT INTO THE FUTURE

In the 1990s, air traffic controllers may be overseeing an automated system that relieves them of routine chores and makes air travel safer

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USN&WR/Chick Harrity

P: *And, uh, can you drop us down to about 2287?*
C: *No, I can't do it now, there's traffic departing beneath you: climb to five.*
P: *Okay.*
P: *Uh, just looking at it, if we could go north of the airport for a right turn into [runway] 27, it looks like it would work out better weatherwise.*
C: *We're going to try to get ya as quick as we can down . . . reference departure traffic . . . we can't do it at the moment . . . expect visual traffic pattern to runway 27 left . . . All right?*
P: *Roger.*

That routine conversation between an airline pilot and air traffic controller is repeated thousands of times each minute in an attempt to govern the growing airborne traffic over the United States. In ten years that same conversation, however, might be carried on noiselessly by computer surrogates. That, at least, is a major thrust of the Federal Aviation Administration's (FAA) current proposal to automate the air traffic control system (ATCS). Currently, the ATCS is a nationwide network of 500 airport towers and 20 inter-airport, or en route, control centers manned by some 21,000 ATCS specialists.

In one of their most essential roles, these specialists coordinate information received from a plane's pilot and transponder with the plane's image on a radar screen. In this role, a controller's chief task is to maintain a safe rate and pattern of traffic around a center's vicinity. As a consequence of this dependence on human judgment, the present ATCS is limited in its capacity not by congested airspace but by human capability.

It is little wonder, therefore, that the FAA is motivated generally to come up with a future-generation ATCS in order to deal with the anticipated 62 percent increase in air traffic by the next decade. And littler wonder still that it has responded specifically by proposing an extensively computerized scheme dubbed AERA (Automated En route Air Traffic Control). In this regard, the FAA is proceeding at cruising speed, stating in a report just released that the AERA concept is not only feasible, "the degree of automation implied can be achieved with state-of-the-art equipment" and "the system can be designed so that no aircraft would be placed in hazard by system failures."

Sound as they might like famous last words, that confident assertion on behalf of AERA is a measure of how far along it has come during the decade or so of its development. And indeed, how far along air traffic control altogether has come since the late sixties and early seventies. Consider that not until 1974 did the first ATCS computer become operational in Jacksonville, Fla. Before that time a plane would be identified by its pilot via radio as it flew over a control center. The ground-based controller would assign that plane a "shrimp boat," which was then pushed across the horizontal face of a large radar screen in correspondence with the plane's flight — a scene depicted in many a World War II movie. Now, a plane's transponder can be interrogated by a ground-based radio signal for information on a plane's identification, speed and altitude. This data block is received by a ground-based computer, which prints it onto a paper strip that is then used by the air traffic controller in conjunction with a radar image of the plane.

The full AERA concept, as it is referred to in the FAA report, is an evolutionary rather than a revolutionary undertaking. As such, it is an extrapolated, collective vision of individual computerized navigational aids already in operation or scheduled to be installed later this decade. (So grandly comprehensive has AERA become over the years, in fact, that its name is now treated as a full-fledged noun, freed of the limitations implied by its original acronymic interpretation.) But as we shall see, the full impact of AERA will not be felt until the existing ATCS computers (IBM 9020s) are replaced with larger-capacity machines sometime in 1988 or 1989.

Because AERA is an evolving concept, it must dovetail with an existing system that has certain inherent limitations. One of these limitations stems from a fundamental ATCS element called the sector. Briefly explained, an airplane that is flying Instrument Flight Rules (IFR; an airplane flying Visual Flight Rules [VFR] need not be in contact with the ATCS) is guided from airport A to airport B in large measure by a system of en route control centers throughout the United States.

A center, which handles a prescribed volume of airspace, is in turn broken up into sectors. Each sector is responsible for a certain ground area and a specified range of altitudes. These blocks of airspace are to an extent defined by cardinal rules that restrict the various kinds of aircraft (e.g., air taxis, commuters, private craft, scheduled airliners, military) to their respective domains. Thus, some general aviation traffic is restricted to altitudes below 18,000 feet, military planes have sole access to certain air corridors, and so forth. An en route center is therefore made up of various sector jurisdictions that tend to overlap and interlock like a complicated 3-D jigsaw puzzle. A plane that flies across a center's airspace is thus received and handed off by one sector controller after another.

Edmund J. Koenke, deputy director of the FAA's Office of Systems Engineering Management, told SCIENCE NEWS that if the number of sectors were to continue to increase, the numerous attendant acts of receiving and handing off would begin to strain the safety of the system. This problem is not unlike that of runners in a relay race, who know well that the trickiest part of their sport is in passing the baton without fumbling or dropping it. In realistic terms, about half of today's 1.5 verified ATCS errors per day occur within the en route centers' airspace, according to the FAA report.

"If I look at the way traffic is growing . . . the 10,000 en route controllers could easily grow to 20,000 in the late 1990s . . . ," Koenke told SCIENCE NEWS. In order to stem this rising number of sectors and controllers, Koenke says, one must increase the effective capacity of each controller to handle air traffic; one of the most practical ways of doing so is to enlist the aid of computers.

By taking over many of the basic tasks repeatedly performed by controllers today, the ground-based AERA computer system will redefine the role of air traffic controller (ACT). According to Koenke, "We're now struggling over what that [long-term] role is to be." But in general terms, it most likely will be a case in which, as the FAA report states: "The controller is the manager of AERA, evaluating situations best resolved by human judgment and utilizing AERA's algorithms to accomplish routine tasks."

Already in this regard, preliminary navigational aids in the spirit of the AERA concept have eased (arguably, since many striking ATC's maintain that repeated computer system failures have multiplied their responsibility) the ATC's burden of routine tasks.

One such aid is the Minimum Safe Altitude Warning System (MSAWS), operational for over five years. The MSAWS depends on the airspace around an airport being imagined as broken up into vertical rectangular cylinders, each with a 2-square-mile base. An airport terminal's computer is programed with the altitude of the highest known, fixed obstacle in each of those cylinders; when any airplane's reported altitude suggests to the computer that there is a potential collision with a fixed obstacle, an alarm is sounded in the controller's tower. The controller then decides on how to instruct the pilot. In New York, for example, the World Trade Center is a familiar fixed obstacle that figures prominently in the arrangement of many a flight path into Long Island's La Guardia and Kennedy airports.

Another navigational aid, this one over two years old, is the conflict alert system. Using a computer, the system extrapolates aircraft flight paths in order to ascertain the possibility of any collision courses. Once again, and this is important, only a warning is issued; the controller is left to decide the best response and to then report it to the pilots involved. Three other aids, which together with those already mentioned can be used in connection with existing ATCS computer capacity, are in line for installation at various times before the 1990s. They will redefine even further the controller's traditional role as air traffic manager and decision-maker.

The first aid is known as en route metering, scheduled to be operational sometime during 1984 to 1985. This system addresses itself to the delays routinely imposed on planes by controllers who wish to thin out congested air traffic by controlling its flow rate. The en route metering system advises controllers on how best to apportion these delays, "best" here referring to delays that keep a plane on a safe course, as close as possible to its original flight plan, and that minimize the fuel expended.

A second aid, to be installed in 1983 to 1984, is the Automatic Traffic Advisory and Resolution Service (ATARS). Simply speaking, it is an extension of the conflict alert system in that it issues a warning about a potential mid-air collision and also advises the controller as to the "best" evasive actions. This advice is usually succinct and in the form of commands: "ascend 1,000 feet" or "bank left 20 degrees."

A third aid that is foreseen but less fully developed than the first two is the so-called Electronic Tabular Display (ETD). Like the other aids, the ETD is designed to reduce the time-consuming, routine chores of the controller. Normally now, one controller in an en route facility needs to tear off the strips of paper on which the computer prints a plane's data block and to walk them over to another controller's radar screen. The ETD eliminates this by simply displaying the data blocks on a screen adjacent to the radar scope.

AERA, in the process of redefining the controller's role, also redefines the very nature of the game that is air traffic control. As Koenke explains it, because of cardinal rules that summarily restrict the various kinds of air traffic to their respective air corridors, the controller's game plan today is to "protect aircraft from airspace." That is, a controller must see to it that a plane enters only that airspace procedurally designated for use by its kind of aircraft. With AERA, however, many if not all of these procedural restrictions will be relaxed, says Koenke, because the computer's capabilities will enable the ATC to handle aircraft that are all mixed together in more complex traffic patterns. Judging from their analyses of how computerized navigational aids already have assisted the ATC, the FAA states in its report: "During the last decade, controller productivity improved by approximately 30 percent ... [and] one would expect [on top of that] at least a 100 percent improvement in controller productivity from full AERA...."

The game of air traffic control becomes one aimed at protecting airplane from airplane. In keeping with this observation, one of AERA's main features is to combine the functions performed separately by the various aids already described, to enhance their collective capabilities and to add yet other safety and fuel-saving features. Thus, for example, ATARS and en route metering will be combined by the new, greater-capacity AERA computer system to make certain that if the ATARS function advocates a certain evasive maneuver, it can be assumed that it serves as close as possible the optimal requirements of traffic flow as determined by the en route metering function.

In summary, Koenke identified for SCIENCE NEWS the four main features of the full AERA system. They are:

- **Fuel efficient route planning.** Mainly because of procedural airspace restrictions, commercial airliners today, especially short-haul flights, are often required to fly at altitudes far below that at which the plane's engines operate with maximum efficiency. By being able to relax the procedural restrictions because of increased air traffic control capacity, planes will more often be enabled to fly the efficient routes. The FAA report estimates an overall three percent fuel savings, which it estimates translates into a thirty percent profit increase for the airlines.
- **Flow planning and traffic management.** This feature centers around the en route metering function already described. This procedure will be fully automated, meaning that the system will use data about planes' whereabouts and headings to maintain a manageable global traffic flow.
- **Strategic Clearance Planning.** This feature centers around the ATARS. At the present time, airborne planes are assigned limited access to the available airspace. They are also kept apart by 1,000 feet vertically at all times and horizontally by five miles en route or three miles within a 40-mile radius of an airport tower. When AERA is fully operational, planes will have greater access to every variety of airspace and the separation minimums are likely to decrease.
- **Full automation: Tactical clearance generation and delivery.** This capstone of the AERA program will involve the installation of a black box, AERA's cockpit brain, in each plane that is to utilize the system. Not only will the on-board computer feed information about its plane's flight status, it also will communicate with the ground computer-controller on behalf of the pilot. In some planes, AERA's flight instructions will even be relayed using a voice synthesizer.

In case AERA would suddenly fail at any one of the en route centers, there are various procedures discussed in the FAA report that could be used to establish control of the airplanes in the failed airspace. In principle, these emergency procedures depend on back-up facilities (perhaps en route centers adjacent to the affected center) taking over temporarily. So that this takeover is orderly, it is suggested that at any time while AERA is operating properly, adjacent centers are kept abreast of vital control information regarding each other's airplane traffic.

The AERA program must still be reviewed before final approval by the FAA and the Appropriations Committee of the U. S. Congress, which has already asked the Office of Technology Assessment (OTA) to study the matter.

A senior analyst for the OTA study, Zalman A. Shavell, told SCIENCE NEWS that the researchers' priority now was "to fully explore the alternatives that are available to us, taking into consideration the limitations imposed on us by the present air traffic control system."

The OTA's report on a future-generation ATCS is expected in early 1982. In the meantime, Shavell expresses admiration for the FAA's AERA proposal, but cautions that any automated system of this scope bears scrutiny.

"It's like the story," Shavell says, "where airplane passengers of the future are invited aboard by a nonhuman voice that says: 'Welcome to the world's first fully automated flight, where nothing can go wrong... nothing can go wrong... nothing can go wrong...'" □