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NEW SWEDISH air traffic control center at Stockholm's Arlanda international airport is that country's first to use digital computers. Present plans call for computers to provide automatic aircraft tracking and display, as well as conflict prediction, using the Digitrac system developed by Standard Radio & Telefon AB. Military traffic controllers sit at consoles, far left, while those at right handle civil traffic.

Digitrac to Aid Sweden's Traffic Control

By Philip J. Klass

Stockholm—Sweden is applying automation techniques to the difficult problem of handling a mixture of heavy military and moderate civil air traffic in Stockholm's multi-airport terminal area. If successful, the techniques are likely to be applied to other centers.

Sweden's heavy commitment to air defense, primarily manned interceptors, and to widespread dispersal of military air bases and emergency operating strips creates the need for automation.

With three military air bases and two major civil airports in the Stockholm area, for example, there are as many as 500 aircraft movements per day and most of these are concentrated between 8 a.m. and 4 p.m. In the Malmo terminal area, near Copenhagen, there are nearly 100 military training flights in the air continuously from morning to late afternoon.

Growing traffic plus the prospect of controlling higher-performance Viggen attack-interceptors in the future has prompted Swedish interest in applying digital computers to traffic control. This is not surprising because Sweden has been a pioneer in West Europe in the use of computers for air defense operations, an application which bears some similarity to their use for traffic control.

The Royal Swedish Air Force, whose own controllers handle military traffic at consoles adjacent to civilian controllers in the new Arlanda center, 23 mi. north of Stockholm, was especially insistent that computers be used to provide semi-automatic tracking of aircraft. The traffic problem is most critical in the terminal area, where positive control is employed at all altitudes.

The Arlanda center is outfitted with two Censor digital computers, built by Standard Radio & Telefon AB, which also supplies similar machines for the Swedish STRIL 60 air defense system.

Standard Radio & Telefon is an affiliate of America's International Telephone and Telegraph Corp. The company also builds the seven controller consoles, each with a 16-in. cathode ray tube display, now installed at Arlanda. The system, including associated equipment, is called "Digitrac."

Two radars provide information on aircraft in the 100 naut. mi. diameter Stockholm terminal area, a Decca DASR-1 short-range 10-cm. wavelength set located at Arlanda airport and a long-range 23-cm. Selenia ATCR-2 situated at the Bromma airport. A wideband microwave link relays the Bromma airport radar information to the control center at Arlanda, with a narrow-band telephone-line link serving as a standby.

Controllers can select for display either of the two radars, depending upon the coverage desired, or they can display a composite picture from the two. No provision is made to compensate for the difference in slant range so that an aircraft that is under surveillance by both radars may appear as two separate blips.

The Arlanda facility serves both as an operational traffic control center and as an experimental test bed during off-hours for trying new automation techniques and then evaluating them in operational use. Basic elements of the system have been purchased by the Royal Board of Civil Aviation, but others will be contracted for only after Standard Radio & Telefon demonstrates their feasibility, according to C. A. Johansson, who directs the agency's traffic control planning.

Meanwhile, Standard Radio & Telefon is working at its own expense with an eye to the large potential market outside Sweden. Its major competitor on the continent is the Satco system being developed by Hollandse Signaalapparaten for Amsterdam's Schipol airport (AW&ST June 14, p. 169).

By this fall, Standard Radio & Telefon hopes to introduce automatic tracking of aircraft, using its Censor computer. The requirement is to track primary radar echoes, which is more difficult than use of secondary radar transponder coded replies. Sweden expects to purchase secondary radar in the near future and the system is to be capable of tracking secondary as well as primary radar returns.

A second Censor computer at Arlanda is used to store aircraft flight plans and to calculate estimated time of arrival (ETA) over fixes for printing out flight progress strips which then are distributed to individual controllers by pneumatic tube.

Later this year, Standard hopes to add automatic conflict prediction capability to the system so that the machine will compare a newly-filed flight plan with those already stored for potential hazard, according to the company's Bo Lindestram, who is responsible for system programing.

CLOSE-UP of controller position shows 16-in. cathode ray tube with area map superimposed electronically, as well as tabular display (arrow, right) which can show important flight data concerning six aircraft of interest to the controller.

Raw radar data is filtered by a digital video correlator before being fed to the controller displays and to the tracking computer to sort out noise and interference from actual targets. The correlator determines whether a received echo is random noise or a target return principally on the basis of whether a required number of echoes are received from a number of successive radar pulses in a specific azimuth-range position. The correlator uses a ferrite core memory for storage of received pulses.

The output of the correlator is in digital format, which gives the X and Y coordinates of each target, for use both by the Censor computer and by the controller console displays. The controller can, if he wishes, also display raw radar data.

The controllers will be able to generate a flight track number tag to give each radar target an identification and this tag will then remain attached as the target moves across the scope, when the automatic tracking becomes operative. To generate this identity tag and initiate automatic tracking, a controller will rotate a small ball-shaped control with the palm of his hand to position a marker over the new target. He will then enter information into the computer on the aircraft, obtained by radio or from flight plan, including such things as aircraft type, altitude and destination, by means of a pushbutton keyboard unit. This information then remains associated with that specific target and subject to call-out whenever the controller desires.

Instead of attempting to show such data on the main console display (plan position indicator), Standard Radio & Telefon gives each controller a separate tabular display which can display information on up to six aircraft at one time. The tabular display uses a rectangular-shaped cathode ray tube which can show both previously stored information on the flight and computer-calculated data such as speed and ETA at subsequent fixes.

Already operational in the console displays are provisions for displaying direction-finder lines from eight different stations to enable the controller to identify an aircraft, and vector-lines which the controller can position to measure precisely aircraft bearing and distance from an airport.

To assist the controller in vectoring an aircraft to a landing during bad weather, he can display runway extension lines from 16 stored in the computer. Runway extension lines project for 20 mi. on the scope, with range markers at 3-mi. intervals.

Another feature which already is operational is the provision for transferring control of an aircraft from one controller to another. Each controller has a distinctive hand-off pointer symbol which he aims at the aircraft, using the previously mentioned rolling ball control. Then by pushing appropriate buttons on his console, he can make his hand-off pointer appear on the other controller's console, flashing on and off to attract attention, to identify the aircraft blip on the latter's display.

The Censor computer which forms the heart of the new Digitrac system is

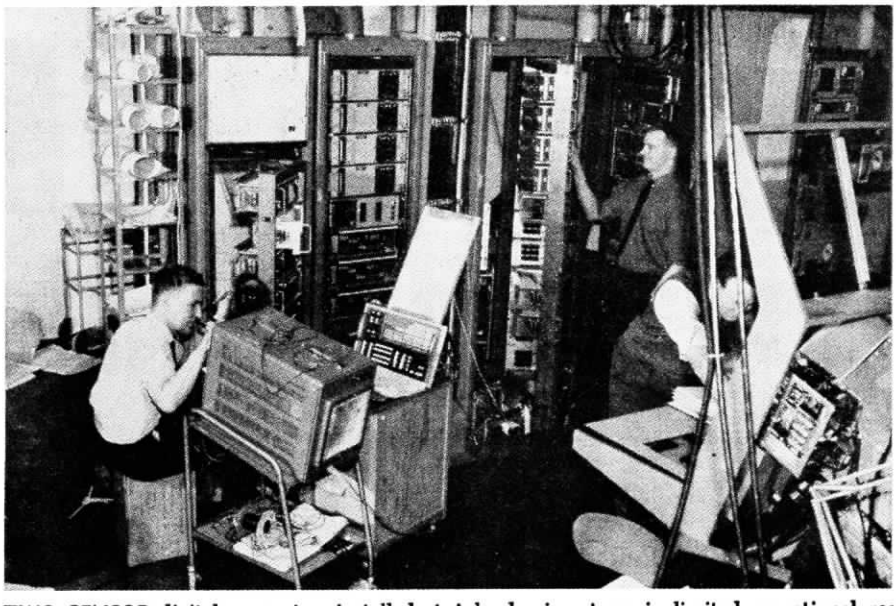
a parallel binary machine designed especially to handle real-time data processing problems, such as air defense and traffic control. It employs a random-access magnetic core memory as an internal store and has a semi-permanent instruction memory with microprograming facilities and an extensive list of micro-instructions. The machine is fully transistorized. Two are presently installed at Arlanda, one intended for automatic tracking, the other for flight plan processing and conflict prediction.

An interesting feature is a common bus line which provides a direct two-way information channel for rapid transfer of data between different elements of the system, at rates of 166,000 words per second, each 40 bits long. Any external unit, such as a controller keyboard, has essentially direct access to the system memory without having to wait until the computer has completed one of its programs. Each input and output device on the bus line has an assigned priority and each is connected to the memory in order of priority relative to others waiting for access at that instant. An external device can gain access to the memory through this priority arrangement in as little as 10 microsec. without disturbing calculations under way in the computer's arithmetic unit.

If the present Digitrac system progresses as Standard Radio & Telefon anticipates, it is expected that a similar facility will be installed at the Malmo traffic control center and another still later at Gothenburg on Sweden's west coast.

Some observers believe that the present Standard Radio & Telefon timetable for achieving automatic tracking and other advance capabilities is overly optimistic. They base this on the difficulties encountered in the U. S. in adapting air defense computer techniques to traffic control and delays which Hollandse Signaalapparaten has encountered in adding automatic tracking and conflict prediction to its Satco system.

The new Arlanda traffic control center was built and outfitted at a cost of approximately $2.5 million, including a $400,000 teleprinter switching center which automatically routes messages to their destination.



TWO CENSOR digital computers installed at Arlanda airport are in limited operational use by Standard Radio & Telefon. Engineers are testing a computer program to permit automatic tracking and conflict prediction. The two computers, similar to those built for Swedish air defense use, are fully transistorized. The computer is a parallel binary machine designed especially to handle real-time data processing problems. It uses a random-access magnetic core memory as an internal store and has a semi-permanent instruction memory.