The Role of the Touch Display in Air Traffic Control

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About the Authors

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Introduction

At the present stage of its evolution the application of automation to Air Traffic Control is, in large measure, a matter of using computers to drive or print tabular traffic displays. The current state of the art is such that much of the updating and amending of these displays has to be done by the controller or his assistant, through the computer, so that the success of any automated system depends to a considerable degree on the effectiveness of the communications between the controller and the computer. This man/machine interface is generally regarded as one of the weakest points in the Controller-Aircraft-Computer Loop.

Communication between controller and computer has hitherto relied heavily on the electro-mechanical keyboard in one form or another — a medium which may set the maximum pace at which information can be handled by the system. R/T messages normally cannot be passed to the computer in the form in which they are received but have to be converted, by the controller, into terms acceptable to a particular keyboard format. For example, items of ATC data such as aircraft callsigns may have to be coded by designating them with a letter or numeral. This conversion process is time consuming, adds to the Controller's workload and is subject to human error. Additionally, the characters/symbols available on an orthodox keyboard are limited and inflexible. These characters and the key-



Figure 1
Operator using Touch Display.

board layout have to be learned by the operator and it may take a considerable time to acquire operating proficiency. Another limitation is that the feedback from the computer, which allows the operator to check the accuracy of his input, has to be presented on a display remote from the keyboard and this may lead to problems of head movement and visual accomodation, and introduce ambient lighting difficulties.

The Touch Display principle offers the means of overcoming, or at least reducing, all of the above limitations.

The Touch Display, in its original form, was invented at the Royal Radar Establishment by Mr. E. A. Johnson, and the first evaluation of its use in an air traffic control context was carried out at the Board of Trade's ATC Evaluation Unit at Hurn in 1965/66. Since then several further evaluations in various ATC environments have been conducted at the ATCEU in conjunction with the RAF Institute of Aviation Medicine.

The advantages of the Touch Display as an input device for some ATC tasks appeared so self-evident that certain plans for including it in future systems were formulated before the evaluation trials had confirmed its worth. Fortunately these decisions have largely proved sound as the evaluations have confirmed that the Touch Display functions very efficiently as an input device and, in the main, is preferable to the conventional keyboard for most inputting tasks.

Description of the Touch Display

A Touch Display is a touch sensitive electronic data display designed to exploit the operators' body capacity in such a manner that a finger touch on an electronical contact — a "touch-wire" — produces a capacitance and resistance to earth which unbalances an inductance capacitance bridge. This produces a signal which can be used to activate a digital computer. In the version illustrated here (Figs. 1 to 3), twenty-four touchwires are arranged in four rows of six wires per row.

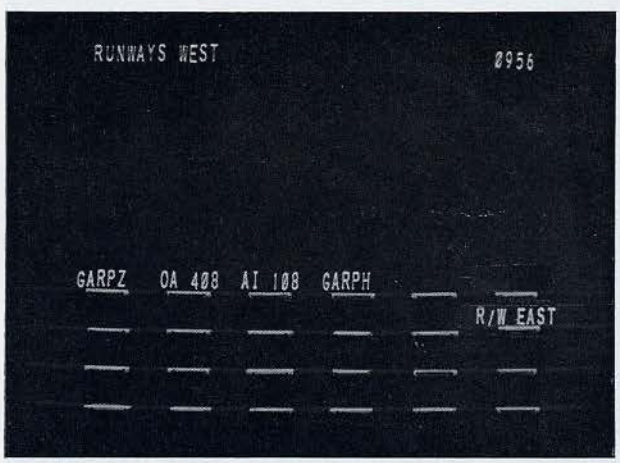
A Touch Display coupled to a computer can be regarded as a keybord, the "key" labelling of which may be varied by computer program to suit any particular requirement. In addition to the key labels, further information may be presented on the display, by the computer, as and when required. A Touch Display therefore combines the functions of keyboard and display. In other words — the input and output functions are integrated.

A simple example of its use in a suggested ATC role is illustrated in Figs. 2 and 3, and the touch display function involved are described in the captions.

Advantages of the Touch Display over the Conventional Keyboard

The first evaluation conducted by the ATCEU compared results obtained by operators using the Touch Display with those obtained in an earlier trial in which a conventional keyboard had been used in an otherwise identical operational role ("en route" Sector Radar Controller). Among the findings of these trials were the following:

1. The training time necessary for operators to reach an acceptable level of proficiency using the Touch Display is significently less than that for the conventional keyboard.
2. Most of the searching and coding problems hitherto associated with locating displayed information are avoided. Only information essential to the operator's immediate requirements need be displayed — the rest is stored but can be made instantly available when required. Information on touchwire labels can be written in full or with only partial abbreviation. This dis-



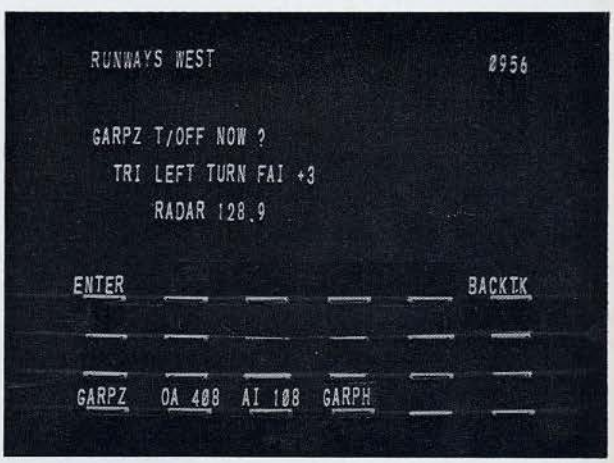


Figure 2 and Figure 3

Suggested Use of the Touch Display for Aerodromes Control.

(A method of meeting the requirement to inform the computer in a central processing complex, of the "airborne" times of aircraft departing from an aerodrome.)

In Fig. 2 (the "REST" picture) an Aerodrome Controller is presented with the callsigns of aircraft about to depart from his airfield. These callsigns have been "fed" to the display by the Ground Movement Controller shortly before they reached the runway holding point.

The take-off direction is also displayed and a digital clock appears in the top right hand corner of the display.

If the controller touches the touchwire under any callsign he will be presented with the aircraft's relevant flight data (Fig. 3: GARPZ).

When the aircraft takes off he touches the wire under "ENTER" and this action immediately informs the main processing computer of the time of take-off and initiates the necessary action to notify the "en-route" controllers of this event. The aerodrome controller's display then returns to the "REST" position — but the aircraft which has just departed will now be omitted from the list of callsigns (which will all move up to the left to "fill the gap").

Should the controller at any time wish to return to the "REST" position from the "Flight Plan" display (Fig. 3), before the aircraft concerned becomes airborne, he may do this by touching the wire under "BACK-TRK".

It will be seen that this Touch Display format also provides the aerodrome controller with the means of notifying the computer of changes of take-off direction (Fig. 2).

penses with the clumsy data line and field identification procedures necessary in some systems which use orthodox keyboards in conjunction with independent displays. Both these features effectively contribute to lightening the operator's workload by substantially reducing the search aspect of the task.

3. The operator can be "led" through any desired sequence of displays by appropriate computer programming — by presenting him with the set of touchwire labels which must be used next. (This is one of the factors which helps to reduce operator training time).
4. By showing only information directly relevant to a given input both on the display proper and on the touchwire labels, it is possible to present an identical layout on each. This avoids the problems associated with a fixed keyboard of making its layout logically compatible with the other displayed data.
5. Because the orthodox keyboard requires mechanical depression of the keys it is slower and demands more effort to operate than a touchwire system. Potentially therefore the Touch Display can provide a faster rate of input.
6. The Touch Display is silent in operation.

Perhaps the most important finding of these trials, however, was that the operators seemed to derive genuine pleasure from using the Touch Display, and all of them were extremely enthusiastic about it. This contrasted markedly with the attitude encountered in the trials using the conventional keyboard.

In a later project (North Atlantic Oceanic Control environment) operators worked at their own pace rather than at the rate set by incoming messages. The superiority of the Touch Display over the keyboard in this role was confirmed, and the trial also showed that performance with the Touch Display could be further improved by suitable computer programming designed to reduce the number of touches required to input any given message.

In addition to the updating of controllers' traffic displays, an important role to which the Touch Display may be applied is that of liaison between one controller and another, through the computer. Any system which might help to lessen the ever growing volume of ATC verbal communications — already near saturation point — cannot be lightly dismissed.

Employment of the Touch Display in the "liaison" data transfer role has been evaluated at the ATCEU in both Controlled Airspace and Middle Airspace environments and these evaluations have produced encouraging results which give reasonable grounds for optimism that the Touch Display's contribution to this aspect of ATC will be an important one. The points which most impressed those who witnessed these projects were, once again:

a) the speed, ease and accuracy with which data could be transferred and displayed;
b) the relatively small amount of training and practice needed by operators to acquire proficiency with the Touch Display;
c) less susceptibility to human error than a system relying on verbal communications;
d) the silence of the operations room.

A Note on Operator Training

Experience on a series of trials has shown that it is possible to introduce operators to the principles of using the touch display by employing books of illustrations of the various display sequences, in which the turning of a page corresponds to the touching of a wire. By this method operators can be familiarised with the way in which the touch display works and has been programmed. It is thus possible for potential operators to become familiar with touch display formats and routines without having to use the actual device itself, thus effectively reducing the amount of costly computer time otherwise necessary during training. It has been found that after such introductory training it is possible for operators to become rapidly proficient on the touch display itself.

Ergonomics

The angle of slope of the face of the Touch Display presents the most important of the ergonomic problems associated with this equipment and has been examined by the ATCEU/IAM. It would appear that an angle of between 30° and 40° to the horizontal is the optimum angle, which is a compromise between treating the Touch Display as a keyboard — when it should be nearly horizontal — and treating it as a display — when the face should be perpendicular to the operator's line of sight (usually about 60° to the horizontal for a seated observer with the display at desk top height).

N. B. The angle of the face of the Touch Display shown in Fig. 1 (62½°) although ideal for viewing purposes was found by the majority of operators to be much too steep for comfortable touching.

However, any display at 30°–40° to the horizontal normally presents considerable problems of lighting and reflections. One possible solution to this dilemma is to detach the touchwires from the display. This would allow touchwires (keyboard) and display each to be set at its own optimum angle although retaining their same relative positions in the other planes. Thus other ergonomic problems such as lighting difficulties could be largely overcome. If such a system were to be adopted, then conventional keys might be used instead of touchwires — the layout of the keys corresponding to the layout of the labels on the display above, thus preserving most of the advantages of the Touch Display principle. However there are some obvious operating difficulties in such an arrangement and these are to be examined experimentally in the near future at the ATCEU.

In Conclusion

This article has covered only a few of the possible applications of the Touch Display to ATC of the future, and everyone who has been concerned with the evaluation of this device is convinced that many other ways will be found of exploiting its latent potential. The evidence to date suggests that the touch display principle represents a major advance in the field of man/computer communications, and that it is particularly suited to Air Traffic Control. The few problems associated with its use should be overcome fairly quickly.

The enthusiasm commonly shown by those who have used the Touch Display may indicate an appreciation that the application of automation to Air Traffic Control, at least in this instance of its evolutionary progress, can help to make the controller's task an easier and more congenial one.