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ERGONOMIC PROBLEMS REGARDING THE INTERACTIVE TOUCH
INPUT VIA SCREENS IN ONBOARD AND GROUND-BASED FLIGHT CONTROL

K. -P. Holzhausen and K. -P. Gaertner

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10. Abstract A significant problem concerning the integration of display and switching functions is related to the fact that numerous informative data which have to be processed by man must be read from only a few display devices. A satisfactory ergonomic design of integrated display devices and keyboards is in many cases difficult, because not all functions which can be displayed and selected are simultaneously available. A technical solution which provides an integration of display and functional elements on the basis of the highest flexibility is obtained by using a cathode ray tube with a touch-sensitive screen. Aspects of sequential page selection for a virtual functional keyboard of an information management system are considered. The employment of an integrated data input/output system is demonstrated for the cases of onboard and ground-based flight control. Ergonomic studies conducted to investigate the suitability of an employment of touch-sensitive screens are also discussed.			
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ERGONOMIC PROBLEMS REGARDING THE INTERACTIVE TOUCH INPUT
VIA SCREENS IN ONBOARD AND GROUND-BASED FLIGHT CONTROL

K. Holzhausen and K. Gaertner

Institute of Anthropotechnology, Werthhoven (Bonn)

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Summary

/1*

Data input into a system via a screen is realized here by means of interactive touch input in communication, in which the image surface itself serves as a functional element. In addition to the standard display widely used today, the objective is also to effect an integration of the functional elements - specifically here into display surfaces. A direct interaction of the pilot with the system of air traffic control by direct touch of the radar screen is recommended in the case of the ground-based flight control with the computer-aided radar map generated without the use of further functional elements. An integrated system for data input/output is discussed on the basis of the activity of hierarchially organized menus of virtual keyboards by the constant

*Numbers in the margin indicate pagination in the foreign text.

increment and variety of onboard systems for reasons of controllability and of floor space required of display and functional elements for information management in the application of a touch-sensitive screen in the aircraft. The communication concerning touch-sensitive screens are explained, based on case studies of the ground and onboard-based flight control, and resulting ergonomic problems in the design of such systems are indicated.

1. Introduction

Modern aircraft technology and a growing density of traffic in aviation necessitate a constant further development of the onboard and ground-based system of flight control. The designing engineer finds himself subjected to restrictions in the onboard-based flight control, which are set by the spatial limitation of the available cockpit space for the placement of displays in the visibility of the pilot and for the pattern of functional elements in the reaching space. Higher demands on modern flight equipment lead, however, to a constantly growing value of information to be shown and of corresponding manual system inputs.

Allowance is made for the growing variety of display information by the use of multipurpose display systems, which offer such information on only one instrument previously distributed on several mostly electromechanical displays. The employment of screens additionally allows the possibility of also placing plastic presentations on one and the same display at the disposal of the pilot in addition to numerous symbolic and numerical information. This process is commonly designated as display integration.

The success of the display integration allows the experiment to appear justified to integrate even functional elements,

in order to save space, on the one hand, and to gain operational advantages in connection with an integrated display, on the other hand, in order to relieve the individual working flight control system. The aspect of the functional element integration can, in the opinion of the authors, also be considered advantageous in the ground-based flight control at the screen image working area of the pilot.

The functional element integration was, first of all, mainly referring to switches and keyboard keys. Examples of switch and key integration are electromechanical keyboards [1,2] and switch arrangements [3], which are integrated in blocks and in which several functional representations are assigned to each key, or to each switch. A suitable connection of concepts for the display and functional element integration brings further advantages. That is achieved by switching fields with a commutable function, whose legend can be digitally commuted. A further step of integration is done with the use of cathode ray tubes as display elements and virtual keyboards shown there as functional elements with the simultaneous use of a touch-sensitive screen /2 for the direct interaction of the operator with the system, since key fields can be computer-aided, arranged completely free and lettered here. Such a concept can be realized by employing a powerful computer system that is no problem in control towers and is also realizable today in practical operation within the aircraft.

It is especially important to suitably design the man-machine-interface from the ergonomic point of view with the opening of such versatile possibilities for information management. The design should not only take the ergonomic view points of an integration of the display and functional elements into consideration, but it must also contain interfacing software for computer system, which supports the individual with strategies,

alternatives, and controlling and monitoring programs [4].

A serious problem in integrating display and switching functions exists, for instance, in the fact that numerous data to be processed by the individual is to be read and executed on demand of a few display and key fields. A satisfactorily ergonomic design of integrated display and key fields becomes difficult in many cases, since not all displayable and switchable functions can be available at the same time. It can thus happen that functions are not exactly available when they are needed.

2. A Touch-Sensitive Screen As the Basis for an Integrated Data Input/Output System

A technical solution, which enables the integration of display and functional elements on the basis of the highest flexibility, exists in the employment of a cathode ray tube with a touch-sensitive screen image surface. As a result, it is a /3 question of a screen which can be graphically programmed with computer support and whose size should conform to the respective application. A device for the decoding of screen positions is mounted on the screen surface, or around it, which signals each screen touch to the computer system as digital coordinates. A possible technical design for the decoding of touch inputs consists of a setting of respectively alternate matrix-shaped infrared diodes designed with a photodetector, which are tested in the time multiplex as light barriers with a sufficiently compact design. If these light rays are interrupted by any one object, e.g. the operator's index finger, then this point is digitalized [5,6]. Touch inputs can be evaluated on such a screen surface as an actuation of supported virtual keys, or as simulation processes in plastic representations.

The application of a touch-sensitive screen enables the concentration of a multitude of necessary functional elements and

display devices in an integrated data input/output system. This universal device holds the advantage in the fact that the display instrument represents also simultaneously the functional element. The possible direct interaction here with the computer system obscures the difference between displays and functional elements.

The application of virtual keyboards requires the organization of relevant system switching functions in functional switch designs, which are to be stored necessarily in the case of a greater variety on "pages" and "chapters" of an "electronic book" [7]. Each page of such a book represents a functional keyboard, which is connected with the respectively pertinent display information. By "paging" in this book, the desired page can be called up or cancelled, according to the desire of the operator. In Figure 1, the initial structure of a page selection is basically shown for an information management system. The Main Dispatcher delineates the highest phase of the hierarchy, which enables the direct selection of the Subdispatcher of the next lower phase. From this point the direction leads further to the "chapters", which must be sequentially searched page by page /4 for the opening of a "page". The return from a page to the Main Dispatcher should occur only as possible, as shown in Figure 1, with an interruption via the Subdispatcher.

3. Employment of an Integrated Data Input/Output System Is Demonstrated for the Case of Onboard-Based Flight Control

To be able to monitor and to operate the numerous systems of a modern aircraft via a single data input/output system, very multifarious virtual key fields and graphic representations are used. Figures 2a and b each represent a virtual numerical and a functional key field.

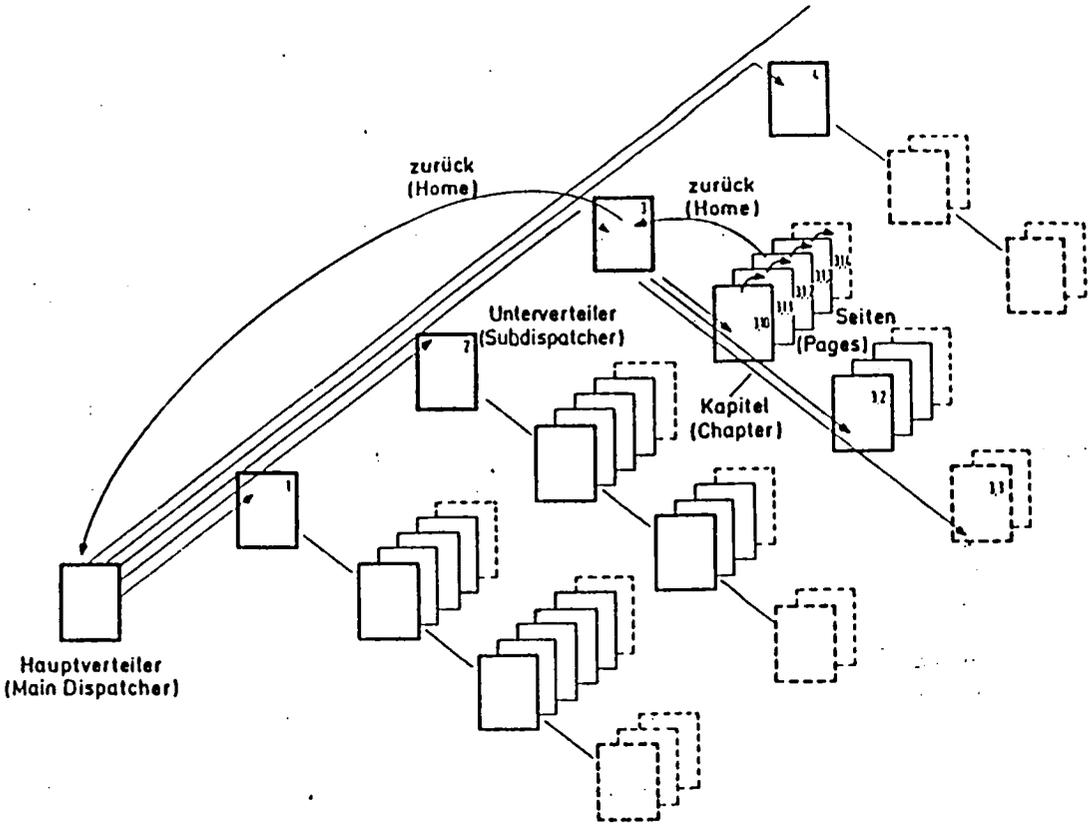


Figure 1: Hierarchical sequential page selection for a virtual functional keyboard of an information management system [7]

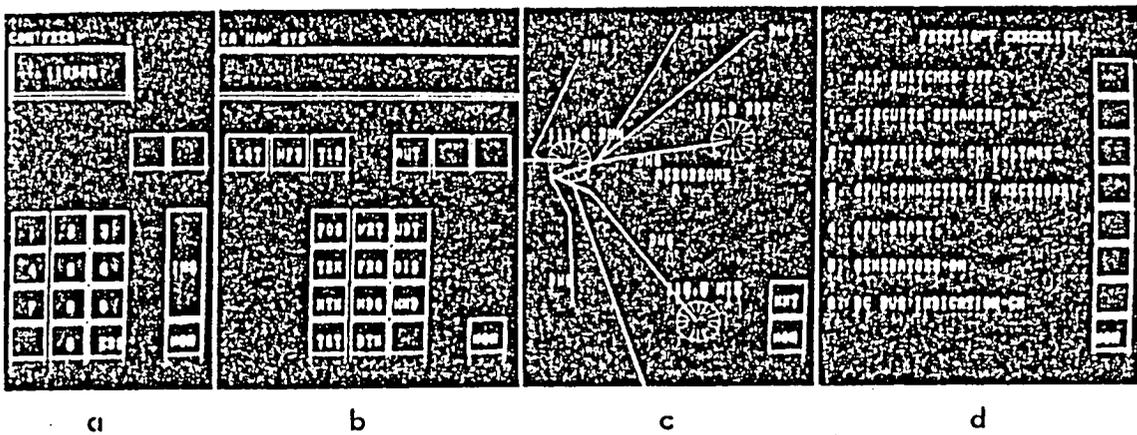


Figure 2: Application of an integrated data input/output instrument in the application of a touch-sensitive screen in the example of an aircraft management system:

- a) Data input via a numerical keyboard
- b) Functional keyboard for the mode selection
- c) Computer-monitored tasking of a checklist

Figure 2c shows the section of a map, which functions as a window. The map can be continuously shifted or stopped by functional keys. A search for controlled information as well as the expansion of interesting image details is furthermore possible. As shown in the illustration, flight path manipulations are thereby directly visible for the pilot while he communicates with the system and give him a comprehensive impression of his flight situation. Figure 2d illustrates the applicable case of a checklist. The list is searched point by point by the operator and checked off by touching the corresponding virtual key.

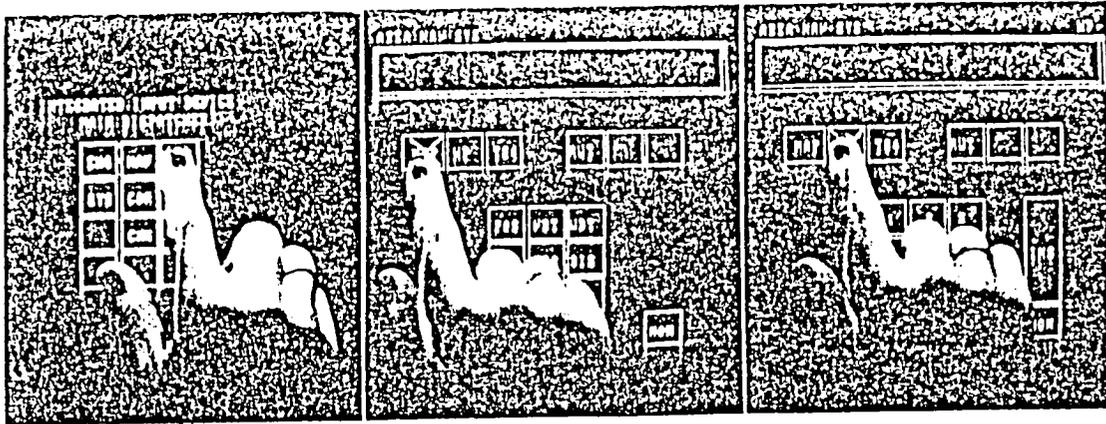
The illustrated series 3a - i is supposed to illustrate its performance with the simulated data input/output system at the Forschungsinstitut fuer Anthropotechnik (FAT) [7]. The operator begins with the Home keyboard (Main Dispatcher), as shown in /6 Figure 3a. It always returns to the location of the respective functional keyboard in this Main Dispatcher. A series of systems can be called up via key pressure. Among others, there are (Figure 3a) the subsystems Engine and Fuel Management (ENG), control of other contained Systems On Board (SYS), Frequency Option of the Navigational Receiver (NAV), Frequency Selection of the Transceiver of Radiotelephony (COM), Checklist Processing (CHK) and Area Navigation System (ANS).

The call-up and the utilization of one of these systems in the operation of a data input/output system with touch input is suppose to be illustrated by an example in the following. The Area Navigation System (ANS) of an aircraft is activated, in order to add to the programmed flight path, which consists of three defined path points, a new fourth path point. The system

simulation is based on Litton's Area Navigation System LTN 72-R [8], which is used with an electromechanical keyboard in Luft-hansa aircraft.

A small infra-red light emitting diode can be seen in the illustrations on the index finger of the operator. This is part of a Selspot System [9], with whose aid the three-dimensional movement of the index finger is decoded by a design of two optoelectronic cameras with rear-positioned digitalization electronics. This design was selected in order to be able also to implement a dynamic survey of the trajectory travelled by the human finger next to the local coordinates on the screen [10].

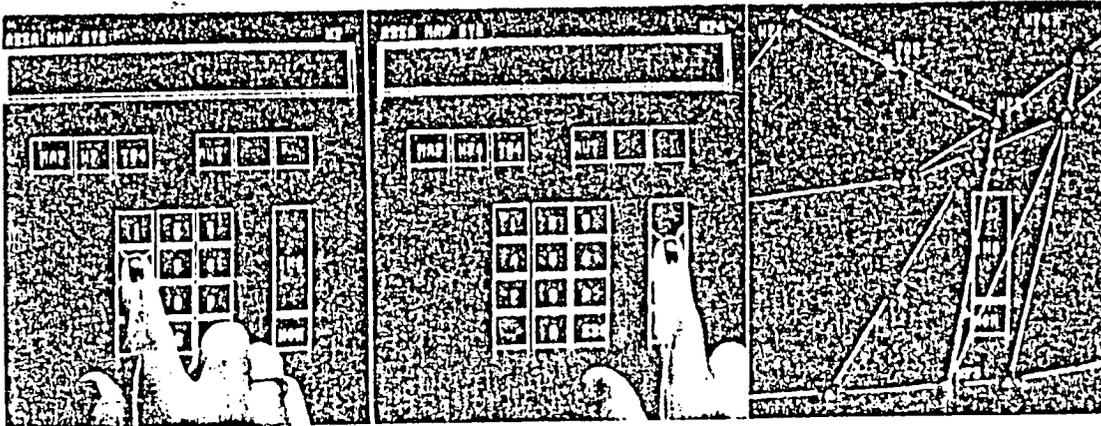
After touching the ANS-key of the Main Dispatcher (Figure 3a), the corresponding Subdispatcher appears (Figures 3b, 2b). By this method the ANS-system is selected. The display field can be seen in the upper portion of the illustration, on which the selected path point coordinates are later recorded. The six virtual keys located in the middle serve the Mode Selection and are used for the status display of the system in functional actions. The underlying functional keyboard permits the /7 selection of ANS-relevant functions. At the bottom on the right, the Home-key is always located on every "page of this electronic book", which permits the operator at all times to return from any page to the ANS-Subdispatcher and from there to the Main Dispatcher. The procedure of the path point input is demonstrated in employing the Map Mode instead of the numerical input of the local coordinates (List Mode). For this purpose the List/Map-key is, first of all, actuated (Figure 3b), in order to shift the system into the Map Mode. The key shows, subsequently, the inscription MAP in order to indicate the implemented shift. Subsequently, the path point key WP is actuated (Figure 3c). The code WP appears at the top on the right above the display field. The ANS-Subdispatcher is automatically



a

b

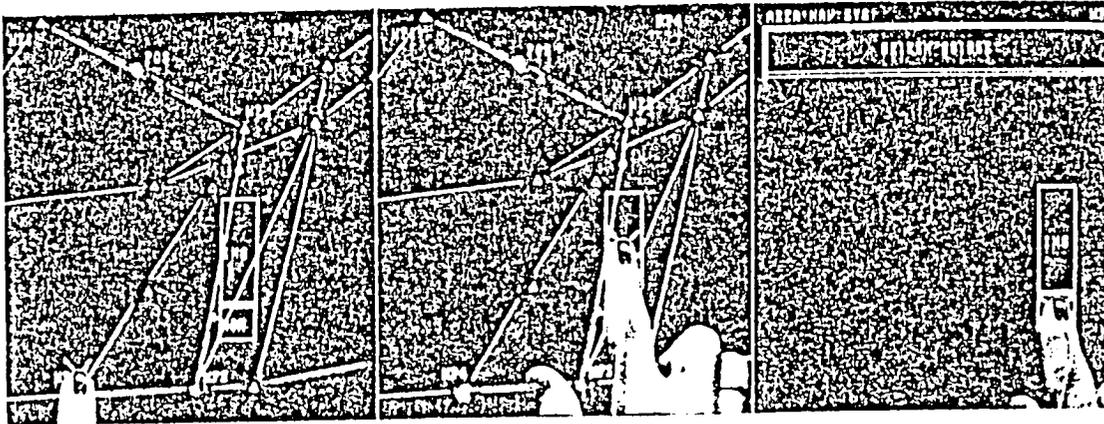
c



d

e

f



g

h

i

Figure 3: Simulation case study of an onboard-based integrated data input/output system in the application of a touch-sensitive screen

Selection of the Area Navigation System and input of a fourth path point in the flight map with control of the path point coordinates in the display field /8

replaced by a numerical keyboard to enable the input of the number of the path point to be manipulated (Figure 3d). In this case, a 4 is input, which, subsequently, is communicated to the system via the input end key INS (Figure 3e), and an entry appears on the path point key as well as across the display field. The flight map is simultaneously plotted with the preprogrammed flight plan (Figure 3f). In the next step, the pilot inputs the new path point WP 4 not yet defined in the flight plan by touching the corresponding screen position (Figure 3g). After that, the symbol WP 4 is entered by the system and the planned flight path extension is indicated by a dotted line from path point 3 to path point 4. The entry of the new path point has been confirmed by the system. By touching the Entry key (Figure 3h), the system receives this information as bindingly communicated and indicates the coordinates of the path point to the pilot in digital form for control (Figure 3i). By one touch of the Home key, the display format returns to the ANS-Subdispatcher and by a further touch of this key, returns to the Main Dispatcher of the integrated data input/output system. /9

4. Application of an Integrated Data Input/Output System Demonstrated for the Case of Ground-Based Flight Control

In the case of ground-based flight control, the requirement exists at the working area of the flight safety pilot at radar operations to recall data concerning controlled flights from the system and to communicate its decisions to the system by inputs. A summary of displays and functional elements is possible here as in the aircraft, while the entire surface of the screen is implemented as a touch-sensitive area of high resolution and thereby as a functional element. Additional corresponding virtual key fields are presented for functional selection and data input[11]. That is possible - unlike in the aircraft cockpit - since screens are generally used with a diameter of about 50 inches at air traffic control operations. /10

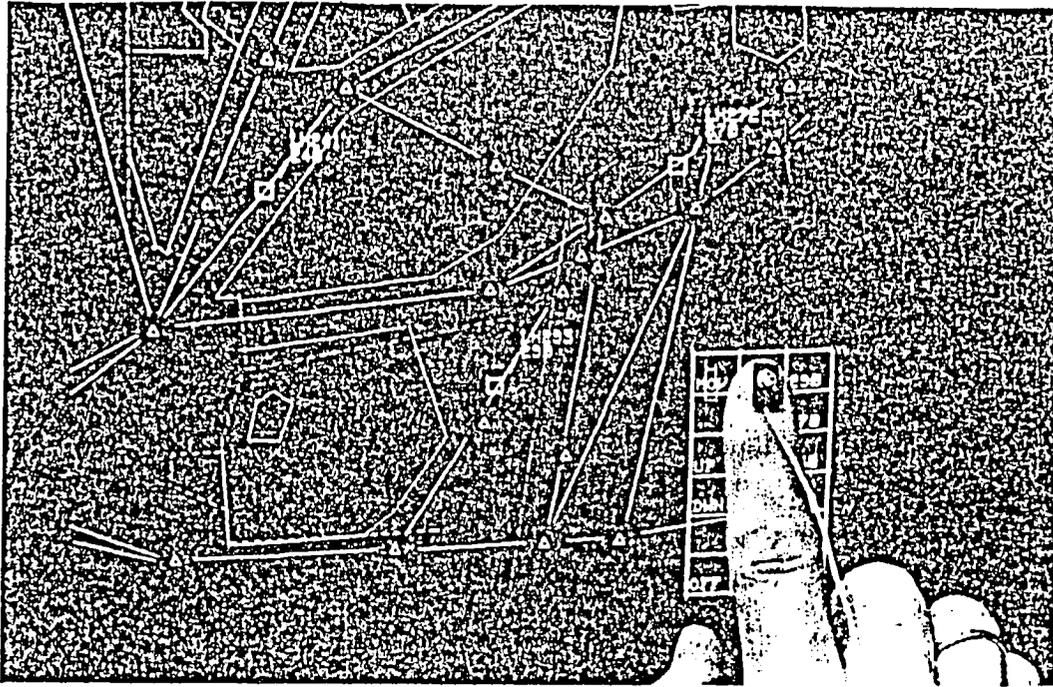


Figure 4: Simulated radar map with a virtual functional keyboard

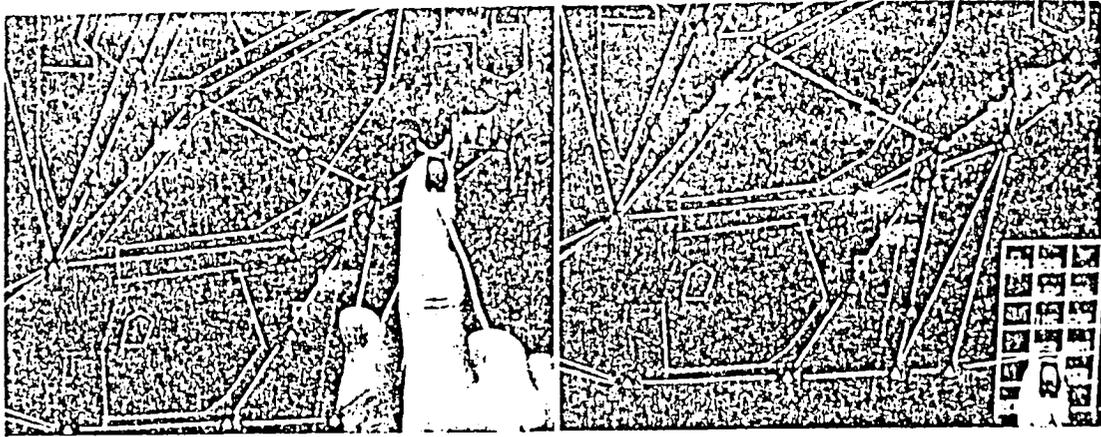
Figure 4 shows a simulated radar map and, additionally, a virtual keyboard at the lower right edge of the screen. The simulated map corresponds in simplified form to the radar map of one part of the upper air space controlled by EUROCONTROL in Maastricht over Northern Europe [12, 13].

Outside of flight paths and warning points, air restricted territories, sector boundaries and other map data are plotted. Flight destinations are characterized by symbols with appending character fields, whereby an aircraft characteristic and commanded air surface are contained in the simplified simulation. Such a radar map serves the pilots of EUROCONTROL for their work with the air traffic control system of MADAP, in the course of which the virtual keyboard was added in the simulation.

The virtual functional keyboard contributes here to the selection of a few operating methods, which are activated in the MADAP system over functional elements, or are not used by the pilot in this form. Such functions apply, in part, to the standardization of the map scale (INC, CMP, ZOM) and displacement of map segments (SCR) and, in part, to isolated flight destinations, schedule and other information in question (LEV, EXP, RER, QDM, etc.) [11].

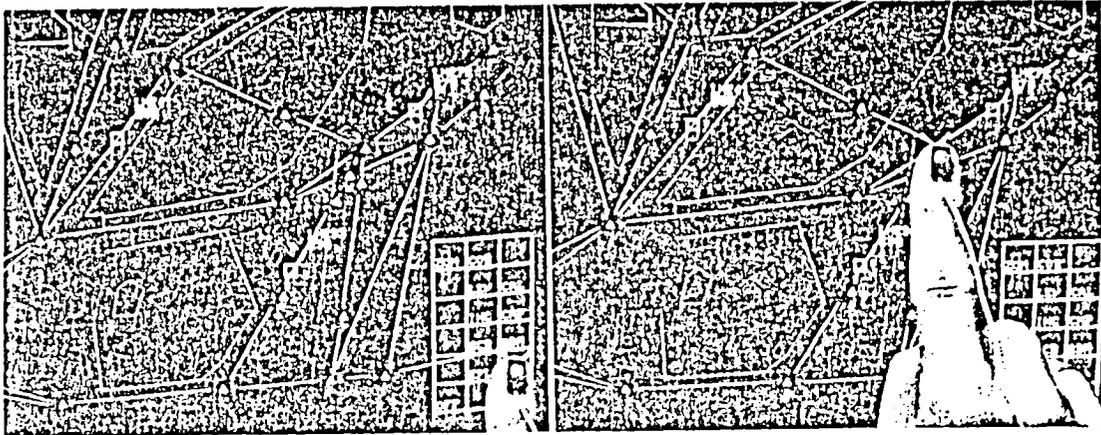
The illustrated series 5a - f is supposed to show, for example, a schedule change could be effected for a definite flight destination with a system of that kind by direct screen interaction and use of a virtual functional keyboard. Since schedules are normally transmitted by the pilot at air traffic control before the start of a flight and are input to the computer system there, they are recallable at any time by the pilot. Traffic situations, meteorological or other reasons require possibly the change of such plans during the flight.

First of all, the pilot can be issued the schedule. For this purpose, he touches the screen position, on which the flight destination symbol is located at the time (Figure 5a) and, subsequently, the virtual functional key EXP for the course extrapolation (Figure 5b). The schedule stored away in the air traffic control system is then represented as a dash-and-dot line /ll on the map (Figure 5b). The directional line dims again as soon as the switch-off key is actuated, or a new operation is initiated. Such a new operation is now the input of the changed schedule. After renewed designation of the flight destination symbol with the finger, the key RER is now actuated for the activation of the reroute function, consequently, for the new input of the flight schedule. The system now waits for the input of the new schedule by designating warning points. In the figures 5d - f, new directional corner points are keyboarded. Each new



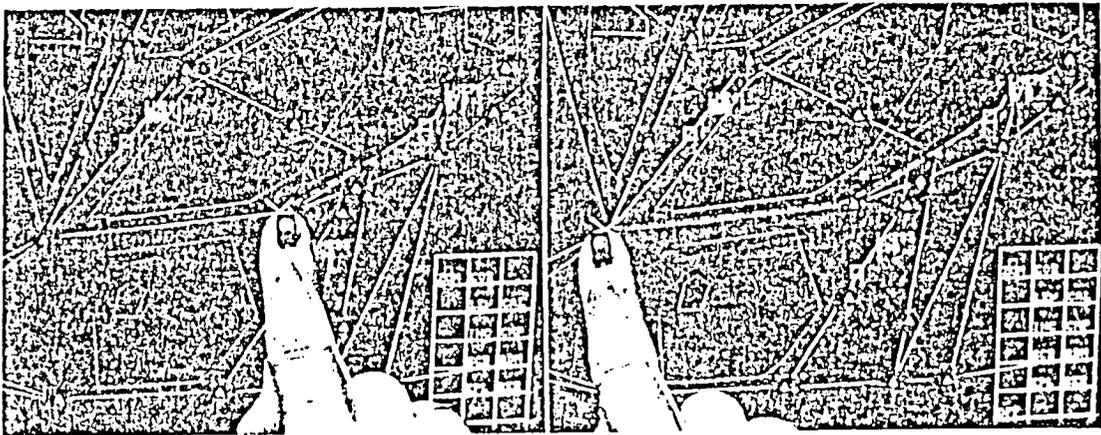
a

b



c

d



e

f

Figure 5: Simulated case study of a ground-based integrated data input/output system during the application of a touch-sensitive screen

Schedule change

/12

flight schedule automatically begins in the current position of the flight destination symbol and is plotted by a dash-and-dot line along the new planned flight path.

In the report, a film is shown for the demonstration of the touch input in conjunction with a data input/output system, which shows selected demonstrations of the interactive communication in data input/output systems in the aircraft cockpit and in the ground-based air traffic control.

5. Ergonomic Investigations and Outlook

The first anthropotechnical experiments were conducted for proof of the basic suitability of touch-sensitive screens for the input of information input into systems.

On one screen a destination range could be simulated from time to time lighting up at a non-foreseeable screen position as quickly as possible and with precision against given odds, i.e. could be reached with a cursor. A pivoting ball and a joystick as well as a radio direction finder and the touch input were used as functional elements.

The time requirements for the chosen task was practically the same for the radio direction finder and for the touch input but significantly greater, on the other hand, for the joystick and the pivoting ball. For that reason, it seems sensible to also consider the touch input for designated functions in addition to other functional elements [11].

/13

The fact to be evaluated as an advantage of the touch input is that input operations are possible at any time without previously accepting functional elements at hand. This fact always plays a part when the operator still has to safeguard a number

of other functions in addition to the inputs.

It was attempted in further experiments to establish suitable key sizes for the actuation of virtual keyboards. For this purpose, a numerical keyboard was presented to researchers on the screen, above which was located a display and an input field. The keyboard is similar to the keyboard represented in Figure 2a. In the display field a four-digit combination, beginning with a 0, appeared, which was, subsequently, to be input. The digits keyboarded for the operator were presented in the input field.

A correction key was located next to the numerical keyboard, by whose actuation the inputted digit could ultimately be deleted. The key was designed under the correction key for the continuous circuit arrangement of the experiment, by which the next combination of digits was recalled. Quadratic virtual keys were used with a lateral length of 16, 22 and 40 mm as the key size. The spaces between the keys totalled 2, 3 and 5 mm.

From time to time, 25 digital combinations per key size could be input with four experimental repetitions. There was concern with these experiments in implementing the function quickly and safely. Before the researcher began with the digital keyboarding, he had to accurately memorize the impending combination of digits. The timing did not begin until after the touching of the first digit and ended after entry of all four digits. In case of inputting wrong digits, or of touching the key extremities between two keys, a greatly increased time requirement was generally recorded for input correction.

As was to be expected after the preceded designation experiments, an enlargement of the keys from 16 to 22 mm led to a diminution of the necessary input times. Interestingly, the key enlargement produced no further time savings at a 40-mm corner

length, but rather an increasing time requirement sooner. That was apparently based on the fact that the researchers tended /14 to fully utilize the entire key field while using larger keys. Faster inputs were possible by the limited requirements of accuracy, which the researchers subjectively felt to be relaxing. This advantage was, of course, reduced by the increased times the hand moved from key to key. The employment of such large keys is only to be recommended in that case when the aspect of faster and more frequent inputs is not a factor.

The acknowledgment of key touchings for the researcher was investigated as a further problem. The operator already received visual acknowledgments via the input by delineating a cursor on the touched screen position in the simulated experiments. This kind of acknowledgment was already welcomed by all researchers in the preceded experiments and also used here. It was not valid as an experimental parameter, because a cursor is unrelinquishable in every kind of screen positioning, especially, in the application of indirect screen functional elements like the pivoting ball or the joystick. Virtual keys have again the basic characteristic of leaving out the accustomed tactile feeling as a restored signal for the methodical actuation of a key when manipulating the keys. That is why ergonomic investigations are necessary in the use of that kind of virtual key fields via alternative solutions for a restored indication supporting the functional method.

For this purpose, practically only auditive acknowledgments are suitable. The above-described digital input experiments were repeated for this reason for a series of different auditive acknowledgments: after the experimental series without acoustic input abandonment, a further series was implemented, in which each methodical key actuation, i.e. each key actuation meets without jointly touching an adjacent key with a 1000-Hz touch

tone. In case of error, this acknowledgment was absent. A further experimental series contained no acoustic acknowledgment in the case of a normal actuation, but a tone combination /15 perceived as dissonant in case of error (false tone).

In the light of data material gained by only three researchers, an effect of these different auditive acknowledgments can hardly be recognized in actuation times in the case of largely correct inputs. Somewhat unexpected, though, was the result that the touch tone was not fully rated affirmatively in the multitude of inputs. Rather, a tendency existed to perceive the touch tone to be unpleasant or even disturbing. From this, it is to be considered whether not the visual acknowledgment will suffice by the cursor dagger. A further effect resulted in an occasionally observed insignificant increment of the input times, when the touch tone was synchronized. The researchers admitted that the tone would have forced a kind of rhythmic coordination during the operation, which subjectively would be contradictory to the experimental purpose of the optimal time input and would lead sooner to a rhythmical operational execution.

The variable functional characteristics in the case of error conditions are of interest. Without a false tone, the tendency exists, first of all, to completely input the digital combinations without taking notice of wrong inputs. Only afterwards does the visual control of the input and the comparison with the display occur, after which the correction process begins. In the case of the false tone open circuit arrangement, the input process is generally, however, immediately interrupted by the operator. Because basically none of the two touched key fields is rated as input in an error operation, the operator could now immediately repeat the next display digit and the input will correctly lead to an end. As a result of the false tone open circuit arrangement, a somewhat faster execution of error-affected inputs was then to be recorded, which subjectively gave the op-

erator a greater measure of security.

Future experiments should help to safeguard discovered tendencies and to prepare investigations concerning practicable menu structures.

REFERENCES

1. de Callies, R.N., "Development of Human Engineering Standards for Multifunction Keyboard Design," Report 76 CH 1137-9 SMC, International Conference on Cybernetics and Society, November, 1976.
2. Fenwick, C.A., "Keyboard Data Entry in Avionics Society of Automotive Engineers," Business Aircraft Meeting, Paper 750 522, Wichita, KA, April 1975.
3. Graham, D.K., "Multifunctional Switching, Methodology and Evaluation," Boeing Aerospace Company, Research and Engineering Division, Seattle, WA.
4. Kraus, K.-F., "Entscheider und Problemlösen mit Rechnerunterstützung," Report No. 36, Forschungsinstitut fuer Anthropotechnik, 5307 Werthhoven, Koenigsstrasse, 1978.
5. Digitatron DI 570, Thompson-CSF, T - VT, Report 34, 92360 Meudon la Foret, France.
6. Touch Input System, Carroll Mfg. Co., Champaign, IL.
7. Gaertner, K.-P. and Holzhausen, K.-P., "Human Engineering Evaluation of a Cockpit Display/Input Device, Using a Touch-Sensitive Screen," Guidance and Control Design Considerations for Low Altitude and Terminal Area Flight, AGARD-CP-240, 1978.
8. Input/Output Display Communications Terminal, Data Systems Division, Litton Industries, Van Nuys, CA.
9. The Selspot System, Selective Electronic Company, Moelndal, Sweden.
10. Holzhausen, K.-P., "A Contribution for Improved Optoelectronic Measurement and Immediate Inspection of Spatial Human Movements," 1st International Conference on Mechanics in Medicine and Biology, Conference Digest, 7570 Baden-Baden, FRG, 1978.
11. Holzhausen, K.-P. and Gaertner, K.-P., "Eine Beruehrein-gabe als Alternative zu Tastenfeld und Rollkugel des Radarlot-sen am Schirmbildarbeitsplatz bei der bodenseitigen Flugfuehrung," The German Society of Navigation and Aerospace, 5000 Cologne, FRG, 1977.

12. v. Villiez, H., "Erste europaeische Luftverkehrs-Kontroll-
zentrale," EUROCONTROL AGENCY, Report MAS-D/106.2.2, Ma-
astricht, U.A.C., 1975.

13. European Organization for Air Traffic Control of Air Travel,
U.A.C. Maastricht, Brussels, Belgium, 1974.



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