A VERSATILE MAN-MACHINE COMMUNICATION CONSOLE

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SUMMARY

This paper describes a unique man-computer communication and buffering device which meets the need for English-language formulations of business, industrial and scientific problems. The console allows individuals not trained in machine language to use a computer directly. Translation and machine-language editing are completely controlled by the console. The time differential between a man's actions and a computer's responses are automatically buffered. The console can be used in a wide variety of information-retrieval and data-processing applications. It was developed by RCA for the Office of Assistant Chief of Staff for Intelligence (OACSI), headquarters, Department of the Army, under Contract No. DA49-083 OSA-2338.

INTRODUCTION

It became obvious during the development of the ACSI-MATIC system that no adequate communication and buffering console existed which would meet the requirements of untrained, non-computer oriented personnel who would have to deal with a complex data-processing system. Accordingly RCA undertook to develop an experimental prototype of such a console for the purpose of testing and evaluating different communication and buffering schemes. The prototype was to have great versatility so that many types of console operation could easily be simulated. The resulting console, called PAC for Prototype Analyst Console, has itself proven to be a powerful and interesting solution to the problem of providing man-machine communication and time buffering. RCA is now in the process of evaluating this prototype for the purpose of making more specialized consoles for the ACSI-MATIC system. In addition, many other programmed applications have been successfully tested on PAC, which demonstrate the generality of the original concept.

Figure 1 shows the operating position of PAC, and Figure 2 the overall console. The console proper contains a CRT display circuit, a core memory, the operator panels, various control circuits, and power supplies. The soft-copy (CRT) display uses a 21" tonotron (storage/display) tube. Careful design has provided an extremely legible display although the number and bulk of the circuits is minimized.

The actual controls and indicators on PAC are functional devices only in terms of the
operator performance for any particular application. The actual function of each control depends upon the computer programming and the restrictions the user wishes to place on the operator. It therefore involves no change whatever in the PAC circuits to completely change the types of console modes and operator identification requirements. The INTERROGATE switch, for example, could just as simply be labelled INTEGRATE, or the SECURITY CLASSIFICATION indication could be changed to BUSINESS AFFILIATION. The only change required would be in the labelling of the indicators and in the type of program read onto a magnetic tape associated with the console.

This tape is called the format tape, and it contains the form of all allowable inputs to the computer. These forms are written on the format tape as soon as computer programs are established to process them. Each format contains both the machine designations required to indicate the program to the computer and a statement, in written English, which indicates the format to the console operator. When the operator selects a particular format,
the PAC reads the entire format into its internal core memory and then displays the written statement on the CRT. It then indicates the type of parameter which the operator must insert to compose an allowable message.

The operator inserts his parameters in the format by operating a standard typewriter keyboard. He types the parameter in English and it is displayed, beside the format statement, on the CRT. Each parameter is also read into a composing core memory, where it is grouped with the appropriate machine language items from the format.

When the operator verifies the last required item in the message, the PAC reads the data out of the composing memory and sends it to the paper-tape punch. The punch control then edits the message, removing all data except the header indicating the program, an operator ID, the characters used to separate items, and the operator’s parameters.

When the message has been punched on tape, the PAC signals the computer that a message is available. The computer may then read the message at its leisure, placing an answer on the magnetic operator tape. The answer may be retrieved by the operator from this operator tape just as simply as he selected the format.

Messages on the operator tape are preceded by a three-character header which indicates the operator and the question answered. When the PAC locates the desired item on the tape, it reads it into its core memory and then displays the first page on the CRT, roughly the same as a standard typewritten page. The operator then has his choice of printing that page and displaying the next, erasing that page and displaying the next, or printing the entire message. He has identical options for each page displayed.

Security requirements for the PAC are met by providing each operator with an identification card upon which is encoded an ID number. When taking his position at the console the operator must set the control panel ID switches to his number and then insert his card. If the encoded number and the number selected do not agree, a security alarm sounds and the PAC is inoperative until attended by a security officer.

The machine inputs to and outputs from the PAC are standard computer words.

Figure 2. Overall View of Prototype Analyst Console (PAC)
comprising seven digits in parallel. Since the PAC is only a communications device, it may be used for any system using similar word construction. The only basic change involved would be to place the new formats on the format tape. In addition, relatively straightforward circuit changes can be made in PAC to enable operation with any number of digit computer words.

THEORY OF OPERATION

Figure 3 shows a simplified block diagram of the circuits and components of PAC. The Master Sequencing Control and Nine Operating Routines blocks contain the most important functions from the standpoint of understanding PAC's theory of operation. A brief description is given here of the remainder of

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Figure 3. Simplified Block Diagram of Prototype Analyst Console (PAC)
the blocks shown in Figure 3, and the next section describes PAC's operating controls through the Master Sequencing Control block.

The Operator Manual Controls, located on the front of PAC (Figure 1), include the card reader, seven ten-digit switches, and a series of indicator switches. The card reader provides an introduction between the operator and the computer, including an identification (ID) number, the operator's security clearance, his particular area of interest or specialization, etc. The seven ten-digit switches indicate the MONTH, DAY and YEAR, the operator ID, and any other routine information desired. The indicator switches are both indicators and switches which determine the various modes of operation of the console. A typewriter keyboard is provided on the console similar to a conventional typewriter, including a space bar and a carriage return. A verify character is added to this keyboard. When the operator is required to supply information, the indicator lamp above the keyboard is lighted; after typing the requested information which is displayed on the visual CRT display character by character, the operator verifies that he has not made a mistake in typing in his information by pressing the verify character.

The numbers in the lower right hand corners of the remainder of the blocks in Figure 3 indicate the physical bay in which they are located within PAC.

BAY 1

The Core Memory is used to facilitate message composition and enable printing one page of data while displaying another. It is therefore divided into two separate storage units, a composing and a format section each with 2,048 characters, the maximum number of characters per page. The Computer Drive accepts the data output of the Paper-Tape Reader and Control, and ensures that the data is exactly matched to the requirements of the particular computer with which PAC is being used.

BAY 2

The Keyboard Register translates the Typewriter Keyboard data into digital character codes required for the Information Register and the Comparator and Comparator Register. The Information Register accepts and routes all data. A combination of gates at the input of the Information Register reads the incoming 7-bit codes into a storage register of 7 flip-flops, which control gates that apply data pulses to the Core Memory, the Comparator and Comparator Register, the Paper-Tape Punch and Control, the CRT Display, the Print Control, or combinations of these circuits, depending upon the operation required. An arrangement of gates also checks for odd parity, which, if not present, stop operation and light the RESTART indicator. The Comparator and Comparison Register stores the three-character codes used by PAC to search for parameters on the format, prior to comparison with the characters read from tape. If they do not compare, a signal is sent to the Memory Addressing and Control to clear the memory and prevent further read-in. The Memory Addressing and Control controls the read-in and read-out of Core Memory data, adding or extracting the data from the required positions in the core matrix. Fixed Data Readout upon command pulses the Stepping Switch to read the operator identification data through the Information Register.

BAYS 3 AND 4

The CRT Display circuits, which consists of the CRT and the circuits which actually write the data on the screen, accepts the 7-bit character codes from the Information Register. The inner face of the CRT is divided into independent areas by a fine mesh, and PAC divides the usable portion of the mesh into 4000 separate scanning areas, each a 5 by 7 matrix of 35 "dots." The 7-bit characters applied to the CRT Display circuits are decoded by an array of AND gates, each causing a specific series of OR gates to be activated, with each OR gate corresponding to a dot on the matrix, according to the particular character being written. As the CRT beam scans a particular area, the activated OR gates cause their associated portion of the screen to brighten, which allow a variety of characters to be presented on the face of the screen. The number of characters written per line is counted, and when the number reaches 80, the trace automatically moves back to the beginning of the next line. After an individual matrix has been scanned, the trace moves to the next matrix position. When the space signal is received, no gates
are activated and nothing is written. When a carriage return is decoded, the appropriate gate drives the trace to begin the next line.

BAY 7

Bay 7 contains the Master Sequencing Control which is the control logic for the overall operation of PAC, described below. The logic for the Nine Operating Routines is also contained in this bay.

BAY 8

The Tape Control located in Bay 8 is the interface between the computer and the Format and Operator Tape Stations. Both of these tape stations can be located with the computer system. The Tape Control upon command switches the output of the appropriate tape to the Information Register, driving the tape forward in search of the information or of the end-tape symbol or until a stop command is given. At end-tape symbol the Tape Control automatically rewinds the tape and searches again. If the end-tape symbol is read a second time, the Tape Control stops the tape and lights the REQUEST NOT ON TAPE indicator. Status signals are provided to indicate whether or not the computer is using the tape. The Print Control controls the hard-copy printing device used with PAC. Upon command from the Master Sequencing Control (when one of the print switches is operated), the Print Control activates the printer and provides the pulses which operate the keys. Upon command from the Master Sequencing Control, the Paper-Tape Punch and Control edits and translates the output of the Information Register into voltage levels capable of driving the Paper-Tape Punch. The Paper-Tape Reader contains the circuits which read the punched-paper tape to develop data signals for transmission to the computer. A counter associated with this reader counts the number of messages punched. When the computer senses a signal indicating that there is a message on the paper tape, it applies an enabling signal to the Paper-Tape Reader which starts the transport mechanism and reads the entire message from the tape into the Computer Drive circuit. As each message is read, a count is subtracted from the message counter. The Light Signal Register accepts the status and alarm indications from the computer and translates them into signals for lighting the appropriate indicators.

BAY 9

The Special ID Decoding circuit is a set of relays which are operated or released in accordance with the settings of the control panel digital switches and the information read by the card reader. This provides the fixed data through the Stepping Switch for transmission with the input messages. This circuit also checks the operator identification number against the number set on the ID switch, and if it agrees, it closes a path which enables the power to be applied to the control panel. The Stepping Switch is a rotary switch which samples the output of the relay circuits in the Special ID Decoding circuit. It is driven by the Fixed Data Readout through a series of 11 positions for the purpose of reading out the information. The Switch Control translates the operation of switches into electronic signals for driving the Master Sequencing Control. The Light Signal Register Decoding controls the lighting of the indicators on the Panel Display.

OPERATING CONTROL

When the operator depresses any of the input mode switches (in the case of PAC utilized with the ACSI-MATIC system these modes are INTERrogation, ORDER to change files, HYPothesis, and NEW MESSAGE input, marked with the capital letters on switches on the front of PAC), it closes a relay in the Switch Control which pulses the Master Sequencing Control. This places the machine in the particular mode designated. It should be understood that the modes are arbitrarily defined by the programming of the computer for any particular application of PAC. The different formats available for any particular mode are given 3-character ITEM Codes, and if the analyst knows the format he is going to use, he depresses the ITEM switch on the front panel and types in the ITEM code on the keyboard. This immediately displays the format on the CRT for his use. If he does not know the ITEM code, the operator presses the INDEX switch, and a list of all of the formats available to him for any particular mode of operation is displayed on the CRT for his reference. He can note the ITEM code of the desired format and then proceed to press the ITEM switch as before for selection of any particular format.
Figure 4 indicates a typical format for an INTerrogation mode with the parameters which might be typed in by an operator for a personnel information retrieval application of PAC. The < symbol is the start message symbol, and the > symbol is the end message symbol. The symbol is the item separator. The first line indicates interrogation item number (AO6), and the identification of the operator (2386100635). Next is the actual format for the operator to use, with the unknown parameters in parentheses. The first parameter which the operator must insert is displayed on the next line, and he types and verifies the word MANAGERS, which represents that he desires information about MANAGERS. After he has typed in his first parameter and verified it, the second parameter appears on the CRT, namely PLANT DESIGNATION. He then types and verifies WEST COAST CENTRAL. The final line provides him with a means of identifying his interrogation, requesting an INDEX after he has typed in and verified the PLANT DESIGNATION. The operator enters 15 as his index for the particular interrogation. The index will be used as a search parameter when the operator wishes to inspect the computer response. This allows batching of inputs at his discretion.

After the operator has composed his message(s), PAC forwards the data to the paper-tape station for punching and storage on tape until the computer can read the information. After the computer has read the information and processed it, it writes its responses onto the Operator Tape and lights the Operator Indicator on the display panel indicating that it has some information for the operator. The operator can select the INSPECT-OUTPUT mode to observe the computer response. This gives the operator an option of viewing the information on the CRT, or of printing the first page and viewing the rest, or of printing the entire response from the computer. The storage persistence of the CRT is such that each page will remain legible for a maximum of about 10 minutes.

The actual logic of PAC which performs the above operations through the Master Sequencing Control is by means of the following nine operating routines: 1) Set-Up, 2) Tape Search, 3) Load Memory From Tape, 4) Display Memory, 5) Read Fixed Control, 6) Rotate Format Memory, 7) Load From Keyboard, 8) Correct Mistake, and 9) Print or Punch. The block diagram Figure 3 indicates where these routines are applied throughout the circuits of PAC by broad arrowheads. Generally, each of these operating routines can be briefly characterized as follows:
1) The Set-Up routine is the sequence by which the operator informs PAC of the item requested, loading the Comparator with the search parameters, either automatically when the INDEX is requested, or manually when the operator types the ITEM.
2) The Tape Search routine controls the comparator and tape circuits to find the message identified by the 3-character header which is loaded in the Comparator.
3) The Load Memory From Tape routine controls the insertion of data into PAC Core Memory from either the format or Operator Tape.
4) The Display Memory routine enables displaying the computer responses or re-displaying the input information after a character or parameter has been erased if it is desired. This allows the operator to make a mistake in composition and to correct it.
5) The Read Fixed Control routine controls the reading of the operator identification and other fixed data from the Stepping Switch into the Core Memory.

< AO6 ◆ 2386100635 ◆
HOW MANY (PERSONNEL CATEGORY) AT (PLANT DESIGNATION)
(PERSONNEL CATEGORY) MANAGERS ◆
(PLANT DESIGNATION) WEST COAST CENTRAL ◆
(INDEX) 15 ◆ >

Figure 4. Typical Format for Personnel Information Retrieval Application of PAC
6) The Rotate Format Memory (Into Assembly Memory) routine controls the reading of the format message into the composing half of the Core Memory from the format half.

7) The Load From Keyboard routine controls the operation of the keyboard and the storage and display of information inserted via the keyboard.

8) The Correct Mistake routine reads zeros into Core Memory to replace either the last character typed, or all characters following the last parameter category. It is controlled by the ERASE CHAR or ERASE PAR switches.

9) The Print or Punch routine controls the reading of information out of Core Memory for duplication on a hard-copy printer or on the paper-tape punch.

CONCLUSIONS

The console described in this paper has been in operation with an RCA 501 computing system and has proven to be a successful man-computer communication device which could readily be understood and used by individuals with no computer experience, in a very short time. PAC has sufficient check schemes built in to prevent mistakes from being entered into the computer and taking important time from processing. It presents a calm atmosphere for operation remote from the actual computer installation if desired, and it can operate simultaneous with other similar devices at the same or other locations. PAC is an invaluable tool both from the standpoint of developing the final operational console to be used in the ACSI-MATIC system, and of demonstrating the potentialities of a computer to specialists whose interest is not in computer problems and jargon, but in realistic results.

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REFERENCES
