EXPERIENCES IN DISPLAYING SEQUENCE-OF-EVENTS INFORMATION

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Abstract

The installation of a sequence-of-events monitor in a large generating plant creates challenging problems in the man-machine interface. As many as several hundred discrete events may take place within the space of a few seconds. Since some or all of these events may be of immediate concern to the plant operators it is important to display the information effectively. This paper outlines the problems faced in one recent installation and the approaches used to solve them.

EXPERIENCE OBTENUE DANS L'ENREGISTREMENT ET L'AFFICHAGE DES SEQUENCES D'EVENEMENTS

Résumé

L'installation d'un appareil moniteur qui permet l'enregistrement et l'affichage des séquences d'événements dans une grande station génératrice présente d'intéressants problêmes dans les rapports homme-machine. Plusieurs centaines d'événements peuvent prendre place dans l'espace de quelques secondes. Quelques-uns, ou même parfois, tous ces événements peuvent être utiles immédiatement après leur occurrence, à la personne en charge du fonctionnement de la station et il est donc très important que la présentation de cet information soit efficace. L'auteur décrit les problêmes qui se sont posés et les solutions apportées dans une installation récente.

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In a modern thermal generating plant there is a large amount of equipment that must perform properly in order for the plant to produce power. Such equipment includes major components like the generators and turbines, as well as the auxiliary equipment such as pumps, coal pulverizers, transformers, circuit breakers, exciters and power supplies. When any of this equipment fails, or is suddenly removed from service by protective relaying, the plant operator must find out what happened as soon as possible, so that he may take appropriate corrective action. As an aid in this task, the operator has at his disposal a large number of meters and annunciator lights. Unfortunately the failure of one component often sets off a whole train of other automatic shutdowns, sometimes within a few tens of milliseconds. In such cases, the operator is hard pressed to decide what caused what. Because of this, it has become necessary to equip generating stations with some sort of recording annunciator to monitor the many hundreds of circuits involved in the plant equipment and present the sequence of events to the operator in a way that he can rapidly follow what is going on.

One such sequence recorder was recently installed at the Nanticoke Generating Station, on Lake Erie. Called the Operations Sequence Analyser (OSA), its function is to monitor and record operations (status changes) in 1200 on-off relaying circuits and then display this information to the plant operators. Although there were a number of interesting engineering problems involved with the mechanics of implementing the hardware, the real challenge lay in the man-machine interface. This challenge, and the methods used to deal with it, form the subject of this brief paper.

Configuration

The OSA consists of a number of remote status-sensing units called "core boxes", a central mini-computer and five display terminals (see Figure 1). Status changes occurring at any of the 1200 input points are detected by the computer and stored on a small disk memory. The time of each operation is recorded with a resolution of ¼ cycle (4.167 milliseconds). The operations are then presented to the station operators at each display terminal, using TV display monitors and special control panels (see Figures 2 and 3). Each terminal is also equipped with a printer for producing hard copy, although these are only rarely used. The presentation of each operation includes the time, the 20-character name of the point and the new status (open or closed). Figures 4 and 5 show typical displays of operations.

The Man-Machine Problem

The challenge in the man-machine interface arises from the fact that during a serious plant disturbance there may be several hundred operations occurring within a fraction of a second. Even a very fast printer would take several seconds to print out all the operations. TV monitors can display all the information very quickly but these only have room on the screen for a certain number of operations to be displayed at a time. Besides, even if all the information could be presented immediately and at the same time, it is doubtful that the operator could do anything useful with it.

Assuming, then, that there are inevitable restrictions on the number of operations displayed at any one time, there are a number of key questions. Should the display always show only the most recent operations even if this means continually erasing old ones? Or should the old ones be left on the screen, until the operator requests a display of more recent ones? Should all of the several hundred operations be covered, or just the important ones? If just the important ones, how do you define "important"? If the display has moved from one group of operations to the next, does this mean that the operator never gets a chance to see the earlier ones again?

A Solution

In dealing with these questions a basic policy decision was made to the effect that the displays should be controlled by the man rather than by the computer. In other words, the man should be the one who decides what to see and when; not the the computer. Past experience has shown that, in cases of large volumes of information, if you let the computer do the deciding, the man has trouble assimilating the information and he easily gets lost.

Examples of "letting the computer do the deciding" would be the use of "roll up" and "overwriting". In "roll up", the information is added to the bottom of the screen and all the previous information is shifted up. "Overwriting" involves starting over at the top of the screen every time the screen gets full. In both cases, when events are occurring rapidly the viewer has to be very quick to read a particular entry before it shifts or disappears.

Applying the policy of the man keeping control, the basic approach used in the OSA was that as operations occur they are added to the TV monitor only up to the point where the screen is full (see Figure 4). At this point, no further changes to the display occur until the operator requests them, even though there may be several hundred new operations not yet displayed.

When an operator has finished looking at the present information for the time being and wants to change the display to see something else, he presses one of an array of push-buttons mounted in front of the monitor (Figure 2). Then in a short time, usually less than a second, the screen is re-written with the specified change implemented. Each display terminal has its own pushbuttons so that the various selections made do not affect other terminals.

There are pushbuttons that permit the operator to leaf through the operations, rather like leafing through the pages of a book. For example, a button marked "MOVE AHEAD 1 PAGE" causes the next 18 operations (after the ones currently shown) to be displayed. Eventually, after enough MOVE AHEAD's, the display will catch up to the present and the rest of the screen will be blank, waiting for new operations (as in Figure 5). Similarly, a button marked "MOVE BACK 1 PAGE" causes the display to leaf backwards in time, to 18 operations earlier. If desired, moves can also be specified in jumps of 1 operation or 10 pages. In this way, all the operations can be presented to the operator, with the operator in complete control of his display at all times.

There is still the problem of how to cope with several hundred operations occurring in a short time. For such cases, to simplify the operator's task of quickly getting the information he really needs, there are a number of pushbuttons for specifying a variety of searching and selection features. For example, the operator can specify that only operations involving certain categories of input points are to be allowed on his display (the input points in his particular part of the station, say). He can delete or select individual points, to allow for special tests. He can specify that only changes to abnormal status will be shown; or he can have only the first operation of a given point shown (as, for example, in Figure 5). He can also ask to see the present status of specified points. This particular mode allows the operator to observe the status of points that have not recently undergone an operation, and hence are not visible on the displays of operations. Finally, by pressing a "PRINT" button the operator can obtain a printed copy of the operations currently selected for display.

The various features, summarized here only briefly, are apparently effective in dealing with the basic problem of how to display a lot of information in a hurry. The operators have become expert at using the various searching features and are quite enthusiastic about the whole machine. It is hoped that the ideas discussed in this paper will be of some value in generating discussion with others faced with similar problems in the man-machine interface.

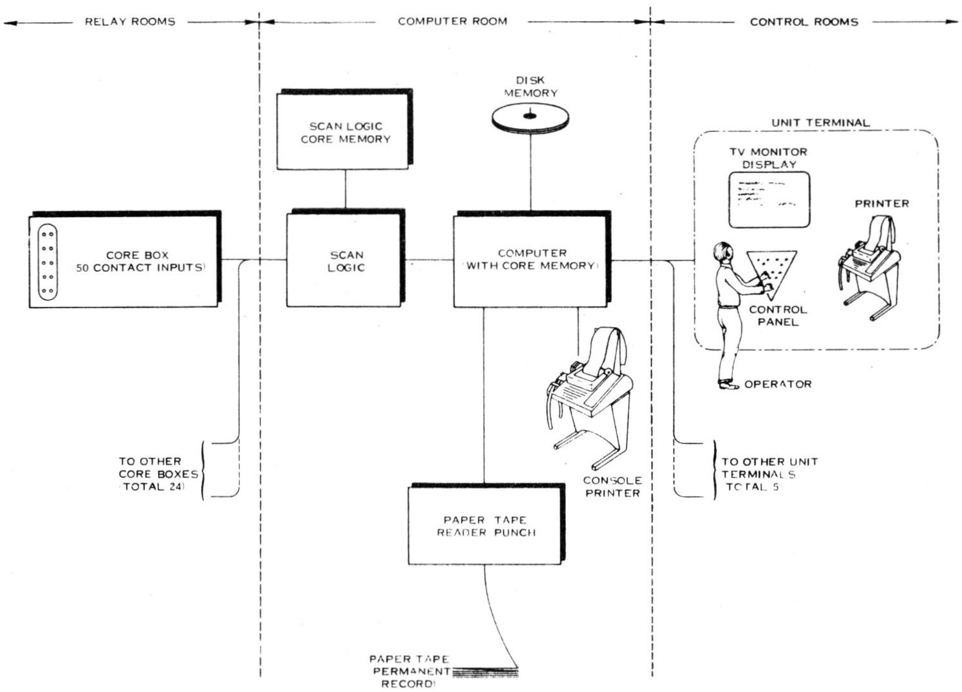

FIGURE I

CONFIGURATION OF THE OPERATIONS SEQUENCE ANALYSER

CHANGES IN STATUS AT ANY OF THE 1200 INPUT POINTS ARE DETECTED BY THE COMPUTER AND DISPLAYED AT SEVERAL DISPLAY TERMINALS, ONE FOR EACH OF THE PLANT'S GENERATING UNITS.

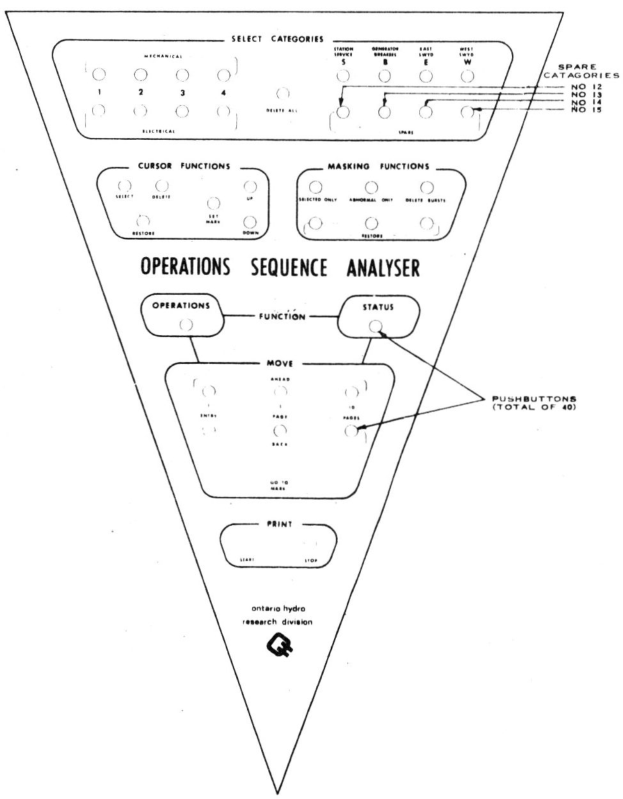

FIGURE 2

AN OSA CONTROL PANEL

THE PUSH BUTTONS ON THIS PANEL ARE USED TO CALL OUT THE DISPLAYS FOR PRESENTATION ON THE TV MONITOR. EACH OPERATOR CAN SPECIFY VARIOUS SELECTION RULES IN ORDER TO CUT DOWN ON THE VOLUME OF INFORMATION AND EMPHASIZE THE EVENTS RELEVANT TO HIM.

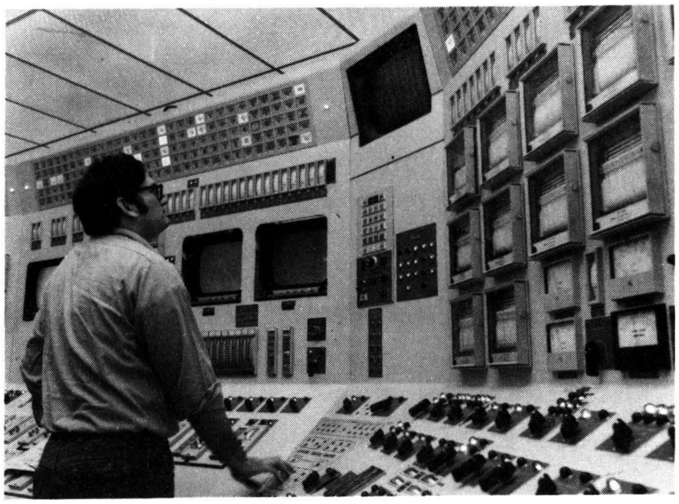

FIGURE 3

USE OF AN OSA DISPLAY TERMINAL BY A PLANT OPERATOR

THE DISPLAY MONITOR AND CONTROL PANEL FOR THE OSA ARE MOUNTED TOGETHER WITH THE OTHER INSTRUMENTATION THAT THE OPERATOR USES TO CONTROL THE PLANT. THE PRINTER PART OF THE TERMINAL IS NOT SHOWN.

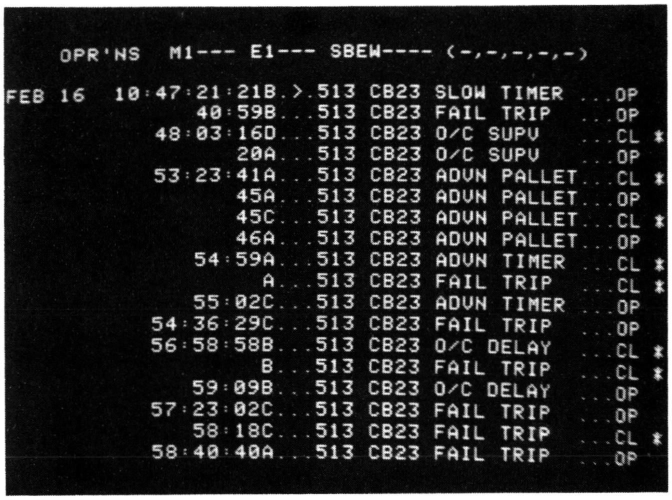

FIGURE 4

TYPICAL DISPLAY OF OPERATIONS

THE TOP LINE INDICATES WHICH SELECTION FEATURES HAVE BEEN CHOSEN. THE REMAINING 18 LINES EACH SHOW AN OPERATION. TIME IS SHOWN TO THE NEAREST QUARTER CYCLE, FOLLOWED BY THE NAME OF THE POINT AND THE RESULTING STATUS, OPEN OR CLOSED. AN ASTERISK MEANS THAT THE RESULTING STATUS IS THE NON-NORMAL STATE (USUALLY CLOSED).

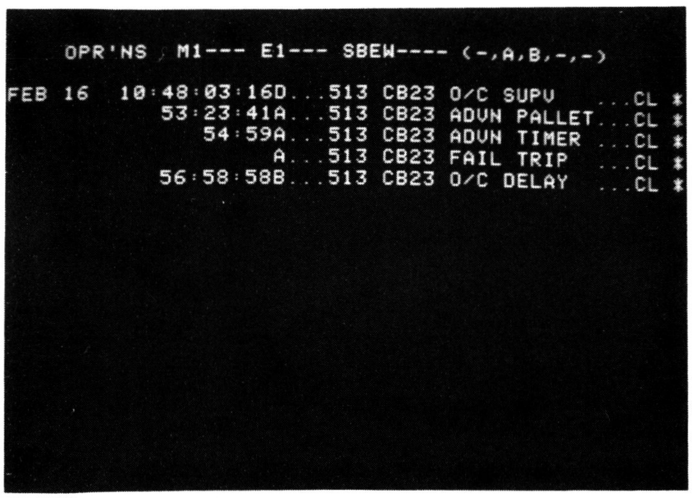

FIGURE 5

SAME AS FIGURE 4 BUT WITH MORE SELECTION FEATURES IMPOSED

IN THIS CASE THE OPERATOR HAS SELECTED "ABNORMAL ONLY" AND "DELETE BURSTS", THAT IS, ONLY OPERATIONS RESULTING IN NON-NORMAL STATUS ARE SHOWN, AND OF THESE ONLY THE FIRST SUCH OPERATION OF ANY GIVEN POINT IS SHOWN.