SESSION XII APPLICATIONS: HUMAN FACTORS

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Mental patients as computer operators

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Tactics of design are described for programs to be used by chronic psychiatric patients on an accounting task in the maintenance of records of token economies at Creedmoor Psychiatric Center. To address the patients' cognitive, motoric, and motivational deficiencies, special attention was paid to display features, branching formats, error detection, feedback, and keyboard utilization.

In the fall of 1982, the authors began "token economies" on the five separate wards that constitute the Intensive Rehabilitation Division (IRD) at Creedmoor Psychiatric Center. The token economy is a behavioral ward management system in which behavioral development is encouraged by rewarding appropriate activities with tokens that are exchangeable for a variety of desired commodities. As with a normal economy, successful management depends critically on close measurement of the behavior of the economy. Because of the unusually large scope of the project (250 patients) and because of the small staff's already considerable paper work burden, it was decided to computerize the recording of the token economy and to have patients serve as the data entry clerks.

It was our intent to develop a system that would not only serve the needs of our application but would also be useful to other similarly underfunded psychiatric facilities. Although it would have been desirable to develop a hardware system specially adapted to the needs of this patient population, it was thought that such innovations would add to the complexity and expense of the system. Instead, we selected a Radio Shack TRS-80 Model III microcomputer with an inexpensive dot matrix printer. (These units can be bought off the shelf at many Radio Shack outlets and are serviced locally.)

The development of programs that can be easily and accurately used by chronic schizophrenic patients has

required us to adapt to several special characteristics of this population. IRD is a "long-term care facility"; the expected duration of hospitalization for the patients is 10 years. The successful discharge rate from these locked wards is less than 1% per month. The patients selected to serve as clerks had IQs in the dull-normal range or better and had a long history of hospitalization. Although they tended to delusional or disordered thinking, this did not appear to interfere with their computer work. They were, however, markedly deficient in cognitive, motoric, and motivational functions.

Cognitive losses associated with the pathological condition and the medication used to treat it are severe. Attention span is unreliable and often short. Memory span is unreliable. Patients often misinterpret information or are overly concrete. For instance, patients may not be able to guess that the name Bob may refer to a person known as Robert. This weakness of vigilance and inferential capacity substantially inflates their error rates.

Although patients with serious sensory-motor deficits were not selected, none of the patients would be called dexterous. Their gross and fine movements were slow and imprecise. None were trained typists, and the use of the keyboard was difficult for them. It became particularly important to deal with the consequences of erroneous keystrokes that could crash the system.

On the motivational side, it was important to deal with the general lassitude of the patients, particularly in the face of what was, for anyone, a rather tedious task.

Another motivational problem was frustration. Patients who were not expected to show strong or

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violent frustration reactions were selected. Nevertheless, we gave some consideration to minimizing the likely damage of a frustrative outburst. All the components except the printer of the TRS-80 were integrated into a single chassis, which made it a heavy and easily secured unit. We protected the opening of the disk drives with a clipboard that also contained name code information. We avoided having clerks work without staff present.

The tasks undertaken by the patient clerks were the simplest but most time consuming of the operations necessary to fully record and analyze the token economy. Most of the higher level operations such as statistical and graphical analysis and file management were done by professional staff. The "tokens" in the token economy were dispensed much as checks from a checkbook. Staff filled out both the token (check) and token stub with the date, patient name, behavior name, staff name, and token denomination, all in a code developed for each ward. The empty stub booklets were collected from staff each week and served as the raw data.

Schneiderman (1980) has summarized the modest literature that describes the human engineering of man-computer interaction. In addition, there is a growing literature describing the use of computers to administer psychological tests to psychiatric patients (Johnson, Godin, & Bloomquist, 1981). A more germane literature is that directed to the special needs of the naive user, but this has concerned itself largely with operating systems and program language design rather than program design (Dillon, 1983; Martin, 1973). However, many of the same considerations are involved. In the following section, the more unusual features of the patient-run programs are described. Often the accommodation involved is no more than an exaggeration of methods used in programming for non-handicapped users. In other cases, however, the requirements of patient use demand fundamentally different program organization.

SYSTEM FEATURES

Display Features

Most display systems work by scrolling computer-user dialogue up the screen, with new lines being displayed at the bottom of the screen once the screen is full. This arrangement was not used with the clerk-run programs. Rather, the screen was cleared before each query, and the new line was entered near the top of the screen. Although this did not allow the user to look back at previous entries, questions were structured with sufficient redundancy to minimize the loss of information.

Special problems arose when the patients were required to transfer information from the token stub to the computer. Primarily, their error tendencies reflected a failure of short-term recall memory. That is, after looking away from the token stub to the computer

screen, patients would be unable to recall the information that had just been read on the token stub. To combat this loss, a procedure that was expected to prompt recall of the information was used. As shown in Figure 1, the CRT display format was composed to resemble the format of the token stub. Requests for information were made by a flashing question mark cursor at the appropriate location on the CRT facsimile, and the entered information appeared beside the cursor on the display. This technique used the display format as a reminder of the appearance of the stub, leaving only the information *per se* to be recalled.

This task was made more difficult by the fact that the computer could discern only the correctness of a coded version of the data. For instance, patient and staff names were known to the computer on the basis of the first three letters of the last name. This was necessary because of the apparently incurable tendency of the ward staff to write onto token stubs a wide variety of name representations, such as first name-last initial, first initial-last name, initials only, last name only, first name only, full name, nickname, etc. Despite their short-term-memory deficit, patients revealed relatively strong long-term memory by learning the codes quickly and well. On the other hand, referring to the code list adjacent to the screen is disruptive to the smooth flow of data entry.

An alternative mode of information transfer that will access a presumably superior form of memory retrieval, recognition memory, is now under development. With this scheme, the patient enters only the first initial of the last name in the appropriate location. A "window" (Thomas, 1981) then appears on the CRT, which displays a menu of all the full names of all entry options beginning with that last initial. Upon recognizing the option that corresponds to the name represented on the token stub, the patient enters the number of the correct option. We have planned a systematic comparison of the recall versus recognition methods to evaluate their effects on speed, accuracy and attentiveness. Although the recognition method appears to be the stronger

Figure 1. A photograph of the CRT display used by patients to enter data is shown on the left. A typical token stub that was the source of the data is shown on the right.

method, the use of the menu format is not without problems (Franklin & Dean, 1974).

Branching Format

Although the menu format for handling within-program optional branches is very popular, even in systems designed for the most heterogeneous user populations, we found them to be difficult for patients. Indeed, menus with more than three alternatives seemed to be prohibitively complex. The alternative is to use two or perhaps three choice menus. This, of course, creates a problem in efficient branch routing. It becomes necessary to ask the same question of the clerk many times to be sure that all options remain open. Although this may bother the staff, it does not appear to bother the patient clerks, and their performance is materially improved.

Error Detection

For a variety of reasons, clerks make a large number of errors. The program was written with an uncommon vigilance for erroneous entries. Each entry in each class was checked against a preentered list of possible correct entries. This procedure trapped almost all misentries. The obvious shortcoming of this procedure is that it produces a noticeable delay in the response of the computer while the relevant check list is searched. This, however, was not a problem with the patient clerks, since their own response times were quite slow.

The programmed consequence of an error was that the screen displayed an error signal, the printer was energized to make a distinctive sound, and the program halted until a distinctive @ character was depressed. The latter requirement prevents clerks from making further entries without explicitly correcting the error. The distinctive key requirement assured that the clerk acknowledged the error and would next enter a correction.

File management operations raise the prospect of disastrous errors. File deletion, for instance, is a necessary option, the misuse of which must be carefully avoided. In conventional systems a double query is often used, such that the user is asked "Are you sure?" after a dangerous operation has been called for. This technique was not successful with patient clerks, and in its place a more "bulletproof" method was used. For instance, early in the program, the patient clerk would be asked, "Do you want to destroy this file?" Later in the program, the patient would be asked the same question in the converse form, "Do you want to save this file?" If the answers agreed logically, the operation would be performed. If not, the program would stop and instruct the patient to seek help from a supervisor.

Feedback

The printer provided feedback, which gave an audio cue in parallel with the screen cue. At the completion of each token transfer, the printer listed the new result. In practice, the patients did not use the printed informa-

tion as feedback, but did appear to use it as an auditory feedback signal that a token had been successfully entered. The printed record also allowed the supervising staff to review the history of recent entries and to check them against the token stubs entered. In all, this use of the printer was well worth the paper it consumed.

Keyboard

The low dexterity of the patients and their lack of experience with the typewriter keyboard made disastrous slips of the finger a strong possibility. The "break," "reset," "enter," "and "clear" keys posed a special problem, because depression of any would halt the program and jettison some, if not all, entered data. Although this did not happen often, those keys were covered with removable caps.

In the simplest BASIC "input" commands, the "enter" key is used to terminate an entry. On the TRS-80, however, this key is not large and, although it is distinctively colored, is surrounded by other keys. To enhance the efficiency of data entry, the program acknowledged the space bar as the terminator. The space bar is much larger and is separated from the other keys. Clerks could easily depress it with the thumb of either hand, which sped up entries and reduced errors considerably.

We had expected at the outset that we would need a special simplified terminal, but the modifications described above allowed us to use the standard keyboard quite suitably.

RESULTS

For a closer look at patient performance, we systematically observed two of the patients' performance on the token rewarding program. Both patients had accumulated more than 100 h of operation time. Their performance was compared with that of a staff member familiar with the program and the codes. One patient, diagnosed as a schizophrenic, paranoid type, was able to enter tokens at an average rate of 17.5 sec per token. The other patient, who was diagnosed as having organic brain syndrome, entered tokens at 18.5 sec per token. The staff psychologist entered tokens at 10.5 sec per token. Error rates, in the .5-h test periods were, for all subjects, not above 1%. Attentiveness, however, varied considerably. Whereas the staff member remained on-task virtually continuously for 30 min, both patient clerks were distracted about 35% of the test time. Token entry times were not counted during obvious distraction. In all, the patients were slower than the nonpatient and were markedly less attentive. The patients were also tested on a paper-and-pencil recording scheme used prior to the introduction of the computer, and their performance was far less accurate and less than half as fast as their performance on the computer program.

To refine the programs, a systematic videotape analysis will be made of task performance. Of special interest

will be factors that contribute to distraction and errors.

Programs designed according to the foregoing principles have now been written for three important ward functions: the recording and analysis of token distributions in the token economy, the recording and evaluation of a comprehensive behavioral survey completed periodically by staff for each patient, and the summary of monthly reports of patient-related "incidents" that require administrative attention. The token recording system has been in place for 14 months and has been highly successful. Records are kept complete and up to date with virtually no expenditure of staff time other than that taken to gather and submit the stub books and that required to evaluate the data summaries returned to them. The otherwise unwieldy administrative burden imposed by the token economy scheme has been sufficiently streamlined to allow the programs to continue and to grow on all five wards of the division.

If there is an integrating principle in the tactics described here, it is that we have sacrificed efficiency and speed for simplicity and clarity. This is not an elegant system, but it does indeed allow patients who would otherwise be no more than consumers in the token

economy to take a role in the management of the economy. More than this, it has been reported that the job of token economy clerk has developed considerable prestige among patients, and those who have served as clerks have become noticeably more confident and responsible.

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