An examination of training problems with naive computer users

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Abstract

This paper describes the design considerations underlying the development of a self-contained computer system which is to form the basis of a Medical Information System. Emphasis is placed on ensuring that the command structures employed are suitable for the naive computer user and can adapt as the users ability increases. The training task is examined in the light of experience gained from a detailed trial of an interactive system with a group of hospital clerical staff. Behavioural patterns are discussed and their influence on the design of command structures.

1. INTRODUCTION

Southend General Hospital is one of the sites chosen for a computer installation as part of the experimental programme of the Department of Health and Social Security*. A part of the philosophy of approach for the computer project has been that the most cost-effective computer configuration should be used, based on a mini-computer implementation supporting application packages written in a high-level language. The applications may be classified into three groups:

(i) On-line information storage and retrieval using a small number of interactive terminals for conversational interrogation and updating of a variety of data files such as waiting lists, admission lists and ward lists each of which consists of a number of patient records. This allows the immediate validation of input and the tailoring of input formats to meet specific needs. It also ensures that the computer system can be made to correspond fairly closely with existing clerical procedures.

(ii) Background processing for the generation of output documents for file housekeeping and rationalisation and for statistical and administrative purposes.

(iii) File maintenance and back-up measures which have to be applied daily in order to ensure the integrity of critical files.

The type of system implemented is similar in concept to that described in general terms by Yntema and Torgerson (1), where the computer assembles input data and presents the main facts which the user will probably need in order to make a decision. The user may call for additional information and will indicate to the computer the action he has decided to take. The machine may make decisions by simple rules and require man to monitor and modify these decisions as necessary.

Adoption of this approach has two major implications. The first is that the system must be self-contained and integrated into the normal work of the clerical staff

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within the hospital. No special computer centre is to be set up and no specialist staff are to be employed to support the system on a daily basis, since the economics of using a computer system would then need to be re-examined (2). The expertise of computer specialists is called upon only in the event of a failure of the system.

The second implication is that a training system needs to be established which will bring new staff to a high level of competence in a short time. There must be a minimum of discontinuity when new staff are employed. The group of people who are to be involved with the computer system are what may be termed totally naive computer users. Whatever level of competence they may reach after training , their use of the computer is likely to remain naive, and one of the problems facing the designer is what level of sophistication in the computer system they can be expected to accommodate efficiently and reliably.

2. NAIVE USERS

The term 'naive user' is employed to describe someone, whose understanding of the way in which the computer system works is limited to generalised descriptions of 'records' and 'files'. In the present context for example, the description of the waiting list system is that a record for each patient is made up from the data which is entered at a terminal and this record is stored in a file for the appropriate consultant. When required, the records can be moved about within the file and printed individually or the file listed as a whole.

A simple analogy is that of the average driver of a car who may be said to be a naive user of his system. He can be in complete control, given sufficient instruction and an adequate set of rules, and provided that the system is robust and exhibits consistent behaviour under different conditions.

The design of a command structure for the computer system is greatly influenced by this description of the naive user. It is obvious that it should not be too complex nor should it contain too many abstract concepts. In the hospital context, complexity can be reduced by splitting the work into a number of easily definable tasks such as waiting list management, patient registration and information services. Each of these tasks is concerned with a manageable portion of the complete system. The number of concepts to be understood is limited by evolving a 'natural' communication language for the task (3). This language is conversational but terse and basic, with redundancy used only to resolve ambiguities.

Despite these rather obvious requirements, there exist innumerable systems with data entry procedures requiring fixed entry formats, using highly complex mnemonic command structures and producing error messages which are often unintelligible to the user. Each of these design faults increases the training problem since the relationship between the complexity of a task and the training required to master it is non-linear, and the major element to training is conceptualisation of the problem.

In the event of a fault, the user must be able to perceive that the system is not functioning correctly and he must have sufficient knowledge to determine whether it is 'safe' to continue. As an example, a corrupted record in a file may prevent the file from being listed even though there may not be a serious fault in the hardware or software. Under these circumstances, the user could probably recover by deleting and re-entering the record. However this requires a good understanding of the system and great confidence. It is also inherently dangerous in that the fault may not be reported. A difficult decision has to be made about how detailed the instruction should be.

Lack of space here, prevents more than an examination of the training task involved with data entry, use of the command structures and conceptualisation of the system.

3. THE TRAINING PROBLEM

During the development of the Southend project a number of detailed working trials have been run using bureau services, in areas of particular interest and difficulty, to evolve solutions to procedural problems (see for example ref. 4). The latest trial to be undertaken is that of a computer-based waiting list system which is to be implemented throughout the hospital Group (5). The opportunity has been taken to use the programs developed for the trial, to investigate the training problems involved with interactive data entry and file manipulation procedures. A detailed study was conducted with a good sample of hospital clerical staff to examine their rates of learning a specific task and their ability to grasp the concepts involved in the manipulation of data records and files under different training methods (6).

Each subject involved with the study was introduced to the computer system by performing a word-association test at a terminal. This was designed to derive a basic measure of their individual rates of interaction with the computer and to establish whether they held any strong attitudes towards computer systems. On the basis of an

assessment of attitude differences, the subjects were split into two groups, the first consisting of those who were antagonistic or indifferent to computers, and the second of those who were favourably disposed. The second group were given manuals to study, explaining the system they were to use, the first group were to learn from the system itself. Half of each group was tested under different conditions. The first half were given verbal assistance and demonstration during the initial tests, the second half were left to use the system or manual to get any help they needed.

Each group consisted of approximately 10 subjects and is referenced as shown in the table below:

	Manual	Self-taught
Assisted	A	B
Unassisted	C	D

The tests were composed of a number (3 to 5) of sessions at a terminal on consecutive days. The same pattern of procedures was followed on each day with different, carefully matched material. The tests were monitored by the computer.

A session consisted of the subject opening a waiting list file for a consultant, adding a number of records to it by an interactive data entry procedure, manipulating records within the file, editing records and producing lists. Three aspects to the task have been distinguished, namely, data entry, record and file manipulation and general conceptualisation of the computer system.

3.1 Data Entry

The data entry procedure tales the form of a question and answer sequence, where the computer prints a cue on the terminal and the user responds with an item of data from the input document. An example of the procedure is given below , with the user responses underlined to distinguish them from the cues.

TITLE:MISS
SURNAME:PETERS
INITIALS:M.J
UNIT NUMBER:401712
PRIORITY:3
DIAGNOSIS:R.FOWLERS OP.

```
CODE:
BIRTH DATE:2/1/19
SHORT NOTICE:YES
CARE:NO
THEATRE:30
STAY:7
CATEGORY:ORDINARY
? ONE OF
NHS PP AMENITY STAFF
CATEGORY:NHS
XRAY:NONE
CONSTRAINTS:NONE
PRETREATMENT:NONE
CALLER:ABC
RECORD 4
```

As can be seen, errors which can be detected are reported and the user is required to re-enter the item.

At each session, a subject entered data from three input documents. The time taken to perform a sequence was recorded and plotted. A curve for a typical subject is shown in figure 1, where the individual times at a session are indicated by crosses.

3.2 Record and File Manipulation

Records are manipulated by means of a number of commands, some of which are immediately executed while others require additional data.

Since the majority of the subjects were almost totally unfamiliar with the procedures involved in the management of hospital in-patient waiting lists, the task was presented to them in the form of a written story with a linked set of instructions which mimiced a realistic hospital situation. At each session, a subject was requested to perform the sequence shown below.

```
WLS:BOOK
RECORD NUMBER:1
123456: JONES G.O. LEFT MEDIAL MENISECTOMY :
PROCEED?:YES
DATE TO COME IN:21/8/73
HOSPITAL:SGH

WLS:BOOK
RECORD NUMBER:2
70006 : JAMES H.M.  KELLERS OP :
PROCEED?:YES
```

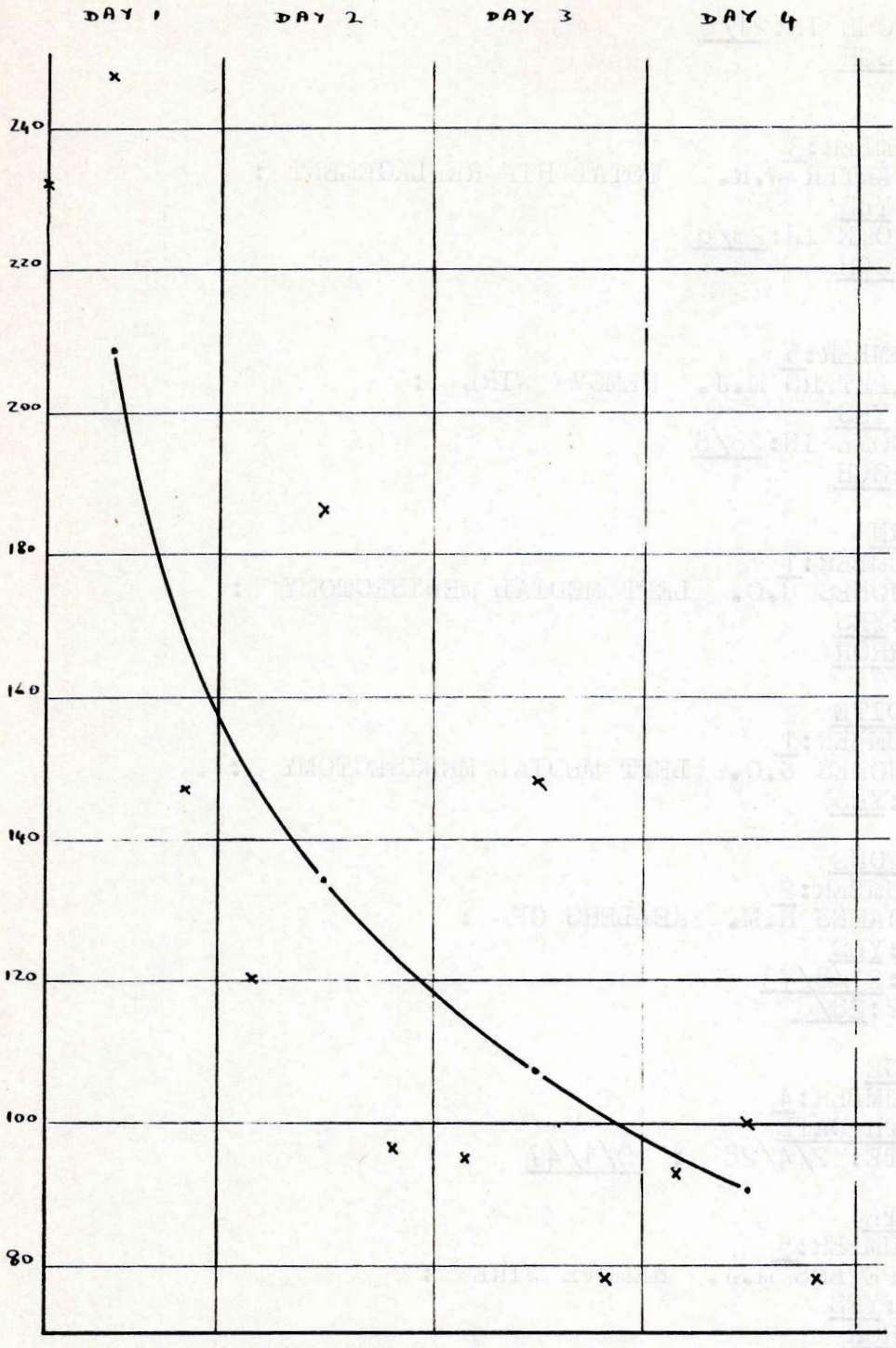


Figure 1. - Subject 1

```
DATE TO COME IN:21/8
HOSPITAL:SGH

WLS:BOOK
RECORD NUMBER:3
221321: CARTER W.R.    TOTAL HIP REPLACEMENT :
PROCEED?:YES
DATE TO COME IN:28/8
HOSPITAL:SGH

WLS:BOOK
RECORD NUMBER:5
441342:  PETERS M.J.  REMOVE WIRE  :
PROCEED?:YES
DATE TO COME IN:28/8
HOSPITAL:SGH

WLS:RETURN
RECORD NUMBER:1
123456: JONES G.O.  LEFT MEDIAL MENISECTOMY  :
PROCEED?:YES
REASON:ERROR

WLS:EXPEDITE
RECORD NUMBER:1
123456: JONES G.O.  LEFT MEDIAL MENISECTOMY  :
PROCEED?:YES

WLS:POSTPONE
RECORD NUMBER:2
70006 : JAMES H.M.  KELLERS OP  :
PROCEED?:YES
TCI DATE:21/8/73
NEW DATE?:28/8

WLS:CHANGE
RECORD NUMBER:4
ITEM:BIRTH DATE
BIRTH DATE: 2/4/28  : 10/1/47

WLS:DELETE
RECORD NUMBER:5
441342: PETERS M.J.  REMOVE WIRE  :
PROCEED?:YES
CAUSE:ERROR
```

Performance was monitored by recording the time taken to complete a procedure and the interval between procedures. In addition, the subject's behaviour was observed and the record of interaction at the terminal

was preserved.

3.3 Conceptualisation

Three concepts can be distinguished for which it is possible to measure the understanding achieved by the subject. The first concerns the 'command-action' process which is the basic conception that there can be a dialogue between the user and a machine, and that in some instances the initiative may belong to the machine. This is a difficult measure since rote learning can mask understanding. However, a measurement can be made of the user's ability to interact with the machine, by recording the interval between completion of one process and the start of the next and by observing his behaviour.

A second, very effective measure of understanding of the system as a whole is the grasp of the concept of 'branching' in the data entry sequence. This contains elements of the idea of a dialogue, the user becomes aware that he is not simply typing into a typewriter. Each user was required to enter data to form three records, the second of these entries contained a logical branch. As can be seen from figure 1, the second entry at each session takes longer than the first or third. A consistent, inverted 'V' pattern is obtained. It has been shown that the dispersion of the three results is a strong indication of the subject's understanding of the entry procedure, and distinguishes it from learning. If the task is fully understood, there need be no pause to accommodate the branch.

The third concept is that of error correction. The user has to grasp the fact that the machine can detect a mistake which he has made. The ability of the user to recover after making a mistake can only really be discussed qualitatively, after observation of his behaviour.

4. PERFORMANCE

A performance measure for the data entry sequence was derived from a combination of the final 'level' reached and the dispersion of individual results at the end of the training sessions. A control scale of expertise was established by users who were experienced with the task. On this scale two points 'expert' and 'competent' were marked and the test group were compared with it. 21% equalled or exceeded the expert level and 70% equalled or exceeded the competent level, after only a maximum of 5 training sessions of 15-20 minutes each. This indicates that the interactive language system has a fairly 'natural' structure, easily accommodated by the users.

Similar results were achieved with the record

manipulation aspect of the task. Conceptualisation has proved to be less easy to measure and it appears that the users take a considerable time to understand the system, but this does not prevent them from using it competently up to a certain level. 90% of the test subjects were able to complete the task at the end of the training sessions and to recover, unaided, after making mistakes; however, a much smaller percentage would be capable of recovering competently from the type of corruption described earlier.

5. TRAINING

The initial reaction of the vast majority of the subjects tested was fear of the terminal. There appeared to be two components to this, the fear of making mistakes and the fear of damaging the system in some way by typing in a wrong reply or pressing the wrong key.

The word-association test was intended, in part, to help the subjects adapt to the terminal and to the concept of interaction with the computer. It failed to achieve this and was universally disliked. However, this was almost certainly due to dislike of word-association tests rather than to their administration by the computer system. Games which do not require a great deal of effort from the user have been shown to play a valuable part in reducing the problems of the initial impact of an interactive system. Typical of these is an arithmetic game where the user responds to questions from the machine. It is soon evident, when such exercises are performed, that the involvement of the user with the system quickly transcends the mechanisation of communication with the machine and a 'natural' dialogue is established.

A significantly lower rate of learning, commencing at a better performance level, was general for those subjects who approached the tests calmly. With very few exceptions, at the end of the tests, the initial fear and tension had been dispelled. The exceptions performed badly and it is evident that fear of the system is a major factor blocking progress.

A measure of the subject's approach to the task is expressed by the shape of the learning curves for the data entry procedure. Compare for example figures 1,2 and 3.

- subject 1 has a fairly even rate of learning throughout and never reaches a peak of performance. It appears that there is room for further improvement. Comprehension of the task grows toward the end, as evidenced by the reduced dispersion of results.

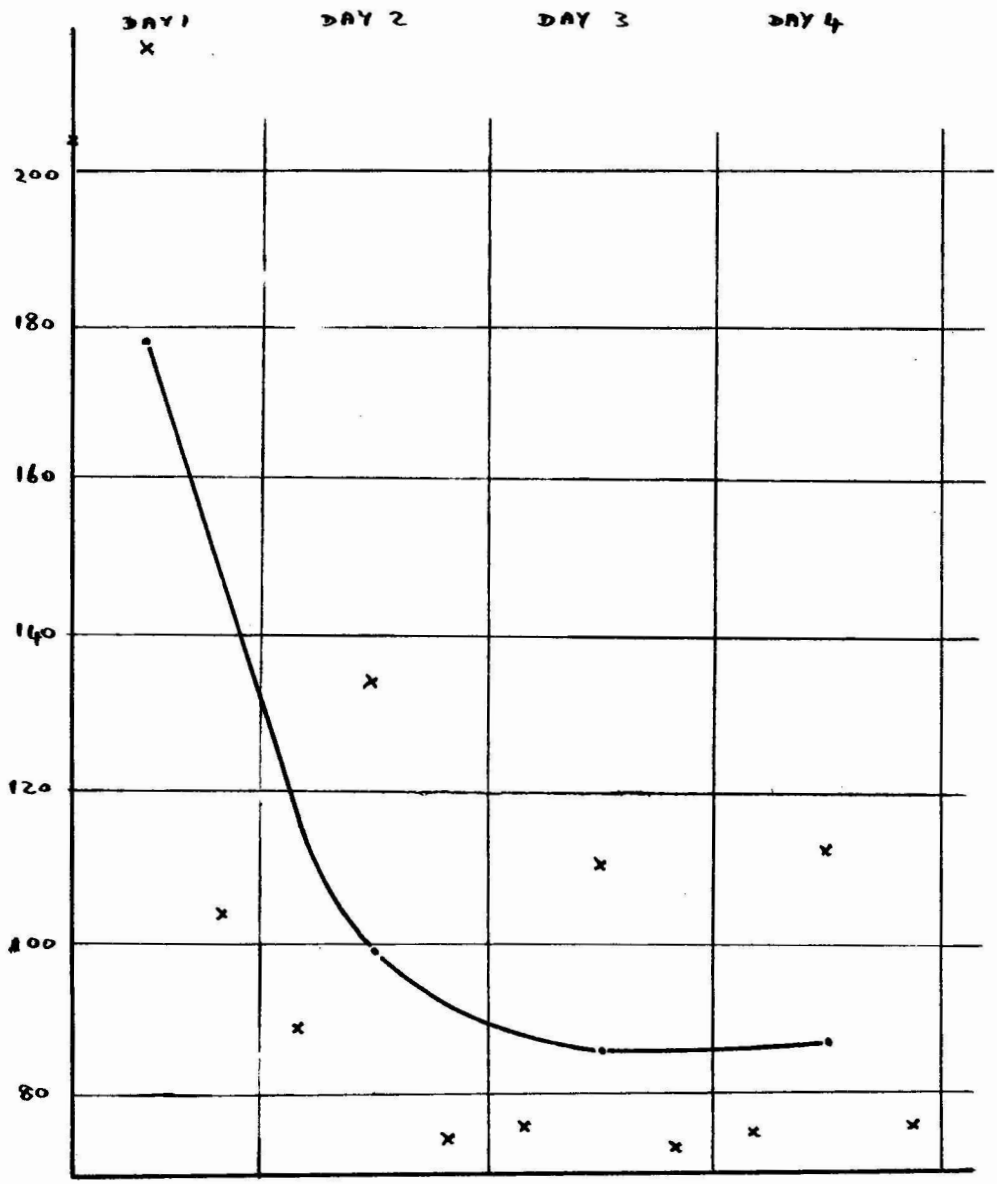


Figure 2. - Subject 2

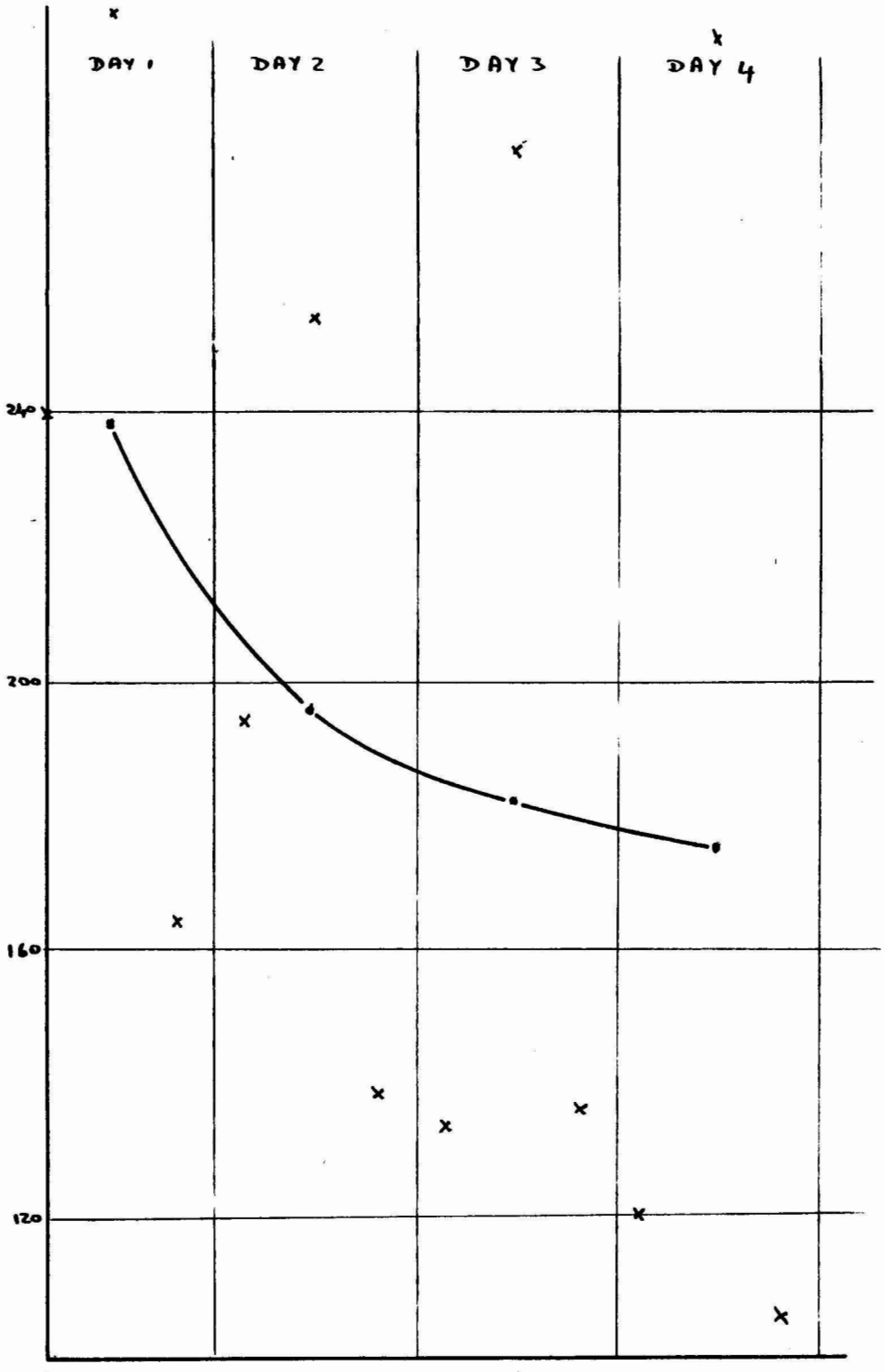


Figure 3. - Subject 3

- subject 2 learns very rapidly, initially, reaches a peak of performance and then shows no further improvement. Comprehension of the task remains virtually constant.
- subject 3 learns very slowly throughout. Comprehension actually decreases as the tests progress.

When all the subjects' combined results are ordered, these three achieved the following rankings, out of 35.

subject 1 - 10
subject 2 - 15
subject 3 - 35

which corresponds well with a qualitative examination of the learning curves and indicates how sensitive a measure they can be.

Groups A and B, who were assisted initially, showed a significant difference from groups C and D. The former learnt the task more rapidly and reached a peak of performance sooner, while the latter showed signs of being able to reach a higher level of performance with a deeper understanding of the task, given sufficient time.

5.1 Self-teaching

Particular emphasis has been paid in the Southend project to the possibility, with an integrated computer system of a user teaching himself by interacting with the machine. For example, a user may request help from the computer at any time in order to continue with a process with which he is having difficulty. If an entry, which is interpreted by the machine, cannot be accepted, the user is given a list of possible entries to assist him in completing the interaction. However, it became very obvious during the trial that the naive user found greater difficulty than anticipated in associating error messages with an incorrect input. An example of such an incorrect entry is given below:

```
CATEGORY:ORDINARY
?  ONE OF
NHS  PP  AMENITY  STAFF
CATEGORY:
```

The brief error message led to some confusion. However a fuller message can be frustrating to a more competent user of the system who has made a simple mistake. This problem has led to a modified design whereby the error messages adapt according to the ability of the user. In general, this may only be a two-state adaptation but in some cases more linear changes are possible.

In the original design, a 'HELP' command was imple-

mented which could be used to give an explanation of each command. In practice, this was rarely used and the system has been redesigned so that the user now simply queries an input in order to find out what he should enter, as shown below:

```
CATEGORY:?
THE FOLLOWING ARE THE ONLY POSSIBLE ENTRIES
NHS  PP  AMENITY  STAFF
CATEGORY:
```

This process is used consistently throughout any interactive sequence so that it is rarely necessary to use a manual in order to learn how the system works.

Consistency of the system under all circumstances is probably the single most important factor in the design of an interactive system for the naive user. It has a great influence in reducing fear of the system and provides a solid behavioural base which in turn evokes a natural response from the user.

6. CONCLUSIONS

Self-teaching, as outlined above, has proved to be the most effective way in which the use of an interactive system of this type can be taught. However, there are several reservations which it isimportant to bear in mind. A test, such as the word assosciation test described previuosly, distinguishes very clearly those subjects who can adapt to the use of the system and benefit from self-teaching from those who need initial instruction by demonstration and example. However, such a test is not a good introduction to the machine. A game may be better and should, perhaps, be used as a palliative to clear the way after any initial tests are given and before training starts. A thorough introduction to the system, either by means of a manual or a lecture, in some cases markedly improved the rate of learning and the final level of achievement. It is quite clear, however, that self-teaching is of most benefit provided that the subjects are adequately prepared for the task in the manner most suited to their individual needs.

The interactive language should mirror fairly closely normal conversational methods. One particular case which has been observed is detrimental effect of pauses during a process. Most processes are fairly similar to short conversations, during which there is a certain amount of tension. Pauses, which occur due to processing time or other delays in the computer system, cause annoyance,

fears that the system had failed and considerably interrupt the flow of input. In general, uncontrolled pauses lead to an increase in tension for the user. Completion of a process however is a natural place for a delay where the user has gained the satisfaction from 'task closure'.

The effect of an interactive system on the naive user is largely unpredictable, however, some of the points raised above may be helpful in identifying behavioural problems.

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