Table I gives the SI units for each physical and thermodynamic property covered in these two sets of critical tables, shown in column 3. Also indicated in the last column are the necessary conversion factors which should be employed to derive the needed quantities in SI units.

It should be mentioned that all new and revised API 44 and TRCDP Tables, which are continuously being issued, are now conforming to SI units and the official IPTS-68 temperature scale, whenever possible.

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(6) The Manufacturing Chemists Association established this critical data project in 1955 at Carnegie Institute of Technology. The project was also relocated with the API 44 Project in 1961 and incorporated into the Thermodynamics Research Center at Texas A&M University under the direction of Professor Bruno J. Zwolinski. The project was renamed the Thermodynamics Research Center Data Project on July 1, 1966, and it has been independently operated on a self-supporting basis since July 1, 1964.
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On-Line Information Systems in Perspective†

SUSAN ARTANDI

Rutgers University, New Brunswick, New Jersey

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The rationale supporting the desirability of on-line information systems and the arguments underlying their development are discussed. A major argument in favor of on-line retrieval has been the assumption that the opportunity to negotiate search problems through on-line access to the data base has the inherent effect of improved system performance. The extent to which on-line retrieval has fulfilled this and other expectations is considered along with trends relating to the operational characteristics of existing systems.

On-line information systems have been with us for some time and, at least on the surface, their design and implementation have become quite routine. At the same time, a variety of rather interesting and significant problems remain, many of which relate to current trends in computer use and to the fact that the community of computer users is becoming increasingly heterogeneous. Computer users today include the many individuals for whom on-line computing is a tool that facilitates their work in their respective fields. The behavior pattern and functioning of these users at the on-line interface have important implications for system design.

In the design of on-line systems the development of the technology and the solution of data and file management problems have been emphasized. Relatively little research has been oriented toward the user concerning the nature of the man/computer interaction in a time-sharing environment and the human factors that affect the quality and productivity of these interactions.

In an on-line information system the user can interface with the computer on a real-time basis and has direct and immediate access to the data base. This type of computing provides both the need and the opportunity for extensive man/system interaction allowing for the combination of the algorithmic and heuristic approaches to problem solving.

It is generally assumed that inherent in the ability to work with the computer in a conversational mode—allowing for continuous two-way communication between user and system—is the potential for improved system performance. It has been argued that the on-line capability will in a very real sense improve output and, through it, overall system performance.

At the most general level, the dynamics of an interactive system can be described in terms of the two states of the interaction: *the working part of the interaction*, the time during which the user is waiting for the system; and the *console part of the interaction*, the time during which the system is waiting for the user.[1]

The major components involved in the interactions are the data base, system parameters, command language, query formulation, feedback, hardware, and cost. All these components significantly affect the performance of the system in terms of its ability to satisfy the user's information needs, and they can be analyzed in various ways. One of these is the point-of-view of the user.

DEMANDS ON THE USER

The user of an on-line information system must bring to the terminal a considerable amount of sophisticated background knowledge concerning the characteristics of the data base, both in terms of its intellectual content and the logic of its organization. This kind of knowledge is essential for the intellectual aspects of query formulation and for the ability to respond to and be able to utilize feedback from the system.

Familiarity with the data base must be combined with the thorough understanding of system parameters to formulate

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queries in the most effective way. Ideally, the user should have great freedom in the use of the system. He should be able to use as many terms as he wishes and should have unrestricted use of Boolean operators, for example. In reality, however, this is not the case. Restrictions are always present and tend to vary alarmingly from system to system.

A dominant factor at the on-line interface is the *command language*, the language used to communicate with the system. The command language is different from the language of the data base, although, in a very broad sense, query formulation involves both.

Command languages are artificial languages, they are usually developed for a particular system, and there is a lack of uniformity among them. The ability to use natural language at the on-line interface has been of considerable interest because it would eliminate the need to learn the variety of command languages associated with the different systems.[2] Equally great variations exist among the indexing vocabularies, the data elements, and structures of the various data bases.

It can be time consuming to learn about these and similar system parameters so that they can be taken into consideration in search situations even when only a single system is involved. In multiple data base situations, the user is required to learn about all the systems he wishes to access. Considering the trend toward the use of several data bases within a single organization, this is an important problem that places great pressure on the user, particularly on the casual, infrequent, nonstaff user.

Many of these problems could be alleviated through standardization or through the development of a "common computer interface—a computer system affecting the translations necessary to allow a user to access multiple, diverse, I–R systems in a common framework." [3] In the meantime some interesting trends have emerged to deal with the situation as it is today.

What seems to be happening is that searching has been returning gradually into the hands of the intermediary (or, it may have largely remained there), the very person the on-line capability was supposed to replace. In most places the picture is not the one that was originally expected. The users do not interact with the systems to take advantage of the potential for improved performance inherent in the direct user/system interaction capability, but rather staff members do the searching for other people. Obviously, the potential for increased effectiveness is still valid as far as the staff searcher is concerned, but it is lost to the user.

The proliferation of data bases may be one cause of this trend but some important human engineering problems also have a role to play.

HUMAN ENGINEERING ASPECTS

It appears that one of the more significant problems facing the designers of on-line systems is that of determining the relationship between the dynamic characteristics of the system and its acceptability to the user.

Accessibility and response time are two examples of system characteristics that should affect the psychology of the man/computer interaction. The user's degree of frustration with the system should be certainly related to the number of times he gets a busy signal or to the length of time he has to wait after getting a busy signal. The question of what is "reasonable access" remains unanswered at this time, however; a crucial factor is the design of operational trade-offs concerning the minimization of idle time in the system while maintaining acceptable accessibility.

Response time is the time elapsed from entering a command until its completion, characterized by the production of output or other signals to the user and the transfer of control to him. In minimum response time situations, however, response time will be of variable length, and it has been found that users usually prefer constant delays to a possibly shorter but variable one. Unpredictable conditions seem to disturb the users of on-line systems.

It also appears that the degree to which the user is frustrated by a delay is not simply a function of its duration. Rather it depends on such psychological factors as the degree of uncertainty in the mind of the user concerning the expected length of the delay, the extent to which the actual delay contradicts his expectations, and what he considers to be the cause of the delay.[4]

The kind of charging algorithm that is used to compute the cost of the use of an interactive system also tends to influence user behavior at the terminal. If, for example, the user is charged on the basis of the amount of central processing time he uses, he can proceed at a leisurely pace and may come to the console relatively unprepared. If, however, he is charged on the basis of connect time, the time he actually spends using the console, then he will tend to prepare more carefully for his session at the terminal.[5]

Ease of use is an important design objective for any on-line system. It raises the problem of designing a system that the beginner can learn to use easily on the basis of the system's built-in teaching capabilities and which at the same time allows the experienced user to bypass the teaching steps.[6] More sophisticated approaches would go beyond these two categories of users to take into consideration a whole spectrum of expertness.

SUMMARY

While many system design problems relating to on-line systems have been solved and in many aspects the design and implementation of on-line information systems have become routine, some problem areas do remain.

A great deal of research is needed to study the psychology of the man/computer interaction because little is known about it and because of the new trends in information retrieval that relate to the wide availability and extensive use of a variety of machine-readable data bases. This development places great demands on the users of on-line information systems with respect to their familiarity with the various data bases and command languages and their knowledge of the system parameters within which they have to operate.

The better understanding of the psychology of the man/computer interaction is an important step toward removing some of the pressures at the user/system interface and, through this, increasing the overall effectiveness of on-line information systems.

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