



The Responsibilities of Computer Science in Continuing Education for Managers

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Jay W. Forrester has defined management as "the process of converting information into action."¹ The conversion process is called decision making. To make a decision a manager should (1) identify a set of feasible alternatives, (2) evaluate each of these alternatives and (3) select the alternative which most nearly satisfies his decision criteria.

Computer science can support this decision making process in two ways: (1) by providing information which is required to identify and evaluate alternatives which involve the acquisition of additional computing capability and (2) by providing systems which aid in the execution of the decision making process. Continuing education is needed in both of these areas. First I will examine the need for specific education to provide information and then I will look at the need for general education in the use of the computer as an aid in managerial decision making.

Computer Science as a Source of Information

The emergence of the computing service industry, the rapid growth of third-party leasing and the development of a used computer market have created many new alternative strategies for acquiring computing capacity. As the number of alternatives has increased the need for relevant, reliable and recent information concerning computers and the computing industry has grown rapidly. Figure 1 illustrates some of the alternatives which could be considered whenever a firm is evaluating a proposal to use the computer for a major new application. Although some of these alternatives can usually be eliminated easily, the remaining alternatives must be examined in detail. This requires a second level of information concerning the specific products or services which are being considered.

The development of computer-communications systems, the increasing importance of system software and the rapid increase in the number of peripheral devices are among the factors which have added to the complexity of the computer acquisition decision. Fifteen years ago if you ordered an IBM 650, for example, you had to decide if you wanted a 1000 or 2000 word memory drum; these were the only alternatives for internal memory. If you wanted auxiliary memory you could add tape units; only one type of tape unit was available and there were no other types of storage devices to consider. Today there are hundreds of ways to configure a computer system. The selection of software and peripheral devices is as important as the selection of the central processing device for achieving the system objectives. The manager seldom needs to have detailed information concerning all of the feasible alternatives. However, to understand the complexity of the decision process he should understand the general strategies that are being explored and he should have some idea of the number

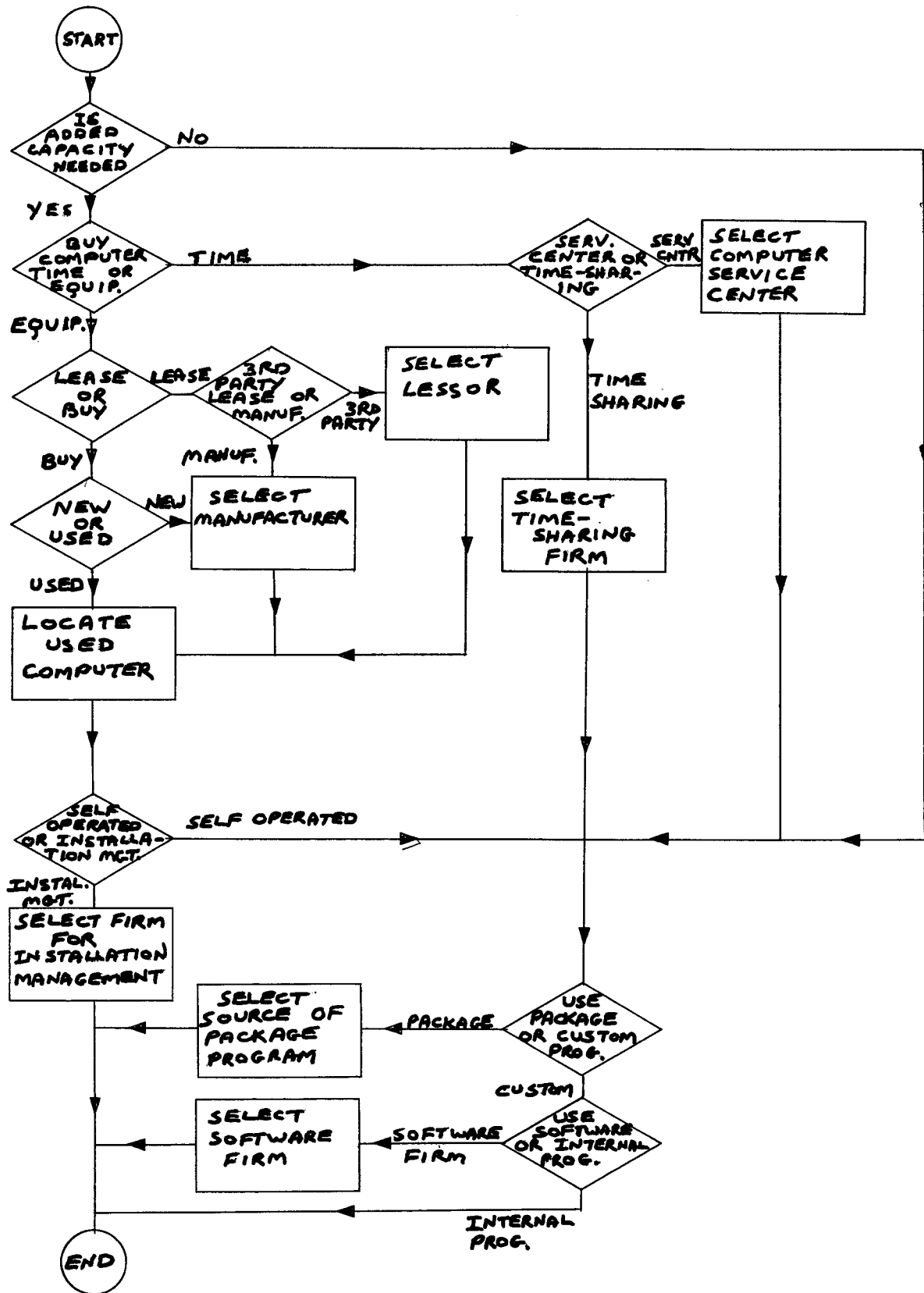
of alternatives that should be evaluated. The manager must realize that the process of identifying and evaluating the alternatives will be costly and time-consuming and that the failure to study at least a partial set of feasible alternatives could be extremely expensive.

What is the most effective way to transmit the required information to managers? The computer manufacturers and the computer service firms can not be expected to identify alternatives which involve the use of competitor's equipment or services. Thus, the availability of an unbiased source of information is of great importance. Although most of the information could be communicated in writing, I believe a short conference or seminar would be a more effective means of communication. The recent conference at the University of California, Los Angeles, entitled "Effective vs. Efficient Computing" dealt with some of these problems. Many other organizations, including the School of Business at the University of North Carolina, have had executive training programs which consider some of the alternatives. But I do not know of any program which is primarily intended to identify and examine computer acquisition alternatives. I would like to see the A.C.M. sponsor a 2 - 3 day meeting for upper and middle level managers to examine alternatives for acquiring computer capability. The first session could be devoted to a general overview of the alternatives aimed primarily at the decisions made at the top level of an organization. The second session could include an analysis of the trends in the development of hardware, software and services which are of great importance in making long-range planning decisions. These sessions could be followed by a series of sessions, intended primarily for middle managers, which would examine some of the alternatives in more detail. The organization of such a conference would be a significant indication that computer scientists are really interested in providing relevant continuing education for managers

The Role of Computer Science in the Decision Making Process

Computer Science can provide support for the decision making process by developing systems and procedures which will assist in the identification and the evaluation of alternatives.

The identification of alternatives requires information, thus the identification process can be greatly enhanced by the development of computer aided information retrieval systems. Although much progress has been made in the theory and art of designing retrieval systems, the development of operational retrieval systems has been retarded by the high cost of establishing and maintaining an up-to-date data base and the cost of developing effective retrieval programs. The general trend toward the use of on-line operational systems and the availability of generalized retrieval programs has significantly reduced the cost of retrieval sys-



tems. However, to achieve reasonable costs it is usually necessary to integrate the systems which support the operation of the firm with the systems which support the decision making process. Long-range planning and managerial support are required to achieve this system integration. Managers do not need to know the technical details of retrieval systems but they must understand the current and projected state-of-the-art if they are to plan and support the development of computing systems which will efficiently utilize retrieval techniques.

There is little reason to utilize resources to identify additional alternatives unless the alternatives can be evaluated. Since alternative evaluation is a task for which the computer is ideally suited, this is an area in which computer science should be able to make a major contribution to the decision making process. The evaluation of alternatives requires techniques which range from simple computations to extensive simulations of complex systems. In general, data manipulation is as important as computation. Thus, computer science can provide great assistance to the evaluation process by developing efficient algorithms for storing and analyzing complex data structures. For example, the evaluation of large decision trees under conditions of risk and uncertainty is a process which has been greatly improved by research in Computer Science. The development of efficient algorithms for evaluating large mathematical programming problems is another area in which significant progress has been made. The availability of efficient techniques for these processes has greatly expanded the number of alternatives which can be evaluated at a reasonable cost.

What is the responsibility of computer science for continuing education in this area? I believe education needs to proceed on three levels: (1) informing managers that the computer can assist them in the identification and evaluation of alternatives, (2) providing information on the use of programs and systems which can perform the tasks required for alternative identification and evaluation, and (3) providing detailed information on the theory which underlies the techniques which support the decision making process.

In general, short seminars can easily satisfy the educational need at the first level. This type of material could be incorporated into the seminar which was proposed above. At the second level, educational programs will vary greatly with the type of technique which is being used and the type of person who is being trained. It is important that the training at this level include information on the limitations of, and the data requirements for the technique as well as specific instructions for the use of the program. Several types of organizations, such as the manufacturers, universities, software firms, specialized educational organizations, and professional organizations, are already providing education at this level. These courses will satisfy part of the need for the continuing education of managers providing they don't assume a highly technical background and they are oriented toward the applications of the technique rather than its technical aspects. Education at the third level would generally be limited to specialists and is really not included in the area of continuing

education for managers. Although the educational requirements will differ with the technique and the trainees, I believe that fairly extensive courses are required to achieve satisfactory results. Courses of this type are currently available at several universities and specialized educational organizations. The educational programs which are available through the A.C.M. and other professional organizations may also satisfy part of this need.

Continuing education in Computer Science is necessary for managers because of the rapid growth and continual change which is taking place in the computer industry. Because of their special knowledge and interests, computer scientists must be involved in the development and implementation of relevant educational programs in computer science. However, the responsibility for the development of such programs must be shared by specialists in other areas such as management, organizational behavior and management science. Continual feedback from operating managers will also be essential if their real needs are to be met. I believe that the most effective educational programs will require joint efforts which utilize the talents and interests of all groups which are interested in the effective use of computers. Although these programs could be organized in many ways, I believe the A.C.M. could play a significant role in mobilizing the diverse resources which will be required for the development of appropriate programs of continuing education in Computer Science for managers.

¹Jay W. Forrester, "Managerial Decision Making", in *Computers and the World of the Future*, ed. M. Greenberger, MIT Press, Cambridge, Mass., 1962