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Systems Approach to Planning and Adjusting to Computer Capacity

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If your computer is overloaded it's not necessarily an automatic signal to rush out and buy new, larger equipment. It may be possible with modern machines to increase capacity by adjusting configuration or improving peripheral units—

A SYSTEMS APPROACH TO PLANNING AND ADJUSTING COMPUTER CAPACITY

by Peter B. B. Turney

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THE IMPORTANCE of defining computer capacity cannot be disputed. The installation of a new computer system generally requires a large investment of corporate resources. An error in the definition of the capacity the system can handle will be serious. The acquisition of a system that is too small to fulfill all the demands on it may necessitate a substantial upheaval and further investment. A system that is too large will provide a commitment to a cost level substantially higher than would otherwise be necessary.

Planning for computer capacity has traditionally emphasized the role of the computer hardware in determining the output of the entire system. This article demonstrates that planning for computer capacity may be substantially improved when other important capacity variables in the system are considered. Where computer systems have been installed and are found to be straining capacity, it is possible to upgrade the system in less costly and less time-consuming ways than by moving to a larger computer. Computer capacity should be considered to be much more responsive to short-run management control than is generally thought.

In other words, if your computer is overloaded, that isn't necessarily a signal to rush out and buy new equipment. There are many other approaches that can be used first.

The traditional view of capacity limits the analysis to hardware considerations alone. More precisely, it is frequently defined in terms of one particular computer model. It is becoming impossible, however, to define the capacity of a modern computer because of its modular design.

Buying a computer system is a little like buying a car. Certain items are standard equipment, other items, such as a "floating point package," are optional extras. If a second processor is found necessary, or if core storage needs to be expanded, this may still be done at a later date.

Many companies include expandability and open endedness as selection criteria. Expandability refers to the ability to increase stor-

age and processing speed without a major disruption such as rewriting many programs. An open-ended system is one where additional equipment may be added without major disruption.

"It may also become desirable to make additions to, or improvements in, the peripheral equipment. More communication lines may be added, or the file capacity may be enlarged. It may be necessary to improve the speed of access to part of the files, perhaps by adding drums."[1]

In addition, most computer manufacturers sell or rent compatible families of computers. The move to a new computer does not imply a constant increment to cost or capacity. A smaller computer may be added to enlarge the current system or a new, larger one exchanged for the older, smaller one.

The significance of all this is the ability to adjust capacity merely by making an adjustment to the existing system to remove bottlenecks. A change in the configuration can eliminate bottlenecks and expand the capacity of the system as a whole. Hardware monitors are available to evaluate the system and determine the location of these bottlenecks.[2] When the system is designed, the capacity of each facility is enough to accept the total demand expected. The total demand may be higher simply because the demand has increased or because the mix and use of resources has changed. Modularity provides flexibility to meet both types of change to the extent allowed by the design of the computer.

1—Martin, James, *Design of Real-Time Computer Systems,* Englewood Cliffs, N.J., Prentice-Hall, 1967, p. 256.
2—Warner, C. D., "Monitoring: A Key to Cost Efficiency," *Datamation,* January, 1971, pp. 40-49.

The performance of the hardware is heavily dependent on the quality of the programs used in the operation of the system. The kind of programing languages, the efficiency of the library routines, utility programs, application programs, and the operating system all determine the revealed performance of the hardware. Changes in these software items will clearly be a source for improving hardware performance. Coyle gives an interesting example of the possible improvements available to users of one kind of software, the Indexed Sequential Access Method (ISAM) for file processing. He improved the processing of new records, for example, by applying the input transactions in descending order and creating the data set with "dummy" records.

"We enjoyed a 400% improvement without buying new software and I only hope that the time we have spent and the techniques we have used can be of help to others fighting the ISAM problem."[3]

Extra operator can be added

Computer equipment is highly automated but it is not independent of human interference; operators must be assigned to run the equipment and help smooth the flow of work. The volume of work that can be handled will depend to some extent on the number of operators working with the computer. There may be a reduction in system delays and rerun times, for example, if an extra operator is added.[4] There is, of course, a limit to the number of operators who can run one piece of equipment. After a certain point there are diminishing returns as new operators are added. Emery argues that changes (such as adding extra operators) have little effect on either total cost or capacity.[5] A recent study on management information systems (MIS) cost behavior showed that in the operations area alone, personnel expenditures are little less than total hardware expenditures.[6] The Diebold Research Group noted that 31 per cent of operations personnel expenditures are accounted for by operators.[7] It must be concluded that capacity may be affected by changes in manning and these changes are likely to affect total cost in a significant manner The pattern of computer operator expenditures in the long run is graphed in Exhibit 1, page 34. The actual pattern of expenditures will be somewhat smoother since overtime may be utilized to increase the volume of work that any one operator can handle.

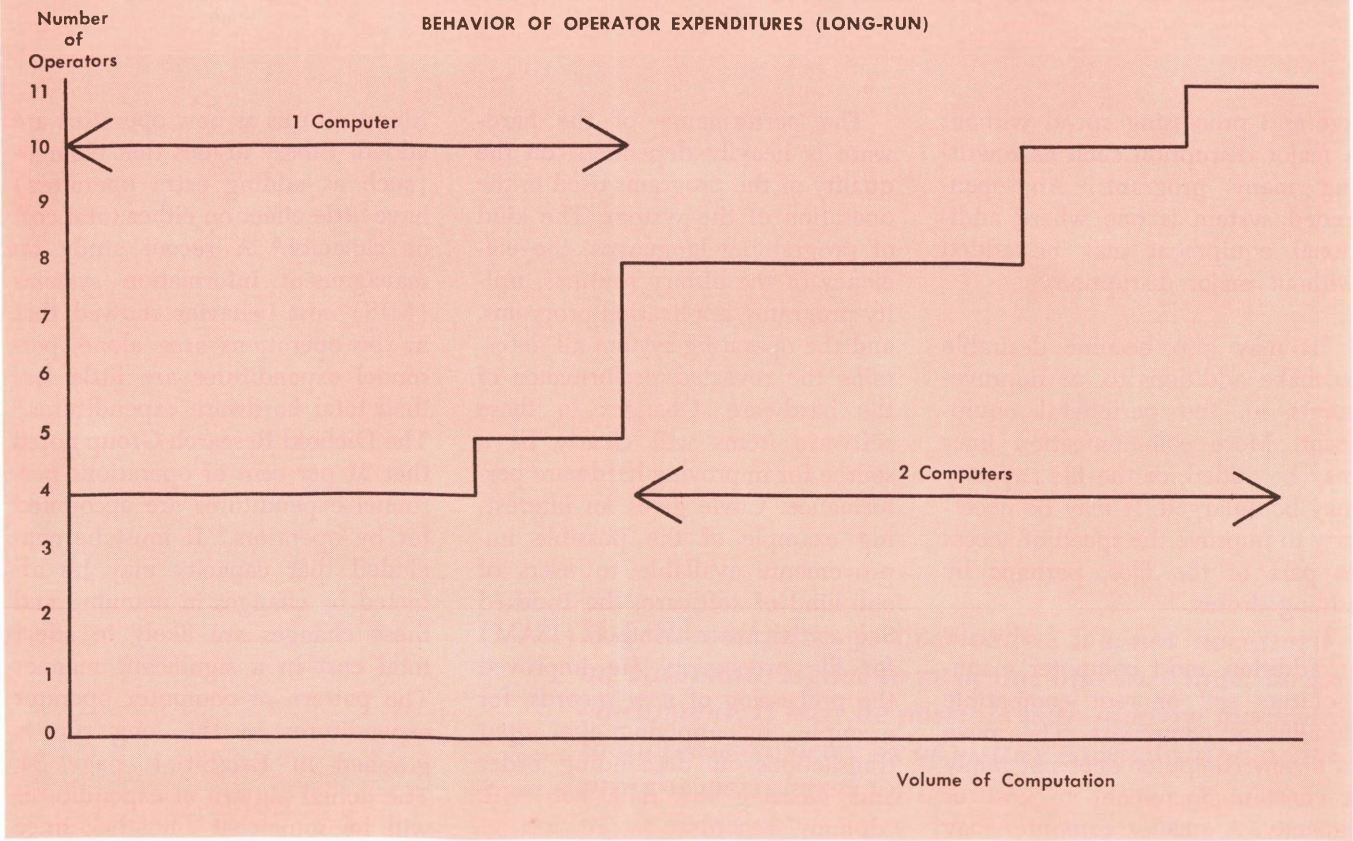
3—Coyle, F. T., "The Hidden Speed of ISAM," *Datamation,* July 15, 1971, p. 48.
4—Ruth, S. R., "The Love and Care of Antique Systems," *Datamation,* July 15, 1971, p. 43.

Systems improvement can help

Equipment capacity cannot be defined in a vacuum (even with a given number of operators). Capacity or throughput capacity is a function of the interaction of all aspects of the system. To increase capacity, for example, the quality of the operators may be improved through training so that they can

5—Emery, James C., "Cost/Benefit Analysis of Information Systems," SMIS *Workshop Report* No. 1, 1971, p. 11.
6—A study was conducted in a large manufacturer of consumer goods. The results of the study may be found in: Peter B. B. Turney, "An Accounting Study of Cost Behavior and Transfer Pricing of Management Information Systems," unpublished Ph.D. dissertation, University of Minnesota, 1972.
7—Diebold Research Program, "Management Costs and Control Studies: Guidelines to the Composition of the ADP Budget," *Management Implications,* M-21, Diebold Group, Inc., February, 1971, p. 14.

EXHIBIT I



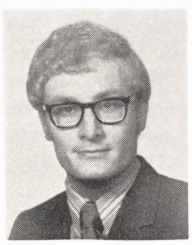
take better advantage of the system. The balance between input and output may be adjusted, even a certain amount of reprograming may be done. Ruth suggests that a 10 to 25 per cent improvement factor in available computer time is possible in many computer centers utilizing such system modifications.

"By taking the worst of all these cases which I've looked at in government and industry there is perhaps 25 per cent more computer time available simply by using better, faster, more efficient procedures in the computer room. Even if it's only 10%, it's very easy to find. And 10% of a million dollars is still worth the trouble."[8]

Capacity must always be defined in terms of equivalent service levels for some given time period. Every user entertains an expectation regarding turnaround time. When a computer is new and few jobs have yet to be converted or programed for it, turnaround time is likely to be as good, if not better, than expected. At a later stage when capacity limits are being reached, turnaround time will become longer. Capacity is thus not a rigid limit; it is as flexible as turnaround times and service levels permit it to be.

The capacity adjustment decision

The capacity increase decision is generally viewed as a long-run decision. From the beginning of a feasibility study for a new system to conversion is likely to take at least 20 months.[9] Once the system has been designed, the equipment configuration set, and the order placed, it may still take six to 12 months before delivery of the equipment can be made. This is only true, however, if capacity is being increased through the acquisition of an entirely new system. If a very large increase in system capacity is required, then it is likely that a company will have to convert to a new and larger system. If the required increment is more moderate, then it may be affected through manipulation of any one of the variables mentioned above. The configuration of the system may be adjusted, core storage may be increased, the operating system may be made more efficient, or an additional operator may be added. None of these changes requires the long-lead time necessary for the installation of a new computer. To



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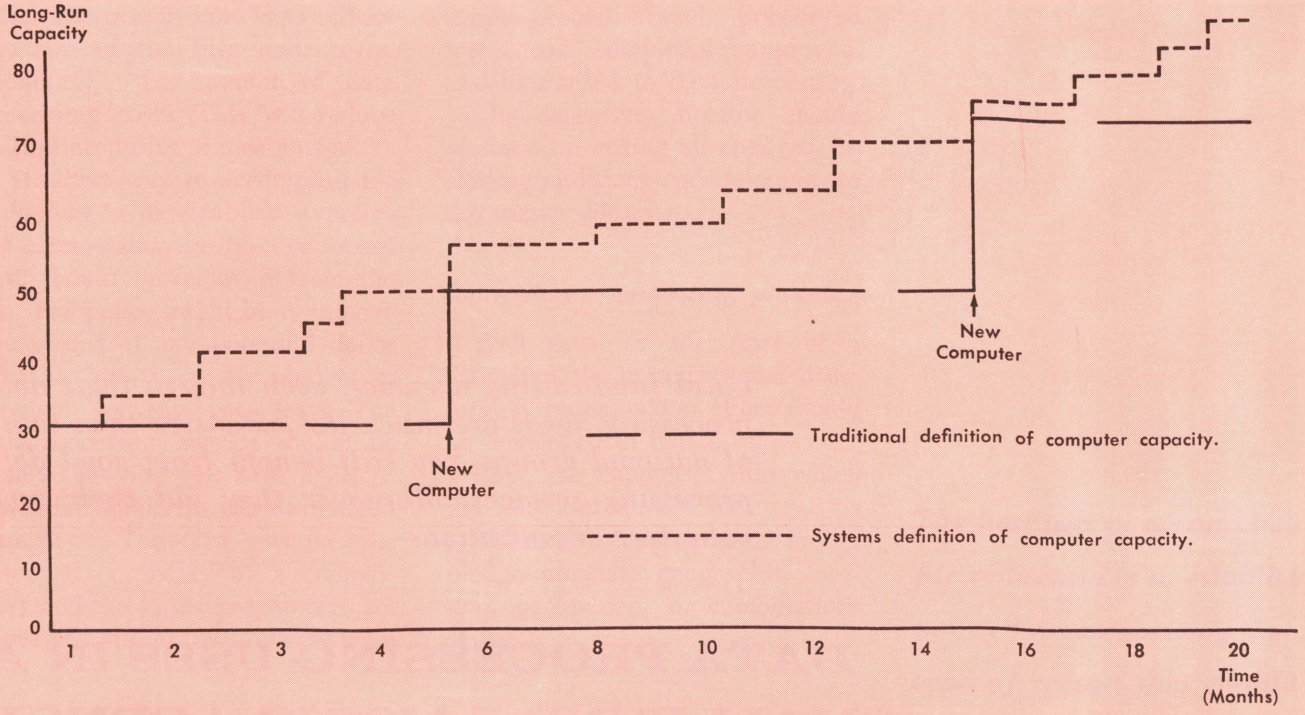
8—Ruth, S. R., *op. cit.*, p. 43.

9—Davis, Gordon B., *Computer Data Processing*, New York, McGraw-Hill, 1969, p. 484.

EXHIBIT 2

COMPUTER CAPACITY



change the capacity of a computer system by ten or even 20 per cent will generally be possible with reasonable alacrity and cost. To change the system by 50 per cent will require a much more fundamental revision and upgrading.

The ability to provide improvements in the short and medium terms should ease long-run planning for computer capacity. It should also provide a new capability for solving systems design errors, adjusting for incorrect forecasts of system demands and unforeseen overloads in the system's work schedule. Exhibit 2, above, compares the traditional approach to increasing and adjusting computer capacity with the more flexible systems approach that is proposed here. The emphasis on upgrading to larger computer systems under the traditional approach limits management's flexibility in the short run and requires capacity changes to be in large and costly increments. Where management considers other system variables that also affect capacity, such as variable operator manning and modularity in computer design, it is possible to reduce the lead time necessary to make capacity adjustments. It further reduces the size and cost of required increments to capacity by smoothing the path of capacity increase.

One of the problems that affects the capacity adjustment decision is the difficulty in forecasting the demand for computer services. If computer capacity were totally inelastic in the short and medium run, an error in forecasting the demands would be critical. It is possible, however, by consideration of computer capacity variables, to adjust and compensate for at least a moderate error. Errors in forecasting demand that are more serious suggest that the planning process for computer capacity is inadequate. Long-run demand for computer services in most companies is managed demand. The demands that are met are those for which the system has been planned or is capable of handling. Demand for computer services cannot be translated into actual output without some delay; in many cases the lead time in designing a new application is as severe as that for acquiring a new system. If long-run demand can be limited to the increase in long-run capacity, the errors in forecasting demand in the short and medium runs may be smoothed out through the numerous techniques outlined above.

Conclusion

Computer capacity cannot be defined in terms of hardware alone. An expanded definition of capacity to include all the factors that interact to create the output capability of the system is a more correct—if more ambiguous— definition of capacity. Further, it implies changes in policy and strategy for the computer management in relation to capacity adjustment. In the short and medium terms, it is possible to adjust or upgrade the system to handle significantly higher demands without requiring the acquisition of a new system.