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SELECTED LITERATURE ON
COST ACCOUNTING AND COST CONTROL
FOR AUTOMATIC DATA PROCESSING
BIBLIOGRAPHY

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PREPARED FOR THE GAO TASK GROUP PROJECTION MANAGEMENT
GUIDELINES FOR COST ACCOUNTING AND COST CONTROL FOR
AUTOMATIC DATA PROCESSING ACTIVITIES AND SYSTEMS

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January 7, 1976

To FGMS Staff Members:

This booklet provides a bibliography with abstracts of recent articles, texts, and Federal reports and policy and guidance documents on cost accounting and cost control for automatic data processing (ADP) activities and systems. The bibliography was prepared as a knowledge base for the GAO's project and task group on Management Guidelines for Cost Accounting and Cost Control for ADP Activities and Systems in the Federal establishment.

The authors represent a variety of viewpoints and backgrounds including practitioners from government and industry, educators and theorists. The task group concluded that the literature offered guidance and concepts that were too different in terminology, scope, and coverage to satisfy the needs of the Federal establishment for guidance in this area. The General Accounting Office does not necessarily endorse the various views of the individual authors, yet it is believed that each article represents a contribution in this field.

The reader will find this sample of the literature to be an interesting cross section of current thought on cost accounting, cost control, and cost management for ADP activities and systems. Entries on the articles and reports are annotated, and organized by key points and conclusions relative to identified topic areas, to assist the reader in selecting material of interest. Each text contains some material but it is not always organized into one section. The texts are organized alphabetically. The policy and guidance documents are listed by identification number by its source, with descriptions if available.

We hope you will find this bibliography a useful guide for your professional reading.


D. L. Scantlebury
Director

SELECTED LITERATURE ON COST ACCOUNTING AND COST CONTROL
FOR AUTOMATIC DATA PROCESSING ACTIVITIES AND SYSTEMS
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PERIODICAL ARTICLES WITH ABSTRACTS OF KEY POINTS

GENERAL MANAGEMENT CONTROL OF ADP

Withington, Frederic G.
"Five Generations of Computers: A Review of the Five Stages Through Which EDP Systems Have Been Evolving in the Past Two Decades and Will Evolve in Coming Years."
Harvard Business Review, July-August 1974, pp. 99-108.

Computers and business applications have been evolving for 20 years and an analysis of five identifiable generations illustrates the evolutionary trend. The first three generations take us up to the present time and include the "Gee Whiz" era of 1953 to 1958, the "Paper Pusher" years of 1958-1966, and "The Communicators" of 1966 to 1974. The key characteristics of each of these generations is outlined.

The fourth generation, identified as the period of the "Information Custodians," 1974-c.1982, is characterized by data-base-oriented processing, the movement of many logistical functions of the firm from the field to headquarters, and the movement of tactical decision making from headquarters out to the field. The fifth generation, "Action Aids: c.1982-?" will represent a logical extension of the fourth generation emphasizing tailored, or personal, information and alerting systems, and decision analysis systems.

Not all organizations evolve through the various generations at the same speed. The principal factors influencing this evolution in the future will be the problems of translating subjective human values to precise computer programs, human communication, shifting corporate and organizational objectives, and cost. The cost considerations require a deliberate, evolutionary approach that proceeds within realistic budget constraints.

Hanold, Terrance.
"An Executive View of MIS."
Datamation, November 1972. pp. 65-71.

In rebuttal to an article by John Dearden ("Mis Is a Mirage," Harvard Business Review, January-February, 1972, p. 90), the author argues that the MIS is real. He initially defines information, managerial information, information systems, the MIS, and accounting information systems. The relationship between accounting and MIS is then established through an example of a flour milling enterprise, taken from the author's own company, Pillsbury. It is shown how data is transformed into information for use in departmental actions through the injection of the functional intelligence of each department. Ultimately, as the information of other functional areas is combined, a level of information flow is reached that meets the needs of general management and thus justifies the label of MIS.

The accounting function does not provide management with the type of information that is necessary for decision making because it is not designed to develop the data or to communicate the information needed by management. The author also notes the different responsibilities of the controller and the financial officer of a firm and establishes the "imperative necessity" for the management information system, the key to which is an integrated data base. He concludes that if "functional information systems cover the operations of the firm with reasonable sufficiency, then there is information in the data base adequate to support an executive management information system."

Neuschel, Robert P.
"Unleashing Computer Power: The Key--Improved Management Quality."
Business Horizons, February 1971. pp. 81-86.

Early success with clerical and administrative applications have not been followed with an equal degree of success on more advanced systems. Against this background, the author attempts to explain why we have not been able to achieve more significant contributions from the computer, and what must be done to put the computer to work successfully on solving managerial problems.

Four reasons are given which account for the limited success: (1) The failure to think fundamentally about business problems; (2) The goal gap between management and computer people; (3) An improper balance in computer projects; and (4) A lack of rigorous economics.

Six actions are suggested to increase the computer impact on the bottom line. (1) Identify high pay-out applications targeting those few activities that are particularly critical to success. (2) Select a balanced "menu" of computer applications that includes both short and long term projects, the key organizational components, and are within the user's and ADP's capability. (3) Increase involvement by key line management to insure operational success. (4) Subject applications to rigorous preevaluation covering technical, economic, and operational factors. (5) Cultivate tough realism on what can be done and how soon. (6) Bring the computer and decision maker together through the use of models and other advanced decision aids.

"Unlocking the Computer's Profit Potential."
McKinsey & Company, Inc., 1968. 38 pp.

Based on a survey of 36 large U.S. and European companies, this report assesses the economic impact of computers on company operations. The findings indicate that many companies have failed to adapt to new and changing conditions and that savings realized from early administrative applications are no longer being achieved, in spite of significant increases in computer outlays. The problem is seen to be a management one, that of emphasizing future direction rather than current effectiveness.

Three tests of feasibility for computer applications are outlined (technical, economic, and operational) and examples are given of projects which did not meet these tests. Management's lack of exposure to the feasibility problem and the inability of the ADP staff to assess the economics of a proposed application are seen as two of the major problems.

The real opportunities for computers in the future will involve operational changes for which management involvement and cooperation will be required. In this context, three lessons for management are given. First, the "rule of high expectations" demands that managers set high goals for all projects. Second, the "rule of diversified staffing," establishes the need for various types of expertise being assigned to computer projects. Finally, the "rule of top management involvement" covers five things that the chief executive must do to insure maximum results. These include approval of objectives and priorities, establishment of organizational arrangements, assignment of responsibilities, establishing the requirement for detailed computer systems plans, and following through to see that planned results are achieved.

Hennessey, Edward L., Jr.
"Top Level Control of Data Processing: Some Guidelines."
Computers and People, February, 1974. pp. 14-15+.

The corporate role in the control of operating entities and the corporate responsibility to insure that each operating unit has appropriate systems to measure themselves is discussed. Corporate level control over divisional or subsidiary data processing organizations is then introduced as a means of controlling expenditures and coordinating development activities between divisions.

An analogy is drawn between the control of DP projects and the controls imposed on new product introductions. Two key aspects to be considered in the assessment of DP projects are the marketability of the project (ie. Is there a need and desire for it?) and its measurability (ie. Can the results be measured in quantitative terms?). The concept of return on investment is recommended as a control device.

The steering committee approach is recommended as one way of exercising divisional control over data processing to assure effective systems development. Another approach involves the identification of that portion of the DP budget that can be invested in systems development, and the use of that figure to compare to alternative ways of spending/investing such funds. Examples of two companies using this approach are given.

Milano, James V.
"Structuring Management Information Systems."
Data Management, September 1970. pp. 69-74.

The author contends that the distinction between advanced ADP systems and the MIS is not clear, and that the first concern should be the integration of certain data structures. A functional grouping of data is suggested--financial management, operational, sales management, personnel-oriented, and research data. The establishment of integrated files within functional areas is seen to be a prerequisite to the integration of data across functional boundaries. Commercial software packages are considered as an economical approach to implementing file management systems.

Some of the key problems in the development of an MIS are discussed: the control of codes, the shortage of qualified personnel, the need for long range planning, the participation of individuals from each functional area, and the design of information retrieval capabilities that are matched to the needs of each functional area. The problems of achieving standardization of data elements and report content throughout the firm are addressed, and the need for cost control and cost/benefits analysis is emphasized.

Dermer, Jerry and Mistry, Percy.
"The Utilization of Computers by Small Business."
Cost and Management, May-June 1971. pp. 14-22.

Although significant benefits have been realized from the computer by larger firms, there is little evidence to show that smaller firms have benefited proportionally. Specifically, only 5 to 8 percent of Canadian firms between \$1 million and \$10 million use computer facilities. Ten modules which comprise the MIS for small business are described and it is shown that the decision making area holds the most promise for small business.

Two managerial problems in the small firm, "management by crisis" and scarce managerial resources, however, combine to limit management's commitment to computer use. In addition, the lack of financial resources results in a high level of risk in the development of computer applications. Some of the alternative ways in which the small business may obtain computer assistance are reviewed. These include the in-house computer, computer service companies, time sharing, and computer co-operatives.

The contributions of the computer manufacturers and consultants in reducing the risk of computerization for the small businessman are assessed and found to be generally lacking. Nevertheless, the authors contend that the computer is the means by which the small businessman can exploit his greatest strengths and recommend that he move toward an MIS.

Beehler, Paul J.
"EDP: Stimulating Systematic Corporate Planning."
Journal of Systems Management, November, 1969. pp. 26-31.

Some traditional problems and hindrances to corporate planning are identified and it is suggested that the economic and organizational changes attributable to EDP may stimulate a revival in corporate planning activity. Total company data processing costs are typically on the increase, in spite of a downward trend in hardware costs. This is caused by the addition of new applications and the availability of new types of hardware which stimulate new uses. In addition, competitive pressures force management to search out more advanced uses of the computer (ie. management information systems, modeling, etc.) to remain profitable.

In an organizational sense, the availability of centralized information centers have caused corporate management to consider again the possibilities of centralized profit responsibility. In addition, the use of the computer to make low-level decisions, once relegated to middle managers, has an impact on the implementation of corporate plans by shortening communication lines and simplifying the implementation of corporate plans.

The computer also helps to focus management's attention on the interrelationships among the various functional components of the firm, thereby stimulating better corporate planning.

ADP PLANNING AND CONTROL PROBLEMS

Greco, Richard J.
"MIS Planning - An Approach."
Data Management, October 1971. pp. 17-22.

An approach used to plan for management information systems is discussed with the intent of contributing some concepts toward developing a viable planning structure. The MIS organization is briefly described and the differences between the operational control, management control, and strategic planning functions are noted, particularly in terms of the different information systems needed to support each function.

The final product of the planning process is a set of six formal plans, each of which is described in turn. (1) The System Development Plan identifies the corporation's need for management information systems and is the basis for the development of other plans. (2) The Managerial Plan establishes personnel staffing requirements and professional development programs. (3) The Technical Plan formulates technical programs to support the systems development and operations efforts. (4) The Equipment Plan is a five-year plan which identifies computer hardware needed and the approach to optimizing the use of equipment resources. (5) The Support Facilities Plan identifies the need for auxiliary support services, equipment, and facilities. (6) The Budget and Financial Plan provides for reports on the financial resources required to support the management information systems program.

The structure of "Action Programs," the implementation of the plans, is outlined and some of the most significant implications of this planning approach are noted.

McFarlan, F. Warren.
"Problems in Planning the Information System."
Harvard Business Review, March-April, 1971. pp. 75-89.

Based on a survey of 15 companies using computer based information systems (CBIS), certain conclusions are reached on what constitutes good planning practice in the computer environment. The principal pressures to plan are first discussed. These include technical improvements in hardware and software, the scarcity of trained manpower, the scarcity of corporate resources, and the trend to systems integration.

The most significant factors which differentiate those companies which are successful CBIS users from those which are not successful are the quality and content of written plans. The contents of a sample plan are shown and its key features discussed. Other factors important to the planning process are the relation to corporate planning, to top management, and the structure of the plan itself. The need for centralized planning is stressed as a means of coordinating the work of multiple divisions and realizing the benefits of centralized computer systems.

Two case studies are presented, the first a division of a major aerospace company, and the second, an international manufacturer of electrical equipment. Their experiences show the need for a CBIS plan and structure that is tailored to the company's specific needs. Finally, four key issues for the future are examined: the comparative benefits of the top-down and bottom-up approaches to planning; the level of detail needed; the time horizon; and whether a company should look for outside services.

Brown, W. F.; Sibaud, R. E.; and Hodgkins, G. L.
"Planning for the Future Computer Complex."
Computer Decisions, January 1973. pp. 30-35.

Seven basic elements of long range planning for the computer complex are identified and discussed. (1) A statement of long range goals and objectives should reflect the company's goals and objectives. (2) The goals of the computer complex should be stated in terms of general functional goals and specific operational goals. (3) An assessment of current status should include an inventory of resources (hardware, software, and personnel), cost breakdowns, and significant accomplishments for the past year. (4) The strengths and weaknesses of the organization should be assessed against the principal resources of the computer complex, including management. (5) A forecast of future technology should consider the impact of changes on the company, the computer installation, and management philosophy. (6) Action plans should be developed in the form of schedules for hardware, software, personnel development, etc. (7) An estimate of the resources needed must be prepared in the form of dollar and facility requirements.

Some basic principles of planning are discussed for use in the development of the computer complex plan. These cover the setting of responsibilities, the participation of subordinates, the concurrent definition of resource requirements, and the documentation of assumptions.

Schwayder, Keith R., and Vierra, Fred A.
"The Top Computer Executive's Boss."
Data Management, June 1972. pp. 17-20.

The job complexity and difficulty of the Top Computer Executive's (TCE) boss can be attributed to several factors: a trend toward a higher reporting level of EDP, where the TCE's boss has less experience with EDP; the increasing technical complexity of EDP; and the increased strategic importance of the computer. Several key decisions made by the TCE's boss are noted, including the evaluation of the TCE's capability to direct EDP operations, review of the ADP budget, utilization of the computer in key areas of the business, and review of the risks associated with the computer.

Several tools which can help the TCE's boss to evaluate these decisions are suggested: a statement of corporate goals, objectives, and strategic and tactical plans; a performance plan (a sample plan for a Director of Management Information Services is included); audit reviews encompassing the status of internal control, resource utilization, and cost/benefit analysis; internal pricing mechanisms; and a computer usage committee. The basic reasons why the TCE himself should adopt these techniques are discussed.

Watson, D. B.
"EDP Policy: Control is Objective."
Administrative Management, July, 1970. pp. 49-51.

Management's responsibility for setting objectives and determining policy in the ADP environment is examined. Specific areas to be covered in the setting of policy should include the prime purpose for having a computer, specific management requirements such as feasibility studies, equipment utilization levels, supplier standards, and documentation.

The need for long-term planning, management's participation in systems development, and the organizational placement of the computer are seen as the three basic control functions which should be exercised by management over computer activities.

An inset deals with the question of charging users for computer services and recommends a standard cost system as opposed to treating the computer as an overhead item, or charging on an hourly usage basis.

ECONOMIC EVALUATION OF ADP PROPOSALS

Emery, James C.
"Can We Develop Cost-effective Information Systems?"
Management Informatics, Volume 1, Number 6, 1972.
pp. 243-49.

The question of cost-effective systems is examined in the context of the value of information, the cost of information, and the tradeoff between the two. A three step approach is suggested for evaluating the value of information and its use is illustrated. A simple model is used to depict the idea that an optimum point exists in terms of information value versus cost.

The achievement of more cost-effective systems can be realized either through cost savings or increased effectiveness. In the former category, specific approaches include improved computer operations, use of multiple vendors, purchase and lease options, proprietary software, changes in the hardware configuration, program optimization, program conversion, data compression, centralization, and specialized systems. Increased effectiveness can be achieved through improvement of the information content of data bases, greater selectivity in reporting, improved timeliness of information, better reliability and accuracy, and improved flexibility of the information system.

The primary benefits of improved information are in the areas of more efficient resource utilization, improved service or quality, and improved management information. The problems of evaluating tangible versus intangible benefits are noted, and some suggestions given for providing management with greater assistance in making cost-benefit judgments.

Fried, Louis.
"Computer Applications Justification."
Cost and Management, July-August, 1971. pp. 35-40.

The recognition of the need for improvement in a process or function of the organization is the first identifiable point in the task of system justification. Subsequent steps involve the identification of the underlying problem, the alternative solutions, and the analysis of those alternatives. The make-or-buy decision is considered and the type of presentation required by management in order to select the best alternative is described.

A methodology for evaluating tangible benefits is presented, including examples of forms for detail and summary costs, cash flow, and payback analysis. A brief description is given of the use of each form. The savings (loss) of each alternative is computed for each year by subtracting the total cost of each alternative from the cost of the existing system.

Intangible benefits are also discussed briefly in terms of the type of information management needs to make a decision. The management processes involved in the selection of computer applications are likened to those involved in product introductions or changes in the production process. As such, the justification is similar to any other capital investment decision.

Hollingworth, F. D.
"Evaluating Computer System Projects."
Canadian Chartered Accountant, May, 1971. pp. 331-333.

Four basic reasons for evaluating computer system projects rigorously are first identified, and the need for continuing evaluation is emphasized. The evaluation process consists of the identification of both benefits and costs. Tangible benefits are those that can be definitely measured, and are primarily in the cost reduction category. Intangible benefits are those which cannot be measured explicitly, although the author recommends that they be quantified in some way. As a last resort, he recommends a "backward" approach that gives the level of benefit required to produce the minimum acceptable rate of return.

The most important development costs to be considered are analyst and programmer time, and some hints are given for preparing accurate estimates. Other development costs to be considered are indirect costs and computer test time. Operating costs should be separated into data preparation and computer processing components, and maintenance costs should be estimated for the life of the system.

The recommended approaches to evaluating projects, given a quantitative statement of benefits and costs, are payback period, return on investment, cash flow, and present value.

Chervany, Norman L., and Dickson, Gary W.
"Economic Evaluation of Management Information Systems: An Analytical Framework."
Decision Sciences, Volume 1, 1970. pp. 296-308.

MIS development is viewed as a problem in decision making for which few operational ideas exist. The prime responsibility of the MIS specialist is to synthesize the major ingredients of the decision problem (controllable variables, constraints, and uncontrollable variables) and to project payoff functions. A framework is proposed for the decision activities in MIS development consisting of a set of analysis and design decisions. Analysis concentrates on the specification of the requirements that the MIS must meet, i.e. the specification of the scope of the system, the specification of information requirements, and the specification of data requirements. Design decisions focus on the statement of processing system requirements, installation requirements, and operations requirements. The economic impact of MIS development decisions must be viewed in the context of the six identified decision stages. A time-oriented analysis of costs and benefits is presented although the authors contend that this does not aid in evaluating the economic benefit of the MIS. Instead, they argue that MIS payoffs must be considered in the framework of decision activities. The lack of mathematical relationships between costs and benefits is noted, further emphasizing the reliance on the decision/payoff relationships. Several areas for further research are suggested.

Pomrinse, S. David; Repe, David N.; and Richard K. Slavin.
"Cost-benefit Analysis of Computer."
Hospitals, March 16, 1972. pp. 76-82.

A study conducted by Mt. Sinai Hospital to evaluate the feasibility of a new computer system is described. The analytical approach that was used consisted of four models, a terminal load model, a terminal user queuing model, a computer loading model, and a cost model. The output of the terminal load model consists of a series of three printouts which show terminal utilization for a week's period and the types of transactions causing the heaviest load. The output of the terminal user queuing model provides data on how many terminals are required at a given location to satisfy an upper limit on wait time. Outputs of the computer loading model are not described. The cost model reports on all of the major cost elements for three levels of system service.

Certain cost offsets were considered in the evaluation, including cost of present hardware, systems personnel to be displaced by the new system, and reductions in clerical personnel. The consideration of capital cost as another offset is also examined. Finally, generalization of the study approach to other hospitals is discussed.

Knutsen, K. Eric, and Nolan, Richard L.
"Assessing Computer Costs and Benefits."
Journal of Systems Management, February, 1974. pp. 28-34.

A case study is initially presented to show that an administrative decision to proceed with a requirements planning computer application paid off significantly, in spite of the fact that it was not cost justified in terms of actual dollar savings. Two fallacies of the capital investment analysis approach to computer applications are noted: first, that costs and benefits are known and susceptible to quantification at the outset; and second, that quantitative measures should be used to set priorities of computer projects.

A multi-dimensional evaluation of computer projects is recommended which treats costs separately from benefits. An approach to estimating costs at various stages of development is recommended which leads to a firm cost estimate approximately 25 per cent of the way through the project. Detailed timetables and key milestones are suggested as alternative control mechanisms. The assessment of benefits should be divided into quantifiable and non-quantifiable groups, with senior management dealing primarily with the latter. Benefit areas to be considered, listed from the most to the least quantifiable include equipment displacement, direct cost displacement, indirect cost displacement, sales increase, managerial planning and control, and organizational impact. The authors conclude that a framework which includes costs/benefit assessment and management review of proposed and ongoing systems will be more effective than approaches based solely on full quantification of costs and benefits such as ROI.

Coe, Ted L.
"Allocating the Corporate Information Processing Resource."
Journal of Systems Management, August, 1974. pp. 18-22.

It is argued that the most typical measures of the data processing organization's effectiveness are inappropriate and not specifically related to the potential contribution to corporate objectives. Two views of the information processing structure are discussed: an organizational view and a process view. The organizational view encourages the use of cost-center control techniques, while the process view is more directly related to the question of project acceptance.

An approach to project approval is suggested that enables management to evaluate the impact of a proposed project on corporate resources and financial position. Estimates of both costs and benefits are needed, but this article stresses the benefits area. A framework for analysis of benefits recognizes both measurable and non-measurable benefits. Measurable benefits fall into two categories: direct cost replacement and indirect cost and revenue changes. An example is given to illustrate the approach. The third category covers benefits in key-result areas and a list of such areas with examples of their qualitative characteristics is given. This analysis allows the firm to evaluate proposed projects on the basis of their effect on those areas identified as critical to the firm.

The framework suggested has the advantage of focusing on the critical problems of the firm, what is gained from the system rather than its cost, and the needs of the user.

COST ESTIMATION FOR ADP SYSTEM DEVELOPMENT PROJECTS

Estes, Neil.
"Step-by-step Costing of Information Systems."
Journal of Systems Management, August, 1969. pp. 31-35;
October, 1969, pp. 20-28.

This two-part article presents a general examination of the steps involved in estimating costs on computer system projects, primarily for the cost analyst who may not be expert in the computer field. Part 1 focuses on the purpose of the estimate, describing the system, and planning the costing effort. The purpose of the estimate may be considered as either a planning type based on a "value flow" concept, or a budgeting type representing a "cash flow" concept. Major considerations in the preparation of the estimate include the scope of activities to be costed, the consistency of the methods used, and the sophistication of the technique.

Describing the system involves understanding system development as an activity, definition of requirements, and the specific functions of system analysis, cost analysis of alternative designs, programming and implementation. In planning the costing effort, the analyst is advised to apply his time in proportion to the relative magnitude of cost elements, their potential variation, and the payoff in research effort. The level of aggregation at which each major type of cost is to be estimated is also discussed.

Part 2 examines the collection of cost data, the derivation of the cost estimate, presentation of the estimate, and use of the estimate for decision making. The scarcity and quality of data are seen as two of the major problems in the collection process and the use of multiple inputs, analogies, and subjective inputs are suggested as methods for improving data inputs. The use of Cost Estimating Relationships (CER's) is discussed at length. Derivation of the cost estimate itself is presented as a melding of heterogeneous data inputs into an integrated single estimate. The use of single-data inputs and multiple-data inputs are discussed and the use of weighting techniques when dealing with multiple-data inputs is illustrated. The problem of uncertainty and its expression is also introduced.

Presentation of the estimate must involve a statement of uncertainty, the general ground rules, and standardizing concepts in order to avoid misunderstanding. Finally, the estimate as a management decision making tool, and the role of the cost analyst in this context is considered.

Gayle, John B.
"Multiple Regression Techniques for Estimating Computer Programming Costs."
Journal of Systems Management, February, 1971. pp. 13-16.

A study is reported in which multiple linear regression equations were fit to various combinations of independent and dependent variables in order to develop equations for predicting programming costs. Data was collected by means of questionnaire for IBM System 360/40 systems and for programs written in COBOL. Methods used to insure reliable data are discussed. The dependent variables to be predicted were man-months, calendar months, and computer hours. The three most frequently selected predictors were the log of the distance between programmer and computer, output formats, and programmer experience. It is concluded that the technique is highly sensitive to the independent variables selected and the range and distribution of the data, although it is felt to be a valuable predicting tool for existing facilities.

Fried, Louis.
"Estimating the Cost of System Implementation."
Data Processing Magazine, March, 1969. pp. 32-35; April, 1969. pp. 24-28.

Line managers often require estimates of EDP projects at an early stage in order to make go/no go decisions. Such estimates require the definition of the basic elements comprising systems analysis and programming, and these are defined. The primary problems in estimating systems analysis are in the areas of problem definition, systems survey, and synthesis (the systems specification phase) which establish the parameters, specifications, and scope of the application. The author states that this portion of the systems analysis function "cannot be estimated with any degree of accuracy." The remaining elements of the systems function comprise two phases, systems definition and systems implementation, which can be estimated with reasonable accuracy.

Part 2 of the article focuses on estimation of the programming function, which is considered to be quite feasible. Estimates are generally based on past experience and subject to the major variables, hardware, software, personnel, and program complexity. The need for historical data on which to base programming estimates is emphasized and several specific techniques for estimating are described.

A three step procedure for estimating is recommended:
(1) Establish system specifications independent of the system definition phase and prior to any project estimate; (2) Prepare an estimate of the systems work when the System Specification has been completed, in writing; (3) Estimate programming costs upon completion of program specifications.

Wolverton, Ray W.
"The Cost of Developing Large-Scale Software."
IEEE Transactions on Computers, June, 1974. pp. 615-636.

The essential results of efforts at TRW to improve software cost estimating techniques are presented. Initially, some of the characteristics of software development which contribute to the problem of estimating costs are reviewed. The software development cycle is defined in terms of seven steps each ending in a discrete event or document. Some traditional methods of cost estimating are reviewed (top-down, similarities and differences, ratio, standards, bottom-up) and a systems approach to software cost estimation developed at TRW is described in detail. A software cost estimation algorithm is then introduced and its use and outputs described. The major advantages of the cost estimation approach are summarized.

The need for a software cost data base is discussed and brief definitions of activities that have been identified for such a data base are given. Some actual data is presented and the conclusion is drawn that there are no simple universal rules for costing software accurately. Several comments are made on the most cost-effective allocation of resources to the various phases of development over the entire period of a software project.

Answers to several key questions are attempted in the summary: (1) What is the typical code production rate per programmer man-month? (2) How does code production rate vary with problem complexity? (3) How does this rate vary as a function of computer availability? Accessibility? Configuration? (4) What are the pieces of information required to make a realistic prediction of software development cost? (5) How does code production rate vary as a function of programmer quality? Quality requirements on the final product? (6) How does cost vary with completeness of problem formulation? and (7) What is the role of "design-to-cost" in the development of large-scale software?

Brooks, Frederick P., Jr.
"The Mythical Man-month."
Datamation, December, 1974. pp. 44-52.

Some fundamental problems in the scheduling of computer projects are addressed. The inherent optimism of programmers leads to estimates that are generally too low, and the typical reaction of management to solve a schedule problem by adding more men is challenged. Training and additional communications tend to reduce the effectiveness of the team when additional manpower is added, thus lengthening the schedule. Failure to allocate sufficient time to system testing is another cause of poor schedules.

Data is reviewed from several sources to show the striking differences in productivity related to the complexity and difficulty of the task. The idea is also put forth that the greatest problems stem from an accumulation of small schedule slippages rather than major calamities. The PERT chart is recommended as a means of establishing concrete milestones against which management can evaluate project progress. Some typical human problems relating to the reporting of schedule slippage are examined and some steps that can be taken by management to overcome inadequate reporting are suggested. The PERT chart is seen as the vehicle for schedule reviews, serving essentially as an agenda for a status review meeting.

Cooke, Lawrence H., Jr.
"Programming Time Vs. Running Time."
Datamation, December, 1974. pp. 56-58.

Two examples are given to show the trade-off between the development time of a program and its execution efficiency. In one case, a four-month slippage in the development of a program cost a company \$4 million. In the second case, a real time system was so dependent on the program's ability to handle five messages a second that any hardware downtime could result in a backlog that could not be recovered.

In order to investigate this trade-off, an experiment was conducted to evaluate a programming problem using different higher-level languages and different computers. The problem was to compute Treasury bill yields, given the price at which the bills were auctioned. The languages chosen included FORTRAN, APL, ALGOL, and a Procedure Oriented Language (POL). The languages were divided into two groups, interpretive (APL and a POL) and compiler languages (FORTRAN and ALGOL).

In general it was shown that execution time was roughly the inverse of development time. Specifically, several conclusions were drawn: interpretive languages offer faster development than compiler languages; compiler languages produce more efficient code and should be favored if the program is to run frequently; both development and efficiency can be improved by the use of expert programmers on the critical areas of a system; and a two-pass approach (early development of an interpretive prototype followed by a compiled system later) may yield the best long-term results.

Boehm, Barry W.; Robert K. McClean; and D. B. Urfrig.
"Some Experience with Automated Aids to the Design of Large-scale Reliable Software."
IEEE Transactions on Software Engineering, March, 1975. pp. 125-133.

Some recent experiences in analyzing and eliminating sources of error in the design phase of large software projects are summarized. Initially, the most significant differences in software error incidence between large and small projects are identified, the most striking difference being the number of design errors over coding errors in large projects. A taxonomy of software error causes is presented and analyzed to show alternative methods of preventing, detecting, and eliminating the errors.

A hypothesis is formed regarding the potential cost-effectiveness of an automated aid to detect inconsistencies between assertions about the nature of inputs and outputs of the various elements of a software design. A prototype version of such an aid, called the Design Assertion Consistency Checker (DACC), was developed and utilized on a large scale software project with 186 design elements and assertions about the nature of 514 inputs and 453 outputs. Results are reported in terms of the number of mismatches identified. The hypothesis is confirmed about the usefulness of the aid, both in terms of useful features and low cost. Some additional features are proposed to make up for some of the deficiencies identified.

Chaplin, Joseph E.
"A Feasibility Study Guide."
Journal of Systems Management, July, 1969. pp. 20-26.

A seven-step approach to a computer feasibility study is presented. Prior to the study, an initial justification is recommended to determine the data processing requirement and the economics of establishing a data processing facility. The seven steps of the procedure include: (1) Preparation of the study plan stating objectives, a time schedule, and a cost budget; (2) Analysis of the existing system to determine the cost of operations that will be impacted by the proposed system; (3) Development of the proposed system, at least in general terms; (4) Selection of equipment and cost determination covering such factors and recurrent monthly expense, processing time and reserve capacity, overtime policies and definition of use time, ease of expanding capacity, and availability of special features; (5) Installation cost documentation covering training and education, systems design and programming, site preparation, program testing and parallel operations, data conversion, and one time costs; (6) Evaluation of study results using a five-year projection to compare the projected savings of the proposed system over the present system; (7) Preparation of final recommendations to management.

Special attention is given to the rent/purchase/lease decision. The major advantages of each approach are cited and some specific questions are given for consideration. Sample forms are shown for a five-year evaluation of proposed system savings and a rent versus purchase analysis.

Fried, Louis.
"How to Analyze Computer Project Costs."
Computer Decisions, August, 1971. pp. 22-26.

The general procedure to be followed for the cost and payback analysis of a computer project is explained, using a personal trust accounting system as an example. The identification of alternatives is first studied and the methods used to develop cost estimates are outlined. Costs considered in the analysis included the amortization of implementation and conversion costs over the life of the system, operating costs, clerical costs, and other one time costs. Forms are shown which were used in the development of cost estimates.

The evaluation of alternatives, including the "make or buy" decision, is described, including visits to other installations as a means of collecting data on other users' experiences. The comparison of estimated costs of the proposed alternatives and the actual cost of the present system are then considered. Work sheets and cost summaries used in the analysis are described and illustrated. These included separate work sheets for implementation and operating costs as well as summaries by year. Annual worksheets were consolidated into a five year operating cost chart for presentation to management. A cash-flow and payback analysis was also prepared, and intangible benefits considered.

"The System Proposal."
Data Processing Manual, Auerbach Publishers, Inc., 1973.
Section 4-02-01, pp. 1-7.

The report suggests that a system proposal be prepared and approved before any commitment is made to dedicate manpower to a system design. The proposal should deal with such areas as how to arrive at a basis for sound cost and manpower estimates, how to develop a system which is acceptable to the user, and how to cancel projects that are not economically feasible. Suggested contents of the proposal include a brief system definition, the desired outputs, the main design concepts, development and cost estimates, operational phase-in, operation of the system, the need for the system, specific benefits, the major steps to be performed, a proposed schedule and a recommended course of action.

Cost estimates should be made for both manpower and machine time. Manpower costs should be broken down into five elements: analysis of present operation, preparation of design specifications, programming, preparation of the final system documentation, and system phase-in. Machine time estimates apply to the programming phase and to system phase-in.

BUYING ADP GOODS AND SERVICES

Snyders, Jan.
"Software: The Make or Buy Decision."
InfoSystems, April, 1973. pp. 38-40+.

It is initially recommended that the user have a reasonably good estimate of the cost of developing a program in-house before considering the purchase of a package. The major items of interest in evaluating a commercial package are then reviewed. These include: cost, both direct and indirect; availability and operational history; system configuration and its impact on throughput; documentation supplied by the vendor; support, in terms of training, installation, etc.; modularity and the ability of the package to handle changes in volume and application growth. The value of contacts with other users, demonstrations, and trial periods are stressed.

The major considerations for the user in contract negotiations are considered. The lease versus purchase decision, discounts, proprietary rights, and reliability are discussed. Cautions regarding delivery and installation are expressed and a checklist is recommended. A number of specific documentation items are listed and some warnings raised about on-site assistance, modifications to the package, and pricing.

Fried, Louis.
"Shopping for Commercial Software."
Data Processing Magazine, August, 1970. pp. 37-39.

The major benefits of commercial software packages are their low costs compared to the cost of in-house development, their usefulness in freeing up analysts and programmers for development of systems unique to the business, and reduced problems of maintenance. A project team approach to the evaluation and selection of a package is recommended. The steps involved include a statement of general system requirements, identification of alternatives, a preliminary screening, and a detailed examination of capabilities, preferably using some form of objective weighting scheme. The types of selection criteria to be used are identified and a number of questions for vendors are listed. Major considerations for contract negotiation are also covered. These include liability, warranties, maintenance and improvements, and pricing.

A flow chart of the decision process is presented along with a set of 14 questions important to the project manager and systems analyst, and a set of 11 questions pertinent to the programmer.

Rullo, Thomas A.
"Understanding the Software Package Market."
Data Processing Magazine, July, 1970. pp. 35-38.

Increasing labor costs and data processing staff instability are seen as two of the major contributing factors to the growth of the software industry. The sources of commercial packages include original developers (users), brokers, and software houses. Some of the key considerations in dealing with each are noted. The availability of software through user groups and government organizations is discussed, along with some of the basic problems of the software industry, particularly pricing and support.

Two evaluations are necessary in making the decision of whether to develop or buy a package: analysis of requirements, and weighing of alternatives. After these evaluations are made, other factors must be considered. The major arguments in favor of in-house development are skepticism over the claims for a package, differences in standards, and maintenance and updating problems. The arguments in favor of buying a package are time savings, lower cost, and limited staff to develop a package in-house. The primary considerations in the selection process are the flexibility of standards and performance evaluation.

Streeter, D. N.
"Cost Benefit Evaluation of Scientific Computing Services."
IBM Systems Journal, Number 3, 1972. pp. 219-233.

Experience gained over several years in providing a variety of computing services to staff members at the IBM Thomas J. Watson Research Center is described. Attempts to understand and quantify the effects of various services on the researcher and his work are quantified. A single jobstream batch processing system model is used to illustrate the increase in system response time with increasing system utilization, termed the system capacity characteristic. Also introduced is the observation that the relative value of computation to an experimenter decreases with time. A two jobstream model illustrates the effect of the priorities both on value to the user and on system capacity. Using a test program, these factors are evaluated for a variety of systems, including time shared systems.

System cost and user benefit tradeoffs are examined for three types of usage: computation only; programming, debugging, and computation; and problem formulation, programming, debugging, and computation. Using a method of differential costs and benefits, it is concluded that a time sharing system is justified where the differential productivity benefits exceed the differential system cost for the average level of loading on that system. The relative values of three services (interactive, high speed batch, and batch) against a continuous spectrum of system responsiveness is illustrated. It is concluded that the immediate advantage of policies that encourage the right choice of computing service is more effective use of equipment and greater productivity of people.

Zani, William M.
"Real-time Information Systems: A Comparative Economic Analysis."
Management Science, February, 1970. pp. 8-350-355.

This paper presents the findings of an empirical study on the costs and benefits of real-time information systems supplied by a computer utility. The suppositions were that costs would be higher for the real-time systems as compared to conventional batch systems, real-time systems would have a positive influence on the operations of a business, and that a marketing advantage could be gained by the use of a real-time system. The research was conducted by comparing three wholesale liquor suppliers using a real-time invoicing, inventory, and accounts receivable system with three comparable firms using batch systems.

The findings of the research were the reverse of expectations. Operating savings due to inventory level were not significantly lower for the real-time group. Operating savings due to reduced receivables were no better for the real-time group. No competitive advantage was realized for those using real-time systems, either in terms of response to customer orders, response to customer and salesman information requests, or inventory stockout performance. Finally, data processing costs were lower for the real-time group. The conclusions reached are that real-time systems do not automatically produce savings for a company, and that benefits can be realized only if the systems are meaningfully integrated into a management process.

Baker, Laurence H.
"Consider the Alternatives Before You Upgrade."
Computer Decisions, May, 1972. pp. 33-35.

A case is made for the consideration of other alternatives before a decision is made to upgrade a data processing system. Some of the reasons why arguments for an upgrade may be invalid are given and the various alternatives to upgrading are considered. Three specific options for financing new equipment are then compared: rent, purchase, or lease. The comparison is based on the use of a time sharing model which computed cash flow differentials for a five year period. A sample of the computation is included.

CONTROL OF ADP SYSTEMS DEVELOPMENT ACTIVITIES

Sollenberger, Harold M.
"Management Control of Information Systems Development,
Part I - Introduction."
National Association of Accountants, 1971. 23 pp.

This study reports on research carried out to determine the actual practices and views of representative firms in managing management information systems development. The research approach is outlined and the three major issues to be examined are identified: management involvement in planning and control of information systems, the information system manager's organizational planning and control techniques, and management control of systems development projects. Eight basic conclusions were drawn from the study: the main ingredient in successful management is experience in general management; user support should be the major objective of the system function; management involvement is needed at every level; a clear-cut assignment of responsibility is critical; open communications between the system function and the user is essential; a planning and control framework is necessary; economic justification of projects is required; and a sufficient authority level and adequate independence are necessary for the system function. Other conclusions relative to management involvement, systems function management, and project management are also given.

Chapter 2 examines the functional role of information systems in the firm and the scope of the information systems function. The need for a documented statement of the scope of the system function is given and an example of such a statement is included. The system manager's role is examined and the major qualities of the individual are noted. Managerial prowess rather than technical skill are emphasized and some corrective actions for typical problems in systems development are suggested.

Schefer, Edward A.
"Management Control of the Corporate Computer Activity."
Data Management, September, 1972. pp. 45-56.

This article concentrates on the approaches and practices to properly plan and control computer systems activities. Five basic areas are addressed: management and user involvement; information systems department organization; systems development standards and procedures; project and personnel planning and control; and computer operations practices. A computer control board at the corporate level and a divisional control board are recommended as means to encourage greater management involvement. The duties of each are described. An information systems department organization is recommended that is based on five areas of specialization: systems development, technical services support, data center operations, administration and planning. The role of each is briefly described.

A standard task approach to the development and maintenance of new systems is recommended. A six phase approach is described, including the feasibility study, system specification, system engineering, programming and procedures, systems acceptance and implementation, system support, and improvement. The key tasks and responsibilities are discussed and a flow chart and responsibility table are included for each phase. A seventh phase, special projects, is defined for projects that may not go through the normal sequence.

Administrative control techniques needed to support the information system department are outlined. Project initiation, the project work plan, appropriate controls for each phase, and a project and personnel reporting system are discussed.

Probst, Frank R.
"A Framework for Planning and Controlling New Computer Applications."
Cost and Management, July-August, 1972. pp. 17-21.

The computer facility is treated as a scarce resource, and the author argues that some allocation procedure is required. He suggests that a budgeting structure that attempts to quantify costs and benefits of computer applications is needed, and challenges the contention that benefits are intangible and therefore not quantifiable. In order to get operating management involved, he suggests the formation of an ADP co-ordinating committee, particularly from the point of view of assessing benefits.

The costing of new applications is the responsibility of data processing management. An approach to standard costing is outlined for the programming function which basically amounts to a formalization of existing estimation procedures. Responsibility accounting is proposed as a cost control framework and a set of performance reports are described. Costs are associated with the individual responsible for them and direct management's attention to problem areas. Individual reports are aggregated into an ADP Center Performance Report.

The implications of the suggested framework are that the components of the expected average project cost (standard) function as predetermined goals for employees, and the predetermined project cost represents the charge to the operating department.

Pokorney, Joseph L.
"Systems Management for Data Processing."
Management Controls, November, 1971. pp. 223-229.

Systems planning and project management are seen as the primary goals of data processing management. Systems planning is the process of translating new ideas, user requirements, technology and resource availability into a comprehensive data processing plan and budget. The planning cycle is described as a series of feedback loops from four major tasks: the organization's goals and objectives; programs to accomplish objectives; cost/benefit analyses for alternative programs; and program budgeting, the basis of a multi-year financial plan.

Project management establishes definitive project plans, assesses progress against those plans, and takes corrective action. Emphasis is placed on the definition of project life cycle tasks and the roles of specific groups such as top management, system users, developers, and operators. Three elements of project management are discussed, specification development, baseline management, and quality assurance. A hierarchy of specifications that describes the system throughout its life cycle is outlined. The various elements of design documentation provide system baselines against which change can be measured. Finally, quality assurance involves the users through design reviews, systems testing and documentation audits.

The combination of systems planning and project management is seen as a comprehensive approach to managing data processing systems. Both processes occur simultaneously and require controlled participation of all parties.

McReavie, Kenneth S.
"A Conceptual Approach to Computer Controls."
Management Controls, July, 1972. pp. 166-173.

Organizational concepts and their role in establishing and assigning responsibility for control activities is first discussed. Limitations of traditional organizations, and the advantages of giving data processing broader responsibilities are noted. Several key organizational and control elements are examined: delineation of duties, job descriptions, functional expertise, and personnel turnover. The need for standards against which data processing can be evaluated are discussed.

A project control system is advised, possibly using PERT or CPM methods, to monitor progress against plan. System design, programming and operating standards are covered. The system design function is responsible for input, process, and output controls. Programming and operating standards are suggested, along with operating control reports. Physical controls are discussed for storage of files, atmosphere, physical access, tape/disk libraries, housekeeping and backup. Sample forms are included for a project control record, project schedule and status report, and a data processing operations report. A systems documentation requirements chart is also included.

McMillen, William E.
"Step-wise Management Controls."
Computers & People, April, 1974. pp. 8-9+.

The methods for accomplishing successful completion, orderly restructuring or timely abandonment of computer projects are the essence of "step-wise management controls." Resource allocation and priority setting govern the assignment of resources to competing projects. Top executive involvement in this process is urged in order to avoid delays and failures.

Project management is likened to product management in that the procedural steps for development of a system can be standardized into specific "unit projects" and planned in a manner similar to the "explosion" of a production schedule. A methodology called "PRIDE" is described that identifies nine major components which correspond to nine stages in a manufacturing process. The nine stages include: systems study and evaluation, general system design, sub-system design, administrative and computer procedure design, program development, computer procedure test, system test, system operation, and system audit. Each of the phases is managed separately and none is firmly scheduled until the previous phase is completed.

In spite of the extra time involved in documenting, estimating, and reporting actual time, the author indicates that time is actually saved in the long run, and that management involvement is assured.

"Managing the Development of a System."
Data Processing Manual, Auerbach Publishers, Inc., 1973.
Section J-03-01, pp. 1-21.

The concept of system development cycle has not been given adequate attention in the development of most systems. The greatest problems have been the diversity of opinion on what tasks are important, how tasks should be performed, and how tasks relate. The life cycle is defined as consisting of eight stages: conception, preliminary analysis, system design, programming, final system documentation, installation, operation, and cessation. Each stage is discussed, in sequence.

Conception of a new system may be initiated at any level, including the DP department, but should be reviewed by a high level group. Preliminary analysis determines the real information needs, summarizes the requirements of the application, and includes a preliminary cost estimate. The importance of the cost estimate, the involvement of the user at this stage, and the contents of the system proposal are discussed. The system design phase is conducted by the ADP department and a set of design specifications drawn up for user management approval. A list of design specifications is given. The next stage is programming and the primary management considerations are in standards for documentation and testing. Final system documentation requires several control points that must be passed prior to turnover of the system to operations. A four-level documentation package is recommended, covering general documentation, program documentation, DP operations documentation, and user operations documentation. During the installation stage, adequate testing is emphasized, and a minimal plan for operational phase-in of a new system is given. A centralized production control unit is recommended in the operations stage and some of the problems of turning over a new application to operations are discussed. Finally, the cessation stage is marked by decline in the usefulness of a system.

Benoit, Paul S.
"Toward Better Management of People."
Journal of Systems Management, October, 1971. pp. 30-34.

The lack of a systematic approach to the management of systems and programming personnel is discussed. Some of the causes have included an over-emphasis on hardware technology, a shortage of competent managers, high personnel turnover, and too few management principles that applied to data processing.

A five-step approach to overcome this problem is recommended. Step 1 is to determine the tasks and subtasks which are performed during analysis, design, programming, implementation and follow-up of a system. Step 2 involves arranging tasks and subtasks into a logical and efficient sequence. A sample list of tasks and subtasks is given. In step 3, management control points are defined along with the level of management which will exercise the control. Control points are related to the assignment of tasks and subtasks under specific categories as defined in step 2. A flow chart shows how management control might be established. Step 4 requires the documentation of tasks and subtasks and where necessary, directions for turning them into permanent procedures. Documented procedures provide the necessary guidelines for accomplishing the installation's objectives. A Standard Practice Instruction format is suggested. The final step is to implement the procedures and insure that they are followed. The author concludes that by adopting the recommended approach, data processing management will again be able to plan, organize, staff, direct, and control.

CONTROL OF ADP SYSTEM DEVELOPMENT PROJECTS

Powers, Richard F. and Dickson, Gary W.
"MisProject Management: Myths, Opinions, and Reality."
California Management Review, Spring, 1973. pp. 147-156.

A number of commonly-accepted MIS principles are questioned, based on an investigation undertaken to answer the question: "What organizational and procedural factors are correlates of success with MIS projects?" Answers to the question were collected both by opinion survey and empirical research in the field. The opinion research was based on a ranking of MIS project factors by 140 MIS professionals. The field research was based on a study of two MIS projects in each of 10 firms. The criteria of success were time, cost, user satisfaction, and impact on computer operations.

Results indicated that considerable difference exists between what people thought to be related to MIS project success and what the depth research showed to be significant relationships. Specifically, it was found that the results applied only to MIS projects and not other types of data processing projects; that the active participation of the actual managers who will use the products is crucial to success; that high documentation standards did not assure quality projects; that estimates were invariably poor; that higher user satisfaction resulted when combination analyst/programmers were used; and that project leaders and users did not usually agree on user requirements, nor what constituted implementation problems.

Harris, William I.
"Project Scheduling."
Data Management, September, 1971. pp. 40-43.

The general management function of planning, and the more detailed requirements of project planning are first discussed. The project plan is introduced as a vehicle for insuring that nothing is omitted or overlooked, a format for reporting and distributing information on a project, and a basis for formal status reporting. The project plan contains schedules, and some of the key parameters relative to the consideration of time in scheduling are noted. A number of project scheduling tools are briefly discussed as means for tracking progress against schedules. These include logic networks, Gantt charts, the Line of Balance technique, dependency networks, CPM, PERT, decision trees, work breakdown structures, and IBM's Project Control System.

Hirsch, Rudolph E.
"Data Processing Can Be Cost Controlled."
Computers and Automation, December, 1971. pp. 8-15.

The failure of management to control data processing costs and to justify initial and continuing information requirements is seen as the cause of excessive DP costs. The author contends that traditional cost control procedures are applicable to computer systems. The basic components of computing costs are itemized and it is noted that an appropriate provision in the chart of accounts must be made. The need to account for all DP costs, including overhead items, is stressed.

Cost control of the programming function is a critical item in a cost control system and some of the reasons for cost overruns are discussed. A formalized time reporting scheme is proposed along with an example of a daily time sheet. A computer time log, either manual or computer produced, is also recommended and used in conjunction with the daily time reports to produce a project and program time and cost analysis and a programmer performance report. Samples of each report are shown. Cost accounting procedures for supplies and magnetic media are also considered.

The author concludes that programming can be managed like any other activity and suggests a programming estimating procedure based on the size of the program, its complexity, the efficiency of the assigned programmer, and computer test time requirements. The possibility of a prediction formula, based on these variables, is suggested.

Smith, Don, Jr.
"An Organization for Successful Project Management."
Proceedings of the 1972 Spring Joint Computer Conference,
Volume 40, pp. 129-140.

The thesis is proposed that success in software development is dependent on a proper separation of responsibility within the project organization in combination with extensive formal procedures. Some of the major problems in software development are then discussed and classified as unsatisfactory product, schedule delays, and excessive costs. The unsatisfactory product is generally caused by too many bugs, instability, or unsatisfactory performance. Schedule delays are normally the result of unrealistic schedules to begin with. Excessive costs are most often the result of schedule delays, low initial estimates, staffing too rapidly, staffing with quantity rather than quality, follow-on costs, and an inappropriate type of contract.

An optimal project organization is suggested in which the functions of development, integration, and project test are separated under the leadership of a project manager. The principal characteristics of good project management are summarized. Development activities are described in terms of the major development function, debugging tools, performance measurement tools, and dependency consulting and problem diagnosis. Integration activities provide for control and visibility of development activities. Test activities and the function of the project test group are outlined.

Procedures for providing project control and visibility are discussed, along with staff and general support activities.

Thompson, Lloyd A.
"Effective Planning and Control of the Systems Effort."
Journal of Systems Management, July, 1969. pp. 32-35.

The responsibilities of the systems man to plan, organize, direct, control and coordinate the systems effort are emphasized, and a four phase approach to a systems study is described. The four phases consist of systems planning, implementation planning, programming tasks, and system maintenance. Individual major and specific steps within each phase are listed.

Systems planning involves preliminary planning, fact finding, analysis, preliminary systems and methods design, the system proposal, and specification. Implementation planning becomes management's control tool for the implementation process, and establishes the specific tasks involved, the relationship among them, and a method for reviewing and approving completed tasks. Programming tasks are broken down into detailed systems design and programming, installation, and follow-up. Systems maintenance is required to adjust to revisions in operating objectives and requirements, and to optimize operation.

The problem of scheduling is noted, and some pertinent questions to ask in order to achieve a workable schedule are suggested. An installation schedule to guide the implementation of the system is recommended.

Keller, Arnold E.
"You CAN Control Computer Costs."
Business Automation, April, 1969. pp. 46-51.

This article is based on a project control system called Data Project Management System developed by the Photo Products Group of Bell & Howell Co. The types of reports produced by the system, and the types of management questions it is designed to answer are summarized. The underlying need for the system is related to the demand for ADP services versus the limited resources available to provide them. A standard policy and procedure for handling requests for service is outlined along with the approval process.

The method of controlling project tasks is described. Analysts and programmers report hours applied weekly by project and task which become inputs to weekly project control reports. The reports are used by management to review project status and variances from original estimates. Several other control practices are noted, including a review prior to the acceptance of an application for production, keypunch operator performance, and ADP operations performance.

A parallel is drawn between data processing and a manufacturing facility to show that controls can work in data processing, providing that users become involved in the planning process.

Dickson, Gary W.
"Control Systems for Information Systems Development Projects."
School of Business Administration, Univ. of Minnesota,
31 pp.

The subject of project control is presented as a subfunction of the overall project management system, and survey results are reported to demonstrate that the subject is not considered a primary problem by most EDP managers. An overall project management system is then presented as a six-stage process consisting of origination, proposal preparation, selection, analysis, design, and installation. Project control is primarily concerned with the analysis, design, and installation phases.

Project control techniques provide for the control of project time schedule progress, project cost performance, and project resource utilization. An example of project stage definition is given, which forms the basis for an associated project control document. Such a document is shown and consists of two sections, one dealing with project time performance and the second with cost measurement. The use of PERT or CPM as a basis for project control is also discussed, although the author indicates that, except for the very largest projects, these techniques may be unduly complicated.

A simpler system is suggested, using Gantt charts to control project duration, bar charts to control costs, and a time-based graphical analysis of resource commitments versus requirements.

Keelan, C. I.
"Controlling Computer Programming."
Journal of Systems Management, January, 1969. pp. 30-33.

A system for the control of computer programming at Johns-Manville is reviewed. All projects are initially submitted as a formal request for data processing service. The programming manager supplies estimates for programming and testing which, in conjunction with other cost estimates, become the basis for management approval. Once the project is approved, a programming projects form is prepared which includes a figure for "estimated hours to complete." The method of estimating programming is described, and it is noted that the company's worst estimates have been for prototype projects.

Each programmer accounts for his time on a weekly basis by project number, including projects for non-applied time such as training and work interruptions. Summaries of programmer time reports are prepared for management showing where each project stands relative to the estimate. Periodically, a report of completed projects is prepared.

Principal benefits of the system are that it facilitates long-range schedules of programmer's time, gives programmers a standard of performance, permits early detection of trouble, and keeps management informed.

Brown, William F. and Richard P. Mason.
"Applying Industrial Engineering Techniques to Computer Programming Management."
Journal of Systems Management, October, 1970. pp. 34-41.

A method to apply specific industrial engineering techniques to programming tasks is described, specifically to improve the output of a group of programmers and to give them more job satisfaction. The program is called Manpower Analysis and Performance Standards (MAPS) and utilizes the techniques of work flow analysis, work place layout, work simplification and methods improvement, facilities utilization, work scheduling and control, and work measurement. The steps involved in the installation of the program include: planning, training and indoctrination, definition, work analysis, controlled reporting, performance goals, and attainment of goals. The approach used by the industrial engineer in analyzing specific jobs and in the setting of standards is explained.

The application of the approach to a programming group was undertaken with the objective of improving output by 25%. A daily log was filled out by the programmers and a work flow was developed. Standards were set for specific activities and an example of one such standard is given. An overall increase in performance of about 40% was realized from the program. Other recommendations led to further savings and improvements. Based on the standards established, a standard reporting system was established. An illustration of a Program Performance Report shows how performance improved over time.

Boehm, Barry W.
"Software and Its Impact: A Quantitative Assessment."
Datamation, May, 1973. pp. 48-59.

Certain transferable conclusions about software development are drawn from an Air Force study on command and control information processing requirements and capabilities. Some statistics are first given to show the magnitude of the software problem in terms of dollars, and three opportunities for reducing software delays are discussed: increasing each individual's software productivity; improving project organization and management; and initiating software development earlier in the system development cycle. Improvement of programmer productivity can be achieved primarily through awareness of where time is actually spent, better languages, and structured programming. Some proven management practices are suggested and the concept of a "software-first" machine is proposed as a means of accelerating software development.

Some guidelines are given for the acquisition of hardware capacity relative to software requirements and the need for better definition of software requirements is discussed. The technical problems of software reliability are explored and some possible future developments that may help to improve reliability are noted. Finally, the lack of a software engineering data base is seen as a hindrance to the analysis of software problems.

An integral part of this article is a software quiz which addresses the following questions: Where does the software effort go? How do hardware constraints affect software productivity? Where are software errors made? How do compilers spend their time?

Black, Donald L.
"Controlling a Computer System."
Datamation, April, 1974. pp. 98-99+.

The need for cost control of programming changes is noted and an alteration control system in use at the Prudential Insurance Co.'s Financial Security Program office is described. The system is centered around two controlling documents, a computer alteration request form and a project/alteration cost-out sheet. The alteration request form is required whenever a modification is to be made to production programs. This form is filled out by the submitting group and the cost-out sheet is prepared in data processing. A detailed description is given of the review and approval procedure.

Use of the system has helped to reduce the ADP workload and eliminate crash projects. A reduction in the systems and methods staff was also realized,

Keller, Stephen P.
"Why Projects Fail."

Decision, December, 1974, pp. 53-55.

One of the primary reasons for failure of data process-

ing projects is that they are not properly defined at the

outset. No distinct beginning or end of a project is estab-

lished and because of this the project may never be completed

as such. Five distinct project phases are identified and the

indicators of an unsuccessful project during each phase are

described. The five phases include pre-initiation, initia-

tion, duration, termination, and post-termination.

Problems during the pre-initiation stage include the

lack of standards for estimating, inadequate definition,

short lead times for estimates, lack of knowledge about per-

sonnel availability, and undefined staff desires. The initia-

tion phase is hampered by lack of documentation, undefined

project leader responsibility, inadequate knowledge of tools

to perform the project, poor project definition, and lack

of planning.

During the duration of a project, some of the major

problems include inadequate reporting and reviews, changes

in personnel, lack of adherence to standards, unanticipated

resource requirements, and the lack of a project manager.

Many projects never really terminate, but for those

that do, deficiencies include the failure to maintain and

record history and statistics, inadequate quality control,

no attempt to transfer knowledge gained, no personnel evalu-

ation, and no formal turnover. After termination, the lack

of follow-up on user satisfaction may be symptomatic of

an unsuccessful project.

technique.

A simple approach to the control of computer test
time is presented, first, data is accumulated during the
month which identifies the programmer, cost, and machine
hours for each program in test. Second, the data is
summarized monthly to show cost, machine hours, and
number of programs tested by each programmer. Third,
average machine hours per program is computed by pro-
grammer and for the programming staff as a whole.
The data can be used by managers to determine and
control six aspects of program testing. Total dollars
spent are used to emphasize the costs associated with
testing and to encourage programmers to keep costs to
a minimum. Programmer testing efficiency can be deter-
mined by comparing to the group average and providing
for counseling where necessary. The validity of test
time charges can be insured by regular inspection of
the data. Required test time can be determined with
adequate accuracy and schedules adopted that provide for
adequate test time. Historical averages can be devel-
oped to improve estimating of future programming projects.
Comparisons with earlier estimates can be used as a
method of developing and refining the estimating

Journal of Systems Management, January, 1971, pp. 23-25.

Benoit, Paul S.
"Test Time Analysis: An EDP Management Tool."

The first is a key point systems review; an independ-
ent key-point systems review group is recommended and their
points fall between each of the five systems development
phases, basically study, basic systems design, detailed
systems design, implementation, and operations. The two
primary qualifications for review personnel are their tech-
nical competence to perform the review, and their independ-
ence from the persons responsible for the information being
reviewed. The make-up of the review team should consist of
a system designer, user representative, internal auditor,
and possibly someone from management.
The post-completion systems analysts compares and eval-
uates the expectations for the project with the actual re-
sults following implementation. The basic purpose of the
post-completion analysis is to improve future decisions,
correct past inefficiencies, motivate and control person-
nel, and evaluate personnel. An analysis of costs is in-
cluded to improve future estimates and decision making.
Analysts of benefits focuses on the degree of benefits
achieved. Finally, an analysis should be made to de-
termine if the original decision to proceed with the proj-
ect was justified, and if its priority relative to other
projects remains the same.

Two control tools are suggested to upgrade the quality
of project control. The first is a key point systems review;

Sollenberger, Harold M. and Arens, Alvin A.
"Assessing Information Systems Projects."

Management Accounting, September, 1973, pp. 37-42.

The five major hidden costs of computing are an-
alyzed. (1) The management-data processing communica-
tions gap is viewed as one of the prime areas for waste
and inefficiency in data processing. (2) The isolation
of the ADP department brings about poor work habits
on the part of programmers and excessive personnel
turnover. Suggestions are given on ways to improve
personnel relations. (3) The security required for
ADP programs and data requires extensive documentation
which is often inadequate, resulting in additional
costs for maintenance. (4) Old software is frequently
not revised and redesigned for new equipment. Old
programs running in the emulation mode use computer
capacity inefficiently, costing the company a great
deal in extra hardware. (5) The proliferation of new
applications put on the computer, without proper cost-
benefit analysis, results in ever-increasing require-
ments for additional computer power. In part, this
problem is blamed on the "full use" syndrome in which
management expects the computer to be "filled up"
without paying proper attention to the value of new
applications.

Laakka, Richard M.
"Keeping Your Computer Out of the Mill."

Computer Decisions, May, 1970, pp. 19-23.

Sollenberger, Harold M. and Arens, Alvin A.
"Systems Control and the Post-completion Audit."
Internal Auditor, March-April, 1973. pp. 22-33.

The growth of the concept that information is a valuable input resource much like those of men, materials, and money, in conjunction with the increase in complexity of information processing systems has led to a separation of the information processing function from users. This separation requires an increasing amount of control over system development projects. In part, this can be achieved through specific management decision points structured into the system development process. The seven phases of systems development are defined as idea origination, feasibility study, basic systems design, detailed systems design, implementation, operation, and the post-completion audit. The key decision points follow the feasibility study, basic systems design, detailed system design, and implementation.

The remainder of the article focuses on the post-completion audit, the intent of which is to compare the benefits and costs resulting from the new system with the expectations that existed when the project was approved. Its basic purposes are to evaluate systems personnel, to motivate personnel, to provide a learning experience for future systems decisions, to provide a means of early corrective action, to independently examine operating efficiency and effectiveness, and to conduct a final assessment of the entire project. The role of the internal auditor and the timing of the audit are discussed. In cases where development of a system extends over several years, a continuous audit process is suggested.

Burpo, Christopher W.
"Is the Post Audit Necessary?"
Data Management December, 1973. pp. 14-17.

A survey of twelve organizations was conducted to determine the necessity of a post-implementation audit. The audit is defined as any procedure for evaluating the performance of a data processing system, key elements of which include management review of the results, documentation, and objectivity. The implications of objectivity, relative to the choice of a person to conduct the review, are discussed.

Results of the survey indicated that relatively few companies used the formal post audit procedure. The author indicates, however, that one of the primary justifications for the post audit is to identify the causes for cost over-runs in order to prevent similar occurrences in future systems. The audit approach used by a large retail chain is briefly described to show the advantages that can be realized. The elements of the post audit that are essential to its success are timeliness, methodical examination, managerial review, publicity of the results, separation from personnel evaluation, and objectivity.

Carlson, Eric D.
"Evaluating the Impact of Information Systems."
Management Informatics, Volume 3, Number 2, 1974. pp. 57-67.

The concept of impact evaluation is introduced and described in terms of two systems: an initiating system whose impact is to be evaluated, and a target system upon which impact is to be measured. Six methods for evaluating the impact of information systems are discussed. These include event logging, attitude survey, rating and weighting, system measurement, system analysis, and cost/benefit analysis. Each method is described, its apparent advantages and disadvantages listed, and examples of its use given.

Some common problems of all the methods include the choice of measures, data collection, identification of factors influencing the evaluation results, interaction effects, difficulty of control, and judgment criteria. A general model for impact evaluations, adapted from experimental statistics, is proposed as a method of mitigating the complexities. The elements of the model include a statement of objectives, a choice of measures, the choice of treatments and experimental units, the plan for assigning the treatments, a sample selection plan, and the choice of analysis criteria and techniques. An example of the use of the model is given for a statistical evaluation of the impact of an information system on the preparation of a budget.

Harris, Richard D.
"EDP Systems Audits."
Data Management, September, 1971. pp. 64-71.

Early efforts at systems auditing are evaluated and found to be lacking on at least four different grounds. The question of whether external audits cover ADP systems sufficiently is raised and seven reasons given why internal auditing should be concerned with ADP systems. It is recommended that the function be an integral part of the Internal Audit organization and that it possess both ADP systems and auditing capabilities.

The goals of systems auditing are derived from such system characteristics as security, reliability, auditability, control, performance, and cost/effectiveness. The principal action programs include operational audits of data centers, review of systems development projects, and technical assistance for financial audits of business functions. In addition, an action program that crosses all areas is involved with security and protection. The lack of supporting standards and policies for ADP auditing is noted, several administrative policies and technical standards are suggested, and an example of an audit checklist is given.

Working relationships between internal auditing and systems people are discussed and several specific problems are raised. These include measurement of system usage, documentation, post-audit reviews, and modifications to systems. Finally, the implications of systems auditing for audit planning are examined.

CONTROL OF ADP OPERATIONS ACTIVITIES

Dearden, John and Nolan, Richard L.
"How to Control the Computer Resource."
Harvard Business Review, November-December, 1973.
pp. 68-78.

The computer resource is differentiated from other staff activities in three ways. First, it has a simple purpose, economy, although its control is far more difficult than it appears on the surface. Second, it has a complex set of supply/demand characteristics including a high ratio of fixed to variable costs, economy of scale, rapid growth of the need for ADP services, and cyclical loads. Third, the computer resource is relatively new resulting in investment decision and staffing uncertainties.

Three case studies on the subject of chargeout of computer services are presented, the first with no chargeout, the second with full chargeout, and the third with partial chargeout. The no chargeout case is characterized by the treatment of the computer as a free good and the requirement for a central body, or steering committee, to control the use of the computer resource. The full chargeout case uses a pricing mechanism to allocate computer resources and decentralize the responsibility for effectiveness of computer use. In the partial chargeout case, the pricing mechanism is used to ration resources while certain controls over use of the computer remain centralized. The authors recommend the use of full chargeout systems, with partial chargeout systems as an intermediate step until more experience is gained.

A framework for management control of the resource is presented based on a four level analysis covering guidelines for use of the computer, operation of the control system, monitoring and control of efficiency and effectiveness, and how services should be altered for continued effectiveness. A senior management steering committee, a project management system, and a determination of the level of user accountability are seen as the necessary ingredients to establish good control.

Gildersleeve, Thomas R.
"Organizing the Data Processing Function."
Datamation, November, 1974. pp. 46-50.

Organization of the data processing function is treated on two levels: systems and programming, and the computer center. Four possible approaches to the organization of systems and programming are examined: application, functional, project-functional, and project staff. The application approach is well suited to situations where applications are distinct and not interdependent, but is weak in cases where systems are integrated. The functional approach is not advised for systems and programming since the work is primarily of the project type. The project-functional organization, or matrix organization, gains the advantages of the functional organization without its disadvantages. It is suitable for large, mature systems and programming departments but generally too expensive for smaller groups. The project-staff organization is more suitable to smaller organizations, but problems arise from the lack of line authority on the part of the staff function.

The computer center is primarily a production operation and the appropriate organizational approach is functional. Three functional areas are recommended: the computer floor, the control room, and the library. A schematic diagram shows the flow of material between these three functions and the user and programming groups. Certain responsibilities which are shared between the computer center and systems and programming (such as personnel development, standards, and research into new equipment and techniques) suggest the need for a staff group under the data processing director as well.

Nolan, Richard L.
"Managing the Computer Resource: A Stage Hypothesis."
Communications of the ACM, July, 1973. pp. 399-405.

The lack of a normative theory for the use of computers in organizations is noted, and the use of stage theories for developing knowledge in diverse fields during formative periods is discussed. A stage hypothesis for the use of computers in organizations is then developed based on the pattern of computer budget growth for three companies. The specific tasks of planning, organizing, and controlling are related to the four defined stages of budget growth: computer acquisition, intense system development, proliferation of controls, and user/service orientation.

Stage I is characterized initially by a lack of consistent management approach and a final commitment by management to the computer. Stage II is characterized by management's attempt to use up the capacity of the computer and to increase the range of applications. The computer budget increases exponentially and becomes a major management concern. In Stage III, management attention is focused on controlling expenditures and various control devices are instituted. Stage IV is characterized by a maturing of the computer function, a refinement of controls, a slower growth of the computer budget, and increases in efficiency.

Three tables outline the various tasks and subtasks associated with the management functions of planning, organizing and controlling during each of the four stages.

Gibson, Cyrus R., and Nolan, Richard L.
"Managing the Four Stages of EDP Growth."
Harvard Business Review, January-February, 1974. pp. 76-88.

Four stages of ADP growth are established (initiation, expansion, formalization, and maturity) and within this framework, three types of growth are discussed: growth in computer applications, growth in the specialization of ADP personnel, and growth in formal management techniques and organization. The characteristics of each type of growth during each stage are shown graphically, followed by a discussion of the four stages.

In stage I, the computer is typically located in the department where it will be first used and management pays little attention to longer range implications. Neither payback criteria nor costs are scrutinized carefully, and budgets typically expand rapidly. In addition, disruptions may be caused as a result of employee fear of the new computer. Stage II is characterized by an explosive growth of computer applications brought on by the enthusiasm generated from early successes, more user demands, and a lack of management controls. Key management actions during this stage involve the development of strong middle managers and a recognition of the increasing specialization of personnel within the computer department. In stage III, the budgetary crisis brought on by runaway costs in Stage II results in excessive control methods by management that may put a stop to growth. Three suggestions are given for management during this stage. First, there is a need to centralize some parts and decentralize other parts of the computer resource. Second, top management must become involved in the direction of the computer resource. Third, the systems analysis function must be reorganized to properly reflect user needs. Stage IV requires that the manager find a balance between stability and technological advancement, the key to which lies in the quality of communications between himself and top management, and between the MIS department and the users.

Wood, Donald R. and Dietz, Arnold E. "Managing EDP Costs." Financial Executive, October, 1971. pp. 72-83.

Some of the reasons for management concern over increasing EDP costs are first identified and the need for a structured, project approach to planning, developing and implementing EDP systems is recommended. The basic elements of such a system are defined as follows: a three-phase structure consisting of planning, development, and implementation; management by project; user involvement; performance standards; and the assignment of a project leader. Four types of EDP costs are identified (direct variable, variable overhead, programmed, and standby) and discussed in the context of two broad categories of cost, developmental and production. It is emphasized that the budgeting, cost determination, and financial reporting systems used in any business organization are applicable to data processing. Further, the project structure provides a mechanism for cost management by allowing management to review project status and alter plans at various stages during a project. Some specific opportunities for cost reduction are suggested: measurement of the effectiveness of equipment utilization; workload leveling to reduce peak load requirements; optimization of equipment configuration; analysis of the workload to better balance equipment utilization; comparison of actual versus predicted running times; data conversion; and centralization and the allocation of its costs to user departments is discussed.

Frazer, Ronald. "Cost Control Systems in EDP." Cost and Management, November-December, 1971. pp. 7-14.

Two types of control within the data processing organization are identified, transaction and operating. The former is concerned with ensuring the validity of the information produced by the system; the latter with the effective use of funds invested in the EDP installation. This paper is primarily concerned with the operating category and a cost accounting control system. The need for cost accounting control systems are based on three issues. The first has to do with who will manage the system in order to ensure that all areas of the organization will benefit. The second issue relates to the method of cost control to be used and whether cost plus a markup. The third issue relates to the type of tasks to be performed by the computer and their justification on a cost/benefit basis. The combination of higher level control of EDP, increasing use by departments other than finance and administration, and new applications have established the need for cost accounting systems.

The operation of the data processing department is likened to the production department to show that the types of cost systems are not new to the industrial accountant. A job cost type of system designed around the responsibility accounting concept, using standard cost products, is recommended. The system helps the data processing executive to manage his operation and aids management in its planning and control function.

Fried, Louis. "Steering Committee Offers Unique Control Over EDP." Computerworld, April 17, 1974. p. 13.

The characteristics of the data processing organization that make it unique within a company are reviewed and a steering committee approach to control is suggested. The steering committee acts in an advisory and top-level decision making capacity to a function for which it is not directly responsible. Its basic objective is the limiting and control of EDP costs and the allocation of an expensive resource.

Two types of steering committees are recommended, a permanent committee and a project committee. The permanent committee is responsible for the overall control of the EDP function. The project committee is responsible for the successful completion of individual projects. The makeup and duties of each type of committee are outlined, and benefits of the steering committee approach to both EDP management and the user are described.

Burdick, R. W. "Operational Planning Techniques: Planning for Profit." Data Management, September, 1970. pp. 50-54.

The concept of operations planning is first defined in terms of profit-oriented techniques, and the planning environment of the Boeing Company is described to illustrate the influence of organizational structures on planning. The planning cycle is next outlined as consisting of the development of a workload profile, scheduling requirements, computer resources and capacities, manpower, and the development and analysis of management information systems.

The development of the workload profile is discussed and some of the tools used in its preparation are noted. The workload profile becomes a primary input to the scheduling function which also uses production standards, machine and resource utilization reports, resource capacity and throughput charts, time-line flow charts, and master schedule layout boards to schedule the workload.

Several tools used by the operations manager in the planning cycle are described. Operational performance standards are used as the basis for planning a good balance between capacity and workload. Software packages are used to report on equipment utilization and to simulate job profiles and schedules related to various configurations of equipment. Finally, a management information system is used to give visibility to any deviations from planned objectives.

"Recognition of EDP Operational Problems." Management Advisor, January/February, 1973. pp. 55-57.

The bulk of this article is devoted to a two-dimensional chart that identifies the adverse results that can occur due to the absence of certain techniques in the management of data processing. The techniques covered fall under the general headings of organization and planning, systems analysis and programming, current operations, security, buying of computer resources, and miscellaneous. The adverse results are grouped under four general areas: effect on employees, effect on systems, effect on equipment, and other effects.

The chart serves primarily as a checklist on the steps essential to efficient operation of a company's data processing department.

Battaqlia, Vincent J.
"Cutting Computer Costs."
Financial Executive, August, 1972. pp. 26-30.

"Value Received Analysis" (VRA) is proposed as a method of measuring computer operations accurately enough to improve productivity. It is shown by example that most systems are not utilized fully, and that typically applications are not chosen on the basis of payback or profitability. The value received analysis consists of two phases. The first is essentially a computer effectiveness audit that evaluates the department itself with respect to organization, functions, and efficiency. Specific areas to be evaluated include personnel productivity, the level of utilization of hardware, the choice of software and operating systems, and analysis of the production environment covering such items as scheduling, testing procedures, library procedures, supplies, quality control, physical layout, and security.

Phase II of the VRA focuses on the use of the ADP resource by both user and non-user departments and the benefits received. This phase concentrates on such areas as the value provided to users by data processing, the effectiveness of the tools being generated, future user needs from data processing, and profitable applications or cost savings that are being overlooked. A brief case study is given to show how a multi-divisional company used a VRA to reduce expenditures by 15%.

Smith, Hendrick S.
"Cost Control for Computers: Applying Bread-and-butter Principles."
Business Horizons, February, 1973. pp. 73-82.

The stakes involved in the cost of ADP installations are highlighted by figures showing current expenditure rates. The author's contention is that management can control costs in the ADP area, and some specific approaches are outlined. Planning is the first step and should be used as the basis for management questions about future computer expenditures and methods of reducing costs. Associated with this is the need for clearly defined budgets and the charging of users for services rendered. Top management should also insist on a comprehensive information system for ADP, one that includes utilization reports, efficiency reports, and cost exception reports.

Although top management need not be familiar with the technical aspects of evaluation products, he should at least be aware of the value of such tools as monitors and simulation, and question the DP manager about their use. Outside audits are also recommended for larger companies as a means of finding cost reductions, particularly the possibility of purchasing services or software on the outside. The treatment of ADP as a profit center is judged to have merit in terms of forcing the ADP group to be competitive with outside services. Finally, because "people costs" constitute such a large part of the budget, productivity measures and tools to automate certain tasks are suggested.

Turney, Peter B. S.
"A Systems Approach to Planning and Adjusting Computer Capacity."
Management Adviser, July-August, 1974. pp. 32-35.

The author's basic premise is that it is possible to increase system capacity in less costly ways than upgrading to a larger system. The modular design of today's computers permits incremental adjustment of configurations to better match workloads and to eliminate bottlenecks. Similarly, software changes can often improve system performance and avoid major system upgrades. Other factors influencing system capacity include operator staffing, system improvements, and the tradeoff between turnaround time and capacity.

Capacity adjustment is generally viewed as a long term decision, but the author points out that smaller incremental changes in capacity through configuration changes, add-ons, operations staffing, and software improvements can ease long run planning for computer capacity. The lead time for making capacity adjustments is greatly reduced and the ability to correct for forecast errors is greatly simplified. Management gains flexibility in the short run and, to a large extent, can avoid capacity changes in large and costly increments.

Primavera, William J.
"Cost Savings Possible in Data Preparation."
Computers and Automation, May, 1971. pp. 19-20.

In spite of the fact that costs per computation in computing equipment have decreased about tenfold with each computer generation, data entry costs have continued to rise. This is attributed primarily to the extra personnel expense involved. Several inefficient practices are identified, including unscheduled batches of work, lack of production standards, poor document formats, and company policies of 100% verification.

Some suggested solutions include more computer editing to eliminate verification, more realistic scheduling, measurement of operator performance, and new equipment. Operator productivity is seen as the most important factor to assess, and a technique for predicting data preparation times is suggested that can aid in evaluating different alternatives for data preparation. Experiences of two companies demonstrate that improved measurement and control, and the application of basic production and schedule controls can greatly increase productivity.

A chart compares the characteristics of the standard keypunch, the buffered keypunch, key-to-tape, and shared processor key-disk-tape within the general categories of operator productivity, error control, machine utilization, management control, and operating costs.

Blevins, Herbert H. et al.
"Managing MIS - Part 1: Controlling Costs; Part 2: Auditing for Accuracy; Part 3: Personnel; Part 4: Security; Part 5: Future Developments."
Financial Executive, June, 1974. pp. 26-36+.

This five part series is based on the responses of five top-level ADP managers to specific questions in each of the subject areas. In Part 1, the question "What techniques do you use to control MIS costs?" was asked. The approaches used included time accounting systems, education of users to eliminate wasteful projects, microfiche, billing of user departments, cost/benefit analyses, and project status reports. In answer to a question regarding the control of growth of systems, the data base approach, regular review of outputs, and project reviews are suggested. As to the financial justification of the MIS department, the general consensus was that dollar savings could be quantified, even though many of the advantages of the MIS were essentially intangible.

Schroeder, William J., Jr.
"Data Processing - Now Frontier for Scientific Management."
Management Adviser, July-August, 1971. pp. 17-42.

Eight techniques of scientific management that are applicable to data processing are examined: work measurement, internal scheduling, responsibility accounting, cost control and budgeting, project management, project evaluation, personnel management and long range planning. Work measurement leads to standards which can be useful in managing throughput and determining personnel requirements. Internal scheduling helps to increase throughput in multiprogramming systems and identify critical points within the overall work flow. Under responsibility accounting, the various functions within data processing would be treated as separate cost centers as a means of better controlling costs. Charge-back of data processing costs to user departments is proposed as a means of making users more cognizant of the costs of computing, while the data processing manager retains responsibility for accomplishing tasks within his budget. In addition, a cost control system is recommended to provide management with better breakdowns of actual expenses by project and function. A project management approach, similar to that used for major capital investments, is suggested and the basic steps in project authorization are described. A project evaluation technique is also recommended to provide management with guidelines for future projects as well as assessment of current project status. Improvements in personnel management are needed to increase the efficiency of the programming function. Finally, the need for long range planning is emphasized.

Adams, Donald L.
"Data Processing Management."
Management Controls, July, 1969. pp. 148-153.

A checklist of techniques for management of the data processing center is given and each is briefly discussed. The need for an organization chart is first noted and sample charts for a small, medium, and large scale installation are included. The separation of duties into operations, programming, and systems is recommended, as is the preparation of formal job descriptions. An independent control group to balance and evaluate input and output is suggested. Operations practices should include workload scheduling, machine logs, standard times for recurring jobs, and formalized operating procedures. File protection procedures, including guidelines for retention, standards for housekeeping, and the recovery of scrap cards and paper are discussed.

For the programming group, documentation procedures, flow charting standards, and testing procedures, including procedures for new programs, are examined. Finally, a policy for the evaluation of data processing personnel, insurance coverage, procedures for emergency situations, and the need for a long-term plan are discussed.

Porter, W. Thomas.
"Control Considerations in Systems Operations: The Necessity of EDP Systems Controls."
Data Management, September, 1970. pp. 29-33.

Three types of controls are considered: management, organizational, and procedural. Management controls require standards for equipment, personnel and projects against which performance can be measured and appropriate corrective actions taken when necessary. In conjunction with this, a long range plan is recommended for the establishment of policies and priorities.

Organizational controls separate the systems planning and programming function, the operations function, and the program maintenance and library function. In this organizational context, the roles and functions of each group are discussed.

Procedural controls involve three levels: source data, data processing, and reporting. Source data controls are used primarily to determine that transactions have been properly recorded at the point of origin, and that they are properly transmitted to data processing. The use of programmed editing of source data is discussed as a means of replacing some of the traditional human checks on data accuracy. Data processing controls are used to detect the loss or non-processing of data, to check on the accuracy of arithmetic operations, and to determine that all transactions are posted to the proper record. Reporting controls insure that outputs are complete, substantially correct, and that errors detected during processing have been corrected.

Reid, N. V.
"Problems in Managing the Data Processing Department."
Journal of Systems Management, May, 1970. pp. 8-11.

The growing sophistication of computer systems has added to management's problems in controlling them. Several of these problems are examined with an eye toward helping management to recognize and deal with them in the future. The difficulty in measuring the productivity of systems and programming personnel is first noted and an approach to work measurement is discussed. Product quality is another problem area, and the pre-installation audit concept is proposed as one approach to eliminating delays and errors. Third generation software has added to costs, not only because of unbundling but also because of increased maintenance problems. In conjunction with this, greater personnel turnover will further aggravate the situation.

In the operations area, proper standards, documentation, and operator training are identified as key elements of a successful operation. In particular, the sophistication of today's machines demands proficient, well-trained operators to assure efficient operations. Data entry is frequently a problem area, and the possibility of OCR as an input source, thereby eliminating many of the problems of keyboard data entry, is suggested.

Future impacts on management will be felt from continued hardware advances, independent peripheral offerings, unbundling, personnel shortages, and increasing training costs.

Rutledge, Ronald M.
"Installation Management - The Next Ten Years."
Proceedings of the 1972 Spring Joint Computer Conference,
Volume 40, pp. 833-839.

The author gives an extrapolation of the challenges facing installation managers in the coming years, and the manner in which his own installation, Carnegie-Mellon University, expects to react to them. The various computer generations are briefly traced and some of the chief characteristics of the fifth generation are identified: low cost mass storage, reliable and economical tele-communications, networking, and management information systems.

Personnel and organization are seen as one of the key challenges, particularly the need for highly qualified people. An executive gap is described and it is suggested that an executive position with the responsibility for coordinating and integrating the organization's computer resources is needed. Changes in system configurations and reliability will encourage the use of minis surrounding a centralized CPU. Networking will allow the linking of local computers, the reduction in redundant facilities, and the elimination of duplicate costs. New approaches to performance measurement, cost control, and financing will lead to further savings. Reductions in hardware maintenance and improved software engineering methods will result in increased competition and more options for user selection of outside maintenance services. Other areas discussed include the impact of contracts and law, standards, competition, and management information systems.

Jung, David C.
"Facilities Management - A Marriage of Porcupines."
Proceedings of the 1972 Fall Joint Computer Conference,
Volume 41, Part I, pp. 123-134.

The concept of facilities management is first defined and its origins in the federal government and in the health care field are discussed. Not all companies can benefit from facilities management and large companies, who have already achieved economies of scale, are seen as the least likely to realize any advantage. Benefits to small and medium sized users are primarily related to better control over ADP operations, smaller investments to upgrade computer capacity, elimination of ADP personnel problems, easier conversion to current generation software, less concern with selection of new equipment, and less requirements for in-house development personnel. Major cost savings are based on the economies of scale realized by the facilities manager but a well written contract is essential to assure that the savings are not offset by conversion or other costs. The long range benefits of the relationship are seen as the key to success and the permanent nature of the agreement is emphasized.

The market structure and forecast for facilities management are examined. Major markets are in discrete and process manufacturing, the medical sector, the federal government, and the finance sector. The market potential for any sector is dependent on five criteria: homogeneous business methods, similar products or services, regulation by government agencies, prior evidence of subcontracting services, and special ADP operating problems. Forecasts of the market size by 1977 are given for various sectors.

Guidelines are suggested for evaluating the vendor, his proposal, and the contract. The three key areas of evaluation are financial stability, past record, and level of industry expertise.

Streeter, D. N.
"Centralization or Dispersion of Computing Facilities."
IBM Systems Journal, Number 3, 1973, pp. 283-301.

The relationships and tendencies that influence the centralization-dispersion decision for computer facilities are examined with the objective of devising a methodology for the decision. The advantages of centralization are first discussed, with an emphasis on economies of scale and the elimination of duplicate data base maintenance. The tendency toward decentralization is next examined. Aside from several psychological factors favoring decentralization, certain communication costs, errors, and interruptions are avoided. Specifically, the user-computer communication cost, the cost of service interruption, and the cost of centralization for N installations are considered. A cost minimization solution is presented and illustrated using a hypothetical example of a satellite-central network.

The effects on quality of service provided by centralized or dispersed computer facilities are next examined using system turnaround time as the indicator of performance. A queuing model is developed that permits the determination of a cost of the quality of service. In conjunction with the previously defined costs, guidelines are established to aid in decisions of centralization versus dispersion of computing facilities. The basic strategy proposed is the linking of large regional service centers providing standardized production services with satellite centers that perform local personalized services.

Fredericks, Ward A.
"A Case for Centralized EDP."
Business Automation, January, 1972, pp. 20-24.

Three basic reasons are given for the trend toward centralization of information processing activities. First, the desire for standardization stems from a need to reduce duplication. Enforcement of standards requires a centralized authority. Second, application complexity is an outgrowth of a demand for increasingly sophisticated computer applications, which require data from various functional areas. Third, a shortage of ADP personnel compels management to bring them under central management and control priorities on a company-wide basis.

Centralization requires that the ADP function be assigned directly to corporate management rather than a functional organization. Problems in the relationships with traditional organizational functions are noted and a slow and deliberate approach to integrated systems is advised. A five-step systems development process is suggested which includes identification of a business need, formulation of an approach to satisfy the need, refinement of the approach into a workable plan, implementation, and ongoing support. The approach resembles the life cycle of a corporation and contributes to the success of a centralized ADP activity.

The structure of a centralized ADP organization at Massey-Ferguson is described and an analogy to a total corporation is drawn. This approach is seen as the key to successful centralization of the ADP function.

ACCOUNTING FOR ADP COSTS

O'Connor, Thomas F., and Raam, Ronell B.
"Can Cost Accounting Help Manage the Rising Costs of ADP Operations?"
The GAO Review, Fall, 1972. pp. 46-52.

The growth of ADP expenditures by the federal government and the difficulty in defining the precise level of expenditures presents a challenge to the accounting profession to assist in managing the rising costs of ADP operations. Two aspects of the problem are the lack of consensus on what constitutes ADP operations, and which accounting principles and standards should be applied. The first problem is one of management visibility and is characterized by the problems of identifying exactly which hardware is to be considered as part of ADP, which personnel should be charged to ADP, and what supplies are properly considered ADP supplies. Variations in accounting practices also exist among different government agencies, particularly with respect to the accounting for software and the question of capitalization versus expensing.

The concern over ADP operations and their costs is based on their unique and widespread impact, the rate of change of the technology, and the magnitude of the expenditures. In this context, the need for an appropriate cost accounting system is stressed. A GAO project to develop more specific guidance in this area is noted.

Reichardt, Karl E.
"Capitalizing Costs of Information Systems."
Management Accounting, April, 1974. pp. 39-43.

Because of the substantial nature of systems costs and the fact that their useful life usually extends beyond one accounting period, an argument is made for capitalizing certain of the costs of development and maintenance of information systems. It is stressed that the form of an asset, whether it be physical or non-physical, should not be a deciding factor. A system is said to be an asset because it possesses the three essential characteristics of an asset, namely, that it possesses present and/or future benefit, that its benefits accrue to the business, and that the right to its use is a legally enforceable claim.

An analogy is drawn between systems costs and two other costs which are frequently capitalized, organization costs and research and development. The similarities between systems costs and these other two costs are used as a basis for justifying capitalization. Arguments against capitalization are reviewed and the fallacies in each are identified. These arguments include the fact that systems is a continuous function, that measurement is difficult, that there is uncertainty as to future benefits, and that accounting conservatism should not take precedence over accurate representation of actual assets.

The author suggests that capitalized systems costs be classified as intangible assets and allocated over the entire useful life of the system. He concludes that capitalization communicates the existence of an important asset to the users of financial statements.

Deckard, Noble S.
"Capturing the Development Costs of an Integrated MIS."
Journal of Systems Management, January, 1970. pp. 14-17.

A technique for gathering and analyzing cost data during the development of a management information system is presented. The four major steps, or phases, of development of an MIS represent a convenient method for cost classification. The first of the steps is the "organization functional review and system identification" to build an organization synopsis and define information needs. The second step is systems analysis and synthesis which determines how to best fulfill the using organization's information needs. The principal category of costs in both steps is manpower. The third step, systems development, involves the actual design and development of the project through programming and user training. Here, costs involve system analyst and programmer manpower, plus computer time and user training. The final step, system implementation, keeps the system operating and growing. The major cost category is computer time and related processing.

Proper reporting categories must be established to identify the costs relating to a project. A list of eight such categories is suggested. The cost categories provide the basis for two management reports that serve as administrative tools for reviewing current project costs, and for gathering cost information for future cost-benefit comparisons. The first is a monthly expenditure report; the second is a subsystem expenditure report which provides cost information as the subsystem develops through the major phases. Samples of each report are shown.

Finney, John E.
"Costing in a Data Processing Department."
Management Accounting, October, 1974. pp. 29-35.

A scenario is developed in which a consultant is called in to investigate a large overrun in a development project. Analysis of cost records indicates that the actual cost per hour for systems and programming personnel had been running more than twice as much as the figure the company had used to make its estimates. A cost accounting system is then recommended that provides budgeted hourly rates for each cost center within the department. Cost centers for both personnel and the machine room are defined and an annual budget by cost center is prepared. The approach to determining budgeted hourly rates is then outlined. This involves setting a "percent utilization expected" figure for each cost center and applying it to total available hours to arrive at "expected productive hours." This figure, when divided into the total cost center budget amount, gives the budgeted hourly rate. Finally, the approach to job time recording for both personnel and equipment is outlined.

The major benefits derived from the approach include improved control over data processing costs, realistic costing of all work performed, better cost estimates, the ability to compare actual costs to estimated costs, improved evaluation of efficiency, and the ability to measure profitability.

Rohan, Kenneth E.
"EDP Cost Information Systems."
Modern Data, June, 1973. pp. 28-29.

The author poses a hypothetical question to an ADP manager from his company's president: "Can you prove EDP's profitability to our company?" The proficient manager would have a book of Management Reports ready that would tell clearly whether or not the priorities of the company are being served by data processing, whether the departments of the company are following the pre-determined business plan, and the actual level of ADP expenses versus planned expenses. A different ADP manager might have to call a crisis meeting of his subordinates in order to piece together an answer.

What is needed to answer such questions is a project reporting, or project management system that provides time and cost information covering project history, current projects, planned projects, equipment utilization, and personnel utilization. The use of an ADP cost information system enables a company to maintain much tighter control over ADP costs. When charges are billed to user departments, they encourage greater efficiency in the use of computer resources. Brief descriptions are given of five packages on the market that account for computer utilization and/or provide project control.

Heinkamp, John G.
"Technical Information Center Management: An Accounting Deficiency."
The Accounting Review, July, 1969. pp. 605-610.

The absence of relevant revenue and cost information in the operation of most computerized technical information centers is noted and an investigation into the use of managerial accounting applications in such centers is described. The operation of a technical information center is first discussed in terms of its objective to aid in the search for technical information. The role of the computer in this activity is briefly described.

Some of the underlying reasons for a lack of good accounting practices are related to the fact that the technical information center is a by-product of the traditional library function which has always been lacking in good accounting methods. Specific problem areas in developing good accounting practices involve professional personnel, who often object to any form of measurement, the difficulty of defining quality standards for output, the high fixed cost nature of the center, and joint cost occurrences resulting from simultaneous searches and normal maintenance activities.

Rettus, R. C. and Smith, R. A.
"Accounting Control of Data Processing."
IBM Systems Journal, Number 1, 1972. pp. 74-92.

An integrated accounting system consisting of general ledger, budgeting, and resource utilization is presented. The method of identification of cost centers is described and their integration into the general corporate chart of accounts is explained. Standard rates for each resource are next computed by dividing the budgeted cost by the productive time. Specifics of the computation are covered using a computer system as an example. The measurement of resource utilization is based on information provided by the Systems Management Facility and standard job costs are computed using the previously developed standard rates.

The inputs and outputs of the three subsystems comprising the integrated accounting system are identified. Inputs to the general ledger system come from payroll, accounts payable, and journal entries. Outputs include transactions by account, transactions by account within cost centers, balance sheet and income statement, cost center statement, and profit center gross profit. Inputs to the budgeting system come from cost center managers and include detailed expenses by account by month. Outputs of the budgeting system provide monthly budgets with an annual recap reported by cost center group. Inputs to the resource utilization system consist of the actual utilization data. Outputs report on resource utilization, throughput analysis, and job costs.

Grampp, F. T.
"A Computer Center Accounting System."
Proceedings of the 1972 Fall Joint Computer Conference,
Volume 41, Part 1. pp. 105-114.

A computer center accounting system in use at Bell Laboratories is described. The system collects computer usage data in the form of original run statistics, and storage and service measurements from a variety of sources, converts these to charges, and reports charges by organization and project. Several design criteria are listed, the most important of which is the ability of the system to report on costs by project and department.

A detailed description is given of the system's data base at two different levels. At the first level, the appearance of the data base to the user is discussed in terms of data structures, the associations among the structures, and the routines for accessing them. At the second level, the details of data base implementation are examined, in particular those which make the system easily expandable and maintainable, and less vulnerable to disaster.

In terms of the user's interface to the system, four activities are described: the creation of the data base, modification of the data base, inputting of charges, and production of reports. An approach used to permit the incorporation of new sources of charging information is explained. Three standard reports are prepared: one by project to be sent to the controller, one by department to be sent to the department head, and one by job to be sent to the person responsible for the job. Several levels of backup are also described.

Miller, Victor E.
"Responsibility Time Reporting for Management Control Over EDP."
Arthur Andersen Chronicle, June, 1971. pp. 8-11.

The long-standing opinion that ADP is not subject to traditional controls is disputed by the author. Management has frequently relied on ADP personnel to develop their own systems for control, and these have often turned out to be ineffective due to a lack of day-to-day analysis and follow-up. The same basic control principles that are applied to other areas of the company are appropriate for ADP. Specifically, the need for responsible financial planning and the comparison of results against a plan are the key to effective control.

A responsibility time reporting system is suggested which consists of four steps: the establishment of standard times (the budget), the development of a utilization reporting system, a comparison of performance to the standard, and an analysis of variances. Standards are developed based on the running times of programs and used to schedule operations, to report on variances, and to charge users. Checks and balances are brought into play by the interests of three different parties, the scheduler, the operators, and the user. These opposing forces help to keep the standards at an accurate level. Review and follow-up of variances from standard are the basis for corrective action and improved management control.

Hurtado, Corydon D.
"A System to Measure EDP."
Journal of Systems Management, January, 1972. pp. 32-35.

Although many users measure the efficiency of their systems, few have programs for measuring operational effectiveness. A comprehensive evaluation system should be able to perform a continuing evaluation of both efficiency and effectiveness. Evaluation is defined as the process of determining the level of success in achieving a predetermined objective. Efficiency relates to the production of results proportionate to the effort expended. Effectiveness is the extent to which the ADP function contributes to the accomplishment of the user's programs.

The evaluation system should strike a balance between measures of efficiency and effectiveness. Problems relative to the development of an ADP evaluation system model include the lack of standards for the ADP installation, and the variety of management opinions on the nature and reliability of a comprehensive evaluation system. Objectives must be set and the criteria for their measurement determined. Finally, a judgment must be made as to both the efficiency and effectiveness of the system.

Campise, James A.
"Computer Aided Data Processing Management."
Data Management, November, 1973. pp. 12-17.

In spite of the fact that the computer is used regularly to control costs in other areas of a business, the computer department has been slow to adopt the use of the machine to control its own activities. A list of both apparent costs and hidden costs is given and the problem of developing some kind of accounting for both people and machines is discussed. A particular problem area is the reluctance of professional people to be measured and the difficulty of quantifying creative work.

Standards are needed for the measurement of costs and certain conventions must first be established. Operators need conventions for the handling of forms and magnetic media, and the sequencing of jobs. Programmers need conventions for the use of subroutines, languages, file design, and flow charting. Systems analysts need conventions for forms design, documentation, reports, etc. In all three areas, strict adherence to conventions increases the chance of establishing measurable standards against which each can be measured.

Examples of several control reports are given from both a small and a large installation. Manual logs of people and machine time are shown as well as machine-produced reports for monthly accounting cost distributions, operator time analysis, job analysis, and computer time analysis. The advantages of such reports to management in monitoring overall performance are finally discussed.

Stanley, W. I.
"Measurement of System Operational Statistics."
IBM Systems Journal, Number 4, 1969. pp. 299-308.

A special-purpose program called the Job Accounting System (JAS) is described. The system was developed to automatically and continuously monitor the activities of a NASA real-time operating system. Statistics gathered are used to bill users of the computer facilities and to evaluate system performance. The article focuses on the use of JAS to evaluate performance.

The history of the system, the data collected, and the performance reports produced are first described. Design and implementation considerations are then presented. These involve the measurement of resource usage rather than resource utilization duration as a means of reducing overhead cost, the accumulation of statistics in a data base, the selection of two levels of statistical detail at the console, the use of multiple collection points within the operating system, ease of operator control, and the accomplishment of the monitoring function as a series of system tasks. Finally, a simulation approach used to validate standard timer accuracy is described.

"Getting the Most Out of System Usage Accounting."
EDP Performance Review, April, 1973. pp. 1-8.

The contribution of a job accounting system to the improvement of system performance can be realized in either of two ways; first, by influencing user departments to make more efficient use of the computer, and second, by providing management with meaningful data on system performance. The basic elements of the accounting system are defined as resource measurement, the establishment of a cost recovery policy, the setting of rates, the actual billing process, and management reporting. The definition of a billing formula is discussed and an example of one such formula is given.

The manner in which job accounting influences system use is examined. On the one hand, the rate setting process can be used to encourage or discourage the use of certain resources as well as the time of day that jobs are run. On the other hand, performance reports generated by the job accounting system may be used by management to control costs. Various types of reports are described that enable the manager to evaluate the performance of a system with an eye to better controlling workloads and efficiency of use. The implementation of a job accounting system is briefly discussed, including the make-or-buy decision. Finally, profiles are given of 14 proprietary job accounting software packages.

Babb, Maurice.
"Data Base Controls Computer Operations."
Journal of Systems Management, February, 1971. pp. 33-38.

The author contends that it is the systems manager's responsibility to inform operations what is to be done, how long it will take, when it is to be done, and how it is to be handled. To perform this function he needs actual and projected run times and cost analyses as well as knowledge of the job streams. In turn, Operations needs written instructions for controlling day-to-day production.

A system is proposed which permits the integration of all these needs through a data base of job stream data. The data base permits a computerized loading of computer time for each day of a forthcoming month. The system generates a listing of the job load by day and system, work orders sequenced by day, report disposition orders, and external file labels. In addition, other reports may be prepared for the systems manager or DP manager including a list of runs, a logic census, cost forecast, and a projected/actual cost comparison.

"Get More Computer Efficiency."
EDP Analyzer, March, 1971. pp. 1-14.

A case study is first presented to show how one company benefited from the adoption of a scheduling system to control computer operations and increase the level of multiprogramming. The major functions of computer operations are then outlined (tactical, strategic, control, and administrative) and it is shown that efforts to improve efficiency can have significant impacts on each area.

The improvement of efficiency generally falls under two main headings: reduction of idle time, and reduction of the misuse of resources. The reduction of idle time is dependent on a complete reporting system to identify which sources of idle time are large enough to warrant investigation. To this end, two job log and utilization reporting systems are described as examples of the reporting requirements. The use of multiprogramming as a means of achieving greater throughput, and the advantage of a scheduling package to improve the level of multiprogramming is discussed. Scheduling for serial processing is also explored through another case study.

Approaches to system tuning and redesign with the aid of hardware and software monitors are examined, again in the context of identifying idle or wasted resources.

REVIEW AND EVALUATION OF ADP OPERATIONS ACTIVITIES

Bain, Dennis A.
"Another Look at...The Part Time Computers."
Business Automation, April 1, 1971. pp. 39-41.

This article is basically a rebuttal to an earlier article ("The Part-time Computers", by Walter J. Schroeder) which described the findings of an A. T. Kearney study on the relatively low utilization of computing equipment. The author asks the question: "Should a full-time computer really be the objective?" He takes exception to the statement that computer systems should be manned more than 64% of the time on the grounds that the cost of extra shifts would greatly exceed the cost of current idle time. He argues that "meter hours" is not a good measure of capacity and that, in fact, there are many areas of inefficiency not cited by the original report. He also points out that much of what the Kearney report considers as wasted time is unavoidable and that the real key is "throughput per computer dollar spent." Finally, he contends that the implication that the EDP manager is becoming less and less of a business manager is a premature conclusion.

A companion article ("Maybe It's Really Part-time Management") by the original author provides a response to Mr. Bain. In it, Mr. Schroeder suggests that the blame may lie with top management for not paying closer attention to the ADP organization. He suggests a five step plan to establish quantifiable objectives: find out where you are; define objectives; establish measures of performance; develop goals and plans; and measure and motivate. He suggests that top management should regularly review the performance of ADP to assure that company objectives are being met.

Menkhaus, Edward J.
"EDP: What's It Worth?"
Business Automation, November, 1969. pp. 49-54.

In order to assess the value of computer-based projects, Sun Oil Company calculates costs and benefits prior to requesting authorization from top management. A formal control system uses a "Value Index" which measures the number of times that a project's cost is recovered over its life. Two types of expenses are involved, development and production. The first represents funds spent to acquire a new capability for the company; the second represents funds spent using the acquired capability. A different formula is used to compute the Value Index for each type of expense. "Present Worth" factors are used to incorporate the time value of money.

Three types of projects are identified, those for which the value is known, those for which a value is expected, but not known, and those for which there is no expected value but which must be done. An example is given to show how the formula is applied in a hypothetical development project, using a Value Assessment Summary form to compute the value index. Certain data is then transferred to the project authorization form which goes to the appropriate level of management for approval. Monthly reporting tracks performance against the project authorization. Exceptions to the general approach involve projects that consist of many small parts which are individually difficult to evaluate (such as engineering computations) and major development where value of the total project cannot be assessed until preliminary analysis is completed.

Gabay, A.
"Are You Getting Full Value?"
Accountancy (Great Britain), October, 1973. p. 95+.

The concept of Value Received Analysis (VRA) is proposed as a method of determining why computer systems are not making their full contribution to business profitability. Unlike the computer efficiency audit, VRA starts outside the computer room and focuses on the impact of the computer on the total enterprise. The process begins with an examination of the organization and all of its functional areas. The information needs and the information supplied analyzed and proposals developed to provide the kind of information needed to meet management requirements. A thorough examination of the computer department is then undertaken to evaluate the suitability of the department and its equipment to meet the defined information needs. In addition, the analysis should cover feasibility plans for future systems, potential cost reductions, and possible improvements in the effectiveness of applications.

A VRA checklist is included covering potential problems with current information systems, the management of data processing functions, and ADP installation problems. It is top management's responsibility to see that regular analyses are conducted and a recommendation is made for multi-discipline team of people to assist management in interpreting their needs to the data processing people.

Fried, Louis.
"Making Data Processing Pay Its Way."
Computer Decisions, March, 1972. pp. 24-27.

A six-step approach to cost-effectiveness measures in a computer installation is first outlined. Two viewpoints of cost effectiveness analysis are then discussed. The accounting and control viewpoint establishes the elements of costs that must be accounted for and controlled through an appropriate cost accounting facility. The performance audit viewpoint examines the effectiveness of use of an installation's resources. Functional divisions of such an audit include administration, operations, systems and programming, applications, and controls.

Tips are then given for tuning ADP operations and include operator training, documentation standards, estimation techniques, economic feasibility analysis, project control, purchasing practices, computer utilization, a master plan for systems development, improved communications, and the charging of users for computer services. Some trade-offs are finally discussed which can contribute to increased system effectiveness. Included are discussions of experienced versus inexperienced personnel, the use of the computer to aid in debugging, economies of scale of computer equipment, redesign of old systems, the use of commercial software packages, and the use of contract programmers during peak periods.

Clinch, J. Houstoun M., Jr.
"Financial and Operating Performance for Bank EDP Installations."
Magazine of Bank Administration, May, 1973. pp. 20-25.

A communications gap between top management and systems people, coupled with the rapid increase in ADP costs requires improved management controls over those costs. The author contends that ADP is not significantly different from other activities and recommends the establishment of a financial and operations reporting system that both top management and ADP personnel can use to effectively manage ADP resources. It is based on the premise that each manager has certain resources at his disposal which he should be able to measure against a set of norms or standards. An example of computer utilization by application is shown to indicate the type of management information that can be derived from such information.

The measurement of each unit within the computer area is discussed in terms of measurable activities and standards of performance. Standard formats for operations performance reports are suggested so that consolidation and review by various levels of management is permitted. Once the operations performance reporting system is in place, the accounting system should be modified to permit financial accounting by organization unit on a responsibility accounting basis. The financial information, in conjunction with operating performance data, provides the vehicle for generating cost, budget, and variance information. Two keys to the success of such a system are the participation of both top management and line management personnel, and full confidence in the information reported.

Brown, William F., and Mason, Richard P.
"Overhauling the Computer Center."
Journal of Systems Management, March, 1973. pp. 28-32.

A specific industrial engineering technique called "Manpower Analysis and Performance Standards" (MAPS) was utilized by the Avco Systems Division to increase the efficiency and effectiveness of AVCO Computer Services Operations. The program utilizes the principles of workplace layout and work-flow analysis, methods improvement, work simplification and measurement, and work scheduling and facilities utilization.

The study was broken down into four areas: operations (job) control, keypunching, EAM, and computer operations. The study approach and the recommendations for corrective action in each area are summarized. At the completion of the study, standards were set for each area and a controlled performance reporting system was established. Savings of over \$100,000 were realized in the first year.

Bell, T. E.; Boehm, B. W.; and Watson, R. A.
"Framework and Initial Phases for Computer Performance Improvement."
Proceedings of the 1972 Fall Joint Computer Conference, Volume 41, Part 2. pp. 1141-1154.

Three possible approaches are suggested for increasing the capacity of a computer system: upgrade the system, tune the system, or reduce the workload. An overall procedure for improving computer system performance is presented consisting of seven phases: understand the system, analyze operations, formulate performance improvement hypotheses, analyze probable cost-effectiveness of improvement modifications, test specific hypotheses, implement appropriate combinations of modifications, and test the effectiveness of modifications. The remainder of the paper concentrates on the first three phases.

In order to fully understand the system, a preliminary questionnaire is proposed which consists of 21 questions covering organization, workload, hardware, software, and accounting. Phase two involves a more detailed questionnaire on operational characteristics, system characteristics, job characteristics, and current measurement and evaluation activities. In phase three, several methods of analysis are presented. These include similar situation identification, outlining value discovery, detection of patterns in performance variables, and the identification and resolution of inconsistencies in measurement data. Some sample hypotheses are then proposed for the three performance improvement possibilities of reducing the workload, tuning the system, and upgrading the system. A final warning is given that hypotheses are valid only within the context of a given installation and its management objectives.

"What Management Should Know About Performance."
EDP Performance Review, January, 1974. pp. 1-6.

In spite of the highly technical image surrounding performance measurement, there are a number of simple measures that ADP management should be receiving and that they are completely capable of understanding. Two primary considerations are regularity and conciseness, the first to focus attention on performance on a regular basis, the second to permit quick and meaningful interpretation of the data.

Four specific management responsibilities are outlined which are closely related to an understanding of an installation's performance. These are cost control, planning and budgeting, service to users, and vendor relations. Ten measures of performance are then described and illustrated: hours of operation, component loading, jobs completed, multiprogramming depth, reruns and aborts, equipment failures, workload statistics, programmer output, user billings, and user satisfaction. A table relates the ten measures with the fulfillment of each of the four management responsibilities.

It is indicated that the performance measures suggested are not difficult to come by, requiring no special hardware or software other than a job accounting system. The value of the information to lower level, line management is also noted.

Moore, Michael R.
"Achieving Full Value from Your EDP Operations."
Journal of Systems Management, February, 1970. pp. 8-12.

Recent trends in data processing are outlined as evidence of the need for increasing attention by management to ADP operations. Three aspects of management involvement are discussed: responsibilities and problems in planning and implementation, the impact of the computer on the organization and people, and the need for continuing management audit of the ADP center.

Management's responsibilities in planning and implementation require deep involvement in order to provide proper guidance to systems people and to avoid crisis-type requests. The basic steps in planning are outlined and the need for interim milestones are emphasized. Other problems that need to be addressed by management include good communications, documentation, and realistic staffing.

The impact of the computer on the ADP organization itself is felt most dramatically on the selection and retention of well-qualified personnel in the systems, programming, and operations areas. The computer's impact on the rest of the company may be felt through job displacement, changes in job content, scheduling of work, and decision making.

An annual management audit of the computer center is recommended to evaluate the effectiveness of the company's ADP program. The audit should focus on whether planned improvements and other benefits have been realized, whether the promises of new systems were actually implemented and the adequacy of controls over the risk of loss and the cost of failure.

Russlan, Vincent P.
"Rx for Top Management: A Periodic Checkup of EDP Operations."
California Management Review, Spring, 1972. pp. 11-37.

The historical problems experienced by a hypothetical, medium-sized company in the operation of their ADP department are traced as evidence of the lack of management controls and understanding of the function. A "Management Review of Data Processing" is suggested to give a company's top management a comprehensive and objective evaluation of its data processing program. The review contains two main sections, an overall profile and specific observations and recommendations for action.

The profile presents the current status of data processing and where it is heading. It helps management to assess the suitability of current equipment, software, personnel, and workload. Cost information aims at providing an analysis of overall ADP costs.

The specific observations and evaluations fall into three subject areas: plans and accomplishments, organization and administration, and operating effectiveness and efficiency. Within the plans section, attention is focused on the planning capabilities of the department, the use of cost/effectiveness analysis, and the review of the current status of plans previously made. In terms of organization and administration, the review emphasizes administrative procedures, relationships with users, and controls over new projects and day-to-day operations. Operating effectiveness and efficiency are analyzed for both the operations section and systems and programming, covering such topics as operating procedures, languages, maintenance activity, input/output controls, and scheduling. Finally, security, software, and documentation are evaluated.

McFarlan, F. Warren.
"Management Audit of the EDP Department."
Harvard Business Review, May-June, 1973. pp. 131-142.

The author calls for a broader definition of senior management's responsibilities with respect to the control of the ADP resource. Initially, several special considerations are discussed to underscore this need: the growth in ADP expenditures, the lack of integration with other company departments, the increasing complexity of data processing, and the rapid advance of the technology. Four key topics for management examination are suggested: management control, resource allocation, operations and technology management, and project management.

Two key structures are suggested to control ADP: a financial reporting system, and a procedure to account for ADP expenses. The basic requirements of a financial reporting system and the advantages and disadvantages of overhead versus chargeout accounting are examined. In terms of resource allocation, emphasis is placed on the involvement of lower levels of management, project selection, and the need for feedback from operations to development. The evaluation of technology and operations requires an inventory of hardware and software resources, an evaluation of the configurations of hardware and software, and of the company's sources of technical knowledge. In the review of operations, management should focus its attention on the performance reporting system, user satisfaction, operations involvement in the selection hardware and software, competent management, and scheduling. The final area of management concern, project management, covers the management of risk in new projects, and the use of a formal project control system.

Schussel, George.
"Scoring DP Performance."
Infosystems, September, 1974. pp. 59-60+.

Based on discussions with ADP management seminar attendees, a list of 14 performance criteria were developed and subsequently evaluated by other managers. The evaluation was in terms of actual importance versus a perceived ideal importance. Significant findings were as follows: meeting deadlines received the highest actual ranking and fourth in the ideal category; accuracy and completeness were considered second, both in the actual and ideal rankings; quick response to user requests received third place in the actual rankings, but sixth place in ideal rankings; although many managers admitted to a lack of cost controls, budget performance and cost control ranked fourth in the actual column and third in the ideal column; operational tranquility received an actual ranking of fifth, but only tenth as an ideal; cost/benefit analysis was placed sixth in the actual rankings and fifth in the ideal rankings; the greatest variance in the rankings was in the area of long-term goals which ranked first as an ideal criteria, but only seventh as an actual. Those criteria which placed in the last half of the total list in terms of actual rankings included appraisal by superiors, aggressive DP promotion, personnel quality, knowledge of the company's business, user vote on DP quality, use of latest technology, and personnel turnover ratio.

ALLOCATION AND ASSIGNMENT OF ADP COSTS TO USERS

Gallop, W. J.
"The Great Cost Allocation Debate."
Canadian Datasystems, November, 1972. pp. 22-25.

The basic questions addressed in this article are whether users should be charged for data processing services, how such charges should be based, and whether users should have the option of going outside the company for services. It is argued that in cases where excess computer capacity exists, no charges encourage greater utilization. In addition, charging can be costly and is often an inexact process. On the positive side, charging permits management to assess the cost effectiveness of systems and to make realistic decisions on computer usage.

Three basic ways to allocate costs are examined: using estimates of resource utilization; from actual usage data; and negotiated charges based on processing workloads. The importance of a stable price structure to all three methods is emphasized and price increases are justified only on the basis of expanding volumes. The use of marginal costing to evaluate new projects is recommended, but certain conflicts are noted because of the need to charge constant rates to all users. Other problems relating to a breakeven or profit objective, and the charging for development of multi-division projects, are considered. Finally, the question of whether users should be allowed to contract for services outside is addressed and some advantages noted.

Schaller, Carol.
"Survey of Computer Cost Allocation Techniques."
Journal of Accountancy, June, 1974. pp. 41-46.

Initially, three possible structures for a data processing department within the overall organization are identified: the support department, the service department, and the profit center. The advantages and disadvantages of each are outlined. As a support department, new applications are encouraged, but possibly at the expense of ineffective use of the computer. The service structure charges the user for services received and encourages better use of the system but may discriminate against departments with smaller budgets. The profit center approach charges for services at the going market rate and encourages more efficient utilization of the computer but may obscure overall corporate objectives.

Two allocation methods are possible, full costing and standard costing. Full costing charges out all ADP costs but may discourage use because of the high fixed costs and, therefore, high unit costs when utilization is low. Charges are also likely to fluctuate with demand making costs difficult to control by the user. Standard costing uses nonfluctuating standard rates and facilitates user planning but does not reflect changes until the end of a period. Three methods of standard costing are described: standard full cost allocation, standard operating cost allocation, and standard marginal cost allocation.

Various units of utilization which can be used as the basis for standard costing are examined. These include elapsed time, adjusted elapsed time, CPU time, kilobyte hours, the standalone method, detailed measurement, and flexible pricing.

Criner, James C.
"Managerial Accounting for Federal Automatic Data Processing Services."
The Federal Accountant, December, 1972. pp. 43-55.

The author first discusses the allocation of ADP resources among users and the basic pricing criteria. The function of pricing in dealing with the problem of priority/turnaround time is examined and problems relating to the differing ranks of government users, as well as questions of machine ownership and their influence on priority are assessed.

The duties allocated to the General Services Administration for managing ADPE within the federal government are grouped into four areas: procurement, management of an ADP revolving fund, maintenance of an ADP Management Information System, and operation of a sharing program. With respect to procurement, the issue of agency independence vs. economy through consolidation is addressed and some of the problems outlined. Under-capitalization of the ADP fund and the restrictions of laws and policies are seen as long-term hindrances to the viability of the fund. The measurement of the ADP sharing program in terms of cost avoidance is discussed and some of the results evaluated.

The operation of working capital funds within the government are examined, as is pricing under such a fund. Finally, the implications of GSA ownership of all Federal ADPE is examined.

Butler, David.
"Chargeback for Information Systems,"
Data Processing (Great Britain), July-August, 1973. pp. 250-253.

Some of the complexities of the chargeback mechanism and the ways in which it can be counter-productive are examined. Initially, the major motives that encourage firms to adopt chargeback schemes are identified: cost control, the ADP manager's desire to improve his image, the application of user judgement to project evaluation, the resolution of decisions regarding technical advances, and the escape from cost-effectiveness evaluations within the ADP department.

Certain limitations of the chargeback approach are examined. First, the ADP department is cast in the role of a supplier with a possible preoccupation with costs that can hamper progress. Second, the emphasis on user department justification of ADP expenditures may tend to obscure the advantages of certain applications that fulfill overall corporate objectives. Third, chargeback schemes can lead to excessive bureaucracy and over-emphasis on accounting. Fourth, the question is raised as to whether chargeback is really a delusion and whether internal charging is meaningful since it does not contribute to profit. Finally, there is the problem of inequity brought about by the setting of prices to allow for planned capacity growth.

Six characteristics are suggested for a chargeback system: reproducibility, equitability, auditability, allowance for cost estimating, efficiency, and cost recovery. Finally, the alternative methods for measuring usage and computing charges are briefly discussed.

Nolan, Richard L. (Session Chairman)
"A Panel Session--Charge-out System for Management
Acceptance and Control of the Computer Resource."
Proceedings of the 1974 National Computer Conference.
Volume 43. pp. 1013-1016.

It is the author's contention that standard cost type systems for computer services are feasible and offer a powerful management tool for controlling the computer resource, although some problems remain in the design of appropriate systems. The basic objectives in that design are to assist the information systems department to achieve its objectives of increased service to users and the control of costs of resources.

Five management design issues are discussed. First, what computer services should be charged out? Second, on what basis should computer services be charged (ie. market price, cost recovery, average cost, standard cost, etc.)? Third, what is the relative importance of key design parameters for a charge-out system? Here the general problem is to trade-off the extent and sophistication of effectiveness design parameters with their implementation and maintenance costs. Fourth, how should the system be administered? Central administration and policy-making are keys to effective use of the pricing mechanism, but some conflicts may arise where information systems departments are set up as profit centers. Finally, how should charge-out systems be used to ensure computer system efficiency?

It is noted that the pricing strategy is likely to be influenced by the transfer pricing policies of the host organization and the basic economics of the host's industry.

Nolan, Richard L.
"Preliminary Ideas on Research Design to Investigate Internal Pricing of Computer Resources for Management Control." Data Base, Volume 5, Numbers 2-4, Winter, 1973. (Proceedings of the Wharton Conference on Research on Computers in Organizations) pp. 69-86.

The management control problem is first analyzed and it is suggested that a good management control system should provide information to answer questions regarding the financial resource commitment to computing, how it should be deployed, and whether resources are being employed efficiently. The unique characteristics of supply and demand for computer resources are next analyzed. In the personnel area, there is a shortage of qualified people and an ever-increasing demand for new applications. In terms of the computing facilities, supply is characterized by a high ratio of fixed to variable costs, hardware economies of scale, and the acquisition of capacity in large steps. Demand is characterized by peak processing demands and flexible priorities.

Two approaches to management control, the central steering committee and the decentralized user approach, are analyzed. The latter involves the charging of users for services provided. A research model for management control of computer resources is presented as the basis for determining how information is provided to answer the three questions originally posed, and to assess the way in which the system functions.

A research design for investigation of internal pricing of computer resources for management control is finally proposed. The design consists of five phases: identifying the stage for managing the computer; defining the relationships of current management control system for computer resources and the role of the internal pricing mechanism; specifying the "ideal" internal pricing scheme; evaluating the effectiveness of the ideal scheme; and analysis and interpretation.

Anderson, John J.
"Direct Chargeout of Information Systems Services Costs?" Management Adviser, March-April, 1974. pp. 27-33.

The two basic types of systems costs, data processing and systems development, are first analyzed and the use of charging systems is seen as one way of encouraging more effective managerial controls and user involvement. The desirable attributes of a charging or costing system are listed: comprehensive in scope, costs categorized by project, adequate detail, understandable cost algorithm, equitability of charges, stability of charges, flexibility, and economy of operation. The development of rates for four categories of costs--professional systems personnel, computer, data handling costs, and other costs--is discussed, and examples of two types of computer billing formulas are given. The modification of cost rates to encourage or discourage the use of certain resources, and to remain competitive with outside services is suggested.

The major advantage of a direct charge system is that user managers are encouraged to take more interest in the use of the computer and the value of applications. The primary arguments against a direct charge system relate to the possibility that some worthwhile projects may be discouraged because of the costs involved, and the high costs of developing and administering the charging system itself.

Brown, C. H., and Reed, D.
"Can the Computer Department Pay Its Way?" Accountancy (Great Britain), October, 1969. pp. 730-733.

The handling of losses during the early stages of a computer installation and the need for education of user departments is discussed. The complexities of accounting for computer costs is next examined. Although a possible write-off of expenses in the early stages is acknowledged, the need to balance expenses against income is emphasized. After budgeting for expenses for several years out, forecasts of income are prepared. Complications in forecasting arise because of the early losses of the computer center and the absence of benefits to user departments. Some suggestions are made to help defer expenses as long as possible during the implementation period.

Some specific subsidiary controls are suggested, such as the charging of staff to specific projects, the establishment of standard hourly costs, preparation of monthly profit and loss figures, and monthly project status reports. The overall degree of control should be related to the costs of the computer department relative to the firm as a whole, and the cost system should reflect the value of the computer department to other departments. In addition to showing monthly profit and loss position, it is also valuable in tracking project progress and machine utilization.

Grindley, Kit.
"Internal Charging for Computer Services."
Accountancy (Great Britain), March, 1973. pp. 32-35.

The most common approaches to charging, and the problems relating to each are discussed. Full cost allocation charges all the costs of the department to users but is complicated by the shared nature of many of the operating costs. No cost allocation treats the computer department as a general overhead expense but offers little control over the use of the computer since users do not directly bear the expense. Operating cost allocation charges operating cost only to user departments and absorbs development costs as company overhead. The major problem in this approach lies in the lack of control over development work. Marginal cost allocation charges only variable costs to users but is likely to encourage marginal applications. Standard cost systems charge on the basis of units of usage but problems may arise because the real value of certain units differ for different applications. Finally, the treatment of the computer department as a profit center tends to introduce some improper motivations.

A method of costing is suggested that tailors the charging system to the particular application. It is called "costing by objectives" and consists of four stages: identify objectives, examine suitable systems, design the system, and review. The approach is better suited to satisfying the objectives of the transfer charging system for a particular application.

"Who Shall Pay the Piper?"
ADP Newsletter, March 19, 1973. pp. 1-4.

The basic rationale behind charge-back systems is that there is a relationship between the cost paid and the "value received" for computer services. They can be used to promote or discourage efficiency within the ADP function, and to encourage or discourage usage of the resource. The four philosophies of charge-back are reviewed: no charge-back; operating time only; development and programming only; and full cost recovery. Of those using charge-back, the majority use the full cost approach. A variation of full cost recovery, the profit center, is also discussed.

The design criteria for an effective charge-back system are listed: reproducibility, equitability, auditability, allowance for cost estimating, encourage efficiency, and recovery of costs. The alternative approaches to charging are also briefly explained: average costing, overhead charges, wall clock time/job, elapsed time in monoprogramming mode, elapsed time in multiprogramming mode, fixed fee, and total cost recovery. A table rates the various approaches according to the above-mentioned design criteria.

"Charging for Computer Services."
EDP Analyzer, July, 1974. pp. 1-13.

Three case studies are first presented to illustrate different approaches to the chargeback problem, two of which use market pricing. The question, "Why charge for computer services?" is then addressed, and two basic reasons given: to encourage better use of computer resources, and to provide a means of rationing scarce resources among competing users. Three types of chargeback systems are then explained: cost recovery, resource allocation, and soft money systems.

The mechanics of a charging system are examined. Initial decisions must be made regarding the goals of the system (and hence the criteria it should meet), its integration with the company's accounting system, and the stability of prices. The factors to be used in computing charges, charging for shared resources (i.e. CPU, input/output channels, and the data base), and charging for allocated resources (core, tapes, allocated disk units, and other peripherals) are discussed in terms of the complications that each causes. Sources of job accounting packages and their basic elements (data collection mechanism, raw data edit, job accounting, resource usage reporting, and simulation capabilities) and the use of accounting data for performance analysis are reviewed. The subtle effects of charging schemes on user behavior, and the justification for charging at all are finally discussed.

Sollenberger, Harold M.
"Management Information Systems: A Charge to Users and Cost Control."
Management Accounting, November, 1970. pp. 25-28+.

Cost allocation systems are viewed in the context of the contribution they can make to solving management problems such as the allocation of scarce resources, providing needed computerized services, and internally managing the computer services function. The pros and cons of pricing are argued and the issue of management involvement is seen as one of the key reasons for a cost allocation scheme for data processing. In addition, it contributes measurably to improved systems planning and control.

The effect of charging systems on the system development function can be felt in several ways. First, user participation in the development process is generally increased. Second, charging influences the selection of projects, and encourages those that are most profitable. Third, schedule performance is improved by the additional focus on costs.

In the data processing area, charging helps to focus attention on total costs and places controls on capacity growth. It is indicated, however, that charges can be a source of bad feelings between the computer department and users. Finally, the charging system helps to place responsibility for defining data needs.

Gosden, John A.
"Effects of Pricing and Charge-Back Policies."
Senior Management and the Data Processing Function.
Edited by Stanley J. Pokempner and Rochelle O'Conner.
Conference Board Report No. 636. New York, The Conference
Board, 1974. pp. 63-66.

The special effects of charge-back systems peculiar to ADP operations are discussed. A typical charge-back structure is defined which charges for two basic types of activity, development projects and running jobs. Charges for labor and data entry are relatively straight-forward and are not considered in the paper. Charges for computer time, on the other hand, are more complex and require that either a detailed cost-recovery approach or a fair-pricing approach be adopted. The problem with the former is that it introduces distortions as demand for service varies. This often causes users to "game against" the charging policy, requiring changes to the details of the policy to influence user behavior in a preferred direction.

Examples are given of the effect of specific charging policies on program designers. For example, charges for tape set-ups for test shots resulted in a decrease in the proportion needing set-ups from 60% to 30%. Penalties were used to discourage programs that monopolized any single resource.

The effect of the charge-back approach on management is to encourage greater attention to the details of charge-back policies and their effects on user behavior. In addition, greater realism is developed for cost/benefit studies. Finally, charging schemes improve forecasting of loads and the measurement of system capacity.

"The Effects of Charge-back Policies."
EDP Analyzer, November, 1973. pp. 1-14.

Three case studies are presented to show different approaches to charge-back by different users. Two are universities, the third is the data processing subsidiary of a major retail chain. The pros and cons of charging are briefly outlined. The arguments in favor are generally based on better cost control and resource allocation. The opposing view centers on the cost of administration, possible inequities, and a bias favoring wealthier departments.

Certain complexities are then introduced to illustrate the depth of the subject. These involve the establishment of goals for charging, the philosophy of pricing, the determination of what resources to price, the influence of pricing strategies on user behavior, the selection of a measure of work, the currency used, the quality of service, user desires regarding the charging system, and methods commonly used to "beat the system."

The influence of various pricing philosophies on user behavior is examined in the context of using charge-back as a cost allocation versus a resource allocation method. An average cost pricing scheme is designed primarily to recover costs but can lead to certain inequities such as high prices when demand is low. Flexible pricing, on the other hand, is aimed at recovering costs and influencing the allocation of resources. Finally, the question of what actually constitutes full utilization is explored and it is concluded that the definition of capacity of a computer is still unsettled.

Arndt, Donald A. et al.
"Budgeting for the D. P. Department/Chargeback to User Departments."
The Interpreter, August, 1974. pp. 24-31.

Five short papers are included from a panel session in which the panelists presented their companies' views on the question of charge-back.

Donald A. Arndt of the Northwestern National Insurance Company outlines the major advantages and disadvantages of charge-back and the reasons why his company has elected to charge both internal departments and other subsidiaries for computer services.

Rick Fabing of the Continental National American Group explains the problems created by the lack of a charge-back policy and outlines the steps being taken to establish such a policy in order to eliminate the weaknesses in the existing budgeting scheme.

Sid Johnson of the Federated Mutual Insurance Co. explains why user departments do not budget for computer services in his company. Instead, the company allocates computer systems, computer programming, and computer time back to the user on a direct allocation basis.

Curt Shankel of Western Casualty and Surety presents the major advantages of budgeting and charge-back from the point of view of the data processing department. He also examines the three main elements of a billing system: the data collection mechanism, the formula for allocating the cost of resources, and the rates for each data center resource.

Don Kanzler of Integon Corp. explains how his company budgets for computer services, how the costs are charged back to the user, and the basic advantages and weaknesses of the approach.

Wiorowski, Gabrielle K., and Wiorowski, John J.
"A Cost Allocation Model."
Datamation, August, 1973. pp. 60-65.

The measures of resource usage on which charges are based are first examined and the necessity for charging on the basis of individual peripherals as well as CPU and core is established. Various cost-charge categories are outlined and the computation of rates for each is explained. Rates for each category are computed by dividing the total cost of all resources in a category by the product of the resource unit, time unit, and percent usage. The specific calculations for each of the 12 categories are explained and the collection of data to support the percent usage figures is discussed.

One of the disadvantages of the cost allocation model is the difficulty users have in understanding the charges. Early indoctrination in the approach and the availability of a project costing program are recommended to help overcome user resistance. Nine benefits of the approach are cited. Of these, the most important are that it provides a quantitative basis for equipment evaluation, that each resource is priced to pay for itself, that the charging data may also be used for operational analysis, and that percent usage figures may be used to adjust the center's operational schedule.

Junanaker, J. F., and Whinston, A.
"Computer System Management: A Macro Planning Cost Allocation Procedure."
Management Informatics, August, 1973.

The responsibility center concept is first introduced as a means of allowing the computer center to operate so as to allocate resources efficiently. The necessity of a planning process is emphasized and the five basic steps to planning are identified. Included in those steps are a detailed statement of requirements, the translation of requirements into a system design (by both manual and computer-assisted methods), and the allocation of costs. A cost allocation formula is developed that allocates greater costs to the user whose alternative costs are greater. An example is given of the use of the formula in a company consisting of four user groups.

A methodology for determining the optimal computer system is presented in which the cost allocated to one user depends on the amounts of service to other users. The fact that the activity of one user can affect the quantity and quality of the service received by another user implies the need for some sort of global control and cooperation. The cost allocation procedure is one such control and is directed toward fair allocation of resources to all user groups.

Bookman, Philip G.
"Make Your Users Pay the Price."
Computer Decisions, September, 1972. pp. 29-31.

Two basic reasons for job costing are given: to compare the cost of a job to its value, and to charge users for computer center services. The basic goals of any billing policy are identified as accuracy, repeatability, understandability, and competitiveness.

The three main elements of the billing process are then discussed. A data collection process is required to measure the actual use of system resources, and problems relating to accounting data accuracy in a multiprogramming environment are noted. It is shown that the cost of data collection is directly related to the degree of accuracy and repeatability desired. The development of a formula for cost computation is next considered and examples of both a simple and a complex formula are given. Some criteria for selecting the right type of formula for a given installation are also provided. The third element in the billing process is the setting of rates which are computed by dividing cost by utilization level. The major considerations in computing costs and utilization are described, including the implications of various financing arrangements.

Courtney, Ralph.
"Who Pays What? Solutions to the Job-accounting Quandary."
Computer Decisions, July, 1973. pp. 12-16.

Seven commercial job accounting packages designed to process IBM's System Management Facility (SMF) data are reviewed within the framework of three capabilities: job accounting and control, resource utilization monitoring, and billing. A description of the operation of SMF, including a schematic diagram, is first given and the use of user exits to monitor job flow is explained. Of the reviewed systems, only two make use of user exits. The data collected, and the major factors in a billing algorithm are outlined.

Capabilities of the various systems to produce resource utilization reports are summarized, including a chart showing the general areas covered by each of the packages. The billing function is found to be the weakest in all of the packages, and some of the necessary billing features are discussed. Possible future improvements, particularly for VS systems, are highlighted.

Emery, James C., and Morgan, H. L.
"Management and Economics of Data Base Management Systems."
Data Base Management Systems. Edited by Donald A. Jardine.
New York: American Elsevier, 1974. pp. 185-193.

The major economic and managerial issues that should be considered in the installation of a data base management system are considered. In terms of benefits, a reduction in application programming effort is realized because of the elimination of many input/output considerations. The common data base approach leads to a reduction in the use of storage and easier integration of applications. Other benefits include greater flexibility, maintainability, portability, and reliability. The major costs involved are in acquisition and installation, operating costs (particularly core and CPU overhead), and certain intangible personnel costs.

The installation of a DBMS also has certain managerial implications. It is often necessary to appoint a data base administrator who has authority over all aspects of data base administration. The DBMS also influences centralization in some respects and decentralization in others. Processing and organizational planning tend to become centralized, while users of the system and some levels of decision making become decentralized. Charging for information services is more complicated because of the high fixed costs and sharing of the data base by many applications.

This paper is part of the proceedings of the SHARE working conference on Data Base Management Systems and is followed by a discussion among panelists.

Taylor, Alan.
"Computer Bills: Should the Charges Vary With Each Job Execution?"
Computerworld, November 3, 1971. p. 7.

The author shows how the same program running in three different environments can produce three different measures of elapsed time. Because of the desire to charge users consistently for the same program, elapsed time is generally not used for billing purposes. In place of this, many users have chosen to charge on the basis of I/O execution counts. The fallacy of this approach is then explained. Specifically, programs are likely to be overcharged for the use of less expensive peripheral devices, unit record equipment, small block sizes, and serial operations. The conclusion is drawn that variable charges based on elapsed time are actually more equitable than consistent charges based on I/O execution counts.

Sorovits, Israel.
"The Pricing of Computer Services."
Data Processing (Great Britain), May-June, 1974.
pp. 160-163.

Three objectives are given for using accounting systems: to allocate resources among customers, to evaluate computer system cost/benefits, and to provide data for planning and budgeting. The charging algorithm used should be based on four principles: charges for the use of the joint facility must cover all costs; charges for a given job will be the same regardless of time and mix of jobs; the charge is independent of the names assigned to users; and if the units costed are modified, then cost allocation is changed appropriately.

Three accounting components are defined, including overhead costs, the costs of dynamic usage of hardware components, and costs relating to the static use of equipment. A general cost equation is given. The establishment of price parameters to be used in the equation requires the definition of cost centers, the expected service level, and the depreciation of the equipment. Prices may have to be adjusted from time to time to reflect deviations from planned usage, changes in equipment, or changes in the charging policy. An illustrative example is given to show how charges are computed based on the concept of average costs. The example shows how overhead costs are allocated to cost centers, how throughput is determined, and how price parameters are calculated. Outputs of the accounting system are briefly described.

Grillos, John M.
"Pricing EDP Resources."
Computer Decisions, November, 1974. pp. 16-17.

A sophisticated management and planning system is needed to insure that centralized data processing reaches its potential. The major tools of such a system include a programming, planning and budgeting (PPB) system for ADP, ADP accounting, a transfer pricing system, and performance standards and reporting. The key to a successful accounting system is in the definition of applications and the ability to collect usage data against specific programs. The pricing of services is the chief demand-regulating device, and serves to ration demand and to motivate more efficient use of resources. The interaction of prices and costs determines whether the center runs at a profit or loss, which in turn influences major decisions regarding capacity.

Three criteria are suggested for the setting of prices: prices should be set to yield breakeven revenue at a projected usage level; charges should be distributed to users according to the resources used by each; and measures of resource consumption must reflect the difference between application types (ie. batch, remote batch, teleprocessing, data base, etc.). A sequence of calculations which result in a set of resource rates is presented in a series of charts representing a hypothetical DP center.

Sobczak, J. J.
"Pricing Computer Usage."
Datamation, February, 1974. pp. 61-64.

The author argues that an accounting system must be cost reflective if it is to maximize the benefit of the dollars spent on computers. Microeconomic theory is used to demonstrate that pricing for a profit, or pricing below cost produces a less than optimum value for the firm as a whole. Within this context, however, it is assumed that departments buying computer services respond to prices in a prudent and sensible fashion.

Some common non-cost reflective accounting practices are noted. For example, charging on the basis of elapsed time or any single resource does not properly account for resource usage. Similarly, certain types of penalty charges as well as charges that do not reflect total resource usage are not reflective of true costs.

Accounting algorithms that make use of standard measures of work are inadequate because they do not reflect different charges resulting from different types of equipment. It is also argued that surcharges for "expensive resources" are unnecessary, and that cost sensitive algorithms will reflect the proper cost structure. A proper balance between simplicity and accurate cost reflection must be reached. The key element in effective use of charging is the degree to which charges actually affect data processing users. If charges do not influence user decisions, then the accounting system will be an unnecessary expense.

Giudice, John J., and McElroy, John J.
"Allocating Job Costs for Multi-Programming Systems."
Data Processing Magazine, Spring, 1972. pp. 15-19.

The desirable characteristics of a cost allocation algorithm are first outlined: it must be logical and represent the economics of the real world; it must be simple and understandable by all affected parties; it must produce repeatable results; and it must be economical to operate. The alternative cost allocation schemes include the stand alone/standard cost model, detailed measurement systems, and single element allocation. The latter method is selected as being the most simple, economical and reasonable.

Under a single job stream system, wall clock time is the simplest and most equitable single element on which to base cost allocations. In multiprogramming systems, however, wall clock time is not a repeatable measure and an alternative, called work time, is suggested. Work time is defined as the sum of CPU time actually used by the job plus the input/output wait time. Although this approach produces more repeatable timings, it is not as simple to explain to users as straight wall clock, or elapsed time. It is, however, quite simple and inexpensive to implement, and provides adequate accuracy for cost allocation.

Kreitzberg, Charles B., and Webb, Jesse H.
"An Approach to Job Pricing in a Multi-programming Environment."
Proceedings of the 1972 Fall Joint Computer Conference, Volume 41, Part 1. pp. 115-122.

The problems of charging for jobs run on third generation systems as compared to second generation systems result from the sharing of resources among the resident programs, and the variation in elapsed time from run to run of a given job. Because of this, the traditional charging formula (cost equals program run time multiplied by rate per unit of time) is not applicable to third generation systems, although its simplicity and intuitive appeal are far greater than most charging formulas used for multi-programming systems.

An approach is suggested which enables the third generation user to adapt measures of usage to the second generation formula. First, a "computed elapsed time" is defined which is the sum of CPU time for a program plus its voluntary wait time. This value is equivalent to the wall clock time if the run were executed by itself. Second, a scheme is devised for the partitioning of the system into a subset computer for the computation of a rate representing those resources used by the run. Given these two values, the simpler second generation charging formula can be used to compute charges which are equitable and reproducible.

Jacobs, Donald.
"Equitable Machine Cost Accounting in a Multi-programming Environment."
Data Management, November, 1973. pp. 21-25.

The most common practice in job accounting involves measuring a combination of central processor utilization and input/output requests to arrive at an approximation of elapsed time. It is shown that this approach does not motivate the programmer to improve the efficiency of his programs. In place of this approach, a modified version of elapsed time, called step time, is suggested. Step time is computed by subtracting certain periods when a program is blocked from execution by other programs from the elapsed time. Tests were conducted to determine the amount of variance of step time from stand-alone elapsed time and it is concluded that step time can reliably be used to equitably distribute the resources a job uses.

The charging formula using step time is constructed simply by multiplying the rate for each resource by the step time, avoiding the use of averages or estimates. The advantages claimed are equitable cost accounting and the encouragement of good programming practices.

Chanoux, Jo Ann; Goodrich, Michael; and Scaletta, Phillip.
"How Much a Second for a CPU?"
Computer Decisions, December, 1974. pp. 38-39+.

The determination of total cost for time sharing services is not a simple calculation and is compounded by the variety of pricing schemes offered by time sharing vendors. An example is used to show that the cost of services from two competing vendors is not necessarily related to their stated per second CPU rates. Total cost is a function of connect rates, CPU rates, I/O rates, file storage, and other services. A formula is developed to show how all the variables interact to make cost predictions extremely difficult. For example, charges for connect time are influenced by number of users logged on to the system, average system response time, and transfer rates. CPU time may be influenced by processor speed, and the vendor's job scheduling scheme.

Benchmark tests are suggested as one means of predicting actual costs if vendors are unable to provide reasonable estimates. An accompanying chart lists the major evaluation criteria for selecting a time sharing service.

Selwyn, Lee L.
"Computer Resource Accounting in a Time Sharing Environment."
Proceedings of the 1970 Spring Joint Computer Conference, Volume 36. pp. 119-130.

The background of time sharing services is first considered along with the major implications of various types of services on the pricing policies of a supplier. It is shown that a pricing structure must be flexible and accurate, encourage the use of proprietary software packages, and be consistent with the operating procedure. The evolving nature of the time sharing business and its management information requirements are reviewed.

The basic design objectives of a managerial accounting and control mechanism are then summarized. These include the ability to allocate resources among various types of users, to provide for flexible pricing, to permit decentralized management of resources, to control system access, to record the details of system usage, and to provide for accounting on a subsystem basis. The implementations of two such accounting systems are then described. The first, called the "BUYTIM" resource allocation system, was designed for the IBM 7094 under CTSS. The mechanism provides the user more direct control over available funds. The second system was implemented for the PDP-10 and incorporated a number of advances over the first system. These included dynamic pricing, accounting for specific services used, improved access control, resource management, and system security.

Burner, Weston J.
"Trade-offs in Time Sharing Pricing."
IEEE International Computer Society Conference, 1971.
Conference Digest: Hardware, Software, Firmware Trade-offs. pp. 1-7.

Three purposes for the establishment of charging or pricing schemes for computer usage are noted: recovery of the cost of providing the service; distribution of the expenses in an equitable fashion; and management of the resource itself. An appreciation for the charges and accounting cost control by users is essential if any pricing scheme is to work.

A number of trade-offs exist with respect to both users and suppliers. Suppliers are concerned with the manner in which individual resources are to be separately priced, and the forecasting of expected usage, which is the key to profitability. Individual software charges may be levied by one supplier, while another does not charge for software usage, hoping that revenues will be generated by the execution of programs and the use of CPU time. Users may elect to trade-off connect time charges for slower, but less costly background execution of jobs. It is recommended that prospective time sharing users trade-off their own specific needs against the specific pricing policies of vendors and use multiple vendors where warranted.

Emery, James C.
"Problems and Promises of Regional Computing."
Datanation, August, 1973. pp. 55-58.

The formation of a regional computing center, called UNI-COLL, by a number of colleges and universities in the Delaware Valley was undertaken to gain economies of scale in hardware, software, and operations. It was believed that such an arrangement would provide computing capabilities that could not be matched by individual facilities. However, a number of problems were encountered: complete cooperation between the independent organizations was not achieved; prices did not reflect the economy of scale of the larger system because of limited usage; idle capacity existed and agreement could not be reached on an approach to marginal pricing; full commitment to the concept was not made by all participants; compromises had to be made in services offered; and the reallocation of funds to the regional center by individual schools was not completed according to plan.

Based on these experiences, predictions are made relative to the future of regional computing. First, a hierarchical network is envisioned with small local computers, a regional center, and a connection to a national network. Operating functions will tend to be decentralized with local institutions providing services within their areas of expertise. A complex pricing structure will be required to motivate users' behavior. Eleven principles are given for such a price structure. Finally, a financial commitment of the users will be required in the form of a revenue guarantee, with some built-in flexibility related to the quality of service provided.

Bowden, E. K., Sr., and Barr, W. J.
"Cost Effective Priority Assignment in Network Computers."
Proceedings of the 1972 Fall Joint Computer Conference, Volume 41, Part 2. pp. 755-763.

The author contends that the implementation of user-oriented load-leveling in computer networks is the key to developing economically self-supporting network computers. The hypothesis is presented that jobs requiring essentially the same resources are not necessarily of equivalent value to the user with respect to time. A priority assignment technique is proposed which represents the worth of the tasks in the system, based on a user-specified "deadline." A mathematical measure of cost-effectiveness is proposed to evaluate the performance of a network as well as each system individually. This measure leads to a reward/cost ratio which is the basis for the development of a priority assignment scheme. A priority assignment algorithm is developed and several examples of its use are given.

The more general problem of load leveling within a network of computers is addressed. An algorithm is suggested that assures completion of each task within a center by its deadline, or, if there is danger that the deadline might be missed, then the task is considered for transmission to another center which can meet the deadline.

Diamond, Daniel S., and Selwyn, Lee L.
"Considerations for Computer Utility Pricing Policies."
Proceedings of the 1968 ACM National Conference, Volume 23,
pp. 189-200.

A pricing framework is proposed consisting of three dimensions: the amount of resources used, the relative demand on the system resources at any given time, and the value of work being done by the system. In the context of these three dimensions, the various alternatives for pricing computer services are given: fiat rate, connection time, transaction, and resource usage. The applicability of each to the three dimensions is discussed, as are certain constraints or limitations that may be placed on usage under any of the policies.

Three dimensions of service are introduced. These include the distinction between user-written programs and utility-supplied subsystems, the type of access granted to the user, and the demands on system resources by user programs. These dimensions correspond to the pricing dimensions discussed in the first section. Various pricing policy selection criteria are then discussed, including both market-oriented criteria and operation-oriented criteria. In the former category are the customer's ability to predict cost, payment only for services used, maximization of services for a given cost, payment of proper share of common costs, payment for "value" of services, and desire for priority service. Operation-oriented criteria are primarily concerned with profit maximization and the influencing of user behavior. The final portion of the paper examines the pricing policy for Multics as an example of the more complex computer utilities soon to come.

Nielsen, Norman R.
"The Allocation of Computer Resources--Is Pricing the Answer?"
Communications of the ACM, August, 1970. pp. 467-474.

Earlier work on the question of computer resource allocation is first reviewed and it is shown that allocation by administrative regulation is inadequate. A two-stage procedure for allocation is suggested under which top management, computer center management, and users would each make certain resource allocation decisions for which they are most qualified. The top level group would make decisions regarding the general level of utilization by various projects. Users would make detailed resource usage decisions. Computer center management would be primarily concerned with providing an adequate quantity of the most appropriate resources.

The major considerations in the setting of prices relate to their stability over time, the use of long-run capital and operating costs as the basis for setting prices, and the influence of pricing on user demands. Selection of resources to be priced is based on the measures available from the host system. As small a set as possible should be used, and only those over which the user perceives that he has control should be priced. In the short run, allocation problems can be handled by permitting prices to vary dynamically with demand.

Several clarifications are made regarding some of the more frequent misconceptions about pricing and examples are given to illustrate the different circumstances under which pricing can be effective.

Nielsen, Norman R.
"Flexible Pricing: An Approach to the Allocation of Computer Resources."
Proceedings of the 1968 Fall Joint Computer Conference,
Volume 33, Part 1. pp. 521-531.

In spite of the emphasis on costing procedures, few have been designed to allocate scarce computing resources. To do so, an array of flexible or adjustable prices, responsive to demand, are required. Measures of utilization are defined and the various resources of the system are related to those measures. Selection of measures for pricing should be based on those to which users can easily relate their resource usage, those which are easily obtained from the system, and those which account for a major portion of the system's resources.

Prices are then assigned to the selected measures. Major considerations in pricing relate to their stability over time and their influence on user behavior. A flexible pricing scheme is proposed that is based on priorities and allows the user to select appropriate queues depending on the price and/or turnaround time associated with each. A test of such an approach was conducted at the Stanford Computation Center. It was demonstrated to be practical from an operating standpoint. Improving the performance of the computer center and relieving management of numerous resource allocation decisions.

Nielsen, Norman R.
"Using Your Computing Resources to Best Advantage."
Journal of Contemporary Business, Spring, 1972. pp. 35-49.

The shortcomings of the most common methods of computer resource allocation are outlined and the need for a better method is noted. It is suggested that a three-stage procedure be adopted whereby management determines the general level of resource utilization by functional area, users select the specific resources, and computer center management determines what level of resources to provide. A unit of global resource utilization is defined and prices established for these units. Such a price structure can be used to motivate user behavior in the selection of computer resources. Considerations for the setting of prices are given.

The role of the computer facility is to provide the required services at the lowest possible cost. In this context, pricing can be used to adjust the types and quantities of services made available. In addition, the demands of users help to define their actual requirements and aid facility management to plan for future capacity.

Timing considerations are introduced as a possible justification for varying prices to meet different levels of user demand. A series of priority queues with associated prices is suggested. The major benefits of the use of a pricing procedure are the increase in value of computer services provided, the improved allocation of both physical and temporal computer resources, and better management of the computer facility.

Smidt, Seymour.
"The Use of Hard and Soft Money Budgets, and Prices to Limit Demand for Centralized Computer Facility."
Proceedings of the 1968 Fall Joint Computer Conference, Volume 33, Part 1. pp. 499-509.

One of the disadvantages of decentralization is the effect that decision makers may have on other parts of the organization without having knowledge of that effect. This paper concentrates on ways of overcoming this disadvantage in cases where a centralized computer facility services many decentralized users. The problem is one of limiting demand for computer services by users who are attempting to maximize some goal that cannot be expressed in monetary terms. The basic decision variables involved are the amount and type of computing facilities, user budgets (demand), and the terms on which computer services are made available to users (price).

A set of four mathematical models is presented which aid in determining what basis should be used for establishing prices for computer use, and whether or not users should be given a separate budget applicable only to their computer usage. In this context, hard money refers to money that can be spent for any purpose; soft money can be used only in some limited way. The first model assumes only internal financing (hard money) with prices set by the organization. The second model allows for the possibility that some users receive part of their budget allocations from outside sources, considered to be soft money from the point of view of the organization. In the third model, it is assumed that the organization can make both hard and soft money allocations to users. The final model adds the further assumption that computer capacity is fixed, and cannot be adjusted to demand. An appendix gives the mathematical details of each of the models.

Kanter, Herschel; Moore, Arnold; and Singer, Neil.
"The Allocation of Computer Time by University Computer Centers."
Journal of Business, July, 1968. pp. 375-384.

The allocation of computer time by university computer centers is significantly affected by federal government auditing rules which require that computer time for government-sponsored research be based on "average full costs." Three kinds of problems arise because of this. First, the university's inability to charge based on quality of service leads to certain inefficiencies and inequities for other users. Second, because charges are based on full costs, some overinvestment can result. Third, a market is created in which a few buyers of computer time have an important influence on the prevailing price.

An analysis of the theoretical solution to the allocation of computer time suggests that marginal costs are significant, contrary to popular belief, and that pricing in accordance with some measure of service quality is feasible and desirable for computer services.

Present government regulations are examined and it is shown that there is generally more leeway under present rules for charging than the universities have taken advantage of. In particular, the major conditions imposed by the government are that costs be established for periods no longer than one year, and that price differentials be somehow related to costs. It is suggested that a change in the rules be made to clarify the freedom implicit in the present rules.

Singer, Neil M.; Kanter, Herschel; and Moore, Arnold.
"Prices and the Allocation of Computer Time."
Proceedings of the 1968 Fall Joint Computer Conference, Volume 33, Part 1. pp. 493-498.

The basic operation of a pricing mechanism in any environment is first evaluated and it is shown that a price system can solve the problems of distributing goods and services among consumers, allocating resources among producers, and conveying information to control resource flows. The conditions for pricing to work in allocating computer time are that computer time be made available to any user willing to pay the price, that all costs and benefits be incurred within the market, and that prices be free to fluctuate without regard to the cost of production. It is concluded that pricing is an effective mechanism for allocating computer time in the short run, but is more complex in the long run due to variations in the supply, or capacity, brought about by changes in hardware.

The pricing mechanism is further supported by the lack of good alternatives. Average costing is discussed and is shown to produce improper incentives among users. Overhead charges establish no basis for allocation and are likely to be inequitable. Priority schemes are the most satisfactory alternative, but their good points are essentially parallel to the good points of pricing.

Marchand, Maurice.
"Priority Pricing with Application to Time-shared Computers."
Proceedings of the 1968 Fall Joint Computer Conference, Volume 33, Part 1. pp. 511-519.

A pricing procedure with several levels of priority is suggested as a means of remedying the defects of the simple first-come-first-served rule. A model is then presented which maximizes a linear combination of individual utility functions subject to technological constraints and market clearing equations. Some conditions are found that the prices must satisfy in order to lead to a Pareto optimal allocation of resources. Certain results of queuing theory are presented which help to determine which characteristics of the demands for jobs must be charged. The economic interpretation and the practical implications of the optimal conditions are then derived.

The extent to which results may help in the design of efficient pricing procedures for time sharing systems are investigated.

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Alward, Sam A., "How to Cost and Charge for DP Services," Data Management (September 1975), pp. 54-59.

Examines the question of whether or not to charge for data processing services. Outlines basic principles.

"Benefits of Standard Practices," EDP Analyzer (Aug. 1975).

Argues for the use of standards, standard practices, and charging for computer services. Includes examples of use.

Connors, Kevin, "Management Control over the Systems Development Process," Interpreter (Jun. 1975) pp. 19-22.

Describes ten-step ADP system development management approach employed by the Equitable Life Insurance Society.

Cotton, Ira W., "Microeconomics and the Market for Computer Services," Computing Surveys (June 1975), pp. 95-111.

Discusses elementary microeconomic concepts in the data processing services pricing context.

"Developing EDP Projects Successfully," EDP In-Depth Report (Jul. 1975).

Discusses ADP systems development project management.

"Do We Have the Right Resources," EDP Analyzer (Jul. 1975).

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Ghanem, S.B., "Computing Center Optimization by a Pricing Priority Policy," IBM Systems Journal (Fall, 1975) pp. 272-292.

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Gladney, H.M., Johnson, D.L., and Stone, R.L., "Computer Installation Accounting," IBM Systems Journal (Winter, 1975).

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Parkin, A., "Bringing Cost into File Design Decisions," Computer Journal (Eng., Aug. 1975) pp. 198-199.

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Ransdell, William K., "Managing the People Who Manage the Computer," Journal of Systems Management (Sep. 1975), pp. 18-21.

States need for a systems personnel performance standard.

Safford, Herbert, "Measuring Cost and Potential Benefits of Computer Projects," Data Management (Jul. 1975) pp. 40-43.

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Discusses data communications planning in a total systems context. Cost considerations are pointed out.

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Zmud, R.W., "Two Enhancements to a Flexible Pricing Control System for Allocating Computer Resources," Computing Journal (May 1975), pp. 112-114.

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- B-115369 Letter Report to Congressman Armstrong on ADP Costs of the Federal Government, May 12, 1975.
- B-115369 Opportunity for Savings of Large Sums in Acquiring Computer Systems Under Federal Grant Programs (FCMSD-75-34) July 24, 1975.

- B-115398 Civil Agencies Make Limited Use of Cost-Benefit Analysis in Support of Budget Requests (FCMSD-75-10), January 14, 1975.
- B-133394 Administration of Cost Plus Award Fee Type Contract for Computer Programming and Operational Support Services, December 18, 1969.
- B-140389 Financing Agency Programs Other Than By Direct Appropriation -- Revolving Funds, March 6, 1970.
- B-146796 Ways to Improve Management of Automated Data Processing Resources -- Department of the Navy (LCD-74-110), April 16, 1975.
- B-146864 Improved Planning--A Must Before a Department-wide Automatic Data Processing System Is Acquired for the Department of Agriculture (LCD-75-108), June 3, 1975.
- B-158685 Better Controls Needed in Reviewing Selection of In-House or Contract Performance of Support Activities, March 17, 1972.
- B-158685 Better Management Needed in Civil Agencies Over Selection of In-House or Contract Performance of Support Activities, July 31, 1973.
- B-163074 Problems in the Acquisition of Standard Computers for World-Wide Military Command and Control System December 29, 1970.
- B-163762 Resource Management Can Be Improved by Greater Use of Productivity Techniques (CGE-75-56), April 16, 1975.
- B-164031 Improving the Acquisition of Computer Systems, January 24, 1974.
- B-164031 Increased Efficiency Predicted If Information Information Processing Systems of Social Security Administration Are Redesigned, April 19, 1974.
- B-164031 Letter Report to the Secretary of Health, Education, and Welfare on Office of Education's Financial Management Activities, March 5, 1975
- B-164031 Letter Report to Department of Health, Education, and Welfare on Systems of Accounting and Internal Control at Region III, Office of Education and the Social and Rehabilitation Service, May 22, 1975.

- B-164250 Army's Evaluation of Alternative Designs for Providing Computer Capabilities Needed for SAFEGUARD Antiballistic Missile System, August 20, 1971.
- B-164497 Improved Planning and Management of Information Development Needed -- Federal Aviation Administration, Department of Transportation (LCD-74-113), August 13, 1975.
- B-166655 Review of Status of Development Toward Establishment of a Unified National Communications System, July 14, 1969.
- B-169857 Improvements Needed in Management of Department of Defense Communications, October 19, 1970.
- B-169857 Letter Report to the Secretary of Defense on Air Force Logistics Command's Set 8 (Univac 418) and Army's Automated Multi-Media Exchange (AMME), March 17, 1975.
- B-171019 Development of a Nationwide Criminal Data Exchange -- Need to Determine Cost and Improve Reporting, January 16, 1973.
- B-178806 Problems and Progress of the U.S. Army Materiel Command's Automated Data Processing Service Center Concepts, October 9, 1974.
- B-180235 Problems Affecting Operations at the St. Louis Postal Data Center, December 10, 1974.
- B-182852 Letter Report to the Secretary of Defense on the Need for More Effective Management of Transportation Data Systems (LCD-75-205), February 11, 1975.

Guidelines for Managing Information Processing Systems (Draft), May 1974

Management Guidelines for Cost Accounting and Cost Control for ADP Activities and Systems: A Report of Recommendation of the GAO Task Group, September 17, 1975.

Staff Report on the Scope and Concept of the Standard Budgetary and Fiscal Information System, August 1972.

General Services Administration:

A Revised Table of Contents and Index for OMB Circulars, July 1, 1972.

This table lists all current OMB regulations and instructions and indicates whether or not the issuance has been revised.

ADP Management Information System (MIS) Processing Procedures, April 1, 1974.

This manual prescribes procedures "for developing, operating, and maintaining an ADP MIS to assist GSA and other Federal Agencies in carrying out their management responsibilities for the most effective and efficient utilization of ADP under FAC 74-2".

ADP Responsibilities Study, July 1958.

The objective of this study was "to identify and clarify the Government-wide functions performed, or to be performed, in the utilization of ADPE and to propose assignments of these functions to specific agencies".

An Appraisal of Government-Wide and Internal ADP-Related Activities by Fry Consultants for GSA, March 13, 1972.

Data Processing Standards Manual, April 12, 1973.

Internal manual providing management and operating guidelines governing actions on ADP services, to include new jobs, systems design and programming, and data processing division personnel, equipment, supplies and facilities.

Five-Year ADP Plans, Spring 1974.

This compendium includes the five-year ADP plan of each Federal Agency owning ADPE. The plans reflect: FY 1973 ADP obligations incurred; a narrative statement on the agency's use of ADP, future plans, critical issues; an ADP financial plan; and source of funding.

Inventory of ADPE in U.S. Government for FY 1972, FY 1973, FY 1974, and FY 1975; February 1973, December 1973, December 1974, and December 1975, respectively.

Reference Guide to ADP Directives, May 30, 1974.

This document is the prototype of a guide which was to reflect the hierarchy of ADP-related issuances among

the various Federal Agencies, to include OMB, GSA, the Departments of Defense (DoD) and Commerce (DoC), the Office of Telecommunications Policy (OTP) and others. The issuances are categorized by such ADP functional areas as acquisition, the ADP Fund, communications, disposal, contractor vs. in-house activities, excess, operations, planning, reutilization, security and privacy.

Report of Task Force on Long-Range Plans for ADP in the Federal Government to the Interagency Committee on ADP, May 1971.

This report recommended establishment of a Presidential Commission of Government and non-Government designees to conduct a comprehensive review of ADP in the Federal Government, with emphasis on long-range planning, to include present concerns that have future relevance; i.e., management structures, ADP technology, standards, planning, programming, budgeting, central ADP funding, procurements, privacy, confidentiality, and security of information.

Report to the Subcommittee to Study the Shortening of the ADPE Acquisition Cycle, February 8, 1973.

This study addresses such problem areas as RFP preparation time, technical and cost evaluations, standardized third-party documents, intricacies of the procurement process, time of solicitation arrival at GSA, temporary regulation E-25, and mandatory requirements contracts.

Software Exchange Program (Draft FPMP), April 1974.

GSA ADTS first enunciated the policies and procedures for such a program in this draft publication.

Summary of Federal ADP Activities for FY 1973, January 1974.

Companion volume to the Inventory of ADPE in U.S. Government for FY 1973 and includes cost, manpower, and utilization data on General Management Classification and Special Management Classification ADPE.

Task Group Report on Methods for Reducing Time and Cost Required for ADPE Procurement, December 1972.

This study addressed the following ADP issues: Federal Supply Schedules, Standard Benchmarks, the Late Proposal Clause, Uniform RFPS, Delegation of Procurement Authority, and Post-Selection Benchmark/Functional Demonstrations.

Government of Canada:

Computer Communications Policy, Department of Communication.
Federal Government of Canada (Undated).

The document states that, as an overall goal, computer communications should be oriented in such a way that they emphasize national identity and achievement of social and economic aims and that they maximize Canadian influence and control over key activities and services. The report summarizes 29 statements that were developed to support these goals and explains their relationships to recommendations of the Computer/Communications Task Force.

EDP Master Plan, Treasury Board, Federal Government of Canada, December 1972.

This report describes the GoC EDP centers, their organization, staffing, and personnel management issues associated with their operation, financing, and implementation.

Guide on EDP Administration, Treasury Board, Federal Government of Canada, December 3, 1972.

A guide covering: roles & responsibilities of agencies, centers, and departments, planning for EDP needs, development and control of EDP projects, choice of EDP services, procurement of EDP goods & services, EDP financial administration, computer performance improvement EDP records management, security in an EDP environment, and EDP standards.

New Approach to Systems Development and Operation,
Management Board of the Cabinet, Government of Ontario,
Canada, September 17, 1973.

Plan for EDP and Systems Services in the Ontario Government,
Management Board of the Cabinet, Government of Ontario,
Canada, September 17, 1973.

Report on EDP in Federal Government Canada, Treasury
Board, Federal Government of Canada. November 30, 1971.

This report reflects proposed long-term EDP policy in Canada, their implications, preimplementation requirements, and implementation.

NATIONAL TECHNICAL INFORMATION SERVICE:

Arinc Research Corp., Annapolis, Md.
"Guidebook for Systems Analysis/Cost-Effectiveness"
Mar 69 451p AD-000 154

The purpose of the guidebook is to provide Army personnel with a text and reference material in Systems Analysis and Cost-Effectiveness. It is intended for those technical, scientific, management, and administrative personnel who are responsible for preparing information, making decisions or reviewing decisions made by others regarding life-cycle cost, system effectiveness (availability, dependability, capability), or technical feasibility of a system or equipment at any phase in its life cycle. It is immediately useful to personnel who are familiar with a system or equipment under study but are not familiar with the methodology and techniques of Systems Analysis and Cost-Effectiveness.

Army Electronics Command, Fort Monmouth, N.J.
"Army Programs Cost Estimating Guide"
(Methods and Factors)
12 June 72 86p AD-765 561/6

The report has been compiled in an effort to provide guidance to US Army Electronics Command (SOLM) personnel in the formulation of cost estimates for planning, programming, and budgeting purposes. It is intended to provide the approaches necessary to meet the requirements set forth in AR 37-18 for life cycle cost studies, as well as providing pertinent areas of consideration for estimates required by other management documents (i.e., commodity management plans, materiel need documents, advanced procurement plans, program changes requests and other special cost studies).

Army Materiel Command, Washington, D. C.
"Engineering Design Handbook: System Analysis and Cost-Effectiveness"
Apr 71 410p AD-604 151

The purpose of this handbook is to provide a text and reference material in System Analysis and Cost-Effectiveness. It is intended for those technical, scientific, management, and administrative personnel who are responsible for preparing information, making decisions or reviewing decisions made by others regarding life-cycle cost, system effectiveness (availability, dependability, capability), or technical feasibility of a system or equipment at any phase in its life cycle. It is immediately useful to personnel who are familiar with a system or equipment under study but are not familiar with the methodology and techniques of System Analysis and Cost-Effectiveness.

Barnett, Arnold
"Selected Papers on Effective Data Systems Development"
1971 59p ED-052 788

The four papers included in this document are: (1) "Preparing Management for MIS" presented at the Guide-12 Meeting, May, 1971; (2) "Training Management for MIS" presented on March 17, 1970, to the Central New York Chapter of the Association for Systems Management; (3) "How to Unlock the Computer's Profit Potential" presented at the 1969 Spring Seminar of the Steel Valley Chapter of the Association for Systems Management; and (4) "The Process of Effective Data Systems Development" presented at the 1968 Data Processing Management Association Convention.

Battrick, B
"The Future of Co-Operative Information Processing in Europe"
Aug 74 105p N75-23384/1ST

Twelve papers on the development of cooperation in information processing in Europe are presented. Topics dealt with include information planning and economic realities, social science documentation data bases, nuclear information, a cooperative chemical information project in the Netherlands, chemical information systems, information for casts, cooperation in European networking, retrospective chemical searching, and a computer-based industrial information system. The resolution on information processing cooperation in Europe, as accepted by the Euclid full members, is also presented.

Bland, Robert P.
"Cost Analysis for Computer Communications"
Sep 74 40p COM-74-50926/6SL

This report summarizes a communication cost study relevant to the needs of the NSF Networking for Science Program. The primary purpose of this report is to provide an approximation to the communications costs of connecting a specified number of host computers in selected locations with a specified number of interactive user terminals. Cost factors from existing, proposed, and modeled value-added networks are applied to hypothetical traffic demands to arrive at cost estimates.

Carter, D. M., Gibson, H. L., Rademacher, R. A.
"A Study of Critical Factors in Management Information Systems for U.S. Air Force"
31 Mar 75 186p AD A009 647/9ST

The report discusses the effectiveness of computer-based information systems as dependent upon many factors. The investigators in the MIS study addressed two major questions --(1) What are the most critical factors contributing to the successful development of an information system; and (2) can the factors be measured so that a model(s) can be developed to predict the success or failure of a particular information system effort. Data were collected through interviews with systems and management personnel in various industries and governmental agencies, through use of questionnaires, and through a search of the literature. Study efforts resulted in the development of a general purpose goal programming model in the interactive computer mode.

Charlotte, N.C., Department of Housing and Urban Development,
USAC Project
"System Documentation Guide
Mar 75 95o PB-241 451/451

The report is from a USAC series produced by the city of Charlotte covering activities from systems analysis through implementation and evaluation of urban information systems. The development of an Integrated Municipal Information System which encompasses all the common functions of a municipality requires the successful performance of five major technical tasks. These tasks are: systems analysis, systems conceptualization, systems design, systems development, and systems implementation. In addition, management, orientation, training, and evaluation activities are carried on by the department. To coordinate and control these activities internally and to meet the external objectives specified by USAC, efficient and comprehensive documentation procedures must be affected. This document, the Charlotte MIS Documentation Guide, addresses the establishment and operation of such procedures. Included as an appendix is a brief description of each type of document produced, listing any forms that are part of the particular document and the format requirements to be followed during its production.

Charlotte, N.C., Department of Housing and Urban Development,
USAC Project
"System Methodology Guide
Feb 75 49o PB-241 450/651

The System Methodology Guide, describes system building approach used in the design and development of the Charlotte Integrated Municipal Information System. The document provides a general background of the approach, as opposed to the technical design and development documents which detail individual segments of the system. Subjects included in this Guide are directed to the organization, planning, documentation, and conduct and control of the total system effort. The document is intended as a general guide for project staff and also as a reference for other municipalities and agencies seeking to understand the design/development approach taken by the Charlotte Consortium. Used as a reference, the Guide facilitates the proper interpretation and use of Charlotte's orientational transfer products.

Chocrow, Mark, Sparks, David E., Waite, David P.
"Information Service System Modeling, Analytical Tools
for Management Evaluation"
Dec 63 253p PB-169 596

The problem of analyzing operating costs of information service networks by employing mathematical modeling techniques is discussed. As a result of this work, it is now possible to evaluate alternative network configurations on the basis of operating costs. The model developed permits representation of the multitude of variables of subject disciplines, geographic location, communications, the variety of existing forms of input information, the type and location of information processing operations, and many others. This report is presented in two parts: Part I provides an interpretive report to management on the objectives, results, conclusions, and utility of the mathematical model created to represent and evaluate the operating costs. The development of the model and an illustrative calculation are reported in technical detail in Part II.

Craig, Douglas, Grooms, David
"Computer Networks. A Bibliography with Abstracts"
Oct 74 169c COM-74-11372/6SL

The NTISearch bibliography contains 133 selected abstracts of research reports retrieved using the NTIS on-line search system--NTISearch. The report covers all aspects of computer networks including hardware, software, data transmission, time sharing, and applicable theory to network design.

Crothers, C. G.
"Workload Determination and Representation for On-Line
Computer Systems
Jan 74 62p AD-779 81o.4

The paper describes preliminary investigations concerned with workload determination and representation for on-line computer systems. Workloads are described in terms of the work required by users at terminals instead of demands on system resources, thereby avoiding biases due to the specific machine under investigation. Prominent users are identified by accounting data, and their on-line requirements are determined by trace programs, source code frequency counts, and various analytical techniques. Complete on-line test workloads can be described by a set of terminal sessions which are then simulated using the Remote-Terminal Emulator. Experimental work on the MITRE IBM 370/155 is described, and it indicates that actual terminal sessions can be represented by synthetic sessions, thus minimizing the problem of developing and debugging test workloads for each new application.

Decisions and Designs, Inc., McLean, Va.
"Automatic Data Processing Strategy Study: Volume I,
A Summary of the Findings"
Mar 75 81o PB-240 90J 55T

The report presents the results of a study of strategic issues relating to the acquisition, utilization and management of computers in the Federal Government. Sixteen strategic policy issues were identified and examined in detail. The material is presented under three major groupings: Public Sector versus Private Sector Issues, ADP Centralization/Decentralization Issues, and Organization and Management Issues. The study approach involved in-depth elicitation sessions with representative of key Federal Government agencies, where appropriate, industry. Techniques of decision analysis were employed to provide a quantitative basis for rating of options by the participants, and collective judgements were reflected in the results. Conclusions were formulated with respect to each of the key ADP issues. Recommendations for new/revised ADP policies were then formulated as well as a plan for implementation of the recommendations. The findings and conclusions are presented in volume I.

Defense Documentation Center, Alexandria, Va.
"Bibliography - Volume I: Cost Effectiveness Analysis"
Aug 68 225p AD-675 900

The bibliography consists of references on Cost Effectiveness Analysis and Cost references related to cost estimation and evaluation, cost effectiveness, cost analysis and methodology in research and development, management, decisionmaking and systems value engineering. This volume represents a collection of 160 Unclassified-Unlimited references in the DDC data bank that have been cataloged since 1967.

Dei Rossi, James A.
"Cost Recovery in Pricing and Capacity Decisions for
Automated Information Systems"
Apr 75 63p NBS-TN-864

The paper examines the cost-benefit implications of alternative pricing and capacity investment decisions for automated scientific and technical information retrieval systems. Two typical systems are examined and numerical examples presented. In the first system search requests are entered on-site. The numerical examples show how setting price to maximize net social benefit precludes total cost recovery and implies subsidization. In the second hypothetical system, search requests are entered from remote access terminals. Allowance is made for random arrival rates, and distinction is made between system charges to users and other user incurred costs. With these refinements, the numerical examples show how, for certain ranges of out-put, total cost recovery is consistent with the maximization of net social benefit.

DonVito, P. A.
"Annotated Bibliography on Systems Cost Analysis"
Mar 67 80p AD-810 910

The bibliography includes books, pamphlets, articles, papers, and technical and research memoranda. A brief description is presented of the nature and content of each work. The materials were selected and included solely on the basis of their relevance to the subject matter of systems cost analysis, no interpretation or evaluation of the work was intended. Titles have been grouped into categories reflecting broad areas of cost analysis and its application in the Department of Defense. This bibliography was prepared for use by the growing number of cost analysts, particularly those being organized at various levels of the Air Force. The titles and their annotation are intended for use as reference material. They are intended to permit cost analysts to learn of earlier work that may be relevant to a study at hand. The memorandum contains the first revision and updates the bibliography.

Early, Robert F., Turlington, Richard G.
"Management Information, Planning, and Reporting Systems of Milestone and Milestone/Cost"
15 Jun 71 33p AD-731 043

The report contains instructions to offerors and contractors for the preparation of preliminary data to accompany Request For Proposal (RFP) or Request For Quote (RFQ), and recurring data required by contracts to provide Milestone/Cost management information to the Naval Underwater Systems Center. The material contained herein has been compiled from a variety of sources and as a result of experience and use.

Early, Robert F., Turlington, Richard G.
"Management Information, Planning, and Reporting Systems of PEPT/Time and Milestone/Cost"
15 June 71 38p AD-731 045

This publication contains instructions to offerors and contractors for the preparation of preliminary data to accompany Requests For Proposal (RFP) or Request for Quote (RFQ), and recurring data required by contracts to provide PEPT/Time and Milestone/Cost management information to the Naval Underwater Systems Center. The material contained herein has been compiled from a variety of sources and as a result of experience and use.

Early, Robert F., Turlington, Richard G.
"Management Information, Planning and Reporting Systems of PEPT/Time and PEPT/Cost"
15 June 71 30c AD-731 044

The document contains instructions to offerors and contractors for the preparation of preliminary data to accompany Request For Proposal (RFP) or Request For Quote (RFQ), and recurring data required by contracts to provide PEPT/Time and PEPT/Cost management information to the Naval Underwater Systems Center. The material contained herein has been compiled from a variety of sources and as a result of experience and use.

Esposito, J. E.
"Statistical Analysis to Determine Digital Computer Workload Characteristics"
Jun 74 80p AD-746 061/2SL

A real workload of a digital computer is characterized by the magnitude of demands placed on the various system resources. Selected performance variables chosen from these demands can be examined with the purpose of the projecting their statistical characteristics onto a synthetically constructed, representative workload. This paper describes a general approach of statistical analysis for representative workload characterization and presents an illustration of this approach using the IBM System Management Facility data.

Fife, Dennis W.
"Research Considerations in Computer Networking to Expand Resource Sharing"
Jun 74 26p COM-74-50541/3

Computer networking technology is adequately developed now to support research and experimentation to expand computing resource sharing. Whether progress will be made depends upon organizational initiative among multiple institutions, to pool personnel and capital so as to effectively address the major issues in management approach, support and software design that limit the feasible interdependence of computing operations. The organizational requirements are partially revealed by examining progressive stages of resource sharing in organizational and operational terms rather than such technical aspects as load sharing or program sharing that have been introduced in the past. Five stages are identified, ranging from simply establishing multiple service access to the advanced stage where multiple institutions organize for joint development of new resources.

Fisher, G. H.
"Cost Functions and Budgets" (Cost Considerations in
Systems Analysis)
Feb 68 42p AD-666 656

Systems analysis forms the central core of a program budgeting activity. A vitally important part of systems analysis is a cost analysis capability to generate estimates of the resource impact of alternative courses of action being considered for the distant future. Some of the principal characteristics of a systems cost analysis capability are given. Establishing and maintaining a cost analysis capability to support systems analysis studies involves numerous difficulties. One of the most troublesome is the data base problem. Solution to parts of the data problem may be through major overhaul of present formal information systems and through the establishment of new complete enumeration systems. This, however, does not appear feasible as a general solution--at least in the foreseeable future. Short of such major efforts are numerous alternative possibilities. Some examples are given.

Fulkerson, D. R.
"A Network Flow Computation for Project Cost Curves"
18 Mar 60 30p FB-167 413

A network flow method is outlined for solving the linear programming problem of computing the least cost curve for a project composed of many individual jobs, where it is assumed that certain jobs must be finished before others can be started. Each job has an associated crash completion time and normal completion time, and the cost of doing the job varies linearly between these extreme times. Given that the entire project must be completed in a prescribed time interval, it is desired to find job times that minimize the total project cost. The method solves this problem for all feasible time intervals.

Goodman, Arnold F.
"Measurement of Computer Systems--An Introduction"
Jul 72 33p AD-787 104/GSL

Three areas of phenomenal growth--computer utilization, computer technology and computer science--have produced the need for a new field, measurement of computer systems. A summary of activity involving measurement of computer systems is followed by a proposed structure for it, in terms of computer system evolution and operation. In addition, a structure is presented for evaluation of computer system effectiveness--an important unsolved problem for 1970's. This paper is intended to be an introduction to measurement of computer systems, and as such is general and suggestive, rather than detailed and complete.

Graver, C. A.
"Historical Simulation: A Procedure for the Evaluation
of Estimating Procedures"
Jun 69 157p AD-713 174

A recurring problem faced by many analysts is that of devising estimating procedures for predicting some aspect of the future from rather meager data. This is particularly true for the cost analyst who is concerned with estimating the resource requirements of future military systems. Historical Simulation is a method of evaluating candidate (cost) estimating procedures on the basis of their ability to simulate predictions using data that would have been available. In this fashion, Historical Simulation avoids relying on the central evaluation assumption of Regression Theory, namely, that which fits the past data best will predict the future best. This conceptual difference gives Historical Simulation several unique features.

Highland, Harold J., Ed.
"Computer Performance Evaluation: Proceedings of the Meeting
of Computer Performance Evaluation Users Group (CPEUG) (9th)
at Gaithersburg, Md., December 4-7, 1973"
Sep 74 152p COM 74-50911/6SL

The Eighth Meeting of the Computer Performance Evaluation Users Group (CPEUG), sponsored by the United States Army Computer Systems Command and the National Bureau of Standards, was held December 4-7, 1973 at NBS, Gaithersburg. Among the papers presented were those dealing with hardware and software monitors, workload definition and benchmarking, a report of FIFS Task Force 13, computer scheduling and evaluation in time-sharing as well as MVT environment, human factors in performance analysis, dollar effectiveness in evaluation, simulation techniques in hardware allocation, a PDCSIM status report as well as other related topics.

Johnston, William B., Abbott, Frederick K. Jr.
"Criteria for Evaluating the Cost Effectiveness of Optical
Character Recognition Equipment in Base Telecommunications
Centers"
Aug 74 96p AD-767 197/JSL

The objective of this research was to develop and demonstrate a method for calculating the cost effectiveness of Optical Character Recognition Equipment (OCRE) in military communications centers. Six AFSC bases were studied and a break-even cost for OCRE was developed for four of the bases: Wright-Patterson, Tinker, Robins, and Hill. Elements of cost of the current system considered were personnel, teletype equipment, and paper. No survey was made of OCR devices on the market to see if a specific device would be cost effective; rather, prices at which OCR devices of various capabilities would become cost effective were developed. Single and multitap OCR capabilities in both 10 and 12-bit were considered.

Weston, Robert
"A Data Processing Feasibility Study of a Cooperative
Computer Facility" 79c PB-233 062/9
Jan 74

The study examines: (1) extent of commonality of ADP requirements of nine municipalities ranging in population from 7,000 to 69,000 to test feasibility of sharing equipment, software, and staff; (2) extent to which the individual jurisdictions' current commitments to present arrangements are compatible with a joint effort; (3) extent to which physical and locational priorities would inhibit effective service to all in a cooperative arrangement; (4) the size and costs (installation and operation) of a system to meet all needs; and (5) what is the best and most cost-effective means for the nine jurisdictions, individually or collectively, to meet their needs.

Krishnamoorthy, V.
"Critical Path Methods: A Review"
1968 112c AD-672 524

The paper brings together different aspects of the Critical Path Analysis exclusively in terms of the mathematical development in this area during the last eight years. The survey is divided into seven sections. The first one deals with the four stages of development, each successive stage being more representative of the real situation. The next five sections give explicit reference to the different articles which contribute to the stages of development described in the first section. The articles are reviewed in terms of the network algebra, PERT assumptions, cost/time trade off, resource allocation (heuristic) and resource allocation (analytical). Finally, the seventh and last section of this paper provides a summary of ideas and possible directions of research, some of which are currently being undertaken.

Krohn, C. A., and S. S.
"Development of Cost Effectiveness Allocation Programs:
Local and Distribution Technique Extensions"
June 69 52p AD-698 177

The results of the second task concerning an investigation of optimization techniques in connection with the Navy Systems Performance Effectiveness program are presented. The approach of the investigation has been first to develop computer programs for solving simple problems and then to generalize the capability for solving more of the problems of interest. Under the first task two programs were prepared. These are: Reliability Cost Trade-off Analysis (RECTA), which is based on a direct search approach, and Separable Integer Program (SIP), which is based on the dynamic programming principle. Under the second task preparation and plans were made for programming modifications and improvements. A major modification to RECTA is a computerized search for the optimal weights on constraint functions and to SIP is to generalize the program for objective and constraint functions which are not completely separable. The Lagrange multiplier technique is to be incorporated into both RECTA and SIP, and both programs are to be modified to facilitate the handling of user-specified objective and constraint functions. A total lifetime cost model for the allocation problem of interest is structured, and the presentation includes relevant highlights of engineering economy on which the model is based. Effectiveness models are identified which are additional to the reliability models used in RECTA and SIP. Models are included for availability, reliability with repair, availability and reliability, and three-state reliability.

Lientz, Bennet P.
"Computer Network Usage -- Cost-Benefit Analysis"
15 June 75 19p AD-A011 375/3ST

With the establishment of several computation-communication networks several questions arise as to the cost-effectiveness of a network for a particular potential user. Analysis is necessary to determine which software systems can be established and used on a network rather than the internal computer of user's organization. The kinds of transactions to the network must also be found. A methodology for cost/benefit analysis is presented. For multiple systems, an extended horizon and restricted resources, an integer programming method is developed. Approximations for planning and a discussion of stability are given. A numerical example is included.

Lientz, Bennet P.
"Cost Tradeoffs Between Local and Remote Computing"
15 June 75 11c AD-A011 376/1ST

A major problem in communication networks analysis is to determine the degree of centralization of computer power that is desirable from both an operational and cost/benefit point of view. An example of this problem occurs in a manufacturing complex wherein decisions must be made on the distribution of data, process power, and redundancy. Because of the many parameters involving hardware, system software, and communications, a purely analytical approach is often impractical. The method here is to employ an analytical simulation model to obtain measures of cost, throughput, and response time. After the model itself is examined, focus is placed on several experiments which reveal the superiority of semi-centralized configurations. Application to logistic and manufacturing systems are explored along with the development of a network link construction method.

Lientz, Bennet P.
"Guidelines for the Acquisition of Software Packages"
Jul 74 21p AD-782 477/4

Many decisions dealing with computer software systems involve the potential acquisition of packages for a specific or limited general purpose nature. Guidelines for acquisition are presented here which stress the implementation feasibility of such packages. This reflects the behavior that operational considerations not only impact the cost of a package but also are neglected in favor of traditional cost/benefit analysis. The use of the guidelines in the areas of operations management, computer systems management, and accounting are discussed.

Lozan, Robert, O'Neil, Harold P. Jr., Wilson A., Harmon, E. Glynn
"Technical Literature Review Concerning Management Information Systems"
May 74 44p AD-781 749/7

The primary objective of the literature review was to obtain sources of information relevant to the feasibility and utility of an on-line data management system in support of the management and planning effort in the research and development environment of the Air Force Human Resources Laboratory. The formal documentation of the technical literature reviewed resulted in an annotated bibliography of 112 references. The intended audience for the bibliography was middle- and lower-level management personnel. Documents were selected that would familiarize such personnel with the context and interrelationships of the many aspects of management information systems (MIS); that is, with how analysis, design, operation, evaluation, and user considerations affect management information systems.

O'acre, K. Power
"Management Strategies for ADP Networking"
1974 170p AD-785 976/4SL

The purpose of this report is to identify the fundamental long range issues affecting the environment in which future Army ADP support must be provided and to discuss the emerging theories of ADP network management. This is one of several reports to be produced by the Multicommand Networks Project. Whereas other reports of this Project will make specific recommendations regarding Army installations, this report establishes a frame of reference broad enough to transcend all the alternatives to be considered. For the purposes of this report, the terms 'computer networking,' 'ADP networking,' and 'ADP consolidation' are considered to be synonymous. In the fullest sense of networking, each organizational element in the network can be a producer, or a consumer of ADP services, or both.

National Association for State Information Systems,
Lexington, Ky.
"1973 NASIS Annual Report: Information Systems
Technology in State Government
Aug 74 197p PB-241 461/3ST

The 1973 report contains the results of the fourth annual survey by the National Association for State Information Systems (NASIS) covering the 50 states. The objectives of the annual reports are: To present an annual 'snapshot' of the state of the art in information systems and other computerization in the states; to provide data for analysis of trends in state information systems; and to assist in increasing the exchange of information among the states on (a) information systems legislation, policies, management practices and problems, and funding; and (b) actual systems design and computer programs for use 'as is' or as necessarily revised. The classes of data covered include coordination and control, computer inventory, personnel, training, difficulties experienced in EDP management, formalized plans and documentation, intergovernmental information systems relationships, applications, funding, data security and privacy, and transfer projects.

Newell, A., Robertson, G.
"Some Issues in Programming Multi-Mini-Processors"
Jan 75 14p AD-008 650/3S1

Large computer systems can be constructed by joining together many minicomputers creating what can be called multi-mini-processors. The first such systems are just reaching the point where problems of programming and use dominate problems of design and construction. This paper attempts to share some of the early perceptions about what these problems of programming and use are.

Nutt, Gary J.
"Computer System Monitoring Techniques"
Feb 73 49p PB-213 172/2

The paper discusses both hardware and software monitoring techniques that have been employed to assess the performance of computer systems. The relative assets and liabilities of each approach are described, as well as the difficulties encountered in the measurement of a computer system by any means. The environment of a measurement project is also considered.

O'Neill, Hugh V.
"A Technology Assessment Methodology"
Volume III: Computers-Communications Networks
Jun 71 261p PB-202 778-3

The paper describes a pilot computer technology assessment study. The study has as its goal the development and illustration of technological assessment methodology and in addition, as a secondary objective, the investigation of certain salient segments of the general computer situation. The report includes: a summary; task definition; technology descriptions; state of society/ universe assumptions, attributes, and conditions; relevant impact areas; initial impact analysis; action options and recommendation for future research and development program; forecasts/ projections, uncertainty and analysis of future impacts; and conclusions and recommendations.

Reynolds, W. E.
"The Critical Region in Relative Cost-effectiveness"
Jun 67 35p AU-820 657

Cost-effectiveness analysis and its counterpart, cost-benefit analysis, are widely recognized as among the best analytic approaches to many types of decisionmaking problems. One of the most difficult problems faced by the analyst working in the area of defense problems has been satisfying one of the DOD requirements for an evaluation of competing systems--namely, that the cost-effectiveness of the proposed item is favorable in relationship to that of competing items. This problem, which will be referred to as the relative cost-effectiveness problem, is usually approached by showing that alternative A is preferred to alternative B under a given set of conditions. A sensitivity analysis is then run on the variables to determine whether small changes in the values assigned the variables will change relative ranking. This document describes an alternative approach to the relative cost-effectiveness problem. Instead of seeking the favored system under a given set of conditions, this approach seeks to identify the conditions under which alternative A is preferred to alternative B. These conditions are defined in terms of a 'boundary' of preferredness: The boundary, which is critical in the choice in the choice between the alternative systems, consists of system characteristics that indicate system merit. The values of these system characteristics generally have some uncertainty associated with them, and when this is the case, the critical boundary becomes a 'critical region.'

Pumbaugh, Stanley A., Vanlooy, Dorothy R.
"A Procedure for Identifying User's Requirements
for a Management Information System"
Apr 74 26p ED-089 685

In response to the specifications of a United States Office of Education grant 'Common Core of Data for the Seventies' (CCD-70), the Michigan Department of Education developed a procedure for identifying user's requirements relative to a State Education Information System. The project sought to identify users, to locate and prioritize their management concerns, to identify related linkage questions, and to relate these to the flow of information. The tools developed by the study included an interview guide and a consensus survey employing a modified Delphi technique. Results indicated that these procedures responded to users' needs, for they generated the major questions faced by users, identified the data needed to answer these questions, and located the data which was available. It was concluded that these procedures could be adopted in other contexts since they represented a viable means for identifying user needs with respect to management information systems.

Rverson, William R.
"Allocation Model Applications for Management Planning
and Control - Selected Abstracts"
Dec. 72 64p NTIS-PK-147

The bibliography contains 63 selected abstracts of research reports retrieved utilizing the NTIS on-line bibliographic search system -- NTISearch. The abstracts include studies on resources, cost effectiveness, transportation, network flows and various techniques for optimization.

Rverson, William R.
"Applications of Management Planning Models - Selected Abstracts"
Dec. 72 120p NTIS-PK-145

The bibliography contains 119 selected abstracts of research reports retrieved using the NTIS on-line bibliographic search system -- NTISearch. The abstracts include studies on Program Evaluation Review Technique (PERT), Critical Path Method (CPM), Monte Carlo Technique, Sensitivity Analysis and Gantt Charts.

Seals, Eugene
"Computer Performance Analysis -- Industry Needs"
Oct 73 12p AD-786 658/5ST

The report discusses the needs of industry for ways and means to evaluate computer systems efficiency.

Seals, Eugene
"Exception Reporting: An Aid to the Computer
Performance Analyst"
Mar 74 17p AD-786 859/9ST

As computer performance analysis gains more and more proponents and practitioners, more and more confusion and inefficiency is introduced into the analysis process. One area in which this is especially true is the selection of application programs for analysis and modification. This paper summarizes the existence of the problem and the brute force approach commonly taken in search of a solution. In addition, a new approach is suggested which greatly simplifies the analyst's approach and therefore his resolution of performance problems. An example of the exception-reporting concept is presented, using actual data from production facilities.

Taback, M. A., Ditmore, M.C.
"Estimation of Computer Requirements and Software Development Costs"
Mar 74 51p AD-782 220/8

The report seeks to determine a means of quantifying computer software development costs from overall system requirements. A procedure is developed for translating system performance requirements into data processing speed and memory required to implement the various computer functions. Several computer architectures are proposed as a means to provide sufficient computer speed and memory to perform the derived requirements. A cost estimating relationship (CEP) is presented for computer software development which models the following effects: Program size; computer language; complexity; and, hardware constraints. A hardware/software cost tradeoff is performed to demonstrate the model, using the AN/UYK-7 computer as an example.

Wald, Bruce
"The Throughput and Cost Effectiveness of Monoprogrammed,
Multiprogrammed, and Multiprocessing Digital Computers"
17 Apr 67 136p AD-654 364

A generalized model of a digital computer system with a workload drawn from a proffered infinite workload was investigated to determine the factors that affect throughput and cost effectiveness to allow optimization of the system parameters. Throughput was defined as the sum of the products of the cost of each component and the proportion of the time each component was beneficially used. Cost effectiveness was defined as the quotient of throughput and system cost, with unity being the ideal quotient.

Watson, P.
"Computer Performance Analysis: Applications of
Accounting Data"
May 71 70p AD-730 326

Virtually all third-generation computer systems collect and record computer accounting data. However, these data are seldom used except at those installations that use accounting data to charge for computer services. This report describes the types of accounting data generally available at most computer installations. It then discusses techniques for conditioning and reducing the data, along with various reports on system performance and workload characteristics that can be generated from the data. The report mainly concerns specific applications of accounting-data analysis in computer performance analysis. The most heavily stressed application employs the statistical analysis tools of regression analysis and cluster analysis to measure the effects on performance of a major system modification. Other applications of accounting-data analysis include validating and supplementing the data collected by hardware or software measuring devices, and use in developing effective computing charging schemes.

Weiss, David M.
"The MUDD Report: A Case Study of Navy Software
Development Practices"
21 May 75 33p AD-A010 818/3ST

The MUDD report is a study of Navy software-development practices which is based on a series of interviews with those responsible for the development of Navy systems. The study chronicles the development of a fictional system with requirements typical of Navy tactical systems currently operational or under development. A history of the decisions made during the development of the system is first given. Following the history is an analysis of the impact of each decision on the software developed for the system and on the life-cycle of the software. Finally, a set of recommendations for avoiding the pitfalls described in the report is given. The recommendations are designed to assist Navy program managers responsible for software development.

Wortham, Albert W., Gibson Robert H.
"System Cost Analysis"
15 Jul 68 17p AD-674 429

Decision makers in today's highly technical space-age industries have many responsibilities during the design, development, and implementation of new complex systems. One of which is the efficient allocation of funds during the early stages of system planning. Can these financial decisions be based on two fundamental costs. The purpose of the paper is to give the decision maker a basic cost model which can be used as a starting point in system cost evaluation. This model is composed of two costs. One for design and development called "Initial Cost" and the other for system support and maintenance called "Support Cost".

Young, Ralph R.
"Computer Systems Development Documentation Standards"
Aug 71 59p AD-142 601/3ST

This volume provides standards for the evaluation, design, development, and implementation of computer-based information systems. It includes an overview of the systems development life cycle, and guidelines for the feasibility study, the general design document, the detail design document, program standards, catalogued procedure standards, the implementation plan, and the post-implementation evaluation. The standards have been successfully utilized and have been instrumental in achieving effective implementation of planned systems development projects.

Young, Ralph R.
"Fairfax County Government Computer Systems Plan, 1974-1979"
Feb 75 515p PB-241 786/3ST

The report provides a comprehensive long range plan for utilization of information technology by a large local government. Fairfax County, Virginia, a suburb of Washington, D.C., provides the full range of local governmental services to a population of more than one-half million people in a 406 square-mile area. The document includes an explanation and flow chart of the Planning Process developed by Fairfax County to transform the ideas of managers and staff into specific plans for computer systems. Aspects of computer systems development approaches which have been successfully utilized are discussed. A brief overview of the County's Computer Systems Development Documentation Standards is included. The document provides short-range and longer-range plans for development of computer systems; a discussion of security, privacy, and confidentiality issues; workload projections and equipment requirements based upon information systems needs; and funding requirements. It includes requirements for the general County Government, the School Administration, and the Water Authority, which jointly manage a Cooperative Computer Center. The computer systems plan could be applied to other localities in general.

Young, Ralph R.
"Planning for the Effective Use of Computer-Based
Information Systems in Local Governments"
Mar 74 30p PB-242 599/9ST

The existence of a planning process for use of information technology in a large organization is discussed as a key factor in making effective use of a computer. The planning process for Fairfax County, Virginia, consists of a conceptual approach utilized to take maximum advantage of information systems and computer-related resources. Alternative strategies to meet current challenges are reviewed. A methodology is provided to convert the ideas and plans of managers into systems development and hardware plans. Preparation of short and long-range plans is suggested as a means to evaluate and prioritize alternative information systems development opportunities.

Zusman, Morris
"The Quantity Versus the Quality of the Data Used
in the Derivation of a Cost Estimating Relationship"
Sep 69 35p AD-679 131

Trade-offs on how a cost analyst might best allocate his time between collecting data on additional programs and analyzing in further detail the data already in his possession are presented. The measure of the cost analyst's productivity is the reduction in the confidence bandwidth about the cost estimate.

FEDERAL ADP-RELATED GUIDANCE AND POLICY DOCUMENTS

Public Law:

- 89-306 Brooks Bill, 89th Congress H.R. 4845,
 October 30, 1965.
- 91-510 Legislative Reorganization Act of 1970,
 October 26, 1970.
- 93-344 Congressional Budget and Impoundment Control
 Act of 1974, July 12, 1974.

Executive Office of the President:

Executive Order:

- 11556 Assigning Telecommunications Functions to OTP.
- 11717 Transferring Certain Functions from the Office
 of Management and Budget to the General Services
 Administration and the Department of Commerce.

Office of Management and Budget Circular:

- A-11 Preparation and Submission of Annual Budget
 Estimates, June 12, 1972.
- A-27 Policies and Responsibilities on the Sharing of
 Electronic Computer Time and Services in the
 Executive Branch, June 15, 1964.
- A-44 Management Review and Improvement Program,
 May 24, 1972.
- A-49 Use of Management and Operating Contracts,
 February 25, 1969.
- A-54 Policies on Selection and Acquisition of ADP
 Equipment, October 14, 1961.
- A-61 Guidelines for Appraising Agency Practices in the
 Management of Automatic Data Processing (ADP)
 Equipment in Federal Agencies, August 3, 1963
 (Superceded by FMC 74-5).

- A-71 Responsibilities for the Administration and Management of Automatic Data Processing Activities, March 6, 1965.
- A-76 Policies for Acquiring Commercial or Industrial Products and Services for Government Use, August 30, 1967.
- A-83 ADP Management Information System (ADP/MIS), October 5, 1971 (Superceded by GSA FMC 74-2).
- A-86 Standardization of Data Elements and Codes in Data Systems, September 30, 1967.
- A-94 Discount Rates to be Used in Evaluating Time-distributed Costs and Benefits, March 27, 1974.
- A-97 Rules and Regulations Permitting Federal Agencies to Provide Specialized or Technical Services to State and Local Units of Government under Title III or the Intergovernmental Cooperation Act of 1968, August 29, 1969.

Office of Telecommunications Policy Circular:

- OTPC-9 Guidelines for Leasing of Telecommunications Services for the U.S. Government and Negotiation of Inter-Governmental Agreements for/or Involving Telecommunications Facilities and/or Services, February 1, 1972.
- OTPC-11 Frequency Spectrum Policy Concerning the Development and/or Procurement of Communications-Electronics Systems, November 24, 1972.
- OTPC-12 Government Communications Planning Program, October 12, 1973.
- OTPC-13 Federal Use of Commercial Telecommunication Service, June 21, 1974.

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Directive:

- 4000.19 Basic Policies and Principles for Interservice and Interdepartmental Logistic Support, August 5, 1967.
- 4000.25 Administration of Military Standard Logistics Data Systems, March 23, 1971.

- 05.55 Selection and Acquisition of Automatic Data Processing Resources, May 19, 1972.
- 4105.65 Acquisition of ADP Computer Programs and Related Services, June 29, 1970.
- 4120.3 Department of Defense Standardization Plan, June 6, 1973.
- 4160.19 DOD ADP Equipment Reutilization Program, April 5, 1973 and D 4160.19M, Defense ADPE Reutilization Manual, August 1969.
- 4630.1 Programming of Major Telecommunications Requirements, April 24, 1968.
- 5000.19 Policies for the Management and Control of DoD Information Requirements, June 2, 1971.
- 5100.40 Responsibilities for the Administration of the ADP Program, August 19, 1975.
- 7000.1 Resource Management Systems of the Department of Defense, August 22, 1966.

Instruction(DODI):

- 4140.38 ADP Management Information System (ADP/MIS), June 18, 1973.
- 5000.22 Guide to Estimating the Cost of Information Requirements, October 17, 1974.
- 5010.27 Management of Automated Data System Development, November 9, 1971.
- 5010.32 Department of Defense Management Review and Management Program, June 1, 1973.
- 5030.40 Government-wide ADP Sharing Program, March 27, 1971.
- 7040.5 Definitions of Expenses and Industrial Costs, September 1, 1966.
- 7041.3 Economic Analysis and Program Evaluation for Resource Management, June 29, 1970.
- 7110.1 Guidance for Preparation of Budget Estimates, Operating Budgets, Financial Plans and Apportionment Requests, and Related Support Material, August 23, 1968.

Air Force:

Air Force Manual (AFM):

- 171-10 Data Processing and Reporting: General Instructions (Vols. 1, 4, & 5), September 15, 1967.
- 171-400 ADPE Performance Management System,
December 1, 1972.
- 178-1 Economic Analysis and Program Evaluation for
Resource Management, December 28, 1973.
- 178-6 Resource Manager's Handbook, April 20, 1973.
- 178-7 Management and Control of Information Require-
ments, January 7, 1972.
- 178-430 Cost Center Performance Measurement System
(B3500), July 1, 1973.
- 300-1 Air Force Data Automation Planning Concepts
1969-1978,
- 300-6 ADP Resource Management, June 1, 1974,
- 300-12 Procedures for Managing ADP Systems,
December 10, 1971.

Air Force Regulation (AFR):

- 26-12 Use of Contract Services and Operation of Com-
mercial Industrial Activities, January 29, 1974.
- 300-1 ADP Program Management, November 15, 1974.
- 300-2 Management of ADP Systems, February 14, 1975.
- 300-3 ADP Planning, Programming & Budgeting System,
March 20, 1974.
- 300-6 ADP Resource Management, June 1, 1974.
- 300-7 ADP Planning Concepts, April 19, 1974.

Memorandum:

- HQ/USAF FY 1976 Budget Estimate Cycle Update of ADP
Management Information System, June 21, 1974,

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- 18-1 Management Information Systems Policies, Objectives, Procedures, and Responsibilities, August 4, 1971.
- 18-3 ADP Management Information System, November 10, 1971.
- 18-7 Data Processing Installation Management, Procedures and Standards, September 29, 1966.
- 37-13 Economic Analysis of Proposed Army Investments: Determination of Computer Lease or Purchase, April 6, 1973.
- 37-15 Budget Development and Review, March 31, 1966.
- 235-5 Management of Resources: Commercial and Industrial-Type Functions, November 1972.

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- 18-10 Information Processing Systems Exchange, (Series).

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Chief of Naval Operations Instruction (OPNAVIST):

- 5231.1 Procedures for Management of Automated Data System Development, May 31, 1972.
- 5236.1 Guidance on the Economic Analysis of Proposals for ADP Equipment, February 25, 1972.
- 5236.2 ADP Services Procured by Contract, July 1, 1974.

Secretary of the Navy Directive (SECNAV):

- 4860.44A Management of Automated Data Systems (ADS) Development, October 27, 1971.
- 5200.25 Department of the Navy ADP Program, September 20, 1970.
- 5200.26 Department of the Navy ADP Program, Department Level Procedures, September 20, 1976.

- 5231.1 Management of ADP Systems Development,
February 20, 1972.
- 5236.1 Specification, Selection, and Acquisition of ADPE,
December 17, 1971.
- 5236.2 ADP Services Procured by Contract,
February 13, 1974.
- 5238.1 Department of the Navy, ADP Program Reporting
System, Resources Accounting, February 15, 1973.
- 7000.14 Economic Analysis of Proposed Department
of the Navy Investments, March 15, 1973.
- 10462.16A Government-wide ADP Sharing Program,
December 1, 1969.
- 10462.17 ADPE Reutilization Program, August 5, 1969.
- 10462.18 ADP Review and Evaluation Program, April 6, 1971.
- Marine Corp Order(MCO):
- 1462.4A Use of Auto-Data Processing Equipment.
- 4860.3A Operation of Commercial or Industrial Activities.
- 10462.5A Auto-Data Processing Service Contracts.

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(Revised), 1972.

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- 74-2 ADP Management Information System (MIS),
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- 74-5 Management, Acquisition, and Utilization of ADP,
July 30, 1974.

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- 101-32.00 Government-wide Automated Data Management Services.
- 101.32.2 ADP Resources Utilization.
- 101-32.3 Reutilization of ADP Equipment and Supplies.
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- 101-32.7 Management and Control of Computer Rooms and Related Support Areas.
- 101-32.8 Federal Data Processing Centers.
- 101-32.9 ADP Co-location and Consolidation Program.
- 101-32.11 ADP Communications Support for ADP Systems.
- 101-32.14 Computer Performance Evaluation of ADP Systems.
- 101-32.15 Future Plans for ADP and Telecommunications Systems.

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- E-22 Delegation of Authority to the Secretary of the Air Force to Operate a Federal Data Processing Center for ADP Simulation, March 3, 1972.
- E-29 Sole Source ADPE Procurements, January 28, 1974.
- E-32 Use of ADP Schedule Contracts, June 28, 1974.
- E-57 Ownership and Rights in ADP Systems, August 13, 1968.
- E-63 Maintenance of Government-owned Automatic Data Processing Equipment (ADPE), January 28, 1969.
- E-91 Obtaining Automatic Data Processing Services from Commercial Sources, December 28, 1970.
- E-99 Acquisition of Excess Leased Automatic Data Processing Equipment (ADPE), September 14, 1971.
- E-111 Reporting Accrued Rental Credits on Leased Automatic Data Processing Equipment (ADPE), October 17, 1972.