



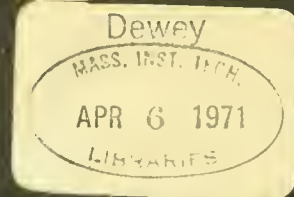


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ALFRED P. SLOAN SCHOOL OF MANAGEMENT

SYSTEMS ANALYSIS AND MANAGEMENT DECISIONMAKING<sup>\*†</sup>

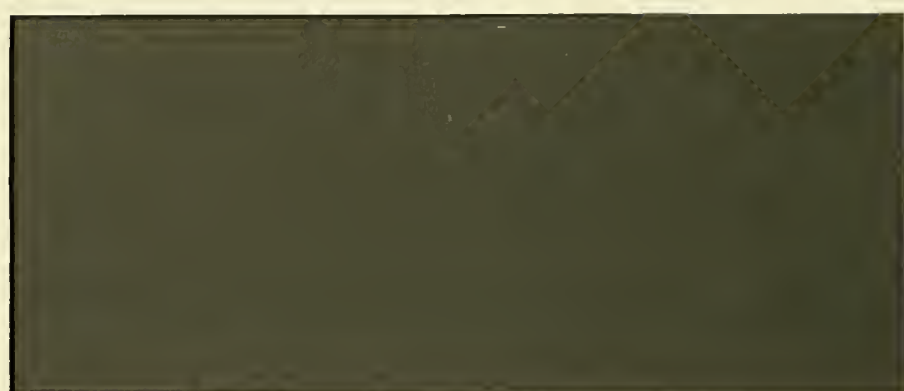
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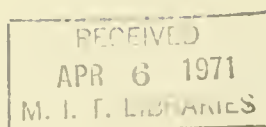
SYSTEMS ANALYSIS AND MANAGEMENT DECISIONMAKING<sup>\*†</sup>

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by

Leon S. White

## I. Introduction

The purpose of this paper is to describe the elements of systems analysis and relate these elements to what Simon [13] has termed the manager's "process of decision". The between the lines message I shall try to convey is simple: systems analysis is an input to decisionmaking; its effective use, therefore, depends on both the quality of the analysis and on the capability of the decisionmaker to use the analysis to improve the quality of his decisions. The paper is divided into two basic sections. In the first section I shall present a two dimensional framework which is intended to facilitate an understanding of the concept of decisionmaking. And in the second section, I shall outline my view of what systems analysis is.

## II. The Management Activity Matrix - A Framework

As Simon, among others, has pointed out, managers are basically decision-makers. They identify problems, mull them over, and take action. Their success or failure depends largely on their knowledge, skill, judgment, and ability to influence others.

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In a more formal sense, what managers do can be described within the framework of a management activity matrix (see Figure 1). The rows of this three by three array correspond to the basic categories of managerial activity defined by Anthony in his book, Planning and Control Systems: A Framework for Analysis [1]. Anthony's first category, strategic planning, row one in our matrix, is defined by Anthony as,

"...the process of deciding on objectives of the organization, on changes in these objectives, on the resources used to attain these objectives, and on the policies that are to govern the acquisition, use, and disposition of these resources", [1, p. 16].

Thus, strategic planning decisions determine the basic character and direction of an organization. They affect the physical, financial, and organizational framework within which the output producing activities of the organization are carried on. Examples of strategic planning activities in an academic medical center include: choosing teaching, research and service objectives; planning the organization; setting admissions policies, faculty recruitment and retention policies, financial policies, and hospital affiliation policies; and choosing new "product lines", e.g. physician assistants.

Anthony's second category, management control, is described by him as,

"...the process by which managers assure that resources are obtained and used effectively and efficiently in the accomplishment of the organization's objectives", [1, p. 17].

Thus, management control decisions are made by managers within the framework of objectives and policies derived from the strategic planning process. Moreover, such decisions are to be measured in terms of their effectiveness



	INTELLIGENCE	DESIGN	CHOICE
STRATEGIC PLANNING			
MANAGEMENT CONTROL			
OPERATIONAL CONTROL			

Figure 1.      The Management Activity Matrix



and efficiency. In this context, effectiveness is defined by measures that relate output to objectives, while efficiency is defined by measures that relate outputs to inputs. Examples of management control activities in an academic medical center include: formulating budgets, planning academic and non-academic staff levels, formulating recruiting practices for new faculty and students, deciding on research projects, deciding on curriculum modifications and deciding on rearrangements in physical plant.

Anthony's third category and the third row in our array, operational control, is defined as,

"...the process of assuring that specific tasks are carried out effectively and efficiently", [1, p. 18].

Anthony distinguishes operational control from management control in two basic ways: (1) The focus in operational control is on the accomplishment of specific tasks (e.g. the scheduling of classrooms), whereas, the focus of management control is on the manager and his performance, and (2) The tasks to which operational control relates are well defined so that the need for management judgment as to what is to be done is minimized, whereas, management control activities are not specified, on the contrary, these activities require decisions as to what's to be done within the general constraints of the strategic plans. Examples of operational control activities in an academic medical center include: controlling the preparation and distribution of periodic budget reports, scheduling the use of a hospital's operating rooms, short-term cash management, and the scheduling of classrooms and laboratories.

To summarize, then, the three rows of our management activity matrix are labeled strategic planning, management control, and operational control.





They represent distinctive types of management activity, although as Anthony makes clear not all management activity fits easily into this categorization scheme. Nevertheless, the taxonomy provides a useful discription of what I shall term the levels of management decisionmaking.

The three columns of our management activities matrix are labeled intelligence, design, and choice as defined by Simon in his book, The New Science of Management Decision, [12]. Intelligence, design, and choice are the names Simon has given to the three principal phases of the manager's "process of decision". The intelligence phase of this process is carried out by a manager when he searches his environment for conditions that call for a decision. Pounds [9], has called this the problem finding phase. In the design phase the manager is involved with the creation, development, and assessment of possible courses of action. And in the third phase, choice, the manager selects a course of action from those available.

Thus, when viewed as a whole the management activity matrix indicates both the levels at which decisions are made and the phases that constitute the decisionmaking process at all levels. Moreover, the matrix provides a frame of reference for discussing how decisionmakers actually solve problems and how they ought to solve them. And finally, and most important for my purposes, the matrix provides a framework within to relate the role and activities of the manager to the process of systems analysis.

### III. Systems Analysis - An Overview

Systems analysis is a method for investigating complex management decision problems. Its scope is broad enough to support the entire process of decision-intelligence, design, and choice. Moreover, it can be applied at all three



levels of decisionmaking, although its procedures, techniques, and ultimate contribution will most often be different at the different levels. The coherence of the approach lies in the fact that regardless of level, the basic questions to which systems analysis efforts are addressed are the same. They are, in the simplest terms\*:

What is the problem?  
 What are the alternatives?  
 Which alternative is best?

As a brief definition of systems analysis, then, I would accept the one following by Quade:

"...systems analysis...can be characterized as a systematic approach to helping a decisionmaker choose a course of action by investigating his full problem, searching out objectives and alternatives, and comparing them in the light of their consequences, using an appropriate framework - in so far as possible analytic - to bring expert judgment and intuition to bear on the problem", [10, p. 2].

Systems analysis has its roots in the scientific tradition and the quantitative, rational approach to problem solving. In fact, many of its practitioners were formally trained in the sciences and engineering. However, systems analyses is carried out in the real world where as James Schlesinger has pointed out, "in the search for preferred policies such encumbrances as social values and goals, constraints, institutional requirements (both broad

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\* From John Dewey, How We Think, New York: D. C. Heath & Company, 1910, Chapter 8 as quoted in Simon, [13, p. 56].



and narrow) pertain (and) truth becomes only one of a number of conflicting objectives" [11]. Thus, in practice, systems analysis might be described as the systematic application of common sense in a fettered search for truth. The motto for this activity was contributed by members of the Systems Analysis Office of the Office of the Secretary of Defense some years ago. It reads: "Better roughly right than precisely wrong."

The approach a systems analyst uses to assist a decisionmaker in his search for a "best alternative" is usually described in terms of the steps the systems analyst goes through: he specifies the problem, he identifies the relevant objectives and develops evaluation criteria, he defines alternative courses of action, he formulates models by which to predict the consequences or output of each alternative, he collects the data required to make the model operational and, then, using the criteria previously established, he evaluates the alternatives. The process, of course, is decidedly non-linear in the McLuhan sense. The interaction between objectives and means must be continually explored; it is seldom if ever that a systems analysis begins with given objectives and proceeds directly to an optimal alternative.

The fundamental elements in a systems analysis are diagrammed in Figure 2. They can be described and related to each other as follows:

#### Problem Specification

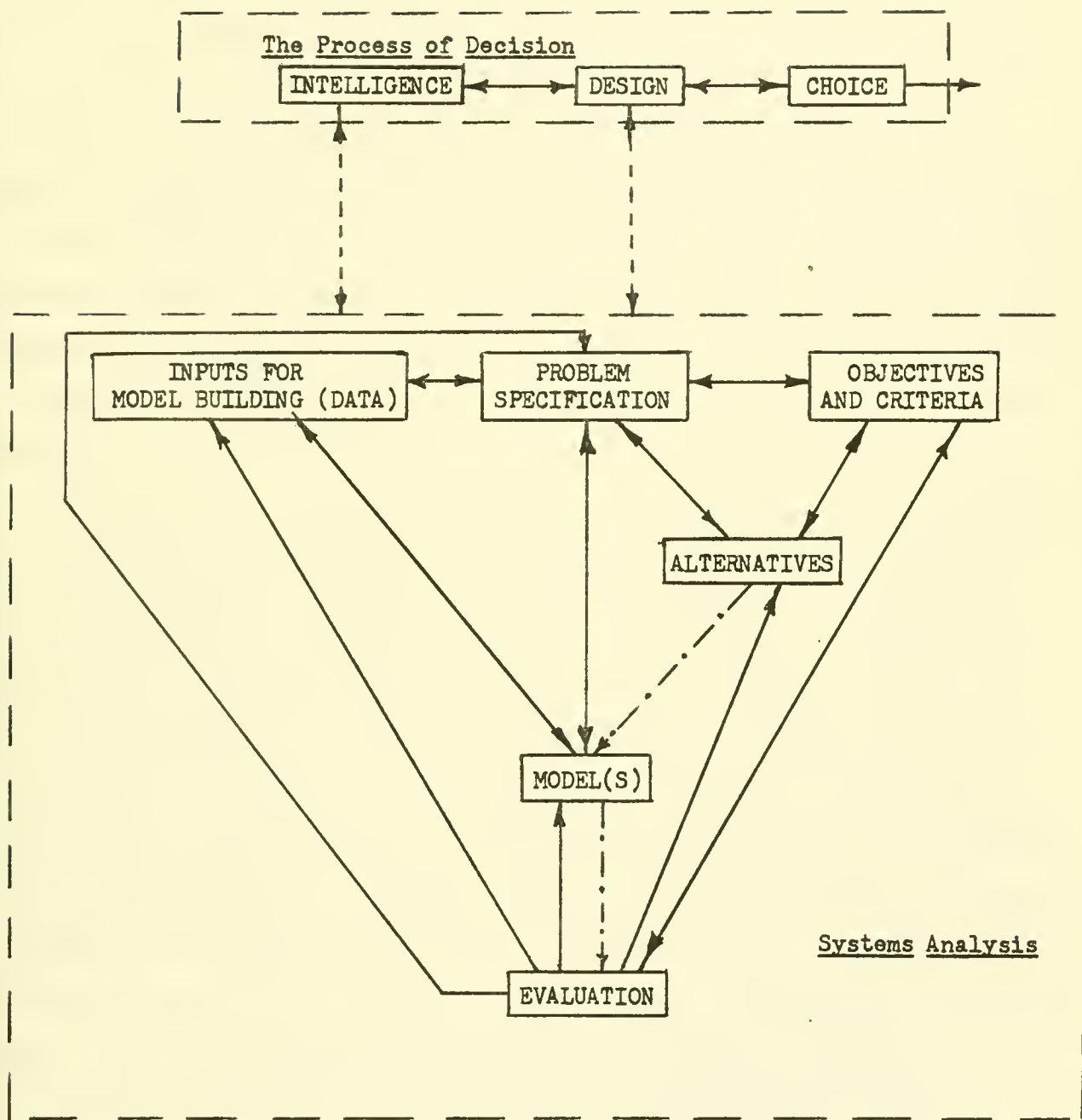
In a systems analysis, problem specification is invariably a non-trivial, time consuming exercise. It may also be the most important factor in determining the ultimate success or failure of the analysis. As Daniel Moynihan has written\*: "...the crucial phase in solving a problem is the process by which

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\*New York Times, January 12, 1970.







Information and communications - - - - -  
 Links in the analysis - - - - -  
 Alternative evaluation path - · - - -

Figure 2



it comes to be defined". This process must identify the important questions and issues to be considered and must fix the context within which these issues are to be studied and resolved.

Clearly, the work of specifying the problem cannot be carried out by the analyst in isolation. It begins with the decisionmaker's description of what he thinks his problem is and ends with an agreement between the analyst and decisionmaker that the analyst's formulation, regardless of how different from the original statement, is acceptable to both parties. If there is no substantial agreement, the analyst runs the risk of committing what in Statistics is termed an error of the third kind - finding the right answer to the wrong problem.

The process of problem specification is necessarily subjective and marked by the consideration of numerous trade-offs and judgments. The more inclusive the formulation, the greater the data requirements and multiplicity of objectives. On the other hand, a narrowly specified problem may omit important considerations and lead to the evaluation of an incomplete set of alternatives. As Pounds [9] has observed, decisionmakers find problems by identifying differences between their perception of what is and some standard as to what ought to be. An obvious example is the often talked about doctor shortage. The difficulties arise when the attempt is made to convert an indicated problem into a well defined real problem. The knowledge, creativity, skill, and teamwork required to accomplish this task are formidable.

The following summary problem definition is offered as an example:

At present approximately 600 residents of the state of New Revenue are applying for admission to medical schools throughout the country each year. Of this number approximately 50% have been admitted annually. It has been estimated by the Dean of the state's lone public medical school and state officials that approximately 150 of the unsuccessful applicants are, in fact, qualified for admission in the sense that their



entrance examination scores and undergraduate academic records compare favorably to the averages computed for all admitted students, nationwide. Thus, when population-age data is added to the above information, it seems reasonable to project that in the next 5 to 10 years the annual pool of qualified New Revenue students applying for admission to medical schools will increase to between 500 to 550. Furthermore, if financial and other barriers to success are removed, this pool might be enlarged to the range 550-600. Currently, the entering class at New Revenue Medical School numbers 100, out of which 85 are state residents. Both the board of trustees and the Dean of the medical school and the Governor of the state are agreed on the need to provide effective medical education opportunities for larger numbers of state residents.

### Objectives and Criteria

From the beginning, the systems analyst searches for a clear statement of the purposes and goals that underlie the problem he is attempting to define and help solve. Such a statement will, when formulated, reflect the experience, knowledge, values, and attitudes of the decisionmaker, the systems analyst, and others whose expertise is incorporated. The statement will try to answer the most value-laden and elusive of questions: What are we trying to accomplish? In complex decisionmaking situations it follows almost directly that a definitive answer to this question cannot be written down. Nevertheless, the question cannot be avoided if there is to be an identifiable basis for the development of criteria by which to evaluate alternative courses of action.

Criteria are measurement scales that allow for a comparison of alternatives in the light of specified objectives. In the development of these measures, systems analysts consider four basic questions:

- (i) How are the costs of each alternative to be measured?
- (ii) How is the effectiveness of each alternative in reaching the objectives to be assessed?



- (iii) What role does the time dimension play and what is the appropriate planning horizon within which to assess costs and effectiveness? And,
- (iv) How is the likelihood of implementation of each alternative to be measured?

Probably the most difficult of these questions to answer in any specific application is the question of how to measure the effectiveness of an alternative. In a recent paper in the Journal of the Operations Research Society of America [5], Hatry describes three often used but inadequate approaches to the measurement of effectiveness and then suggests a fourth approach which he believes in. The first inadequate approach he identifies assumes that "effectiveness is either not measureable at all or is not needed". In this approach the cost of an alternative is usually used to represent its effectiveness. Thus, for example, if two proposed curricula for a new program of instruction are being considered, and the first has a higher expenditure per student ratio than the second, it might be concluded that the first is more effective than the second. This may well be true but clearly there is an assumption being made about the efficiencies of the conversion processes of the two alternatives, and this assumption must be substantiated before cost can be used as a surrogate for effectiveness.

The second inadequate approach to the measurement of effectiveness relies on workload measures and physical standards. For example, a workload measure such as the average number of patients seen at a neighborhood health center per month is useful in judging the level of activity at the center, but says nothing about the estimated improvement in the health of the individuals who visit the center. Similarly, a physical standard such as x hospital beds per undergraduate medical school student may be a useful characteristic to





display when describing a plan for clinical education but says little about its effectiveness. In the case of the x hospital beds this is especially true if a large number of them are empty.

The third deficient approach insists upon translating the effects of each alternative into a common unit of measure "while at the same time suppressing (either consciously or unconsciously) more relevant, but noncommensurable, measures", [5, p. 774]. Hatry points out two forms of this approach: cost-benefit analysis, and weighting techniques that result in a single, overall index of worth. In a cost-benefit analysis the focus is on translating all benefits and costs associated with each alternative into monetary terms so that benefit to cost ratios may be formed. However, many benefits (and costs), especially in health care related problems, strongly resist efforts to place dollar values directly on them, e.g. what is the monetary value of a physical check-up? Moreover, in evaluating an alternative it may turn out that the costs and negative effects are borne primarily by one set of population subgroups while the benefits accrue to another, (Here Medicaid might serve as an example.) So that in these cases even if all costs and benefits could be quantified, their ratios would be difficult if not impossible to interpret. More generally, the whole question of the distribution effects of alternatives on different population groups is almost naturally overlooked in both the cost-benefit and the single index of worth approaches.

Hatry's answer to the question of how to measure effectiveness is simple, straightforward, and as might be expected the most difficult to apply. He says, "What is needed for evaluation are criteria that come as close as possible to reflecting the basic, underlying objectives...(and) these criteria should be expressible in any units that are appropriate", [5, p. 783, p. 775].



Hatry's answer may be interpreted more as an objective for the systems analyst than as a prescription for how to do it. But if this goal is not accepted, the link between the objectives towards which the alternatives are aimed and the criteria by which the effectiveness and other attributes of the alternatives are measured may never be forged.

Throughout my discussion of criteria I have focused on criteria to evaluate alternatives, i.e. evaluation criteria. I have not directly considered choice criteria, the criteria used by the decisionmaker in the choice phase of the decision process to select a course of action. Clearly the two kinds of criteria are interrelated and the systems analyst will contribute to the development of the decisionmaker's choice criteria, just as the decisionmaker will influence the evaluation criteria used in the analysis. But unless the systems analyst and decisionmaker have through their combined efforts succeeded in reducing the selection process to a completely measurable, automatic routine, the choice remains with the decisionmaker and the whole of the systems analysis can only realistically be viewed as an input to the little understood process by which decisions are made.

### Alternatives

Given an initial problem specification, a tentative set of objectives and related evaluation criteria, the systems analyst can move to what has been termed the "creative core of the analysis", that of generating alternatives. Alternatives are simply means of achieving ends. But when the ends are complex and multiple, the alternatives to be considered are not obvious, and this is the usual case in a system analysis problem.

As I have previously stated, systems analysis is intended to support the



entire process of decision, but often its primary contribution will be to the design phase of the process, where alternatives are created and assessed. A fundamental role of the systems analyst here is to enrich the space of alternatives by formulating feasible courses of action not readily apparent to the decisionmaker. The process of alternative generation within a systems analysis is interactive in the broadest sense. In developing alternatives the systems analyst will be guided by the ideas of the decisionmaker and others thought to be knowledgeable, as well as by his own ideas, both those held initially and those that he arrives at in the course of his analysis.

The process of alternative generation directly confronts the questions: "What is the problem?" and , "What constitutes a solution?" As Donald Schon [12] has pointed out, problems are often moving targets not susceptible to once-and-for-all answers. Thus, Schon suggest that acceptable solutions must have the characteristics of "learning systems" and must be "capable of transforming themselves to the situations in which they function", [12, p. 49]. In the next ten years the areas of medical education and health care will undergo extensive transformation and in this environment the systems analyst has to be especially careful to recognize that any solution he considers be adaptable to changing requirements; otherwise, it may be obsolete even before it can be applied.

### Models, Model Building, and Evaluation

The basic activity within a systems analysis that synthesizes the efforts of problem specification, objectives and criteria development, and alternative generation, is that of model building. In Quade's words, "the very essence of systems analysis is to construct and operate within a model", [10, p. 11].





The term model as I shall use it is defined as a purposeful representation (or misrepresentation) of something real or imaginary. (A more philosophically interesting definition might be a purposeful representation of something imagined to be real; see Mitroff [8] for a discussion of models and reality.) In a systems analysis such representations may range in character from the purely quantitative mathematical model to the basically qualitative verbal description. Moreover, there is no limitation on number or type of models that may be formulated and used to represent different aspects of a problem.

As examples of different types of models consider the following three models related to aspects of a hospital's operation:

- (i) A hospital census model, [6]. The basic factors that influence the rise and fall in a hospital census have been identified as the admissions rate and the length of stay. Several research studies (listed in [6]) have shown that the number of admissions per day can be characterized by a Poisson mass function,

$$(*) \quad P_n = e^{-\theta} \theta^n / n!, \quad n = 0, 1, 2, \dots,$$

where  $P_n$  denotes the proportion of days with 0, 1, 2, ... admissions and  $\theta$  is the average daily admissions rate. On the other hand, the length of stay of any inpatient has been characterized by a gamma density function,

$$(**) \quad f(t) = e^{-at} a^r t^{r-1} / (r-1)!, \quad t \geq 0,$$

where  $a$  and  $r$  are parameters. Thus,

$$F(b) = \int_0^b f(t) dt$$

describes the proportion of stays which last  $b$  or less days. Consequently, given equations (\*) and (\*\*) and numerical values for the parameters  $\theta$ ,  $a$ , and  $r$  it is possible, for example, to estimate the percentage of time a hospital census exceeds any particular level.



- (ii) A hospital expansion model, [2]. For the past several years Berry has been studying the question of whether or not short term general hospitals exhibit a systematic pattern in expanding their facilities and services. He has concluded that a definite growth pattern does exist and he has described it as follows: "There is such a thing as a basic service hospital. As hospitals add facilities and services there is a strong tendency to first add those that enhance the quality of the basic services. Only after the services that enhance the quality of the basic services have been acquired do short term general hospitals display a tendency to expand the complexity of the scope of services provided. The final stage of the expansion process for certain hospitals occurs when they add those facilities and services which essentially transform them from inpatient institutions to community medical centers", [2, p. 31]. A list of the facilities and services by service type is given in Table 1.
- (iii) Resource allocation for patient service (RAPS) model, [4]. The resource allocation for patient service (RAPS) model was developed at RAND to characterize relationships between inputs and outputs in the cardiovascular unit in a university hospital. The model is intended to demonstrate the feasibility of using mathematical models in planning hospital facilities. It is largely based on the observation that the seemingly wide variety of patients entering the cardiovascular unit can be classified into a small number of patient types. These types are described in terms of seven basic paths taken by patients through the hospital subsystem. Moreover, each patient type is described by a patient service vector which lists each facility on the corresponding path and the average time the patient is in contact with the facility. Thus, in the simplified case of two patient types and two facilities\* illustrated in Figure 3, the patient service vectors are (1,2) for patient type 1 and (4,5) for type 2. Moreover, if it is assumed that the hospital can provide a weekly maximum of 80 hours for facility 1 and 130 hours for facility 2, the feasible patient flows can be characterized by the graph in Figure 4. This graph can be used to study the relationship of patients served to resources consumed. For example, all the resources are consumed when there are 40 patients of type 1 and 10 of type 2. However, when the maximum number of patients are served, 65 of type 1, resource 1 will only be used 65 out of the 85 hours available.

The more general case of  $n$  patient types and  $m$  resources can be

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\*This example is taken from [4], p. 13.



Table 1\*

## Facilities and Services by Service Type

Basic Services

Clinical Laboratory  
 Emergency Room  
 Operating Room  
 Obstetrical Delivery Room  
 X-Ray Diagnostic

Quality Enhancing Services

Blood Bank  
 Pathology Laboratory  
 Pharmacy  
 Premature Nursery  
 Postoperative Recovery Room

Complexity Expanding Services

Electroencephalography  
 Dental Facilities  
 Physical Therapy Department  
 Intensive Care Unit  
 X-Ray Therapy  
 Radioactive Isotope Facility  
 Psychiatric Inpatient Care Unit  
 Cobalt Therapy  
 Radium Therapy

Community Services

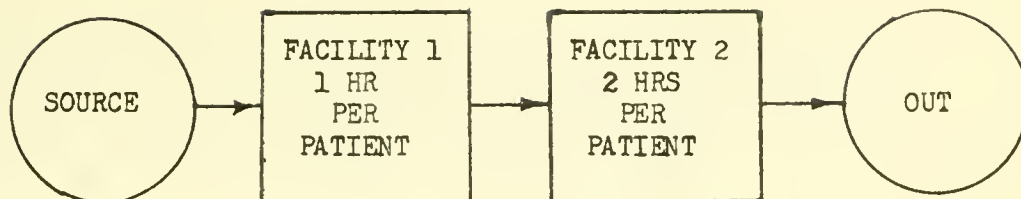
Occupational Therapy Department  
 Outpatient Department  
 Home Care Program  
 Social Service Department  
 Rehabilitation Unit  
 Family Planning Service

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\*Taken from Berry [2], p.32.



Patient  
Type 1:



Patient  
Type 2:

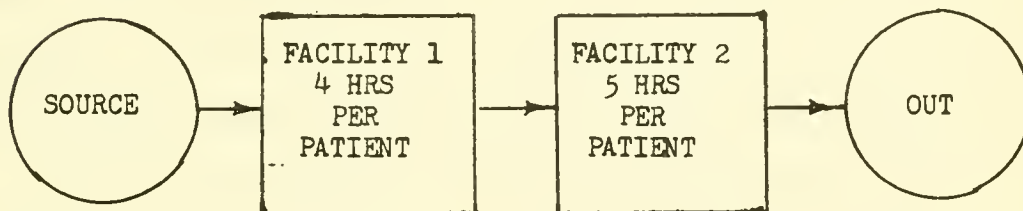


Figure 3. Taken from [4] , p.13.

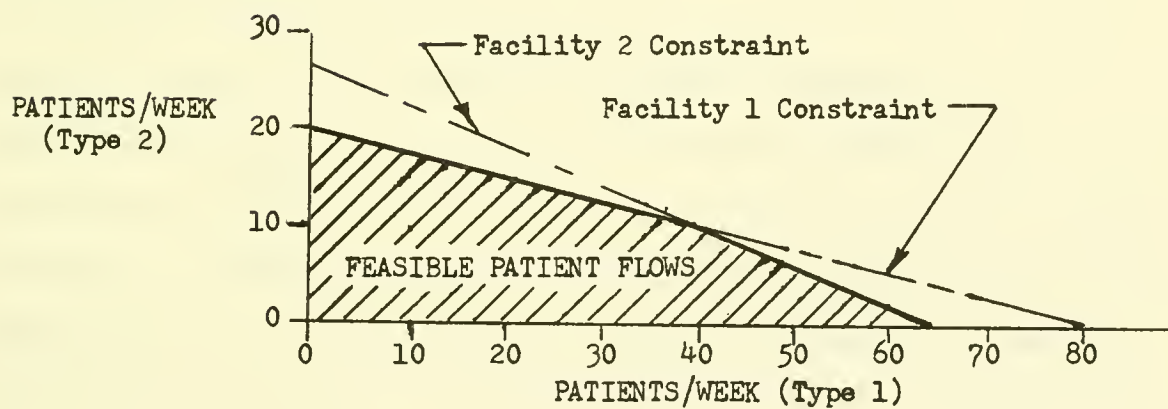


Figure 4. Taken from [4] , p.14.





analyzed in the same way as the two by two example with the aid of a computer. The RAND analysts suggest that this model can be used to study patient-selection policies, changes in organizational arrangements and the impact of technological changes in clinical practices, among other things.

The three models just described represent different approaches to the characterization of hospital operations and are different in type, the first one being a stochastic queuing model, the second a kind of scenario model, and the third a deterministic linear programming model. But the types of models being considered in systems analysis studies today go far beyond these. A recent RAND publication [3] includes descriptions of the following models and modelling techniques: decision analysis, simulation, gaming, scenarios, game theory, relevance trees, forecasting, worth-assessment techniques, Delphi techniques, cohort analysis, "a fortiori" analysis, and network analysis, as well as linear programming and queuing theory.

Systems analysts develop models for a variety of purposes: to find and clarify problems, to evaluate proposed courses of action, to increase understanding about the environment within which action is to be taken, to serve as a basis for negotiation in an adversary proceeding, to describe part or all of the manager's decisionmaking process itself, and in some cases to reduce the choice process to a computer program that replaces the human decisionmaker altogether. Descriptions of systems analysis usually emphasize the role of models in evaluating alternatives and in answering "what if" type questions. This might already be termed the classical role of the model in a systems analysis and often it is a most valuable one. But the other purposes of model building are also being recognized as having value.

The question of getting the most value out of the modelling activity in a systems analysis, however, remains to be answered. Clearly models are constructed, alternatives are evaluated and decisions are made. But who has



evaluated the relationship between the model's output and its interpretation, and the decisionmaker's action? John Little has recently observed that "the big problem with management science models is that managers practically never use them", [7, p. 466]. Little believes that much of the problem has to do with the fact that the models are developed in such a way as to minimize the possibility of communication between the manager and model. As Mitroff has observed in another context, the fundamental problem may be that the systems analyst and manager are acting at cross-purposes because each has a different interpretation over what the purpose and usefulness of models are and what it means to validate a model, [8, p. 644]. Whatever the problem and whatever the reasons, this issue cannot be overlooked in discussions of the application of systems analysis to management decisionmaking. In fact, at this time, an early recognition and discussion of the issue by both the systems analyst and manager may be the best way to minimize its potentially divisive effects.

### Inputs to Model Building

In a recent paper [3a], Gorry and Morton emphasize the fact that information requirements for model building are basically different at different levels of decisionmaking. For example, at the operational control level, models usually require detailed information while at the strategic planning level aggregate information inputs will suffice. As a part of their paper, Gorry and Morton develop a framework for relating various characteristics of information to the different levels of decisionmaking. Their framework is reproduced in Figure 5.



Figure 5.\*

Information Characteristics by Decisionmaking Level

<u>Characteristics of Information</u>	<u>Operational Control</u>	<u>Management Control</u>	<u>Strategic Planning</u>
Source	Largely internal. . . . .	. . . . .	→ External
Scope	Well defined, narrow. . . . .	. . . . .	→ Very wide
Level of Aggregation	Detailed. . . . .	. . . . .	→ Aggregate
Time Horizon	Historical. . . . .	. . . . .	→ Future
Currency of Data-Base	Highly current. . . . .	. . . . .	→ Quite old
Units	Largely others. . . . . (rate, # pieces, quality)	. . . . .	→ \$ and others
Required Accuracy	High. . . . .	. . . . .	→ Low
Frequency of Occurrence of Information Change	High. . . . .	. . . . .	→ Low
Frequency of Use of Information	Very frequent . . . . .	. . . . .	→ Infrequent

\*Taken from [3a], p. 7.



#### IV. Summary

In this paper I have presented a framework for discussing management decisionmaking and I have described the basic elements of systems analysis. In my description of systems analysis I have tried to indicate both the complexity and comprehensiveness of the approach. Systems analysis is, after all, a relatively intellectual exercise with a decidedly practical purpose. It is not just problem hunting, it is not just model building, it is not just alternative evaluation, it is all of these things and more - at least that is my conception. Moreover, no matter how it is described, it cannot long exist in a vacuum. The managers who employ systems analysts must also employ their analysis. That they should employ it depends on the fundamental hypothesis of systems analysis: Good analysis leads to better decisions. When it's all said and done this is the first proposition on which there must be agreement.





## REFERENCES

1. Anthony, R., Planning and Control Systems: A Framework for Analysis, Boston: Graduate School of Business Administration, Harvard University, 1965.
2. Berry, R., Efficiency in the Production of Hospital Services, Progress Report, March 25, 1970, Harvard School of Public Health.
3. Dole, S. H., Fisher, G. H., Harris, E. D. and J. String, Establishment of a Long-Range Planning Capability. RAND Memorandum RM-6151NASA.
- 3a. Gorry, G. A., and M. S. S. Morton, "Management Decision Systems: A Framework for Management Information Systems", Sloan School Working Paper 458-70, April 1970.
4. Gurfield, R. M. and J. C. Clayton, Analytical Hospital Planning: A Pilot Study of Resource Allocation Using Mathematical Programming in a Cardiac Unit, RAND Memorandum RM-5893-RC, April 1969.
5. Hatry, H. P., "Measuring the Effectiveness of Nondefense Public Programs", Operations Research, Vol. 18, No. 5 (1970).
6. Horvath, W. J., "Operations Research in Medical and Hospital Practice", Chapter 6 in Operations Research for Public Systems, Cambridge: M.I.T. Press, 1967, edited by P. M. Morse.
7. Little, J. D. C., "Models and Managers: The Concept of a Decision Calculus", Management Science, Vol. 16, No. 8 (1970).
8. Mitroff, I. I., "Fundamental Issues in the Simulation of Human Behavior: A Case Study in the Strategy of Behavioral Science", Management Science, Vol. 15, No. 12 (1969).
9. Pounds, W. F., "The Process of Problem Finding", Industrial Management Review, Fall (1965).
10. Quade, E. S., Chapter 1 in Systems Analysis and Policy Planning, New York: American Elsevier Publishing Company, Inc., 1968, edited by E. S. Quade and W. I. Boucher.
11. Schlesinger, J. R., Uses and Abuses of Analysis, Committee Print, Subcommittee on National Security and International Operations of the Committee on Government Operations, United States Senate, Washington, D.C.: U.S. Government Printing Office, 1968.
12. Schon, D. A., "Implementing Programs of Social and Technological Change", Technology Review, Vol. 73, No. 4 (1971).
13. Simon, H. A., The New Science of Management Decision, New York: Harper and Rowe, 1960.









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