A PLANNING METHODOLOGY FOR COMPREHENSIVE

HEALTH PLANNING

by

Herbert William Mylks

A Thesis Submitted to the Faculty of the

DEPARTMENT OF SYSTEMS ENGINEERING

In Partial Fulfillment of the Requirements
For the Degree of

MASTER OF SCIENCE

In the Graduate College

THE UNIVERSITY OF ARIZONA

1971
STATEMENT BY AUTHOR

This thesis has been submitted in partial fulfillment of requirements for an advanced degree at The University of Arizona and is deposited in the University Library to be made available to borrowers under rules of the Library.

Brief quotations from this thesis are allowable without special permission, provided that accurate acknowledgment of source is made. Requests for permission for extended quotation from or reproduction of this manuscript in whole or in part may be granted by the head of the major department or the Dean of the Graduate College when in his judgment the proposed use of the material is in the interests of scholarship. In all other instances, however, permission must be obtained from the author.

SIGNED: [Signature]

APPROVAL BY THESIS DIRECTOR

This thesis has been approved on the date shown below:

[Signature]
J. L. SANDERS
Professor of Systems Engineering

[Signature]
Feb 17, 1971
Date
ACKNOWLEDGMENTS

I wish to express my gratitude to all of those persons who contributed to this research.

The time and counsel of the members of my thesis committee, who are Dr. A. Wayne Wymore, Dr. Jerry L. Sanders and Dr. Robert L. Baker, are greatly appreciated.

A special thanks is directed towards Mr. Bigred T. Walker for his spirited support during the early phases of this research.

A very special thanks goes to my wife, Virginia, and my children, Christy and Lee, whose collective patience, understanding, and encouragement were vital to the completion of this thesis.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIST OF TABLES</td>
<td></td>
<td>vi</td>
</tr>
<tr>
<td>LIST OF ILLUSTRATIONS</td>
<td></td>
<td>vii</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td></td>
<td>viii</td>
</tr>
<tr>
<td>1. INTRODUCTION</td>
<td>Comprehensive Health Planning</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Definition</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Purpose</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Planning Environment</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Organization for Planning</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Mission and Authority of the Council</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Decision Makers</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Plan Utilization</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Measures of Effectiveness</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Problem Definition</td>
<td>7</td>
</tr>
<tr>
<td>2. PREPARATION FOR THE METHODOLOGY</td>
<td>The Health Delivery System</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Inputs</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Community Services</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Government Services</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Health Planning Activities</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Health Policies</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Health Services</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Health Delivery System Inputs</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Describing the Consumer's State</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Describing the State of the Health Services</td>
<td>27</td>
</tr>
<tr>
<td>3. THE PLANNING METHODOLOGY: PHASE I</td>
<td>Data Requirements and Utilization</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>Selection of Consumers</td>
<td>41</td>
</tr>
<tr>
<td>Chapter</td>
<td>Page</td>
<td></td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>Census Programs</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>Group Identification</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>Testing the System</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>Admission and Disposition Data</td>
<td>44</td>
<td></td>
</tr>
<tr>
<td>Data Processing</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>Problems Identification</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td>Data Analysis</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td>Survey Data</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>Problem Summary</td>
<td>48</td>
<td></td>
</tr>
<tr>
<td>4. THE PLANNING METHODOLOGY: PHASE II</td>
<td>52</td>
<td></td>
</tr>
<tr>
<td>Priorities</td>
<td>52</td>
<td></td>
</tr>
<tr>
<td>Alternative Plan Generation</td>
<td>53</td>
<td></td>
</tr>
<tr>
<td>Computer Simulation Requirements</td>
<td>54</td>
<td></td>
</tr>
<tr>
<td>Subjective Simulation</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td>Alternative Plans</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td>Typical Plans</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Plan Selection</td>
<td>61</td>
<td></td>
</tr>
<tr>
<td>Evaluating the Plan</td>
<td>62</td>
<td></td>
</tr>
<tr>
<td>5. SUMMARY AND CONCLUSIONS</td>
<td>64</td>
<td></td>
</tr>
<tr>
<td>Summary</td>
<td>64</td>
<td></td>
</tr>
<tr>
<td>Conclusions</td>
<td>67</td>
<td></td>
</tr>
<tr>
<td>APPENDIX: GLOSSARY</td>
<td>69</td>
<td></td>
</tr>
<tr>
<td>SELECTED BIBLIOGRAPHY</td>
<td>71</td>
<td></td>
</tr>
</tbody>
</table>
### LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Health Delivery System Input Factors</td>
<td>11</td>
</tr>
<tr>
<td>2. Health Service System State Factors</td>
<td>16</td>
</tr>
<tr>
<td>3. Consumer State Factors</td>
<td>17</td>
</tr>
</tbody>
</table>
## LIST OF ILLUSTRATIONS

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>The Community Health Delivery System</td>
<td>9</td>
</tr>
<tr>
<td>2.</td>
<td>Problems Identification Flow Chart</td>
<td>40</td>
</tr>
</tbody>
</table>
ABSTRACT

The need for comprehensive health planning is well described in contemporary literature. However, the knowledge of the complex interactions inherent in the delivery of health services is not similarly described. This thesis presents information pertinent to planning health services for an entire community in the context of a simple model of the health delivery system. This model is used to organize the available information and identify the areas that will need extensive research.

The methodology presented in this thesis prescribes the data that should be collected to test the health delivery system for specific problems. Methods for organizing and analyzing this data are presented. A method for designing and evaluating potentially viable comprehensive health plans is developed in this thesis. This methodology should facilitate increased knowledge of the health delivery system in any community.
CHAPTER 1

INTRODUCTION

This thesis is a preliminary study of comprehensive planning for the delivery of health services to the members of a community. The aggregate of all of the agencies, facilities, and other economic entities that are primarily either concerned with or engaged in the delivery of health services in the community is hereby considered to be the health delivery system. The methodology displayed herein should be a useful procedural guide for a systems engineer who is confronted with the task of preparing comprehensive health plans for this system.

This study will be presented in four parts as follows:

a. A study of the background, purpose, and challenge of comprehensive health planning is contained in Chapter 1.

b. A study of the factors that should be considered during the preparation of health plans is presented in the context of a simple model of the health delivery system in Chapter 2.

c. A methodology for identifying problems in the health delivery system is contained in Chapter 3.

d. A methodology for making plans to solve problems in the system is contained in Chapter 4.

The study is summarized in Chapter 5 and a glossary is listed in the Appendix.
Comprehensive Health Planning

Comprehensive health plans may be prepared by any of a number of responsible agencies. However, use of the phrase "comprehensive health planning" in this thesis is restricted to the activities of a health planning council of the type specified in a particular public law. The primary considerations of planning by this council will be discussed in the paragraphs which follow.

Definition

Comprehensive health plans are plans which attempt to improve the aggregate quantity and quality of the health services delivered to an entire community (area) and which are prepared under the provisions of Public Law 89-749. This law is the Comprehensive Health Planning and Public Health Services Amendments of 1966.

Purpose

Battistella and Weil (1969) represent the views of many authors in their discussion of the problems which motivated the requirement for comprehensive health planning. Their remarks are summarized as follows:

a. Spiraling rises in the cost of health care.

b. Imbalances in the supply and distribution of health services facilities and personnel.

c. Lack of acceptable minimum standards of quality for patient care.
Planning Environment

The environment in which comprehensive health plans are created is extraordinarily complex. Ginzberg (1969) says, "The determinants of health are woven deep in the social fabric and improvements in the system of health care are likely to have only small impact (p. 26)."

Ginzberg's remarks are probably overly pessimistic. Nonetheless, it should be clear that many other systems in the community will interact with the health system. For example, the local government's sanitation and waste disposal system may adversely affect the incidence of diseases in the community.

Organization for Planning

On the Federal level, responsibility for implementing Public Law 89-749 rests with the Health Service and Mental Health Administration of the Public Health Service. The law requires that coordination of the local area comprehensive health plans be performed at the state level by a designated state comprehensive health planning agency. Federal funds for planning are to be channeled through the state agency to the health planning council which represents a given community (area).

The health planning council consists of a full time staff and an advisory staff. The full time staff is composed of a director and several planning assistants. The advisory staff is composed of representatives
from local medical agencies, medical facilities, and the lay population of the community.

Mission and Authority of the Council

The health planning council has the following mission: determine the type, capacity, and location of medical services needed in the community; evaluate levels of morbidity; encourage coordination and efficiency in the delivery of health services.

The authority of the council is limited to coordinating the planning performed by other local government agencies and public health delivery facilities. The council appraises plans prepared by local, public or private health delivery facilities that require state or federal funding. They submit their appraisal in the form of a recommendation to the state comprehensive health planning agency.

Jacobs and Froh (1968) observe that the authority to review requests for funds is the greatest source of power for the health planning council.

Decision Makers

The appropriate decision makers in the health delivery system are agencies which control requisite resources. A given plan may require funds, new legislation, or personnel. The appropriate decision makers may be one or more of the following: a Federal agency, a state or local
government agency, the board of trustees for a hospital, a medical society, or a labor union. In general, there is no scalar index of effectiveness which is compatible with the points of view of all of the decision makers.

Plan Utilization

The planning council does not implement the plans it prepares. It either coordinates its plans with appropriate decision making agencies or uses the plans as a basis for appraising the requests for funds made by some of the decision making agencies.

Measures of Effectiveness

It seems likely that at some point in the coordination process the planning council will find it necessary either to defend its plans or to compare its plans to those of some other agency. A valid measure of effectiveness would be useful for these activities.

English (1968) describes several cost-effectiveness techniques that are used by either industrial or military organizations in comparing alternative plans. English shows that by making simplifying assumptions, those organizations can estimate net cost as a function of dollars spent, saved, earned, and denied. Likewise, they are able to express effectiveness as a scalar which is a function of some dominating objectives of the plan such as market position, kill-ratio, profit and so on.

The delivery of health services to a community is worth something in terms of the vitality and productivity of the people which results from
the care rendered. Establishing this worth is difficult, if not impossible. Two attempts to do this are as follows:

Weisbrod (1961) calculated the costs of cancer, tuberculosis and polio by considering the present and future earnings of victims, impact of absenteeism on productivity, costs of treatment, and several other factors. He used these costs to determine a resource allocation strategy for treating diseases. However, Weisbrod ignored the cost of disease to non-wage earners. His approach is typical of that offered by most of the economists that have studied this problem.

Reinhard, Felsman and Moody (1970) expressed the cost of several diseases in terms of the man-years lost due to chronic morbidity and early death. They did not attempt to associate a dollar value to lost man-years. However, their work is useful in comparing the socio-economic impact of one disease to that of another.

Comprehensive health plans should change the state of the health delivery system. This notion will be discussed in Chapter 2. The concern at this point is in finding a scalar measure that will express either the effectiveness or the value of the state which is expected to result from a given plan. Having such a measure could permit the application of decision theory to the process of selecting the most desirable plans.
In Chapter 2 it will be seen that the state of the health system at any given time may be approximated by a vector. Unfortunately, the coordinates of this vector represent factors which are difficult to amalgamate into a scalar by the use of some function.

Packer (1968) claims that the cost-effectiveness method most frequently used in studying complex systems is to present the decision maker with an effectiveness vector for each alternative plan. Each coordinate of the vector would correspond to a type of result. A meaningful ordinal scale should be found for the values obtained by each type of result.

**Problem Definition**

The discussion in the preceding paragraphs has identified the need for comprehensive health planning and such pertinent considerations for a planner as the following: the planning environment, the organization for planning, the mission and authority of the health planning council, the appropriate decision makers and the lack of a commonly accepted measure of effectiveness.

With this background at hand, this study is addressed to developing an explicit scientific planning methodology which is appropriate to the mission and authority of the health planning council.
CHAPTER 2

PREPARATION FOR THE METHODOLOGY

This chapter will present a review of the literature pertinent to the behavior of both the providers and consumers of health services. This material will be presented in the context of a model of the health delivery system. This model is intended to serve as a means of organizing both the information from the literature and the assumptions made in developing the methodology.

It is beyond the scope of this thesis to develop a rigorous mathematical model of the health system. If such a model were available, it would be presented herein. However, in hopes of hastening the advent of an accurate model, the discussion in this chapter is cast in the language of system modeling and the methodology is designed to yield a fringe benefit of improved knowledge of the behavior of the health system.

The medical terms and some of the set theoretic terms used in this chapter are listed in the glossary in the appendix.

The Health Delivery System

Figure 1 is a block diagram of the subsystems of the community health delivery system and the systems that interact with it. This diagram is presented from the point of view of the health planning council.
Fig. 1. The Community Health Delivery System

Note: $a_i \in$ INPUTS.
Therefore, only those considerations that are of interest to them are presented. Each transformation block represents a system that may be decomposed into many subsystems. For example, the comprehensive health planning system is only one of many systems in the Health Planning Activities System.

Inputs

It is assumed that the input sets for each system shown on the diagram are the same. The input set is the vector product of sets that correspond to the different types of inputs.

Therefore, the set \( \text{INPUT} = P_1 \times \ldots \times P_n \), where \( P_i \) is a set that corresponds to a type of input factor, for every \( i=1, \ldots, n \). Some typical input factors are shown in Table 1 and are discussed in detail in the paragraph entitled "Health Delivery System Inputs." Each point in the set \( \text{INPUT} \) representing those input factors would be a vector of the form \( (p_1, \ldots, p_{11}) \), where \( p_i \in P_i \), for \( i=1, \ldots, 11 \).

Community Services

Community Services is a system which provides public and private services, excluding health services, that transform the state of the consumer. These services include employment, transportation, housing, sanitation, education, racial prejudice, legal aid, crime prevention, financial assistance, welfare, and religion. The consumer state
Table 1. Health Delivery System Input Factors

<table>
<thead>
<tr>
<th>i</th>
<th>( P_i )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Consumers</td>
</tr>
<tr>
<td>2</td>
<td>Money</td>
</tr>
<tr>
<td>3</td>
<td>Political Influence</td>
</tr>
<tr>
<td>4</td>
<td>Plans</td>
</tr>
<tr>
<td>5</td>
<td>Personnel</td>
</tr>
<tr>
<td>6</td>
<td>Research</td>
</tr>
<tr>
<td>7</td>
<td>Education</td>
</tr>
<tr>
<td>8</td>
<td>Regulations</td>
</tr>
<tr>
<td>9</td>
<td>Equipment</td>
</tr>
<tr>
<td>10</td>
<td>Decisions</td>
</tr>
<tr>
<td>11</td>
<td>Reports</td>
</tr>
</tbody>
</table>
transformation effected by Community Services has considerable influence in the admittance decision. However, the health planning council has negligible influence on this transformation.

Government Services

Government Services is a system which provides state and Federal government services. Some of those services directly influence the health delivery system. The result of state transformations of the Government Services System corresponds to outputs such as the following: funds for health planning, funds for research, welfare funds, construction funds, decisions on proposed plans, plans, regulations, results from medical research, and political influence.

Health Planning Activities

The Health Planning Activities System represents all of the planning agencies in the community health system. Each planning agency is assumed to be a subsystem. The interactions of these subsystems is complex and confusing. In some cases, particularly with regard to planning activities pertaining to welfare recipients, the agencies have overlapping responsibilities. The result of state transformations by this system corresponds to outputs such as the following: plans for new facilities, plans for new policies, policies, funds, decisions, reports,
and political influences. Of these types of outputs, the health planning council contributes to all of them except funds and decisions.

Health Policies

The Health Policies System is an abstract system. This transformation block corresponds to the set consisting of both the de jure and the de facto policies that exist in the community health delivery system. These policies include the criteria for the admission of consumers to the Health Services System, the managerial policies for operating the sub-systems of the Health Services System and the policies that relate to the practice of medicine by the physicians and paramedical personnel.

The Health Policies System is presented as a separate subsystem of the Health Delivery System to focus attention on the fact that health policies are the primary subject of the health planning council's coordinating and planning activities.

Public Law 89-749 (1966), described in Chapter 1 as the legal basis for comprehensive health planning, establishes the attainment of the highest level of health for everyone as a national goal. However, some consumers can always be admitted to some health service facility, whether they are sick or not; other consumers must wait until they are nearly dead before they can be admitted. Between these two extremes are many subtle differences in the admittance policies.
Managerial policies in the Health Services System were studied by Ginzberg (1969). He found that many of the services provided by that system were usually rendered during the hours of the day that were convenient to the physicians; scant concern for cost-efficiency was evident in the work scheduling activities of health service facilities.

The limit of the health planning council's authority in the policies relating to the practice of medicine is coordination and planning for standards for acceptable quality of care.

Health Services

The Health Services System includes all of the subsystems in the community that are primarily engaged in providing medical care. These subsystems are interconnected in a very complex network that would require a major systems study to analyze adequately.

The feedback loop, shown on Figure 1, between the Health Policies System and the Health Services System is of concern to the health planning council. It represents referral actions whereby a given consumer may be delayed by hours or days in his attempt to receive appropriate care.

The state of each of the n subsystems in the Health Services Subsystem may be approximated by the set of HEALTH SER(j), for j=1,\ldots,n. This set is a vector product of sets which represent the capacity, efficiency, cost, and quality of a given facility. This may be expressed as
\( \text{HEALTH SER}(j) = H_1 \times \ldots \times H_k \), where \( k \) is the number of sets used to approximate the state of a facility. Some typical factors for describing the state of a facility are listed in Table 2. These factors will be discussed in detail in a subsequent section of this chapter. The state of the Health Services System is represented by the set \( \text{HEALTH SERVICES} \) which is the vector product \( \text{HEALTH SER}(1) \times \ldots \times \text{HEALTH SER}(n) \).

The health planning council will probably be unable to measure some of the factors that describe the state of a health facility. Instead, they can try to measure the inputs and outputs to a given facility and try to deduce the state of that facility.

**Health Delivery System Inputs**

Some of the types of inputs to the health delivery system listed on Table 1 will be discussed in this section. Each set that represents a type of input must have an element that corresponds to a zero input.

**Consumers:** These are people who may seek health care from the Health Delivery System. The literature suggests that certain factors which influence the behavior of consumers in this system are important to the efficiency and adequacy of the community's health care program. Some of these factors are listed on Table 3 and will be discussed in the section entitled "Describing the Consumers' State" which will be presented later in this chapter.
Table 2. Health Service System State Factors

<table>
<thead>
<tr>
<th>i</th>
<th>( H_i )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Professional Personnel</td>
</tr>
<tr>
<td>2</td>
<td>Paramedical Personnel</td>
</tr>
<tr>
<td>3</td>
<td>Management</td>
</tr>
<tr>
<td>4</td>
<td>Services</td>
</tr>
<tr>
<td>5</td>
<td>Location</td>
</tr>
<tr>
<td>6</td>
<td>Salary Scales</td>
</tr>
<tr>
<td>7</td>
<td>Capacity</td>
</tr>
<tr>
<td>8</td>
<td>Occupancy</td>
</tr>
<tr>
<td>9</td>
<td>Diagnostic Efficiency</td>
</tr>
<tr>
<td>10</td>
<td>Administrative Efficiency</td>
</tr>
<tr>
<td>11</td>
<td>Waiting Time</td>
</tr>
<tr>
<td>12</td>
<td>Service Time</td>
</tr>
<tr>
<td>13</td>
<td>Attitude</td>
</tr>
<tr>
<td>14</td>
<td>Costs</td>
</tr>
<tr>
<td>15</td>
<td>Investment</td>
</tr>
</tbody>
</table>
Table 3. Consumer State Factors

<table>
<thead>
<tr>
<th></th>
<th>$C_i$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Age</td>
</tr>
<tr>
<td>2</td>
<td>Income</td>
</tr>
<tr>
<td>3</td>
<td>Race</td>
</tr>
<tr>
<td>4</td>
<td>Need-Demand Conversion Lag</td>
</tr>
<tr>
<td>5</td>
<td>Fertility</td>
</tr>
<tr>
<td>6</td>
<td>Occupation</td>
</tr>
<tr>
<td>7</td>
<td>Health Insurance</td>
</tr>
<tr>
<td>8</td>
<td>Housing</td>
</tr>
<tr>
<td>9</td>
<td>Language</td>
</tr>
<tr>
<td>10</td>
<td>Morbidity Perception</td>
</tr>
<tr>
<td>11</td>
<td>Mobility</td>
</tr>
<tr>
<td>12</td>
<td>Location</td>
</tr>
<tr>
<td>13</td>
<td>Mental Health</td>
</tr>
<tr>
<td>14</td>
<td>Attitude</td>
</tr>
<tr>
<td>15</td>
<td>Time</td>
</tr>
<tr>
<td>16</td>
<td>Physical Health</td>
</tr>
</tbody>
</table>
The state of a given consumer may be approximated by a point in the set CONSUMERS. This set is the vector product of the n sets which represent the n factors that are known to influence the consumer's behavior. Therefore, CONSUMERS = \( C_1 \times \ldots \times C_n \), where \( C_i \), for \( i = 1, \ldots, n \), is a set.

**Money:** The input factor "money" represents the private and the public sector funds that are spent in the health system. These funds may be represented by the set MONEY which is the vector product DOLLARS \( \times \) CATEGORIES. The set DOLLARS is the set of non-negative real numbers. The set CATEGORY = \( \{a_1, \ldots, a_m\} \), where \( a_i \), for \( i = 1, \ldots, m \) is one of m funding categories such as public construction, public matching funds, or private funds for paying a physician's fee.

**Political influence:** This factor is difficult to quantify; perhaps the set POLITICAL = \{pro, indifferent, con\} would be a useful approximation.

**Plans:** Proposed actions that are generally taken in the context of making specific inputs to the system to improve the state of the Health Policy System and the state of the Health Services System. In that sense, a plan may be defined to be a function defined on the set INPUTS with values in the set HEALTH POLICIES \( \times \) HEALTH SERVICES.

The set PLANS is the set which consists of all the possible functions defined on INPUTS with values in HEALTH POLICIES \( \times \) HEALTH SERVICES.
This abstract definition of the term "plan" is useful in the context of comparing and documenting planning actions. By carefully identifying the inputs made to the Health Delivery System, the resulting state can be compared to the expected state. This comparison should improve the knowledge of the system's behavior.

**Personnel:** The set PERSONNEL consists of elements which represent all of the categories of job positions in the Health Delivery System. These categories include medical specialists, nurses, and so on. This set accounts for the hiring, retiring, and firing aspects of the system inputs and outputs.

**Research:** The set RESEARCH consists of elements which represent the results of research made available to the system or conducted in the system.

**Education:** The set EDUCATION consists of elements which represent the education programs that are made available to either consumers or provider personnel.

**Regulations:** The set REGULATIONS consists of elements which represent the policies that are generated by each system or subsystem.

**Equipment:** The set EQUIPMENT consists of elements that represent the types of health care equipment that are added to or deleted from the system.
Decisions: The set DECISIONS consists of elements that represent the types of decisions made in the system such as acceptance or rejection of plans, policies, and patients.

Reports: The set REPORTS consists of elements that represent the different types of reports that circulate throughout the system. One of these reports should be a status report on the services available in the system.

Describing the Consumer's State

Table 3 lists some of the factors for describing the consumer's state. Some of these factors are difficult to measure. Therefore, they would have to be quantified by a special survey of the population.

Age: The Public Health Service of the Department of Health, Education, and Welfare (1964) has studied the relationship between age and the incidence of disease. The set AGE is a subset of the set of non-negative real numbers.

Income: The concern of the planning council should be cast in terms of the influence of consumer income in the admittance decision. In this sense, income is a strong factor in the consumer's decision to seek medical care. Welfare recipients usually have access to county hospitals for in-patient care. These hospitals and some private physicians or clinics frequently provide out-patient care for a slight fee, if any at all. Wealthy consumers usually have access to the best medical care available in the
community. Between these income extremes, the cost of medical care tends to inhibit the speed with which care is sought. To some extent, the care cost that the consumer will tolerate is a measure of his utility for good health.

Wagner (1967) observed that, "Health may be seen to be as highly valuable and desirable to one (individual) and lose out by a wide margin to a new car, a color TV set or a bottle of wine to another (p. 4)."

INCOME is a subset of the non-negative real numbers. The incomes may be approximated by the annual income expressed in thousands of dollars. In this case: INCOME = \{ 0, 1, 2, 3, \ldots \}.

Race: Race should have no influence on the admittance decision; unfortunately, it has more influence than is commonly recognized.

Shapiro (1967) studied peri-natal mortality in New York City. He found that this mortality was higher among non-white infants in the highest socio-economic class than among white infants in the lowest class. His research found that a primary cause for this phenomenon was the limited examining care available to non-white women.

Need-demand conversion lag: The need-demand conversion lag is the delay from the time disease symptoms are perceived by a consumer until he seeks medical care. Kennedy (1969) studied this lag and reports that some consumers either wait until their social role is impaired or await peer acceptance before seeking care. He found that in some cases people
that suspected they were victims of heart disease or cancer delayed seeking care for fear of learning the truth.

**NEED-DEMAND CONVERSION LAG** is the set of non-negative real numbers.

**Fertility:** This factor is measured by the number of children per family. The set FERTILITY could be a subset of the set of positive integers, where each integer represents the number of people that live in the consumer's household.

**Occupation:** This factor is important to the incidence of disease and disabling accidents. It plays another role beyond the control of health planners. Under-employed persons are apt to suffer mental anxiety. For example, Goodrich, Olendzki and Reader (1970) found that 47 percent of the black welfare recipients "suffered from nerves" and that they had the highest education level of the welfare recipients studied.

Occupation could be approximated by the set OCCUPATION = \{ none, unskilled manual, skilled manual, clerical, housewife, student, technical, executive \}.

**Health insurance:** This factor serves as an income supplement and thereby makes medical care accessible to consumers who are not wealthy. However, some insurance programs tend to cause over-utilization of in-patient health facilities by reimbursement for services that could have been administered less expensively in a physician's office or a clinic.
This problem has been studied extensively. One recent study may be enlightening.

Lewis and Keairnes (1970) conducted a study on behalf of the Kansas Blue Cross plan to determine the impact on the over-utilization problem of reimbursing patients for out-patient services. They found that no statistically significant difference in either hospital utilization or total cost to the insurance company resulted; the same physicians and patients that abused the conventional in-patient coverage did so under the test coverage.

Blue Cross plans and other equivalent plans are based on the philosophy of fee for service. In other words, the physician is reimbursed for each disease episode treated. A viable alternative form of insurance is prepaid group practice. This form is based on an annual fee to be paid by the consumer to a hospital which has the facilities and equipment to render both out-patient and in-patient care. The prepayment of fees facilitates budgeting by the hospital and encourages cost-efficiency. The basis of the cost-efficiency is in the early identification of disease through annual physicals and health education programs. The Kaiser-Permanente plan, an example of this form of health insurance, is well described by Garfield (1970).

The insurance programs could be represented by the set HEALTH INSURANCE = \{None, Prepaid, Fee for Service\}. 
Housing: This factor represents the living conditions; that is, the sanitation and the crowding, of the consumer's home. Housing influences both the physical and the mental health of consumers and may be approximated by the set HOUSING = \{adequate, inadequate\}.

Language: Non-English-speaking persons are apt to have difficulty in making known their needs for health care. This factor may be approximated by the set LANGUAGE = \{speaks English, does not speak English\}.

Morbidity perception: This factor is the consumer's ability to identify disease symptoms. Goodrich et al. (1970) were surprised to find that welfare recipients were generally good at self-diagnosis. Morbidity perception may be approximated by the set PERCEPTION = \{knows when ill, does not know when ill\}.

Mobility: This factor is a measure of the consumer's transportation requirements. Some physically handicapped persons will require special transportation. However, the mobility of most of the consumers may be described in terms of the public or private transportation systems available to them. Goodrich et al. (1970) studied the mobility effect on the consumer's decision to seek care. They found that 14 percent of the welfare recipients interviewed claimed that the difficulty of traveling in the city delayed their visits to a physician.
The mobility influence may be approximated by the set
\[ \text{MOBILITY} = \{ \text{none, requires special transportation, public transportation available, private transportation available} \}. \]

**Location:** The consumer's proximity to health service facilities has an interesting effect on his need-demand conversion. Klarman (1965) found that the supply of health services in an area created demand for those services.

Sohler and Thompson (1970) studied the first admission rates for mental hospitals and found them to be negatively correlated with the radial distance of the consumer's homes from those hospitals.

The set LOCATION is the set of non-negative real numbers where each number corresponds to the average distance from the consumer's residence to the health services in the community.

**Mental health:** Consumers who are afflicted with psychiatric disorders should seek care from the mental health delivery system. However, they either are unwilling to do so or are unaware of mental disease symptoms. Delays in seeking psychiatric care may lead to physical as well as mental health needs. The care regimen in this event is complex and expensive. These consumers may be thought to represent only a small percentage of the physical health system care load. However, Fein (1958) studied the economic impact of the prevalence and the treatment of mental disease and found that approximately 50 percent of the patients being
treated by general practitioners had psychiatric complications. Fein
suggests that the psychiatric need frequently preceded the physical need.

This factor may be approximated by the set $\text{MENTAL HEALTH} = \{\text{good, psychiatric disorder, physical-psychiatric disorder}\}$.

**Attitude:** The consumer's attitude towards the health system is
a subtle factor which may cause significant differences in the effectiveness
of alternative delivery systems.

Goodrich et al. (1970) found that 26 percent of the young adult
males receiving welfare had a negative attitude towards taking annual
physicals.

Klarman (1965) discusses the phenomenon of the health facility
that is needed but not used due to the consumer's attitude towards it.

The consumer's attitude towards the health system is difficult to
measure; the set $\text{ATTITUDE} = \{\text{positive, indifferent, negative}\}$ may be an
acceptable approximation. However, a special survey would be required
to quantify these elements for some particular consumer.

**Time:** The time factor is a clock that measures the interval from
morbidity perception until proper medical care is administered. As such,
this factor is represented by the set $\text{TIME}$ which is the set of non-negative
real numbers.

**Physical health:** There are several ways of classifying a con-
sumer's physical health. The Public Health Service frequently uses the
International Categories of Diseases and Accidents (ICDA). Allegedly, these categories are considered inadequate by some members of the medical profession. The planning council should coordinate with the health agencies and facilities in the community to determine an acceptable descriptive disease classification system. Once this has been accomplished, the elements of the set PHYSICAL HEALTH will be defined.

Describing the State of the Health Services

The entries in Table 2 are sets which represent factors for describing the state of a health services facility. The state of the Health Services System will be the object of much of the planning council's activities. Where possible, the elements of each set $H_i$, for $i = 1, \ldots, 15$, should be ordered, such that if there are $n$ elements in a set $H_i$, then $H_i$ is set isomorphic to the finite set of integers $\{0, \ldots, n-1\}$. The factors in Table 2 will now be interpreted and, where necessary, justified.

Professional personnel: This factor identifies all of the types of medical specialists in the community. Each of these types is a physician with special training in some medical discipline such as gynecology or urology. Assuming that there are $n$ health services delivery facilities in the community, the set $PROPERSON(i)$, for $i = 1, \ldots, n$, would correspond to the $i$th facility. These sets would consist of elements that correspond to the types of medical specialists employed by each facility.
**Paramedical personnel:** The health planning council should be concerned with the use made of paramedical personnel such as nurses and physician assistants. Ginzberg (1969) observes that most of the paramedical career patterns end at a low level of responsibility, technical challenge and pay.

The cost of training these persons is high. A reasonable return on this investment is unlikely if frequent turnover of personnel occurs.

Recently some physicians have delegated some of their traditional medical tasks to paramedical personnel with the result that the physicians' capacity for treating patients is significantly increased.

The set PARAMEDICAL PERSONNEL may be the set of non-negative integers, where each integer corresponds to the number of paramedical personnel that perform some of the physicians' medical tasks.

**Management:** Kissick (1970), Garfield (1970), Taylor (1969), and Wagner (1967) have each identified physician involvement in the managerial policy of health facilities as being important to the quality and cost-efficiency of medical care.

The set MANAGEMENT could be the set of non-negative integers where each integer represents the number of physicians involved in policy making.

**Services:** The services factor represents the types of services and special equipment available in the system. The term "availability"
does not necessarily imply that these services are physically located in the community; indeed, it may be more efficient and medically advisable to evacuate patients with rare diseases to some central facility that serves several communities. Engel (1968) labels this type of inter-activity organization "satelliting". He claims that it is used successfully in Sweden.

Obviously, the services available should correspond to the type and quantity of the medical needs of the community. However, several authors allege that the hospitals in many communities provide certain specialized services in deference to the demands of their physicians and without regard to the aggregate needs of the community. When the capacity for providing a given service, such as open heart surgery, grossly exceeds the needs of the community, the overhead costs for that service tend to be absorbed by increasing the hospital daily care rates.

It is difficult to express the services rendered by a facility on an ordinal scale. It would be more meaningful to the planning council to simply list the services. Hence, the set SERVICES is defined to be a subset of the set of non-negative real numbers, where each number represents a specific type of service: for example, 1.1 may represent a visiting nurse service, 2.1 may represent a well baby clinic, 5.2 may represent a burn treatment center, and so on. The planning council would have to coordinate with the other agencies in the community to establish a meaningful code for these services.
The set $\text{SERVICE}(i)$, for $i = 1, \ldots, n$, would be a subset of $\text{SERVICES}$ and would correspond to the services offered by the $i$th facility.

**Location:** The location factor for the consumers was discussed previously. In that discussion, it was noted that the consumer's propensity to seek care seems to be correlated with his proximity to health facilities. The planning council could estimate the desirable average distance for consumers to travel to health facilities. The area served by each facility may be estimated. The locational efficiency of the facility may then be estimated by using the actual radial distance to the center of mass of the service area and the desirable radial distance to the service area.

For the facility, $i = 1, \ldots, n$, the set $\text{LOC}(i)$ could be the set of non-negative real numbers from 0 to 1. Each number would express the locational efficiency of the $i$th facility.

**Salary scales:** Salary scales may be used to measure the personnel stability of the facility or the entire system. The national median salary for each medical and paramedical job position is usually available. A comparison of local salary scales to these median salaries could be made and expressed by the set $\text{SALARY SCALES}$. This set could consist of a subset of the set of non-negative real numbers. Each number would express the deviation from the median salary scales of the facility's salary scale.
**Capacity:** Capacity is a measure of the total number of patients that the facility can treat during a specified time interval such as a day or week. Hence, the set CAPACITY is the set of non-negative real numbers.

**Occupancy:** Occupancy is a measure of the amount of system capacity being used at any given time. The set OCCUPANCY is the set of non-negative real numbers on the inclusive interval from 0 to 1.

**Diagnostic efficiency:** This factor is a measure of the ability of the system to properly diagnose disease symptoms. Sparling (1962) made a study of this for five hospitals in Baltimore. The test disease for the study was appendicitis. The pathologist reports for all of the appendectomies performed in those hospitals during a common period of time were reviewed. A community hospital had the lowest efficiency factor; only 38 percent of the appendectomies performed in that hospital were justified by diseased tissue. A teaching hospital had the highest efficiency factor; 68 percent of the appendectomies performed in that hospital were justified. Sparling had access to data that is normally not disclosed to the public. The health planning council would need to use a measure that is correlated with diagnostic efficiency.

Sparling found that the hospitals which regularly used medical audits or peer review had the highest diagnostic efficiency. Garfield (1970) claims that these audits substantially improved the quality of care practiced by the Kaiser hospitals. The audits are performed by the physicians
accredited or employed by a given hospital to determine whether the surgery performed was justified by the symptoms that were evident.

The set DIAGNOSTIC EFFICIENCY could be the set of non-negative real numbers on the inclusive interval from 0 to 1. Each number would correspond to the degree to which medical audits are used by the facility.

**Administrative efficiency:** This factor is a measure of the ability of a health delivery facility to maintain accurate patient records, minimize duplication of effort, maximize the productivity of the administrative staff, and other similar aspects of administration. Administrative efficiency is important for reasons beyond those which may be obvious.

Roemer, Moustafa, and Hopkins (1968) studied the problem of measuring medical quality. They found that medical quality was positively correlated with administrative efficiency.

Goodrich et al. (1970) studied the opinion of welfare recipients in New York of the quality of care provided to them. Their opinion was based primarily on the administrative aspects of care, such as unproductive referrals from one section of a hospital to another. However, their opinions agreed surprisingly well with the ratings accorded these hospitals by the Joint Commission for Accreditation of Hospitals (JCAH). Hence, the influence of administrative efficiency on the consumers' attitude is probably significant.
A third consideration is that both the physicians and the consumers seem to prefer a health system which has continuity of care; that is, they want to foster a long-standing positive physician-patient relationship. This practice is frequently incompatible with the delivery of care by a clinic or a hospital; it may be at least partially replaced by a complete and accurate system of patient care record files.

Administrative efficiency could be measured by a review of the policies and procedures of each facility that provides out-patient clinic and in-patient services. Some standards would have to be determined by the planning council to define an ordinal scale for measuring efficiency. Some value on this scale should be the criterion for adequacy. Hence, the set ADMIN EFFICIENCY may be the set of non-negative integers where an integer would correspond to an administrative efficiency rating.

**Waiting time:** This factor is the average length of time consumers must wait before receiving health care after the admittance decision has been made. Consumers should expect to have to endure at least a brief wait when their state is characterized by a minor disease. However, clinics for treating welfare recipients that are staffed by volunteer physicians are often characterized by waiting times of at least four hours. These lengthy waits may reduce the utility of health care to consumers.

Waiting time would be expensive to measure. A special study would be required to measure this time for each facility.
Service time: Several attempts have been made to use factors such as the duration of patient stay as an index of the quality of service rendered. One of these attempts is that made by Roemer et al. (1968) in which he accounted for the size of the facility, the autopsy rate, and the patient stay duration to compare the quality of hospitals in a given city.

Lengthy hospital stays are costly, in any event, and wasteful, if expensive hospital facilities are utilized for the entire duration. DeVries (1970) made an analysis of the Progressive Patient Care method whereby a patient is transferred to less expensively equipped rooms in the hospital as his recuperation progresses. DeVries found the method offered a slight reduction in cost. However, some of the consumers did not like being moved from better to lesser equipped rooms.

Attitude: The attitude a given facility has towards its consumers and its neighborhood may influence the consumer's attitude and thereby reduce his utility for health care. Facilities which seem to ignore the social problems of the community or don't seem to be sincerely interested in treating some of the consumers are apt to be ineffective in rendering care to their consumers. Wagner (1966) described a situation where a new clinic was heavily damaged during a riot while a nearby clinic was unscathed. The older clinic had an active program for participation in community affairs; the new clinic had no similar program.
It is not easy to establish effective community participation programs. Salber (1970) reported the history of one such program in her study of neighborhood clinics. She found that a lot of time and effort was necessary to establish a rapport between the clinic and the neighborhood representatives.

**Cost:** The cost factor represents the average fee the facility charges for rendering care. Klarman (1965) has studied the medical fee structure and found that physicians' fees are set more by tradition than by market demand. He also found that health services tend to behave as a luxury good; that is, demand increases with price.

In this cost environment, it is not surprising that O'Reilly (1970) found that physicians' fees have increased 58 percent and hospital daily service fees have increased 160 percent in the ten-year interval beginning in 1960.

Ginzberg (1969) analyzed medical costs and found pressures for increased wages to be an important factor. He also found, as have other researchers, that the traditionally restricted flow of new physicians into the health market has aggravated the cost problem.

The set COST could consist of integers that represent the average fee charged by the facility.

**Investment:** This factor represents the amount of government capital expended during the fiscal year for each facility. Hence, the set INVESTMENT is the set of non-negative real numbers.
CHAPTER 3

THE PLANNING METHODOLOGY: PHASE I

Planning consists of the following sequence of activities: data collection and processing, problem identification, data collection and processing, priority assignments, data collection and processing, alternative plan generation, data collection and processing, plan selection, data collection and processing, and result evaluation. The planning methodology will address each of these activities. The methodology is divided into two phases. Phase I will discuss the methodology for data collection, data processing and problem identification; Phase II will discuss the methodology for the remaining planning activities.

In the preceding chapter, it was noted that the health planning council should orient its activities towards the national goal of attaining the highest level of health possible for everyone. The most realistic method of reaching that goal is to provide adequate health care to everyone who needs it.

From the discussion in Chapter 2, it may be assumed that everyone in a given community will either not have access to adequate care when they need it or not seek care when they need it. The latter event depends primarily on the state of the consumer; the former event depends
primarily on the state of the Health Policies and Health Services Systems. The health planning council should try to identify the extent to which these problems exist in the community.

This chapter will describe a methodology for testing the Health Delivery System. The information presented in Chapter 2 will be used to determine the tests that will be conducted. The state of some of the consumers will be estimated in an effort to appraise the state of the Health Policies and the Health Services Systems that corresponds to these consumers. Figure 2 is a flow chart of this phase of the methodology.

Data Requirements and Utilization

The purpose of the data collection effort that is described herein is to identify the state of the Health Delivery System. The values of many of the Health Services System state factors may be estimated either from routine reports such as those pertaining to capacity, costs, salary scales, and personnel or from health service facility admission records. However, factors such as the attitude and the administrative efficiency for each facility and the de facto policies of the Health Policies System are not easily evaluated from these reports. It is assumed that these factors and policies may be evaluated by a survey of selected elements of the population. It is also assumed that the community has a large population and contains some personnel who are capable of rendering medically proficient care.
Survey data are expensive to collect and process. Hence, it should be worthwhile to minimize the survey effort by selecting those consumers who are apt to be most informative about the state of the system; that is, those people who are apparently suffering from the system's inadequacies. Therefore, some sort of indicator statistic is needed to identify the population groups to be surveyed.

Sanders (1964) studied the use of morbidity statistics as an indicator of Health Delivery System effectiveness. He found that "... communities with adequate health care would have a higher prevalence of chronic morbidity than communities where health care is inadequate and the sick die earlier (p. 1064)."

Sanders urged the adoption of the productive man years of the population per 100,000 births as a measure of health system effectiveness. He considered productivity to be the ability of a person to fulfill the social role expected of a person of a given age and sex.

Using Sanders' concepts, lost productivity may be considered to result from either the death or the permanent functional disability of a member of the community. Physicians are required by law to report mortality data; they are not required to report permanent functional disability data. Hence, it will be necessary either to request this latter data from the health facilities on a voluntary basis or to require this data by law. The mortality and functional disability statistic is defined to be the ratio
of the number of victims per year in some group to the total number of people in that group.

Using the mortality and functional disability statistics, it is plausible that a lost productivity profile may be computed for each socio-economic group in the community. This profile would have four entries to correspond to the following age groups:

a. Perinatal.
b. Less than 18 years old.
c. Ages 18 through 65 years old.
d. More than 65 years old.

Assuming that an effective Health Delivery System will maximize the productive life of the population it serves, then a desirable lost productivity profile should reflect the lost productivity which results from old age or chance. In other words, the mortality and functional disability statistic for consumers who are more than 65 years old would probably exceed the values of that statistic for the other age groups. Furthermore, the value of that statistic for the other age groups should be of negligible magnitude.

It is assumed that the consumer groups characterized by the least desirable lost productivity profile will be those which are most aware of the inadequacies of the health system. The method for identifying these groups will now be discussed.
Fig. 2. Problems Identification Flow Chart
Selection of Consumers

At least two groups of consumers will be used in the test of the Health Delivery System. These groups are the Control group and the Test groups.

The Control group is one which is apt to have good accessibility to the best medical care available in the community. The phrase "best medical care" connotes only the quality of the attending physicians' medical skill and equipment. A priori no assumption is made regarding the subset of the set CONSUMERS which may approximate the state of members of this group. However, it is assumed that this group will have the most desirable lost productivity profile associated with it. It is assumed that these statistics will be based on a meaningful length of time and group size.

The Test groups are those which either are not apt to have access to good medical care or are not motivated to seek medical care when it is needed. It is assumed that this group will have corresponding to it a lost productivity profile which varies by a statistically significant amount from that which corresponds to the Control group.

Statistical significance would be tested by the contingency Chi-square test to a predetermined confidence level. This test is well described by most textbooks on experimental statistics, such as that by Fryer (1966), and will not be described herein.
Census Programs

The U. S. Bureau of the Census (1970) has two programs that are of direct use in the planning methodology. These programs are the census, which is conducted every ten years, and the address matching computer program used to analyze census data.

The census collects data on the members of every community. This data is processed in several studies to facilitate statistical analysis of trends and characteristics of the population. One of these studies divides the entire community into Census Tracts and lists the statistics which correspond to each census tract.

A Census Tract is a geographically defined area that is the boundary surrounding a group of the community whose members are described by approximately homogeneous demographic factors. These demographic factors include the following: income, employment, and housing. Some of the statistics available for each group are the following: median income, white population size, non-white population size, average age, and average family size. All of these factors were identified in Chapter 2 as being important to the behavior of the consumers in the Health Delivery System.

The Bureau of the Census has developed a computer program for matching street addresses to Census Tracts. This program is called ADMATCH and is available to any community that requests it. Any data collected on a member of the community may be associated with the
appropriate Census Tract by the input of that person's street address to the ADMATCH program.

Group Identification

The perinatal mortality, live birth, mortality and functional disability data for the entire community for a period of sufficient duration would be listed with the corresponding street address of the victims. This data would be processed by the ADMATCH program and identified with the appropriate Census Tract.

The Census Tract which is characterized by the most desirable lost productivity profile will be labeled the Control group. A sequence of Chi-square tests will be conducted to identify the Census Tracts which should be labeled the Test groups.

Testing the System

The purpose of the tests to be performed on the Health Delivery System is to determine the following: the extent to which the health care resources are being inefficiently employed, the need for new health services or additional capacity, and the effect of the state of the Health Delivery System on the state of the consumer.

The state of most of the members of the Control group apparently is not adversely affected by the health system. Therefore, the admission and disposition records of the health service facilities that pertain to
members of that group should yield insight regarding misdirected demands, misused capacity, and inadequate services.

Misdirected demands are demands for health service that are placed with inappropriate facilities. For example, persons with psychiatric disorders should seek care from mental health delivery facilities. Their demands are misdirected if they are placed with physical health delivery facilities. When these persons are admitted for treatment by an inappropriate facility, the result is that the resources of that facility are wasted and the mental health of the patient probably will not improve.

Misused capacity is the facility capacity of one degree of sophistication that is employed in treating diseases that require a lesser degree of sophistication. In Chapter 2 it was noted that this frequently occurs when the consumer has fee for service health insurance and his physician permits him to be admitted to a hospital for care that could have been adequately rendered in the physician's office.

The services of the Health Service System are inadequate if there is either no service offered by any subsystem thereof that corresponds to some disease that is prevalent in the community, or the capacity of the services offered cannot accommodate the demand for those services.

Admission and Disposition Data

The following data is required from the admission and disposition records:
a. Date of admission,
b. Date of release,
c. Patient's age,
d. Patient's street address,
e. Patient's race (white or non-white),
f. Disease diagnosis,
g. Care prescribed,
h. Cost of treatment,
i. Method of payment (private funds, fee for service insurance, prepaid insurance),
j. Treatment facility identification.

A code would be necessary to describe the disease diagnosis in unambiguous terms. The code should identify quasi-physical diseases; that is, diseases that were precipitated by psychiatric disorders.

Data would be collected at least from the hospitals, plus any other health service facilities that are staffed and equipped to provide it.

Data Processing

The admission and disposition data from the facilities selected would be collected for a sufficiently long period. Using the ADMATCH program, this data would be associated with the appropriate Census Tracts. A data summary for each tract would result.
The data summary should provide the following information:

a. Profile of the frequency of disease treatments for each disease treated.

b. Profile of services used.

c. Matrix of average duration of stay for each facility and each disease.

d. Matrix of diseases treated for each method of payment and each facility.

Problems Identification

The data summary which corresponds to the Control group will be analyzed to determine the extent of misdirected demands, misused capacity, and inadequate capacity. The data summary for each of the Test groups will be compared to that of the Control group. A sample of the members of each Test group will be surveyed to determine the cause of their undesirable lost productivity profile.

Data Analysis

The health planning council would analyze the data summary for the Test and Control groups in a sequence of studies such as the following:

a. Misdirected demands,

b. Misused capacity,

c. Inadequate services.
The analysis would begin with the data for the Control group. When that analysis is completed, the data for each Test group would be compared to that of the Control group and studied for statistically significant differences by the Chi-square contingency test.

The extent of the misdirected demands would be estimated from the number of those diseases treated by physical health facilities that should have been treated by some other type of facility.

The extent to which the capacity is misused would be estimated from the matrix that lists the diseases treated, the method of payment, and the facility used to treat the disease.

The adequacy of the services would be estimated by comparing the profile of diseases treated and the profile of services required.

The assumption made for each of the studies is that the medical profession representatives on the planning council will be able to identify the appropriate facilities for treating each type of disease and will know which services are needed for a given disease.

Survey Data

It is difficult to predict which factors that describe the consumer's state have adversely interacted with the state of the Health Delivery System to cause the lost productivity profile that corresponds to the Test groups. Hence, a survey of each group is suggested. The survey would be conducted on a sample of the members of each group. It would
be oriented by the admissions data analysis and the knowledge of both the consumer and the provider factors discussed in Chapter 2. The survey should study the following aspects of the problem:

a. Significant differences between the data summary for the Test group and that of the Control group.

b. The influence of each of the consumer state factors listed on Table 3 on the consumer's desire to seek medical care when he is sick.

c. The influence of de facto or de jure policies on the consumer's ability to receive good care.

d. The influence of the state of the Health Services System on the consumer's ability to receive good care.

Problem Summary

The result of the above analysis should be an estimate of at least the worst problems in the community Health Delivery System. All of these problems would be listed in a summary for the community. This summary will be the basis for the comprehensive health plans.

An example may clarify the discussion on this point. Suppose that a group has been identified that has an unusually high perinatal mortality statistic. This group may be designated Test group A. Following the procedure outlined in this chapter, a survey would be conducted on a sample of the members of this group. A problem summary could be compiled such as that which follows.

The members of Test group A cannot afford good medical care from private physicians in the community and are using the services
offered by a volunteer clinic in a remote part of town. The volunteer staff does not adhere to a regular appointment schedule. Public transportation to the clinic is not available. Hence, members of the group wait until disease impairs their social role and try to obtain transportation from friends. When they arrive at the clinic, it requires almost an entire day for them to receive treatment and return home. Test group A corresponds to Census Tract X which is located in the southwestern section of the community and has 7,500 inhabitants.

Suppose that the survey conducted on Test group A yielded the following additional information:

a. Median age is 45 years,

b. Median income is $3,500,

c. 55 percent of the people are non-white,

d. Average family size is 6 persons,

e. Housing is inadequate,

f. Language spoken is English,

g. Mortality perception is good,

h. Mental health is generally good,

i. Attitude is antagonistic towards the health system,

j. Average time until disease is treated is approximately three weeks,

k. Physical health is poor.
The planning council can combine the information in the problem summary with that available from routine reports from the health service facilities to estimate the state of the Health Services System. They probably could obtain the following information on that system from routine reports:

a. Professional personnel skills available,
b. Paramedical personnel utilization,
c. Managerial involvement by physicians,
d. Services available,
e. Location of the facilities,
f. Salary scales,
g. Capacity,
h. Occupancy,
i. Medical audit usage,
j. Average cost of care,
k. Investment in each facility per annum.

Using the admissions data, the council could estimate the service time for some of the facilities. The survey of the Test groups could yield an estimate of the administrative efficiency and attitude of the service facilities.

To this point, an estimate of the consumer state for a typical member of Test group A has been made and an approximation of the state
of some of the subsystems of the Health Services System has been made. It now remains to estimate the state of the Health Policies System. This can be done by identifying the de jure policies in the community using the various laws and regulations extant that pertain to health delivery and accessibility thereto. The de facto policies would be gleaned from the surveys of the Test groups.
CHAPTER 4

THE PLANNING METHODOLOGY: PHASE II

Based on the problem summary determined by the methods shown in the preceding chapter, the planning council should arrange these problems by priority, determine alternative plans, coordinate the selection of the best plan, and evaluate the results of that plan. These activities will be discussed in this chapter.

Priorities

The planning council must decide the order in which the problems will be addressed by plans. It would be convenient to have a set of functions defined on the set of all problems with values in the set of real numbers, where each number represents a priority. It is difficult, perhaps impossible, to define such a set of functions that would be agreed to by every member of the council. The problems are too complex to be either easily or accurately described by a scalar. Hence, the collective experience and knowledge of the members of the council would have to be focused on each problem and the priorities assigned by majority rule.
Alternative Plan Generation

In Chapter 2, plans were defined to be functions defined on the set INPUTS with values in the set HEALTH POLICIES \times HEALTH SERVICES. It is assumed that a plan will be chosen for each problem; that is, a problem exists due to some combination of an undesirable state for the Health Policies System and an undesirable state for the Health Services System. The plan is expected to select inputs that will cause a state transition in both of these systems. The planning council must decide which point in the set INPUTS will cause the desired state transitions. Unfortunately, the state transition functions for the Health Delivery System are not known. Hence, the collective opinion of the planning council must be solicited to identify appropriate points in the set INPUTS.

The method for organizing the opinion solicitation process that is suggested is a generalization of the perturbation technique used in conventional analysis. Perturbation techniques vary the values assumed by a selected number of input factors and fix the values assumed by the remaining input factors. The effect of the input vector that is selected is then evaluated by simulating the system on a computer. However, computer simulation requires a completely specified model of the system. Hence, the input vectors for health plans will be evaluated by subjective simulation.
Computer Simulation Requirements

Computer simulation techniques are discussed in detail by Naylor et al. (1968). They state that the model used for simulating a system must be a mathematical system that approximates the real system.

The model described in Chapter 2 is not well defined as a mathematical system. Wymore (1967) states that a mathematical system is defined by a set having the following constituents:

a. A set \( S \), not empty, representing the state of the system,

b. A set \( P \), not empty, representing the inputs to the system,

c. A set \( F \), not empty, representing the admissible input functions of the system,

d. A set \( M \), not empty, of functions that are defined on the set \( S \) with values in the set \( S \),

e. A set \( T \), not empty, representing the time scale of the system,

f. A function \( \sigma \) which is defined on the set \( F \times T \) with values in \( M \) such that \( \sigma \) is onto, and which satisfies the initial state, the time invariant and the non-anticipatory conditions imposed by Wymore.

The model developed in Chapter 2 may be compared to the requirements for a mathematical system as follows:

a. The state of the system was defined to be a set that is the vector product \( \text{HEALTH POLICIES} \times \text{HEALTH SERVICES} \). This set is not empty by the definition of the sets \( \text{HEALTH POLICIES} \) and \( \text{HEALTH SERVICES} \) and the definition of the vector product.
b. The input set was defined to be the set INPUTS. This set is a vector product of non-empty sets. Hence, it is not empty by the definition of the vector product.

c. The set $F$ of admissible input functions was not specified. These functions must be defined on the set $T$ with values in the set INPUTS. This set of input functions must exist since there obviously are inputs to the system. However, a major systems engineering study of the input functions for a given community health system would be necessary before the set $F$ could be completely specified.

d. The set $M$ is the range of the state transition function $\sigma$. This function is not specified adequately. Hence, $M$ is not specified.

e. The set $T$ represents the time scale of the system and is hereby defined to be the set of non-negative real numbers.

f. The state transition function $\sigma$ is not specified. Certainly, it would be necessary first to have specified the set $F$. However, even if the set $F$ is specified, the information necessary to specify $\sigma$ is not evident in the literature. A major study would be necessary to determine the state transitions that will occur for every possible input.

In studying some systems, it is possible to approximate the set $F$ and the function $\sigma$ by making simplifying assumptions. This done,
computer simulations of those systems can be made. It is not clear which simplifying assumptions are appropriate for simulating the Health Delivery System.

Subjective Simulation

Every member of the planning council has some idea of the behavior of the health system. Each of these "ideas" represents an internal model of that system. The process of soliciting an opinion from the members of the council about the state transition caused by some proposed input vector is simply an appeal to them to use their internal models of the system. In other words, they are each subjectively simulating the system using their internal models. These models may be improved when the members of the council learn more about the system's behavior.

Alternative Plans

The method that will be outlined is intended to assist the members of the planning council in their tasks of modeling the system transitions, estimating the undesirable state of the system and selecting the input vector that is most likely, in their opinion, to cause the desired state transition. It is recognized that this is a challenging task and that much research has been done on group subjective probability estimation and decision making. Unfortunately, it is not clear that the results of this research may be applied directly in this complex situation.
By the definition of a plan, the task of preparing alternative plans is that of designing input vectors, belonging to the set INPUTS, that correspond to expected state vectors that belong to the vector product HEALTH POLICIES \times HEALTH SERVICES. Each expected state vector should improve the state of members of one or more specified groups of consumers. The input vectors may have coordinate values that correspond to a zero input for some input factor listed on Table 1. The specific combinations of these factors that are represented in an input vector by non-zero values are defined to be classes of plans. This notion will be amplified and a few conventions for designing input vectors will now be discussed.

The input vectors chosen should represent the minimum effort, in terms of time, money and other resources, necessary to accomplish the desired state transition. Some input factors represent types of inputs that the planning council does not have the authority to generate. These factors are the consumers, the results of research and the decisions to be made on the allocation of resources. Hence, any input vector designed by the council will always have zero values for the coordinates that represent these factors. Other input factors represent types of inputs that the council always generates. These factors represent political influence and reports. The reports that are made as an input factor for a plan are those which identify the decision-making agency and the other agencies responsible for executing the plan. The remaining six input factors are those
which may be combined to form the classes of plans. For example, if the council feels that all that is needed to improve the state of the system is to exert political influence on some other agency, then this plan belongs to the class of plans where only political influence and reports have non-zero values in the input vector. The process of generating alternative plans may now be organized in logical steps.

a. Identify the consumers who should benefit from the plan. Represent some of them by points in the set CONSUMERS.

b. Identify the state of the system that was found during Phase I of the methodology to be adversely affecting the consumers identified in step a.

c. Identify the minimum cost combinations of factors that may be necessary to improve the state of the system. The choice is some point in \( \text{MONEY} \times \text{PLANS} \times \text{PERSONNEL} \times \text{EDUCATION} \times \text{REGULATIONS} \times \text{EQUIPMENT} \). The minimum numbers would be found by considering each factor separately and determining if it will be sufficient to improve the state. If not, consider all 15 pairs of factors and determine if they will be adequate; continue this procedure until all reasonable combinations out of the 64 possible have been considered. Each of these combinations is a class of plans.

d. For each class of plans that seems to be appropriate, decide which values the non-zero factors should assume to yield
the minimum cost. This would be determined by the dialog between the council members as each member subjectively simulates the plan.

e. Identify the classes of plans and the specific input vectors for each of these classes that are undominated. An undominated plan is defined to be one such that:

(1) The values of some coordinates of the expected state vector for that plan are at least as desirable as the values for those coordinates for every other plan that has been proposed.

(2) No other plan has an expected state vector with more desirable values for every coordinate.

In other words, the undominated plans are those for which the council cannot state a preference for one to another but which they prefer to any other plans considered.

f. Test each undominated plan by subjectively simulating the consumer state transition that should occur once the plan has been implemented. The typical consumers identified in step a would be considered during this test.

g. Coordinate the undominated plans that survive the test described in step f with the appropriate decision-making agencies. Document the input values to be obtained by each factor for each of the undominated plans.
Typical Plans

The example developed in Chapter 3 described the problems in the system that is available to a group of consumers (Test group A). This example will be extended to demonstrate both a possible dominated plan and an undominated plan.

The planning council may consider the input vector \((0,0,\text{pro},0,0,0,0,0,0,b)\), where \text{pro} belongs to the set \text{POLITICAL INFLUENCE}, \text{a} belongs to the set \text{REGULATIONS}, and \text{b} belongs to the set \text{REPORTS}. Suppose that "\text{a}" corresponds to a policy that would require the volunteer clinic that is currently providing outpatient care to the members of Test group A to adhere to a reasonable appointment scheduling system. The members of the council would subjectively simulate the system to determine the state transition that they think would be caused by this input. They may decide, after some discussion, that the volunteer physicians would withdraw their services from the clinic rather than have their time allotted by appointment schedules. This plan would be unacceptable and should be dominated by some other plan.

Continuing the plan generation process, the planning council may decide that an alternative plan would be to establish a clinic in rented office space convenient to the members of Test group A. The appropriate vector would be \((0,a,\text{pro},0,10,0,0,b,c,O,d)\), where "\text{a}" belongs to \text{MONEY}, \text{pro} belongs to \text{POLITICAL INFLUENCE}, "10" belongs
to PERSONNEL, "b" belongs to REGULATIONS, "c" belongs to EQUIPMENT and "d" belongs to REPORTS. The symbol "a" represents the estimated operating cost of the clinic. The number ten represents the number of professional medical personnel to be hired to operate the clinic. The symbol "b" represents the policy of providing free outpatient care to the members of Test group A. The symbol "c" represents the equipment that will be needed by the clinic. The symbol "d" represents the report that identifies the decision-making agency and other agencies that are involved in establishing the clinic. Assuming that the members of the council agree that the desired state transition will occur when these inputs are made, this plan could be a candidate for the set of undominated plans. Other plans would have to be generated and the consumer test conducted before the final selection of the set of undominated plans can be made.

**Plan Selection**

The undominated plans identified by the planning council would be submitted to an agency in the Government Services System for a decision. The agency selected would depend on the category of funds that describes the point in the set MONEY for each of the plans.

It may seem awkward to present a decision-maker with several alternative plans which are described by lengthy input vectors and complicated expected state vectors. However, Dodson (1969) used a similar technique in making cost effectiveness studies of urban transportation
systems. He was able to use digital computer simulation methods to compute the expected state vector. His studies yielded 12 undominated plans. These plans were submitted to a Federal agency which made the selection of the most desirable plan.

Evaluating the Plan

Assuming that a plan has been selected by the appropriate decision-making agency, the planning council should measure the effectiveness of the plan. It probably will take a long time for the plan implementation to be completed. Additional time may be required for the effects of the plan to be realized in the state transition of the consumers. During this period the mortality data, the functional disability data, and the admissions data would continue to be collected and would be processed and analyzed periodically. The analysis methods described in Chapter 3 would be applied, including the survey of the members of Test groups. An estimate of the state of the members of these groups and the state of the Health Policies and Health Services Systems would be made. The new estimates for each of these states would be compared with the expected state vectors from the chosen plan.

A plan will be considered to be effective if the estimated values of every coordinate of the system state vector are at least as desirable as the corresponding values of the coordinates of the expected state
vector. However, if the plan is not successful, then the council has a record of the inputs that were made and the estimated state that resulted. They know approximately how the system reacted to those inputs, thereby increasing their knowledge of the system. They also know that different inputs are probably required to obtain the desired state. In this event, a new set of undominated plans would be generated and the process repeated.
CHAPTER 5

SUMMARY AND CONCLUSIONS

Summary

A methodology for preparing comprehensive health plans has been presented which is based on the concept that the goal of "attaining the highest level of health for everyone" should be served by providing adequate care to everyone who needs it. However, the resources for providing health care are not abundant. If everyone who needs care is to be treated, these resources must be used efficiently. Furthermore, some people either are unwilling to seek care when it is needed or are unable to receive care when they seek it. Comprehensive health plans should be oriented towards eliminating the causes of inefficient resource utilization, incomplete need-demand conversion, inaccessible health care and inadequate health care. Therefore, the methodology is directed towards identifying and eliminating these problems.

In Chapter 2, it was seen that the combinations of factors which cause these problems are not well understood; the interactions between the subsystems of the Health Delivery System are complex. In this complex and uncertain environment, it is obvious that some means of categorizing these factors and interrelationships is necessary to minimize
confusion. The simple model displayed in Chapter 2 served this purpose. The model accounts for that which is known about the system and that which should be known about the system. This accounting method is extremely useful and is fundamental to the more detailed methods presented in Chapters 3 and 4.

The model identified three separate subsystems in the Health Delivery System as follows; the Health Policies System, the Health Services System and the Health Planning Activities System. Consumers were identified as one of the many inputs to the system. It is important to note that the planning council cannot directly control either the timing or the volume of the consumer inputs. Instead, the council coordinates plans that should remotely control the consumers' motivation to demand health care when it is needed. This motivation is regulated by the quality, quantity and accessibility of care. This notion leads to a useful definition of comprehensive health plans; these plans are defined to be functions defined on the set INPUTS with values in the set which is the vector product HEALTH POLICIES x HEALTH SERVICES. That definition concisely displays the health system state transition that is expected to occur when certain inputs are made.

Using the structure of the model, the planning council is encouraged to view the process of preparing plans as being analogous to that of conducting an experiment. The experiment consists of testing the
health system's response when certain groups of consumers seek health care. The consumer groups are defined by the Bureau of the Census Tracts. A control group was specified which consists of persons who are apt to have access to the best health care available in the community. This group is identified by the relativity of the desirable lost productivity profile that is associated with it. The values for this profile that are associated with the remaining groups in the community are tested for statistically significant differences from those corresponding to the control group. When a profile is determined to vary significantly from the control profile, the group to which it corresponds is identified as a Test group.

The system is tested by observing the reaction of the system when members of the Control group are inputs thereto. This reaction is observed from its manifestation in the admission and disposition records of some of the health facilities. The reaction to an input by members of a test group is compared to that for the Control group. A survey of a sample of the members in each Test group is prescribed to enhance the understanding of the state of both those consumers and the state of the health services that corresponds to them. The results of all of the tests and surveys are combined with data from routine reports to be the source for the health care problem summary for the community.

The planning council would assign priorities to the entries in the problem summary. Priorities would be determined by majority rule of the members of the council.
The procedure for generating alternative plans consisted of seven steps. This procedure presents the members of the council with well organized information to facilitate the process of subjective simulation of plans. The result of this procedure is a set of undominated plans. This set consists of plans that the members of the council are unable to determine a preference for one undominated plan to another.

The role of selecting the most desirable plan is left to the decision-making agency which controls the resources necessary to implement the plan.

The effectiveness of the plan is evaluated by repeating the tests on the system. The estimated system state vector that is obtained by those tests is compared to the expected state vector identified in the plan. The plan is defined to be effective if every coordinate value of the estimated state vector is at least as desirable as the corresponding coordinate value of the expected state vector. Whenever a plan is determined to be ineffective, the entire plan generation procedure is repeated. The planning procedure and the accompanying documentation should increase the knowledge of the Health Delivery System.

Conclusions

The process of preparing comprehensive health plans is complex. The knowledge of the Health Delivery System is not adequate. Several major studies will be necessary to improve both the planning proficiency
of the planning council and, concomitantly, the delivery of health services to those in need of care. This study has identified some of these studies as follows:

a. Analysis of the Health Policies System.

b. Analysis of the Health Services System.

c. Analysis of the Health Planning Activities System.

d. Analysis of the set of admissible input functions for the Health Delivery System.

e. Analysis of the state transition function for the Health Delivery System and the state transition function for each of the subsystems of that system.

The need for collecting data on the incidence of permanent functional disability in the community was identified. It is recognized that it may be necessary to legislate the reporting of this data.

This thesis has reviewed many of the factors that are suggested by the literature to be important to health planning. It has identified the factors that should be known. These factors have been organized in a logical model which should facilitate the health planning effort. Definitions such as those for comprehensive health plans, classes of plans, undominated plans, and measures of plan effectiveness should serve as useful guidance for comprehensive health planning. The study has identified the data to be collected and the methods of testing and using that data. The application of the methodology to a specific community should be straightforward.
The medical terms listed in this glossary were so defined by Rothenberg (1968); the set theoretic terms were so defined by Wymore (1967).

**Chronic**
Of long duration. Not acute.

**Disease**
A disturbance in the structure or function of an organ or organs.

**Function**
A function \( f \) defined on the set \( A \) with values in the set \( B \) is a subset of the set \( \{(x, y) : x \in A, y \in B\} \) having two essential properties.

a. For every \( x \in A \) there exists an element \( y \in B \) such that \( (x, y) \in f \).

b. If \( (x_1, y_1) \in f \) and \( (x_2, y_2) \in f \) and \( x_1 = x_2 \), then \( y_1 = y_2 \).

**Gynecology**
That branch of medicine dealing with diseases of the female reproductive organs.

**Morbidity Statistic**
The ratio of the number of sick people to the number in the total population.

**Mortality**
The death rate.

**Outpatient**
One who receives medical service in the hospital's clinic and then returns to his home.

**Perinatal**
Referring to the time just preceding, during, or after birth.
Urologist

A physician who specializes in diseases of the urogenital system.

Vector Product

If $A$ is a finite set of sets, $A = \{B_1, \ldots, B_n\}$, where $n$ belongs to the set of positive integers, $n \geq 2$, then the vector product of the sets in $A$ is denoted $B_1 \times \ldots \times B_n$ and is defined as the set of $n$-tuples of the form $(b_1, \ldots, b_n)$ where $b_i \in B_i$ for every $i, i = 1, \ldots, n$. 
SELECTED BIBLIOGRAPHY


Shapiro, S., "End Result Measurement of Quality of Medical Care," Milbank Memorial Fund Quarterly, Apr 1967, 81-96.


