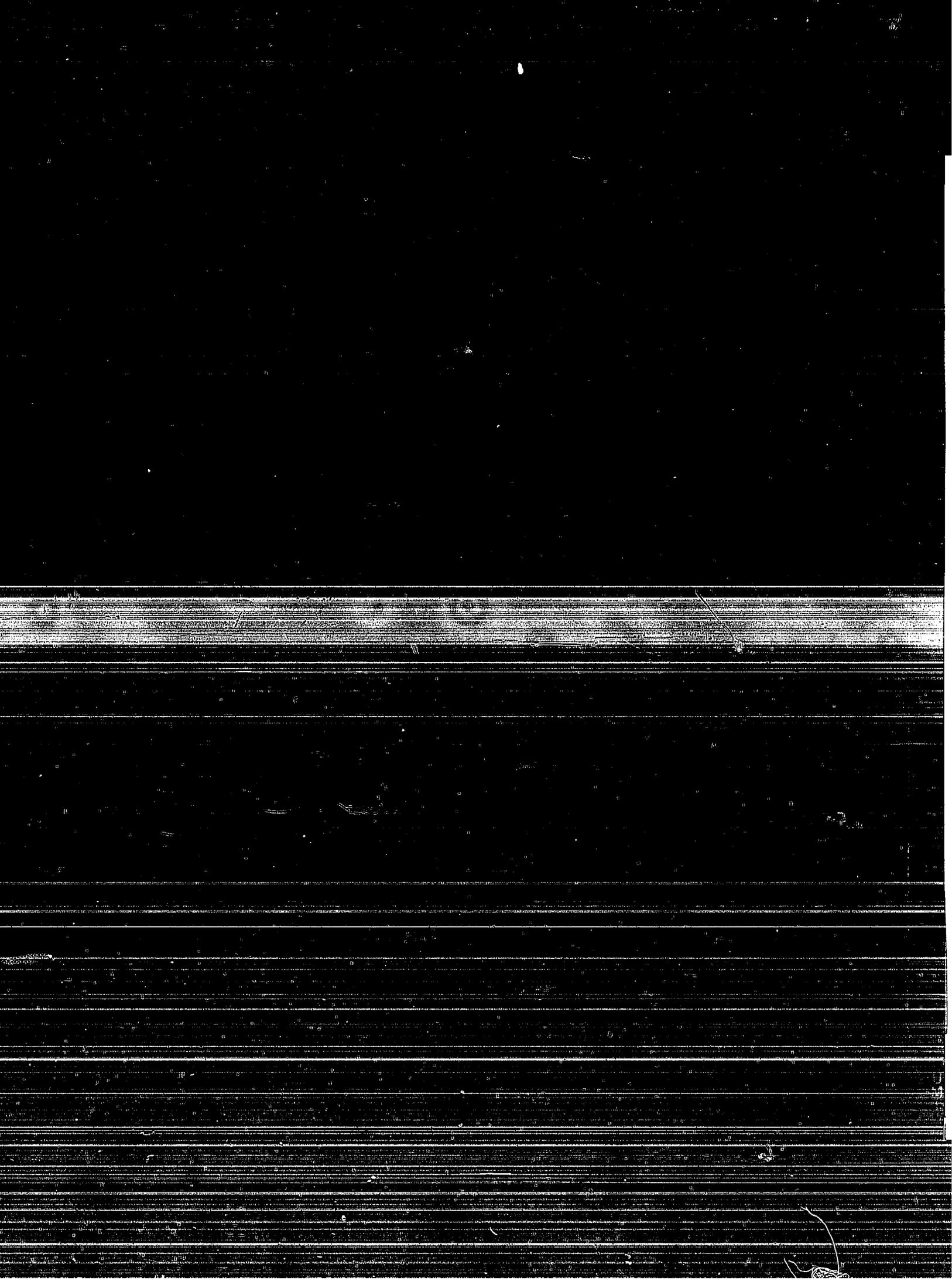


Downloaded from SHAREOK. Persistent Handle URL: https://hdl.handle.net/11244/4983

THE UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

A DECISION ANALYSIS MODEL FOR ADULT EDUCATION PROGRAM PLANNING AT THE VOCATIONAL LEVEL

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

degree of

DOCTOR OF PHILOSOPHY

BY

LONNIE ROBERTS

Norman, Oklahoma

1982

A DECISION ANALYSIS MODEL FOR ADULT EDUCATION PROGRAM PLANNING AT THE VOCATIONAL LEVEL

APPROVED BY

DISSERTATION COMMITTEE

ACKNOWLEDGEMENTS

For his personal support throughout the doctoral program in general and in the course of this research in particular, I would like to extend my sincere appreciation to the committee Chairman, Dr. Lloyd J. Korhonen. The members of the doctoral committee, Drs. Charlyce R. King, Edmund C. Nuttal, Loy E. Prickett, and Don S. Udell, deserve more than mere gratitude for their scholarly assistance in bringing this research to fruition. Dr. Tom Thomas, of the Oklahoma State Department of Vocational and Technical Education, was particularly helpful in the collection of data for this study. And, final appreciation must be expressed to my wife, Sharon, for typing the rough draft, and my children, Sherri and Jason, for providing the moral support that was needed to sustain my efforts during this project.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS iii

LIST OF TABLES vi

LIST OF ILLUSTRATIONS vii

Chapter

I. INTRODUCTION 1

Problem Statement 4
Definitions 4
Limitations of the Study 5
Assumptions 6
Research Design 7
Organization of the Report 12

II. LITERATURE REVIEW 14

Introduction 14
Planning and Decision Making 14
Related Research 29
Summary 37

III. RESEARCH METHODOLOGY 38

Collection of Objective Data - Delphi Technique 38
Analysis of Objective Data 43
Formulation of Linear Objectives 44
Collection of Parametric Data 45
Design of the Goal Programming Model 45
Testing the Model 47

IV. RESULTS 48

Results of the Delphi Technique 48
Initial Design of the Linear Objectives . . 61
Collection and Adaption of Parametric Data . 63
Final Design and Results of the Goal Programming Model 65

Chapter

V. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS 77

Summary 77
Conclusions 83
Recommendations 84

BIBLIOGRAPHY 85

APPENDICES 89

LIST OF TABLES

Table

1. First Round Objectives: Top 33 1/3 Percentile Rankings . . 49
2. Subgroup Indices of Round One Objectives 51
3. Second Round Objectives: Top 33 1/3 Percentile Rankings . 53
4. Subgroup Indices of Round Two Objectives 55
5. Final Round Objectives: Top 33 1/3 Percentile Rankings . . 56
6. Subgroup Indices of Round Three Objectives 59
7. Comparative Intra-Round Rating Convergence: Overall . . . 59
8. Round Two-To-Round Three Rating Convergence: By Subgroups of Round Three 60
9. Comparative Inter-Round Rating Agreement 61
10. Goal Programming Objectives With Associated Priority and Achievement Levels 65
11. Goal Programming Model - First Run Results 67
12. Goal Programming Model - Second Run Results 69
13. Comparison of Results - Net Change in Enrollment Levels . . 72
14. Resulting Deviations From Specified Achievement Levels . . 75

LIST OF ILLUSTRATIONS

Figure

1. Frequency Distribution of the Mean Ratings for Round One 51

2. Frequency Distribution of the Mean Ratings for Round Two 54

3. Frequency Distribution of the Mean Ratings for Round Three 58

A DECISION ANALYSIS MODEL FOR ADULT EDUCATION PROGRAM PLANNING AT THE VOCATIONAL LEVEL

CHAPTER I

INTRODUCTION

We are living in an age in which there is an ever increasing awareness that our resources and raw materials are neither expendable nor inexhaustible. As the demand for various products and services continues to rise we face the stern realization that efficiency, productivity, and parsimony become major concerns given the depleting inventory of supplies and reserves.

The reflection of these concerns in the educational environment is manifest in terms such as accountability, performance based education, and return-to-basics. In this milieu, the educational decision maker is confronted with the task of making the best possible decisions using the resources at hand, a process that is further compounded by the internal and external constraints placed upon the institution. Indeed, the criterion for excellence of an educational administrator is most often based on his or her ability to select an appropriate course of action from a seemingly endless array of variables and alternatives. In reality this decision maker is then, one who attempts to optimize the attainment of a set of goals while functioning in a realm of conflicting interests, incomplete

information, limited resources, and having limited ability to analyze the complex environment.[1]

In the decision making arena there is no substitute for human judgement.[2] However, as the quantity and magnitude of the variables and constraints that influence goal attainment increases, human objectivity becomes increasingly difficult.[3] Consequently, this condition has lent impetus to the pursuit of reliable and tractable means to aid the decision maker in the decision making process. A number of quantitative tools, such as PERT, CPM, stochastic processes, and Linear Programming, have in recent years been adapted to the domain of educational program planning in an attempt to achieve these results. Yet, some have expressed concern that these techniques either tend to oversimplify a complex process, or otherwise they are coldly inhuman, and thus insensitive to the dynamics of the decision making environment. Though some of this criticism may in fact be warranted, this expression is often more of an indictment against the use, or abuse, of the results obtained from using the tools, than it is of the tools themselves.[4] It may indeed be axiomatic to state that optimum results could be achieved by judiciously blending the human

---

[1]Sang M. Lee, Goal Programming for Decision Analysis (Philadelphia: Auerbach Publishers, Inc. 1972), pp. 9-10.

[2]James F. McNamara, "A Mathematical Programming Approach to State-Local Program Planning in Vocational Education," American Educational Research Journal 8 (March 1971):337.

[3]Ronald A. Howard, "An Assessment of Decision Analysis," Operations Research 28 (January-February 1980):6.

[4]Ibid., pp. 21-22.

elements of insight and intellect, with a suitable set of analytical tools to formulate a systematic decision making process.[5]

Administrators of vocational education programs across the United States are confronted not only with many of the more traditional kinds of decision analysis situations, such as budget planning and resource allocation, but they must also satisfy the many constraints that relate to the unique mission of their member institutions. The viability of these programs is dependent upon such factors as the manpower requirements of society, the need to support state and local economics, and the ability to deliver an intensive educational package in a relatively short period of time.

In vocational education, as in all facets of education, there exists an ever present need to reduce the degree of subjectivity in the decision making process. This problem becomes especially acute when the administrator is tasked with assigning values to variables while facing multiple, and sometimes conflicting, objectives.

Linear Programming models have been used extensively in vocational education program planning as a quantitative decision making tool to aid in this process.[6] Unfortunately, these models are restricted to optimizing the achievement of a single objective under a given set of conditions, without regard to the simultaneous accomplishment of any other objectives. Thus the Linear Programming approach

---

[5]James P. Ignizio and Jatinder N. D. Gupta, Operations Research in Decision Making (New York: Crane, Russak & Co., 1975), pp. 3-4.

[6]Robert C. Young, Stanley Zients and Albert B. Bishop. Linear Programming for Vocational Education Planning (Columbus, Ohio: ERIC Document Reproduction Service, ED 902754, 1973), pp. 11-16.

falls short of accurately modeling the true decision making situation in the vocational education environment for all but the single objective decision making situation. However, a more recent Operations Research technique, known as Goal Programming has been developed which will allow the decision maker to model multiple objective problems and thus emulate the decision making environment in more realistic terms.[7]

Problem Statement

This research was directed toward determining a set of factors that guide the decision making process for adult vocational education program planning at the state-level of planning. These data provided the framework for developing and testing a multiple objective decision model. More specifically, answers to the following questions were sought:

1. What goals, constraints, and parameters enter into the decision making process of the state-wide level of program planning for full-time adult vocational education?
2. What priority structure would state-level decision makers assign to the identified goals?
3. How may these data be applied in a Goal Programming model designed to yield an optimum program mix?

Definitions

The below listed definitions applied to this research:

Goal Programming: a multiple objective decision model composed solely of linear functions.[8]

---

[7]James P. Ignizio, Goal Programming and Extensions (Lexington: D. C. Heath and Company. 1976), pp. 1-2.

[8]Ibid., p. 2.

Constraint: a quantifiable objective that represents an absolute limit or requirement.

Goal: a quantifiable objective that represents a desired, or nonabsolute, limit or requirement.

Decision Variables: the set of variables which are manipulated in the solution process of the Goal Programming model. In this study the number of students from each program type was selected as the decision variables.

Parameters: are constants that express the relationships between the decision variables. These are determined from data on the actual operation of the system being modeled.[9]

Full-Time Adult Vocational Education Program: a program designed primarily for youths or adults who have completed or left high school and who are available for an organized program of study in preparation for entering the labor market.[10]

Decision Analysis: is the process concerned with helping individuals make decisions. This process consists of a theoretical paradigm for decision making and a body of practical experience for using this paradigm to illuminate the decision problem for the decision-maker.[11]

Limitations of the Study

The scope of this study was limited to planning for full-time adult education programs at the vocational level within the state of Oklahoma. Although the part-time adult vocational education programs represent a vital part of comprehensive adult education, these programs were not included in this study due to the aperiodic and episodic nature of these programs within the state at the time of this study.

---

[9]Allen Hammond, Mathematical Models in Education and Training (Santa Monica: Rand Corp., [1970]), p. 7.

[10]Oklahoma State Department of Vocational and Technical Education, FY 1979-80 Cost Per Program Report of Area Vocational-Technical Schools (Stillwater: Oklahoma State Department of Vocational and Technical Education, 1979), p. 1.

[11]Howard, "An Assessment of Decision Analysis," p. 6.

The research population was specified to be those individuals who could have direct input into the decision making process of adult education program planning at the vocational level within the state of Oklahoma.

This study was further limited by the mathematical restrictions placed upon the Goal Programming model itself. These included:

1. Linearity: each objective function must be expressed as having a linear mathematical relationship to the associated decision variables. For instance, if it costs 'x' dollars to educate one adult student from a given program type, then it would cost '2x' dollars to educate two such students.

2. Divisibility: non-integer decision variables may be allowed in the solution.

3 Deterministic: the parameters of the model are known constants.

Assumptions

It was assumed that preemptive priority indices could be established at an ordinal level for each objective or group of objectives by the program planners for adult vocational education within the state of Oklahoma. By extension it was assumed that all objectives could be stated in quantifiable terms even if the goals themselves were somewhat subjective in nature.

Remaining assumptions related to the ability to structure a linear goal programming model for adult vocational education given the mathematical limitations imposed on the model as stated above. These

restrictions were not considered to be binding on the design of the model for the following reasons:[12]

1. Linearity: The goals in this model could not, by design, be boundless. Each goal was then in effect piecewise, thus limiting the deleterious affect of any higher order components that may have been present.

2. Divisibility: A non-integer decision variable in the final solution was rounded to the nearest whole unit.

3. Deterministic: The Oklahoma State Department of Vocational-Technical Education maintains a comprehensive data base from which parameter data were evoked for use in the model.

Research Design

Data Collection

The procedure for collecting data to be used in the design of the model was twofold. The initial data collected were related to the determination of a prioritized set of goals and constraints. Using this information, parametric data were then amassed.

A procedure known as the Delphi Technique was used to elicit the first set of data from a select group of state and local vocational education administrators. Based upon a recommendation offered by the Planning Division of the Oklahoma Department of Vocational and Technical Education, panel participation from the following individuals, or their appointed surrogates, was solicited:

---

[12]Ralph A. Dusseldorp et al., "Applications of Goal Programming to Education," paper presented at the 14th Annual International Convention of the Association for Educational Data Systems, Phoenix, Ariz., 3-7 May 1976.

1. State Director for Vocational-Technical Education
2. Planning Coordinator for the Department of Vocational-Technical Education
3. State Coordinator of Area Schools
4. Director of Adult Education-State Department of Vocational-Technical Education
5. Comptroller of Financial Services-State Department of Vocational-Technical Education
6. Superintendant of an Area Vocational-Technical School (AVTS)
7. Director of Adult Education from an Area Vocational-Technical School

A set of goal and constraint statements was compiled from the review of the literature. Collectively these statements, along with a seven-point Likert rating scale for each objective, formed the basis of an initial data gathering instrument used in the first round of the Delphi Technique.

The first round was preceded by a pilot survey to obtain constructive feedback concerning revisions needed to improve content and face validity of the instrument. A group of students enrolled in a graduate level course in Adult Education was asked to complete the instrument given the scenario that they were administrators responsible for making decisions relevant to full-time adult vocational education program planning at the state-level of administration.

The Delphi Technique

The Delphi Technique was used to establish the set of

constraints and goals, along with the associated priority structure, for adaption to the Goal Programming model. This procedure called for the use of three data collection iterations to elicit perceptions from the panel of decision makers, whose individual identities remained anonymous to cohort panelists throughout the study.

Each successive round of the process yielded a set of judgements relating to the perceived relative importance of the individual objective statements. The desired outcome of this process was to obtain a set of ordinally ranked objective statements for adult vocational education program planning at the state-level that could be suitably translated into quantifiable terms.

The data collected from Round One consisted of the ratings, of each objective statement, along with any write-in objectives that any particular panelist perceived as being important to adult vocational education. On the second and third iterations each panelist was given the composite results of the preceding round and asked to assign new ratings. If a respondent gave a rating to a particular objective in Round Two that was above or below the composite mean of that same objective, as computed from Round One, that panelist was asked to briefly state the rationale for assigning this rating. Summarizations of these comments were supplied in the Third Round as part of the instrument so that each decision maker could gain a broader perspective of the various ramifications of a particular objective before selecting a final rating.

Further analysis of the data from each round of the Delphi Technique was aided by computing the standard deviation of the ratings

assigned to each objective statement. The convergence pattern of the individual objective statements was then examined by comparing the standard deviations of the ratings of a particular objective across rounds to detect the relative degree and direction of convergence of those ratings over the successive iterations of the process. Inter-round rating agreement was determined by computing Spearman's rho.

The composite ratings of the third round were used for assigning ordinal rankings to the various goals and constraints. These rankings were then used to establish the preemptive priority structure required to implement the Goal Programming model.

Parameter Data

The objective set deduced form the Delphi Technique determined the kinds of parameter data required to complete the design of the Goal Programming model. These values were esolated from data sources within the Oklahoma State Department of Vocational-Technical Education, with the primary source being the comprehensive computer data base that is maintained by this agency. Only parametric data that could be related to each program area type were selected for constructing the model.

The Model

The Goal Programming (GP) model employed in this study, is an Operations Research tool that belongs to the broader classification of mathematical programming models. The major advantage of this model over the older Linear Programming (LP) model is its ability to derive

an optimum solution mix under the consideration of a multiple set of prioritized goals and constraints. The GP model further has the ability to permit multiple goals to be expressed at the same priority level and then be assigned preferential weights within that level.[13] This option was not, however, applied to the model of this study.

The structure of the model consisted of a set of objective functions, which were linear mathematical expressions of the various goals and constraints; and an achievement function which, when minimized by manipulating the decision variables, yielded an optimum solution with respect to the prioritized set of objective functions. The achievement function was optimized when a student mix was found that resulted in the minimization of the amount of directed deviation away from the specified objectives. The model forced a solution that would result in a minimization of the deviation from the highest priority objective (g_1) first, the next highest priority objective (g_2) second, and so on down through the lowest priority level (g_k), until an optimum solution mix was found. In this manner, g_n was completely satisfied before g_{n+1} and all lower order priority levels in reaching the desired solution. The objectives themselves were considered as either constraints, whose achievement were absolute and thus assigned to priority level one, or as goals which represented desired levels of attainment thus being assigned to lower priority levels corresponding to the predetermined ordinal rankings.

---

[13] Ignizio, Goal Programming, 5-7, 181-185.

Organization of the Report

The report of this study was formatted into five chapters. This first chapter provided a succinct introduction of the background leading to the stated problem that was covered by this research. Following this, clarification was provided of the operational definitions used herein, the limitations and assumptions of the study, and finally a brief description was given of the structure of the research procedure used to address the stated problem.

A review of the related literature was recorded in the following chapter to provide clarification of the theoretical and practical bases of planning and decision making in general, and the application of these bases to adult vocational education in particular. This information gave perspective to this research, as well as providing a resource pool of adult vocational education objectives that were later used to design the initial data collection instrument of the Delphi Technique.

In Chapter III, a detailed description was given of the research methodology that was followed to seek answers to the questions posed in the problem statement. The discussion recounted both the procedure used to collect the data from which the model was developed and the design and testing of the model itself.

Chapter IV related the results of the study. The outcome of the Delphi Technique, the initial design of the model, the collection and adaptation of the parametric data to the form required by the

model, and the final design and test results of the model were presented in this chapter.

Chapter V presented a consolidation of the research summary, the conclusions that were drawn from the results, and the recommendations that were given for both the application of these research findings to an operational environment, and for follow-on research that would enhance the broader realm of adult education planning and decision making.

CHAPTER II

LITERATURE REVIEW

Introduction

A review of the literature was conducted to examine the theoretical and practical bases of planning and decision making. Specific emphasis was given to the consideration of adult vocational education planning and decision making from both a process and a product orientation. Existing decision models in adult and vocational education were inspected for the purpose of (1) contrasting and comparing these models to the model represented by this research, and (2) providing a resource base of adult vocational education objectives to be used in the development of the initial data collection instrument.

Planning and Decision Making

With the expanding complexity of the American educational system over the years there has been a corresponding need for more reliable and systematic ways of developing plans and making decisions.[1] In response to this concern an approach known as the "systems concept" was borrowed from the physical sciences and adapted to the behavioral sciences. A system, in the simplest of terms, may

[1]Joseph E. Hill, How Schools Can Apply Systems Analysis (Bloomington: Phi Delta Kappa Educational Foundation, 1972), p. 1.

be defined as an assemblage of elements having a functional interrelationship. Thus by extension, the systems concept refers to the perception of an assemblage of elements as a system.[2] By viewing the educational process as one consisting of a set of elements, or subsytems, which are linked by a complex network of interactions, both among themselves and with the larger suprasystem known as the environment, it becomes possible to apply the tools of conventional systems theory to educational planning and decision making. This situation represents a specific application of the technique called systems analysis.

When the systems analysis approach involves the steps of developing a model of the system, then performing the analysis using the model, and finally recommending a decision using the information supplied by the model, then this process is known as "decision analysis."[3] The neologist who coined the term, describes decision analysis as

> A process that enhances effective decision making by both logical,systematic analysis and imaginative creativity.[4]

The ultimate purpose of decision analysis is to illuminate the decision problem for the decision maker in such a way that insight

---

[2]Ibid., pp. 9-13.

[3]Robert C. Nickerson and Dean W. Boyd, "The Use and Value of Models in Decision Analysis," Operations Research 28 (January-February 1980): 140.

[4]Howard, p. 4.

is gained to facilitate natural decision processes.[5] Thus applications for decision analysis may be found in education, business, industry, government, or any such complex organizational system, or subsystem, that is conformable to the steps describing this process.

The utilitarian value of systems analysis procedures in educational planning and decision making is now widely recognized. According to Hill, systems analysis is

> rapidly becoming the nucleus of decision making in the highly complex world that is developing in the age of automation and cybernetics.[6]

To this, Hill adds the admonishment that:

> Educators without at least a general knowledge of the (systems)concept are not only at a great disadvantage in understanding many aspects of the world today but will, in a relatively few years, find themelves highly limited in their professional fields.[7]

Knowles conveyed similar sentiments to those involved in comprehensive adult education program planning, expressing that it would "be wise for every adult-education institution to locate a resource specialist in systems analysis and bring him into a consultative relationship."[8]

Not only is it essential to view the educational organization as a complex system, but it is similarily important to perceive the planning process itself as a planning system. One such system for planning vocational education in the state of Missouri identified five interdependent subsystem components as:

---

[5]Ibid., pp. 6, 9.

[6]Hill, Systems Analysis, P. 7.

[7]Ibid.

1. Strategic planning and policy determination
2. Administrative planning
3. Management information system
4. Decision-making support system
5. Evaluation system[9]

The components of this planning system are closely allied to those of the widely used Program Planning and Budgeting System (PPBS). This relationship becomes evident when the aims of the PPBS method are examined. Succinctly these aims may be stated as:

1. the identification of the major objectives of a program-plan
2. defining the programs that can effect planned goals
3. the identification of human and financial resources as specified by the requirements of the objectives
4. performing a systematic analysis of the options available[10]

Although PPBS utilizes the mathematical analysis procedures of Operations Research in the decision process, it is in reality, more of a planning mechanism than a specific problem solution oriented tool.[11]

---

[8]Malcolm S. Knowles, The Modern Practice of Adult Education: Androgogy versus Pedagogy (New York: Association Press, 1970), P. 264.

[9]Jim W. Atteberry, William R. Miller, and James A. Pershing, Improving Vocational Education Planning: More Myth Than Reality?, Final Report. (Columbia: Department of Practical Arts and Vocational-Technical Education, University of Missouri, [1977]), p. 5.

[10]Hill, Systems Analysis, P. 9.

[11]Ralph A Van Dusseldorp, Duane E. Richardson and Walter J. Foley, Educational Decision-Making Through Operations Research (Boston: Allyn and Bacon, Inc., 1971), pp. 134-135.

The Planning Hierarchy

It is also possible to classify the planning process according to the degree of specificity of the planning purpose. This method of classification results in a planning hierarchy wherein the breadth of a particular planning level corresponds to the level of decision making responsibility assigned to an administrator, supervisor, or department head within the organizational hierarchy.[12]

Bearly suggests a three-tiered planning hierarchy consisting of strategic planning, management control, and operational control where

> Operational control is the process of assuring that specific tasks are carried out effectively and efficiently...Management control is the process by which managers assure that resources are obtained and used effectively and efficiently in the accomplishment of the organization's goals....(And) strategic planning is the process of deciding on the goals of the organization, or changes in these goals, and on the policies that govern the acquisition, use and disposition of these resources.[13]

In a Vocational Education context, Atteberry, Miller, and Pershing have defined strategic planning as

> The process of developing plans that deal with broad matters which affect the direction of the vocational education system.[14]

And administrative planning for Vocational Education has been defined as

> planning which deals with the development of operational plans that guide the vocational education system in the use

---

[12]William Bearley. Why Systems Fail (Bethseda, Md.: ERIC Document Reproduction Service. ED 167,117,1979), p. 3.

[13]Ibid., pp. 3-4.

[14]Atteberry, Miller and Pershing, p. 7.

> of resources so that the goals of the system are accomplished.[15]

When used in this context, administrative planning bears the same features as the process of management control as defined above. Thus these terms appear to be functionally synonomous.

Atteberry, Miller, and Pershing further acknowledge that strategic planning and policy determination have received little attention in the literature on vocational education planning.[16]

Strategy Planning and the Delphi Technique

The Delphi concept evolved from an Air Force-sponsored Rand Corporation study, in the early 1950's, concerning the use of expert opinion. This initial study, known as "Project Delphi," involved the application of "expert opinion to the selection, from the view point of a Soviet strategic planner, of an optimal U. S. industrial target system and to the estimation of the number of A-bombs required to reduce the munitions output by a prescribed amount."[17]

Linstone and Turoff describe the Delphi Technique as:

> A method for structuring a group communication process so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem.[18]

These writers further identify four distinct phases of the process where:

---

[15]Ibid., p. 13.

[16]Ibid., p. 8.

[17]Harold A. Lindstone and Murry Turoff, eds., "Introduction," in The Delphi Method: Techniques and Applications (Reading: Addison-Wesley Pub. Co., 1975), p. 10.

[18]Ibid., p. 3.

> The first phase is characterized by exploration of the subject under discussion, wherein each individual contributes additional information he feels is pertinent to the issue The second phase involves the process of reaching an understanding of how the group views the issue (i.e., where the members agree or disagree and what they mean by relative terms such as importance, desirability, or feasibility). If there is significant disagreement then that disagreement is explored in the third phase to bring out the underlying reasons for the differences and possibly to evaluate them. The last phase, a final evaluation, occurs when all previously gathered information has been initially analyzed and the evaluations have been fed back for consideration.[19]

The Delphi procedure may be further characterized by three basic features:

1. Anonymous responses, a factor that is considered as an advantage over face-to-face meetings where disagreements among individuals are potentially severe or politically unpalatable
2. Iteration and controlled feedback, which makes the process "time and cost efficient" in cases where frequent group meetings are infeasible
3. Statistical group response, a condition that allows for the translation of subjective judgements of individuals into an aggregate group opinion[20]

---

[19]Ibid., pp. 5-6.

[20]Paul Frederick Fendt, "Alternative Futures for Adult and Continuing Education in North Carolina: A Delphi Futures Planning Study," paper presented at the First Meeting of the Education Section of the World Future Society, Houston, Texas, 20-22 Oct. 1978.

These basic features have allowed the Delphi Technique to evolve as an important tool for establishing educational goals.[21]

Operations Research

The strategic and tactical exigencies of World War II gave birth to the process known as Operations Research (OR). Actually, Operations Research does not describe any particular decision analysis model but instead it can be thought of as a research process that may be used to complement such human aspects of decision making as intuition, insight, and judgement.[22] Churchman, Achoff and Arnoff express the OR process as consisting of six distinct phases. These include:

1. Formulating the problem
2. Constructing a mathematical model to represent the system under study
3 Deriving a solution from the model
4. Testing the model and the solution derived from it
5. Establishing controls over the solution
6. Putting the solution to work: implementation[23]

When used as a decision analysis tool, the OR process would require a

---

[21]Ray L. Sweigert, Jr. and William H. Schabacker, "The Delphi Technique: How Well Does It Work in Setting Educational Goals," paper presented at the Annual Meeting of the American Educational Research Association, Chicago, Ill., April 1974.

[22]Ignizio, Goal Programming, p. 3.

[23]West Churchman, Russell L. Achoff and E. Leonard Arnoff, Introduction to Operations Research (New York: John Wiley & Sons, Inc., 1957), pp. 12-13.

close working alliance between the decision maker and the decision analyst to achieve valid results in the end.[24]

Ignizio and Gupta describe the underlying philosophy of Operations Research as a combination of the scientific method and the systems approach. The conjugation of these techniques thus results in a research process that attempts to take a logical, systematic, and objective view of the decision problem in its total environment.[25]

Decision Making - The Process and Product Relationship

The literature reviewed to this point addressed primarily the process aspect of planning and decision making. The process itself would, however, have little intrinsic value if there were no useful outcome resulting from the application of the process. The desired end result of the planning and decision making process is then, an acceptable decision which is best for the organization as a whole. Thus, a decision which meets this criterion is said to be an optimum decision; and a decision which is best relative to the functions of one or more parts of the whole organization is called a suboptimum decision.[26]

To accent the relationship between the process and product of decision making, Shull, Delbecq, and Cummings express decision making as

> A conscious and human process, involving both individual and social phenomena, based upon factual and value premises, which concludes with a choice of one behavioral

---

[24]Howard, P. 6.

[25]Ignizio and Gupta, Decision Making, pp. 10-11.

[26]Churchman, Ackoff and Arnoff, p. 6.

> activity from among one or more alternatives with the intention of moving toward some desired state of affairs.[27]

This definition describes a process that results in a product where selection of the product is made on the basis of reaching some desired goal. Howard tersely states that "decision making is what you do when you don't know know what to do."[28]

The "figure-of-merit" in decision technology is established by the degree to which organizational goals are achieved by the decision. Therefore, the outcome of the strategic planning process identifies the organizational goals that in turn provide the foundation for the need of a decision.[29]

A number of tools are offered by the Operations Research Method, for aiding in the decision making process whenever the decision maker is faced with a bewildering array of alternatives. These tools are actually mathematical models that range in complexity from relatively simple rule-of-thumb, or heuristic, models to highly sophisticated dynamic simulation models.

Decision Models

When considering an organization as a nomothetic structure, the systems concept is applicable. Thus the systems approach describes a manner of conceptualizing reality and this conceptualization process is called modeling.[30]

---

[27]Fremond A. Shull, Jr., Andre' L. Delbecq, and L. L. Cummings, Organizational Decision Making (New York: McGraw-Hill, Inc., 1979), p. 31.

[28]Howard, p. 5. [29]Lee, P. 7.

[30]Dussledorp, Richardson, and Foley, P. 4.

Models can be broadly classified as one of three basic types:

1. The iconic model is a pictorial or physical representation of the system.
2. The analog model is a method of representing one system by another wherein the properties of a familiar system are used as an isomorphic representation of the other.
3. The symbolic model is a "formula" representation resulting from the employment of symbols to designate properties of the system under study.[31]

Each of these model classifications can be further subdivided according to various grouping schemes. For instance, mathematical models are one subclassification of symbolic models, the mathematical programming models are a subset of the mathematical models, and Goal Programming models represent elements of the set comprised of all mathematical programming models. The Operations Research technique, as previously noted, is characterized by the use of mathematical models to depict a real-world counterpart.[32]

It is also important to distinguish between the purpose for modeling a system and the classification of the model used to represent that system. When a model is developed for the purpose of representing the total decision making process it is known as a

---

[31]Joseph E. Hill and Augut Kerber, Models, Methods, and Analytical Procedures in Educational Research (Detroit: Wayne State University Press, 1967), p. 15.

[32]Donald R. Plane and Gary A. Kochenberger, Operations Research for Managerial Decisions (Homewood: Richard D. Irwin, Inc., 1972), p. 4.

decision model.[33] This term within itself, however, does identify the type of model used to emulate this process.

There are a variety of decision model types that have come to be identified with Operations Research. Some of the more common of these include:

1. Heuristic Models- refers to the class of models that derive decisions based on the use of a rigorous set of rules or guidelines.

   These models are primarily selected because of their relative simplicity, but they cannot of themselves insure optimum decisions.[34] Simple funding formulas, often used in educational decision making, qualify as heuristic models.

2. Games- involve decision making strategies within a competitive environment. This type of model is often used in military and marketing contexts.[35]

3. Networks- may be thought of as a special type of system composed of elements, where the elements in turn consist of nodes and branches. The problems solved by the use of these models may be classified as: (1) obtaining the minimal path through the system; (2) obtaining the maximal path through the system, or (3) finding the

---

[33]Ignizio, Goal Programming, P. 1.

[34]Atteberry, Miller, and Pershing, pp. 44-45

[35]Hammond, p. 6.

maximal capacity of flow through the system.[36] The Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT) represent two types of network models.

4. Inventory Models- are used primarily in a production environment for determining how many units to produce, when to produce them, required inventory levels, and like matters.[37]
5. Oueing- or waiting line models find application with problems involving waiting and delay in serving people, machines, or materials.[38]
6. Sequencing- deals with the order in which objects are placed. These models usually attempt to characterize problems concerning the sequence which will maximize the output or minimize the idle time of a production process.[39]
7. Scheduling- provides an assignment of arrival times in those systems in which variations in schedules will affect waiting times, idle times, and system output.[40] These models are closely related to queing and sequencing models.

---

[36]Ignizio and Gupta, Decision Making, p. 139-140.

[37]Ibid., p. 18.

[38]Ibid., p. 239.

[39]Ibid., p. 19.

[40]Ibid.

8. Mathematical Programming Models- represent a general class of decision models whereby some criterion of effectiveness, known as the objective function, is maximized or minimized subject to a set of constraints or goals. Linear Programming, Integer Programming, Dynamic Programming, Goal Programming, and the like, are all subclasses of this type model.[41]

Linear Programming Models

These models are designed to derive an optimal solution for a single objective in a condition where one or more constraints restrict the degree to which that objective may be attained. The constraints of this model are stated as linear mathematical functions of the variables that are manipulated. The Linear Programming problem of most organizations is that of allocating scarce resources among alternate choices so that the overall benefits are maximized, or, the total costs are minimized.[42]

Goal Programming Models

Unlike its Linear Programming predecessor, the Goal Programming technique provides the ability to model conditions where it is necessary to derive an optimal solution in a multiple objective environment. By further contradistinction to the Linear Programming models, in which a single objective is either maximized or minimized

---

[41]James F. McNamera, "Mathematical Programming Models in Educational Planning," Review of Educational Research 41 (December 1971): 421-422.

[42]Atteberry, Miller and Pershing, pp. 34-35

subject to the restriction of a set of linear constraints, the Goal Programming technique consists of an achievement function which is always minimized, and a corresponding set of linear goal and constraint equations. In addition to the decision variables, there are two deviation variables associated with each goal and constraint: one representing the degree of underachievement of a given objective, and the other representing the amount by which that same objective is overachieved. The achievement function is formulated from an ordered collection of these deviation variables so as to indicate an optimum solution whenver a unique combination of decision variables causes this functon to result in a minimum value.[43]

An additional characteristic of the Goal Programming approach is its ability to derive an optimal solution based on a priority ranking, by the decision maker, of the various goals and constraints that influence the decision problem. This ranking of objectives allows the model to seek an optimal solution by minimizing the objective deviations, giving priority for minimization to objectives of higher priority levels first. In this way an objective is said to preempt another objective of a lower priority ranking.[44] Given this structure, the true constraints of the decision field are called absolute objectives and are assigned to priority level one. The goals representing desired levels of attainment, or non absolute objectives, are subsequently assigned to lower priority levels corresponding to the predetermined ordinal rankings.

---

[43]Ignizio, Goal Programming, pp. 12-18.

[44]Lee, p. 27.

Any effective model for decision analysis must be capable of reflecting the administrator's judgement about the priority of desired goals within the constraints of the existing situation.[45] The Goal Programming procedure, as noted above fulfills this condition. In answer to the concern some would voice over ordinally ranking the objectives in the model, Lee replies:

> under normal circumstances the decision maker is not capable of measuring precisely how much more important the first goal is than the second in cardinal value. Often the only knowledge the decision maker has is that in his judgement, a first goal is more important for the organization than a second goal. Hence, a preemptive priority structure in terms of ordinal ranking of goals is the more appropriate vehicle for decision analysis.[46]

Another problem that typically arises in the design of the model is that of determining the number of priority levels to be considered. Ignizio addresses this concern stating that

> in practice, it would be rare for a well constructed real life problem to have more than even five priority levels....A problem with more than five priority levels, although possible, should be suspect.[47]

Related Research

This review of related research was directed primarily toward comprehensive planning and decision making as it has occurred in adult vocational education.

---

[45]Ibid., p. 281.

[46]Ibid., p. 34.

[47]Ignizio, Goal Programming, p. 182.

Strategic Planning

From 1975 to 1977, a comprehensive "systems" model for planning vocational education in the state of Missouri was developed and tested. Among other findings of this research, was the discovery that there existed a paucity of literature on vocational education in the area of strategic planning and policy determination.[48] The research team, known as Task Force 1990, found that what planning was done, was that needed to comply with the state planning requirement of federal vocational education legislation; and even in these cases it was found

> that the State Plan itself was not adequately used to guide the vocational education system but served primarily as a document to satisfy federal requirements.[49]

One phase of the Task Force 1990 study resulted in the research conducted by Elbert for a doctoral theses.[50] In his study, members of a group of vocational advisors and a group of vocational administrators were asked to rate seven clusters of elements in vocational education, in the state of Missouri, by perceived importance. Using an instrument having a five-point Likert scale and analysis of variance techniques, Elbert found that, although the overall rating of the majority of the elements ranged from important to essential, a significant difference in ratings existed between the

---

[48]Atteberry, Miller and Pershing, p. 8.

[49]Ibid., p. 14.

[50]Dennis J. Elbert, "Elements in Missouri's Vocational Education System" (Ph. D. dissertation, University of Missouri, 1976), p. 126.

two groups. In addition, the test of the null hypothesis between subgroup ratings of each of the two groups resulted in significance.[51] Comparing these results it would appear that the findings of this research are somewhat inconclusive due to the spread of the intragroup variances. Elbert further acknowledged that a few participants, "primarily from the advisory group, indicated that they did not feel adequately prepared to answer the questions or did not know why they were selected."[52]

The controversial question concerning what the objectives of vocational education should be is not a new one. Becker recounts John Dewey's discontent with the objectives then established for vocational education by a newly appointed Commission on National Aid to Vocational Education.[53] The objectives established by this commission, which ultimately led to the passage of the Smith-Hughes Act, were (1) the need of a substitute for the disappearing apprenticeship system, (2) to meet the demand of employers for more skilled workers, and (3) the need for special training if the U. S. was to hold its own in interational competitive commerce.[54] By contrast Dewey viewed these objectives as too provincial suggesting that instead the objectives of vocational education should be

> to promote equality of opportunity, to teach the real meaning of work, to inculcate a sense of culture related to today's world, to develop a spirit of social cooperation, and to help students grow in industrial intelligence.[55]

---

[51]Ibid., pp. 91-96. [52]Ibid., p. 99.

[53]Richard J. Becker, "What Are the Objectives of Vocational Education?" Phi Delta Kappan 61 (April 1980): 534.

[54]Ibid. [55]Ibid., p. 535.

This concern over education versus training, as an objective framework for vocational education, is still a focal point for much discussion and division.

Houle eschews what he calls the "welfare" theme for adult education in general, stating that:

> Many people seem to believe that learning in adulthood is essentially the effort to give a second chance for basic education to those who missed their first chance or that it is concerned solely with such goals as occupational competence for the unemployed, family life improvement for threatened homes, or consumer skills for poor people. This conception of adult education as solely an activity of a welfare state or of private charity limits its scope and narrows its range of designs....For example...A public school system may offer literacy and vocational courses but never try to educate those community leaders who determine the major social policies of the city.[56]

For the most part, the literature and research conducted in comprehensive adult vocational education planning and decision making, as examined during this research, provided little documentation regarding why or how a particular objective or set of objectives were selected for designing the various decision models. In many of these cases, it appeared as though the objectives were established de facto by the researchers themselves.

In 1974, the Oklahoma State Department of Vocational and Technical Education designed and tested a Linear Programming decision model. This model sought to determine the optimum number of each vocational education program type that would be needed to achieve the

---

[56]Cyril O. Houle, The Design of Education, (San Francisco: Jossey-Bass Publisher, Inc., 1972), pp. 27-28.

goal of (1) maximizing employment entry level wages, (2) maximizing job placement, (3) minimizing program costs, (4) maximizing students served, or (5) maximizing social benefits.[57] Although no rationale was provided for indicating how these particular objectives were chosen over all others, it was concluded that the procedure itself gained general acceptance by the decision makers who had the opportunity to analyze its benefits.[58]

Kim suggested the use of five target goals for the purpose of establishing a cost-effectiveness/benefit analysis model for vocational programs at the post-secondary level. These goals included:

1. Students will be enrolled in the post secondary occupational program to meet their educational needs.
2. Students enrolled in the post secondary occupational program will complete the requirements of the program and be prepared for career development.
3. Program completers will be placed according to their training in jobs which will meet manpower demands.
4. Some students will elect advanced studies after completion of the program.
5. Program completers will increase their job satisfaction, status, and economic benefits.[59]

For the research conducted in the design of a Missouri planning model for vocational education, a prioritized set of eight

---

[57]Oklahoma State Department of Vocational and Technical Education, The Development and Testing of a Linear Programming Technique for Optimizing Occupational Training Program Combinations (Stillwater: Oklahoma State Department of Vocational and Technical Education, 1974), p. 3.

[58]Ibid., p. 30.

[59]Jin Eun Kim. A Cost-Effectiveness/Benefit Analysis Model for Postsecondary Vocational Programs (Bethseda, Md.: ERIC Document Reproduction Service, ED 151 560, 1977), p. 16.

objectives was used. In rank order, from highest to lowest priority, these objectives were listed as:

1. To train no more students in an occupation than there are projected job openings.
2. To increase the number of program completers placed in training related occupations by ten percent over the previous year.
3. To increase the number of program completers to 24,000 students.
4. To limit the expenditure on vocational education in the state to the resources available.
5. To increase the labor force participation of vocational education completers by ten per cent over the previous year.
6. To increase the number of disadvantaged students served by ten percent over the previous year.
7. To limit vocational enrollments to fifty percent of secondary 11th and 12th grade students in the state.
8. To increase the number of program completers continuing their education by ten percent over the previous year.

From this set of objectives, items one, four, six and seven were recognized by the researchers to be constraints and the remaining items were treated as goals.[60]

Evans emphatically states that "there are three basic objectives in any public school vocational education curriculum."[61] In the chronological order of their acceptance, he lists these as:

1. meeting the manpower needs of society
2. increasing the options available to each student

---

[60]Atteberry, Miller and Pershing, p. 91.

[61]Rupert N. Evans, Foundations of Vocational Education (Columbus: Charles E. Merrill Pub. Co. 1971), p. 2.

3. serving as a motivating force to enhance all types of learning[62]

Evans further states, however, that "surprisingly little is known about student objectives in vocational education programs," pointing out that students in many cases may participate in a vocational program to satisfy a strong avocational interest.[63]

The propriety of using the Delphi Technique for establishing educational goals was examined in a Georgia study. This study used nonparametric statistical techniques to test for (1) convergence in perception over rounds, (2) greater convergence on the second round than on later rounds, (3) the reliability of the goal rankings, (4) the necessity of at least three rounds, and (5) the desirability of feedback of self response to participants. The first three assumptions were confirmed and the last two were shown to be questionable.[64]

Fendt used the Delphi Technique in an attempt to evolve and test a futures planning methodology and generate useful program planning data to help meet the needs of adult part-time students. The three round Delphi Technique that was used yielded panel concensus in the primary areas of concern for adult and continuing education from four groups of panelist. These groups consisted of adult education faculty members, members of the state legislature and officials of state and private universities, members of university extension

---

[62]Ibid.

[63]Ibid., p. 4.

[64]Sweigert, Jr. and Schabacker, p. 14

divisions and continuing education departments, and continuing education students.[65]

Decision Making Models

A number of mathematical programming models have been designed for decision making in vocational education. The majority of these models are of the Linear Programming (LP) type.

In the Oklahoma model, five vocational education objectives were selected and optimized, subject to the constraints of the Linear Programming model.[66] Since the Linear Programming technique will not permit simultaneous considerations of multiple objectives, each objective in this model had to be optimized on an individual basis. Thus five separate decision sets resulted instead of a single decision set based on concurrent consideration of all objectives. The range of the derived decisions from this model can be seen by comparing the results of optimizing the various objectives. One example of this is the 173 programs derived when the selected objective was to "Maximize the Number of Programs," compared to 118 programs derived when the selected objective was to "Minimize the Cost of Programs."[67]

In the Missouri decision making model for vocational education, a Goal Programming approach was used.[68] This model resulted in a set of decisions based on concurrent consideration of a prioritized list of eight vocational objectives. After designing the

---

[65]Fendt, pp. 7,13-14.

[66]Oklahoma State Department of Vocational and Technical Education, Linear Programming, p. 3.

[67]Ibid., p. 272. [68]Atteberry, Miller and Pershing, p. 81.

model, it was tested to determine the number of program completers there should be, for each program area, so as to result in the minimization of the achievement function. The initial computer analysis of this model yielded a solution mix in which objectives of priorities one, two, three, four, and seven were fully achieved and priorities five, six and eight were underachieved.[69] In this situation priority seven was achieved coincident to the achievement of the first four priority levels, and priority five could not be achieved without degrading the attainment of a higher order objective.

Summary

The purpose of this literature review was to examine the theoretical and practical bases of comprehensive planning and decision making. Specific emphasis was placed upon the detailed examination of the process of planning and decision making and the corresponding product, or outcome of decision making procedure as it related to adult vocational education. The results of this review provided a framework for the construction of a strategic planning instrument that was used in the first round of a Delphi Technique. The data collected from the Delphi Technique was analyzed for the establishment of a final prioritized listing of adult vocational education objectives for full-time programs within the state of Oklahoma.

---

[69]Ibid., p. 92.

CHAPTER III

RESEARCH METHODOLOGY

The purpose of this study was directed toward the development and testing of a multiple objective decision model for state-level program planning in adult education at the vocational level. The procedure used for actualizing this research consisted first of determining a set of prioritized goals and constraints to provide the structural basis for the decision model. From this prioritized set of objectives, a corresponding set of linear mathematical expressions were constructed in accordance with the specifications required to effectuate the Goal Programming model. Parametric data were then amassed using the existing data base maintained by the Oklahoma State Department of Vocational and Technical Education. The final steps involved the adaption of the parametric data to the refined model design, and then performing an actual test of the model's ability to derive an optimum solution set.

Collection of Objective Data - Delphi Technique

The first phase of this research process consisted of the collection of data regarding the determination of a prioritized set of goals and constraints relevant to adult vocational education. The Delphi Technique was chosen as the research tool for use in eliciting

this information from a select group of state and local vocational education administrators. These administrators, who became the Delphi panelist, were chosen because of their positional roles in adult vocational education planning and decision making at the state-level in Oklahoma. Panel participation from the following individuals, or their appointed surrogates, was solicited:

1. Oklahoma State Director for Vocational and Technical Education
2. Planning Coordinator for the Oklahoma State Department of Vocational and Technical Education
3. Oklahoma State Coordinator of Area Schools
4. Director of Adult Education for the Oklahoma State Department of Vocational and Technical Education
5. Comptroller of Financial Services for the Oklahoma State Department of Vocational and Technical Education
6. A Superintendent of an Area Vocational-Technical School (AVTS)
7. A Director of Adult Education of an Area Vocational-Technical School (AVTS)

An initial set of goal and constraint statements was compiled from the review of the literature. Each of these statements was rated by the panelist along a seven-point Likert rating scale on the first round of the Delphi process. The seven-point Likert rating scale was chosen because:

1. A balanced mid point rating was possible thus limiting

the possibility of skewing the ratings either positively or negatively.

2. A seven-point scale provided more dispersion than a five-point scale thus allowing for higher resolution between priority ratings.
3. A goal having no importance to adult vocational education could be rated as zero and an absolute constraint could be identified as essential.
4. A mean rating for each objective could be determined from the aggregate ratings to represent a concensus group opinion. From the final pooled rating it was possible to establish an overall ranking of the objectives to conform to the Goal Programming decision model.

Pilot Study

Upon completing the construction of the instrument used to collect the initial round of data from the Delphi panelists, a pilot survey was conducted using this instrument. The primary purpose of this survey was to obtain constructive feedback concerning the detection and correction of equivocal objective statements, thus improving the content validity of the instrument.

The participants of the pilot survey consisted of a group of individuals who were enrolled in a graduate-level course in Adult Education Program Planning. These students were asked to rate each objective statement, add any objectives they felt were important to adult vocational education program planning, and also provide comments concerning the ambiguity of any of these statements as well as other

comments relating to the face validity of the instrument in general. The rating instrument was then refined using the results of this pilot study.

The Delphi Technique

This procedure was chosen as a vehicle for eliciting a set of prioritized objective statements that were considered appropriate for adult vocational education in the state of Oklahoma. The Delphi Technique was selected for the following reasons:

1. There was precedence for the use of the Delphi Technique in establishing educational goals.[1]
2. The process is designed to produce increasing accuracy of judgement and increasing agreement among participants from round to round.[2]
3. Anonymous responses are considered as an advantage over vis-a'-vis meetings where disagreement among individuals is potentially severe or politically unpalatable, or in those cases where significant minority opinions may be suppressed due to pressure to conform to group norms.
4. The process is time and cost efficient in cases where frequent group meetings are infeasible.
5. The data generated by the process allows for the

---

[1]Sweigert and Schabacker, p. 2.

[2]Ibid.

translation of subjective judgements of individuals into an aggregate group opinion.[3]

Three iterations, or rounds, were used to elicit goal and constraint perceptions from the panel of decision makers, wherein the desired outcome of the process was a convergent set of ordinally ranked objective statements produced as a result of carefully considered group opinions. In the first round, panelists were asked to rate each of the objectives statements of the instrument, and then to write-in and rate any objectives that were perceived as being important to adult vocational education in the state of Oklahoma. Appendix C contains a copy of the data collection instrument that was used in this first round.

In the second round, each panelist was supplied with a new instrument that indicated the composite results of the preceding round, including any write-in objectives, and again they were asked to rate each objective statement. If a new rating was made above or below the composite rating of the previous round, that panelist was asked to briefly state the rationale for deviating from the mean rating of the group. A copy of the data collection instrument used in this round is contained in Appendix E.

The third iteration consisted of supplying the panelists with the composite results of the preceding round. Also included were the reasons given by the various panelists for deviating from the composite score in the first round. In light of these considerations, the panelists were asked to again rate the objective statements. In

---

[3]Fendt, p. 18

addition to the ratings, each panelist was asked to suggest specific indicies that could be used to select parametric data for certain objectives that were subject to ambiguous interpretation. Appendix G contains a copy of the data collection instrument that was used for this final found of the Delphi Technique.

Analysis of Objective Data

The data collected using the Delphi Technique was analyzed to determine the composite ratings for the objectives in each round. In the final round, the composite ratings were transformed to ordinal rankings for the purpose of establishing the prioritized set of adult vocational education objective statements, as required for conformance to the Goal Programming decision model.

A study of the convergence patterns for the objective statements was examined to provide insight into the evolutionary phases of the goal determination process. This analysis was begun by computing the standard deviation of the ratings for each objective statement within each of the three rounds. Since standard deviation is a measure of dispersion about the mean, this index was selected for comparing the relative degree of rating conversion for each objective statement across rounds. Then by computing Wilcoxon's T, from the signed ranks test, it became possible to evaluate the overall convergence of each round in relation to every other round. For ranking purposes, the standard deviations were used for breaking ties between objectives having identical mean ratings. This procedure reflected the influence of concensus opinion on objective selection, thus epitomizing a democratic decision making environment.

Spearman's rank order correlation coefficient was also computed between rounds by correlating the rankings of the objectives within each round, to the rankings of corresponding objectives in every other round. These indices provided a measure of the degree of agreement between rankings for each round of the Delphi Technique.

Formulation of Linear Objectives

After having determined the objectives that were considered important for state-level strategic planning of adult vocational education, it was then necessary to translate these objectives into quantifiable terms wherein each objective statement would represent a linear mathematical expression. The individual expressions provided a composite characterization of the relationship existing between the students from each program type (e.g. dental lab assistant, medical office assistant, food management, etc.) and an associated objective attainment value. This value represented the total of the contributions of all students from each program type toward the achievement of a given objective expression.

The selection of the appropriate coefficients to be used for relating the students from each program type to an objective attainment value were directly translatable, in most cases, from the objective statements themselves. In some cases, where an equivocal interpretation of an objective statement was possible, assistance was provided by the Planning Division of the Oklahoma State Department of Vocational and Technical Education in selecting an appropriate unit of measurement for that objective.

Collection of Parametric Data

The extensive computer data base, maintained by the Oklahoma State Department of Vocational and Technical Education, served as the primary source for establishing the coefficient values of each objective statement. This data base contained a broad range of elements relating to both students and programs which were selectable using various computer sorting techniques. Using these techniques it was possible to isolate specific student data, for each program type, as was required for conformance to the model.

In certain other cases, where specific information items were not available from the computer data base, it was necessary to identify related data factors that could serve as feasible alternates for the primary coefficient terms. These items, denoted as plausible coefficients, represented the best available data for adaption to the model. The implications for using these data were considered in Chapter V of this report.

Design of the Goal Programming Model

The administrative planning phase, of this decision analysis model, incorporated the use of the Operations Research procedure, known as Goal Programming. This procedure derived a solution set that would be used by the educational adminstrator to achieve an optimum allocation of resources in accordance with the predetermined objectives for adult vocational education.

The structure of the Goal Programming model may be expressed as follows:

Determine the solution, $\overline{X}$, from the matrix,

$$\sum_{j=1}^{J} C_{ij} X_j + n_i - p_i = b_i, \text{ for all } i,$$

so as to minimize the vector,

$$\overline{A} = \{[g_1 (\overline{n}, \overline{p})], [g_2 (\overline{n}, \overline{p})], \ldots, [g_k (\overline{n}, \overline{p})]\}$$

while insuring that,

$$\overline{X}, \overline{n}, \overline{p} \geq 0.$$

where:

$\overline{X}$ = the solution to the model, expressed in terms of the quantities of students for each adult vocational education program area type.

C_{ij} = the parameter (coefficient) associated with program area j in objective i

b_i = the desired achievement level of objective i

n_i = negative deviation variable i -- represents the amount by which objective i exceeds b_i

$\overline{A}$ = the desired achievement function

g = $g_1, g_2, \ldots g_k$ = the preemptive priority rankings.[4]

In the second equation above, the achievement function, $\overline{A}$, reached a minimum value when a solution was found that minimized the absolute value of the selected deviation variables (n's and p's) within that function. This vector was minimized by assigning the highest priority for minimization to the g_1 objective, followed by decreasing priority assignments being given to successive objectives descending to, and including, the objective having a priority ranking of g_k. In this manner, the g_1 objective was satisfied before the g_2

---

[4]Ignizio, Goal Programming, p. 31.

objective, and so on down through the g_k objective, such that level g_n was said to preempt g_{n+1} and all lower priority levels in reaching the solution to the model. The objectives emerged as either constraints, requiring absolute achievement, thus being assigned to priority level g_1, or as goals, representing desired levels of attainment with priority levels below g_1 corresponding to the predetermined ordinal rankings of these objectives.

Testing the Model

The final phase of the research process involved testing the Goal Programming model for its ability to derive a solution set which would satisfy the prioritized objectives for Adult Vocational Education. This solution set identified the number of students from each program area type that should be enrolled for optimum achievement of these objectives.

The task of deriving a solution to the model was handled by a high speed computer using a modified simplex algorithm written in the FORTRAN Programming Language.[5]

---

[5]Ibid., pp. 227-242.

CHAPTER IV

RESULTS

The purpose of this study was to develop and test a comprehensive state-level planning and decision analysis model for adult vocational education. Specifically, answers to the following questions were sought:

1. What goals, constraints, and parameters enter into the decision making process of state-wide program planning for full-time adult education at the vocational level?
2. What priority structure would state-level decision makers assign to the identified set of goals?
3. How may these data be applied in a Goal Programming model designed to yield an optimum program mix?

This chapter records the results of the research that was conducted to pursue the answers to these questions.

Results of the Delphi Technique

A three iteration Delphi Procedure was used as the primary data collection process for seeking answers to the first two questions posed in the problem statement of this research. The Delphi panelists chosen for the procedure, represented a select group of individuals having either the authority to directly make decisions affecting adult vocational education at the state-level of planning, or else provide advisory support to these decision makers in the course of performing

such duties. Since these panelists were specifically chosen because of their positional roles in adult vocational education planning and decision making at the state level in Oklahoma, only descriptive statistical techniques were used to analyze the data collected from the Delphi Technique.

Round One Results

The panelists were asked, in the first round of the Delphi Technique, to rate the relative importance of 27 distinct objectives for adult vocational education using a seven-point Likert scale. In doing this, the panelists were requested to use as much dispersion as possible to effectively discriminate between the objectives with respect to their various levels of importance. Also, the panelists were asked to add any additional objectives to this list that they perceived as being important to adult vocational education, and to likewise supply a rating for these objectives.

The objectives receiving ratings in the top 33 1/3 percentile of this first round are listed in Table 1. This table shows the rank order of the objectives and their associated mean and standard deviation values from the first round.

TABLE 1

FIRST ROUND OBJECTIVES: TOP 33 1/3 PERCENTILE RANKINGS

Rank Order	Objective Statement	Mean Rating	S.D.
1	Maximize employer's perception of training adequacy	5.167	0.408

TABLE 1 (Continued)

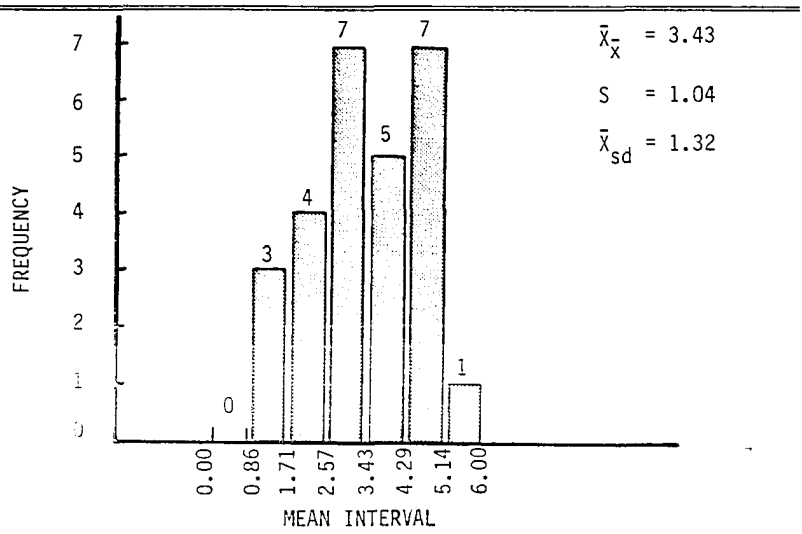
2	Maximize student's perception of training adequacy	5.000	0.0
3	Minimize student attrition rates	4.667	0.516
4	Maximize placement in training related jobs	4.667	1.033
5.5	Maximize placement in jobs within the state of Oklahoma	4.333	0.516
5.5	Maximize the degree of perceived job satisfaction	4.333	0.516
7	Minimize the degree to which manpower supply exceed manpower demand	4.333	1.211

By dividing the six intervals of the rating scale into seven class intervals corresponding to the seven rating categories of the data collection instrument, a value of 6/7, or approximately 0.86, was obtained for the class interval width. Using this value, the frequency distribution of the mean ratings, for all 27 objectives of Round One, was determined. Figure 1 plots this frequency distribution. From this plot it is apparent that the objectives listed in Table 1 all fall within the upper two class interval divisions. The standard deviation value, S = 1.04, gives an indication of the relative spread of the overall ratings, whereas, the index, $\bar{X}_{sd}$ = 1.32, relates to the mean of the standard deviation values for each of the 27 objective statements. This latter index provided an indication of the average degree of non-agreement between the panelists in the ratings that were given to each objective statement.

FIGURE 1

FREQUENCY DISTRIBUTION OF THE

MEAN RATINGS FOR ROUND ONE



By grouping the objectives into three subgroups, according to their individual mean ratings, it was possible to examine the subgroup mean rating and the mean of the standard deviations of these objectives within each subgroup. Table 2 presents these results.

TABLE 2

SUBGROUP INDICES OF ROUND ONE OBJECTIVES

	33 1/3 Percentile Rating Subgroup		
Index	Top	Middle	Bottom
$\bar{X}_{\bar{X}}$	4.56	3.56	3.43
$\bar{X}_{sd}$	0.77	1.57	1.32

From this table, it can be seen, that on the average, there was a higher degree of agreement between the panelists in the ratings that were given to the objectives in the top 33 1/3 percentile subgroup, than was given for the objectives which were rated in either of the other two subgroups.

Round Two Results

The data collected in Round Two were analyzed using the same analytical procedures as those used for Round One. In this round, however, there were a total of 33 objectives, consisting of the original 27 objectives plus six additional write-in objectives that were supplied by the panelists during the first round. Table 3 shows the rank order of the objectives and the associated mean and standard deviation values for the objectives that were rated in the top 33 1/3 percentile of this second round. It is noted, by comparing Table 1 with Table 3, that only four objectives are common to these two tables. Furthermore, the objective receiving the highest ranking in Round One, fell to sixth place in the second round. Five of the eleven objectives in Table 3, including the highest ranked objective, were from the list of write-in objectives obtained during the first round. It would appear that the top ranked objective from Round Two would have the same meaning, in terms of the measurement of success, as the first of the two objectives listed in Table 1 with a ranking of 5.5, although this latter objective dropped to the eighteenth ranking in the second round.

TABLE 3

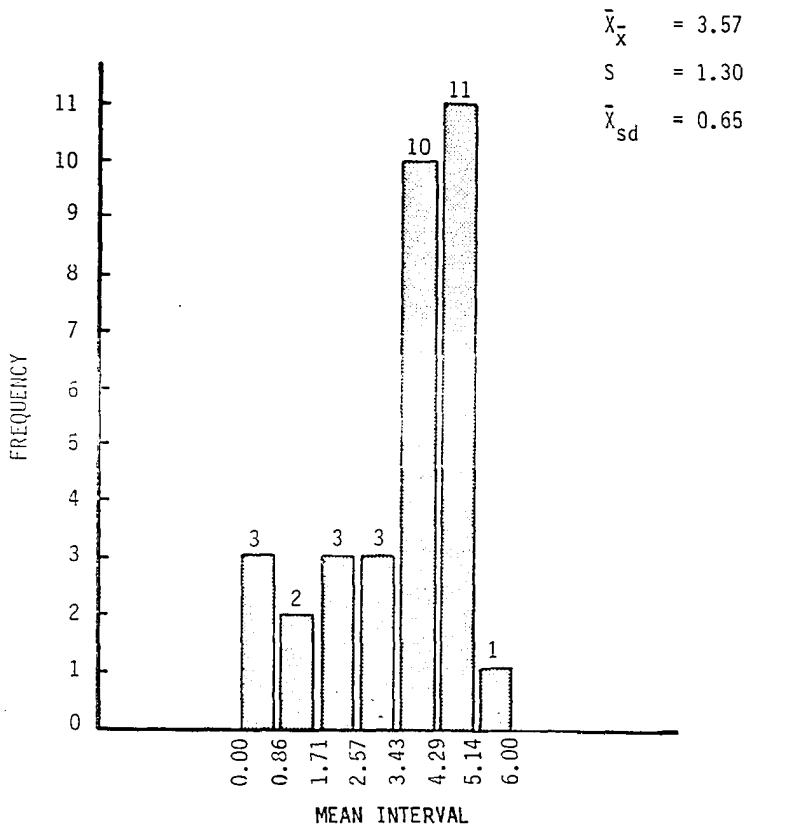
SECOND ROUND OBJECTIVES: TOP 33 1/3 PERCENTILE RANKINGS

Rank Order	Objective Statement	Mean Rating	S.D.
1	Maximize training that supports state and local economic development	5.83	0.373
2	Maximize student's perception of training adequacy	5.00	0.0
3.5	Minimize student attrition rates	4.83	0.373
3.5	Provide maximum support for new programs that would service emerging manpower needs	4.83	0.373
5	Spend no less than the minimum amount required by the Vocational Education Amendments on handicapped programs	4.83	0.687
6	Maximize employer's perception of training adequacy	4.83	0.898
7.5	Place students in training related jobs	4.67	0.471
7.5	Maximize the use of current industry equipment for training	4.67	0.471
9	Maximize the working relationship between public and private training agencies	4.67	1.247
10	Maximize entry-level wages following program participation	4.33	0.471
11	Maximize program offerings that coincide with adult interests	4.33	0.745

The frequency distributon of the mean ratings for Round Two is shown in Figure 2. This plot displays a considerable skew to the left with the largest concentration of ratings falling within the fifth and sixth intervals. The overall mean rating, $\bar{X}_{\bar{X}} = 3.57$, is

FIGURE 2

FREQUENCY DISTRIBUTION OF THE
MEAN RATINGS FOR ROUND TWO



close to, but slightly greater than, the same index from Round One. It is noted by comparing the standard deviation of the means, that a greater degree of rating discrimination, between objectives, was

applied in Round Two than in Round One. Conversely, it is apparent that, on the average, there was a greater degree of rating agreement between the panelists for each objective in Round Two than in Round One; a condition that is denoted by the smaller of the two $\bar{X}_{sd}$ values.

The subgroup indices of Round Two are presented in Table 4. As in Round One, this table shows that there was a greater degree of rating agreement between the panelists for those objectives rated in the top 33 1/3 percentile subgroup of Round Two than there was for either of the other two subgroups of this same round.

TABLE 4

SUBGROUP INDICES OF ROUND TWO OBJECTIVES

	33/13 Percentile Rating Subgroup		
Index	Top	Middle	Bottom
$\bar{X}_{\bar{X}}$	4.80	3.91	2.00
$\bar{X}_{sd}$	0.56	0.69	0.70

Round Three Results

In the final round of the Delphi Technique, the panelists were asked to rate 25 objective statements according to their relative degree of importance for adult vocational education. Those objective statements which were given a mean rating of Low Importance or below in Round Two, were dropped from consideration in Round Three. Likewise, the statement expressing the need to "Maximize the working

relationship between public and private training agencies," was judged to be an operational policy procedure versus a decision related program objective: thus this statement was removed from consideration as an objective in the third round.

The objectives which were ranked in the top 33 1/3 percentile of the final round are listed in Table 5. By comparison it is noted that seven of the eight objectives of Table 5 are common to the Round

TABLE 5

FINAL ROUND OBJECTIVE: TOP 33 1/3 PERCENTILE RANKINGS

Rank Order	Objective Statement	Mean Rating	S.D.
1	Maximize training that supports state and local economic development	5.83	0.373
2	Provide upgrade taining opportunities for individuals and industries	5.33	0.373
3	Employers should feel that training has adequately prepared students for employment	5.17	0.373
4.5	Students should feel that training has adequately prepared them for employment	5.00	0.0
4.5	Provide maximum support for new programs that would service emerging manpower needs	5.00	0.0
6	Maximize the use of current industry equipment for training	4.83	0.373
7	Students should be placed in training related jobs	4.83	0.687
8	Attrition rates should be minimized	4.67	0.471

Two objectives listed in Table 3. The number two ranked objective in Table 5 was supplied as a write-in objective during the second round of data collection, therefore, it was subjected to a single iteration of the rating process.

The frequency distribution of the mean ratings, shown in Figure 3, reflects the removal of the lower ranked objectives from consideration in the final round. By comparison to the distribution of the mean ratings of Round Two, it is observed that the Round Three mode was less than the Round Two mode, although the overall mean of the distribution of the former was greater than that of the latter.

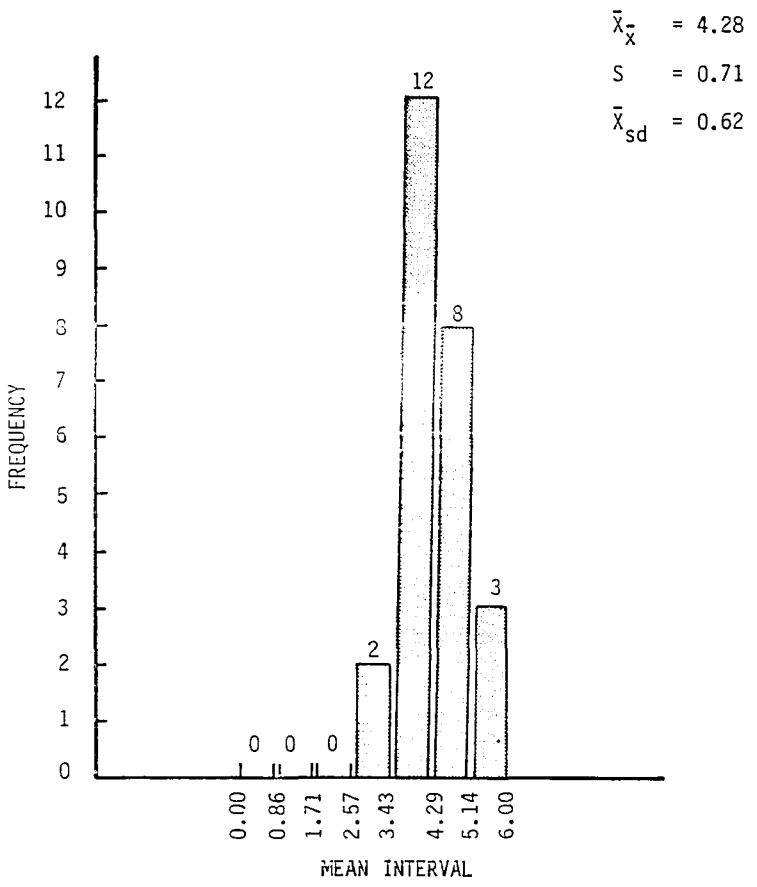
As with the other two rounds, it is seen in Table 6, that the objectives rated in the top 33 1/3 percentile subgroup of Round Three received, on the average, a higher degree rating of concordance between the panelists than that which was received in either of the lower two subgroups of this same round. Furthermore, by comparing the $\bar{X}_{sd}$ values across rounds, it is noted that the average degree of rating harmony was higher in Round Three than in either of the other two rounds for this same upper 33 1/3 percentile rating subgroup.

Overall Results

Wilcoxon's T was employed to provide an indication of the relative degree of overall agreement of the assigned ratings for each objective within a given round in relation to the rating agreement for corresponding objectives within every other round. The T values, shown in Table 7, were determined by first pairing the items in a given round with corresponding items in each of the other two rounds,

FIGURE 3

FREQUENCY DISTRIBUTION OF THE
MEAN RATINGS FOR ROUND THREE



and then computing the signed difference between the standard deviation values of the matched objectives in each set of rounds. Following this, ranks were assigned to the absolute value of the signed

differences, for a given set of rounds, and the ranks corresponding to the minuend and subtrahend were summed separately to give the T+ and T- values respectively. By procedure, no rankings were assigned to those objectives having identical standard deviation values. Thus, this index provided summary information on both the direction and magnitude of the intra-round convergence of one round in relation to the other.

TABLE 6

SUBGROUP INDICES OF ROUND THREE OBJECTIVES

	33 1/3 Percentile Rating Subgroup		
Index	Top	Middle	Bottom
$\bar{X}_{\bar{X}}$	5.07	4.39	3.56
$\bar{X}_{sd}$	0.35	0.71	0.79

TABLE 7

COMPARATIVE INTRA-ROUND RATING CONVERGENCE: OVERALL

Paired Rounds	No. Items Paired	Sum of Signed Differences	
		T+	T-
I-II	26	337	14
I-III	18	148	23
II-III	20	102.5	107.5

From Table 7 it is apparent from the large T+ value corresponding to Round One that there was a considerably lower degree of

rating convergence in the first round than there was in either the second or the third round. Although Pound Two indicates a slightly higher degree of rating convergence than Round Three, the small magnitude of difference between the respective T values infers near identical overall rating agreement between these two rounds.

By collecting the common items from Round Two and Round Three and dividing these into three subgroups, according to the ratings they received in the final round, it was possible to assess the degree of relative convergence between these rounds for each of the subgroups. Table 8 shows the results of this comparison, where the T+ and T- values correspond to Round Two and Round Three respectively. By comparing these values it is seen that there was more agreement, by the panelist, in the ratings that were given to the top 33 1/3 percentile subgroup objectives of Round Three than there was for these

TABLE 8

ROUND TWO-TO-ROUND THREE RATING CONVERGENCE:
BY SUBGROUPS OF ROUND THREE

Paired Rounds	No. Items Paired	Sum of Signed Differences	
		T+	T-
TOP	6	13.5	7.5
MIDDLE	6	11	10
BOTTOM	8	11	25

same objectives in Round Two. Also it is apparent that there was progressively less agreement between the panelists in the ratings that were assigned to the objectives in the lower two subgroups of Round Three as compared to the ratings that were assigned in Round Two for those same objective statements.

While Wilcoxon's T provided an adequate means of comparing intra-round rating agreement between the panelists for paired objectives from one round to the other, it was necessary to compute Spearman's rank order correlation coefficients to assess the degree of inter-round rating agreement. Table 9 lists these inter-round correlation coefficients, for each pair of rounds, and the number of common items between rounds that were ranked. It is apparent, from this table, that the objective rankings of Rounds One and Two agreed more closely than did the rankings for any other set of rounds.

TABLE 9

COMPARATIVE INTER-ROUND RATING AGREEMENT

Correlated Rounds	No. Items Correlated	Spearman's rho
I - II	27	+0.900
I - III	19	+0.611
II - III	24	+0.730

Initial Design of the Linear Objectives

After having compiled the data from the Delphi Procedure it became necessary to structure the objective statements into a format that was compatible with the design requirements of the Goal

Programming model. This phase of the procedure provided an initial basis for determining the general categories of program related data that were to be drawn from the data base maintained by the Oklahoma State Department Vocational and Technical Education.

The process thus became one of translating each objective statement into quantifiable, non-subjective terms that would accurately represent the degree of successful achievement of a particular objective. In many cases, the data elements needed to accomplish this task were apparent from the specific language of the objective statement. While in other cases, it was necessary to interpret the implicit meaning of the objective statements to derive a suitable index for characterizing the objective in quantifiable terms. To aid in the accomplishment of this latter task, the Delphi Panelists had previously been asked, in the third round, to suggest suitable indices that could be used to adequately measure the attainment of certain adult vocational education objectives.

A framework for the initial design of the Goal Programming model was developed using the objectives that were rated in the top 33 1/3 percentile of the of the final round of the Delphi Technique. Appendix H contains a summary of these objectives, in the order of their priority, along with the associated parameters that were initially selected to characterize the degree of relationship between the various program areas and the achievement of a given objective.

Though the objective stating that "Program budgets should not be exceeded" was not rated in the upper 33 1/3 percentile group, it was recognized that this objective must serve as a constraint, or

absolute objective, to preclude the possiblity of permitting the solution to be driven in a boundless fashion toward the fulfillment of the other objectives. Ignizio acknowledged this dilemma stating that:

> the "decision maker" . . . may not order and assign priorities to problem objectives in a manner directly compatible with the goal program model. Consequently, the analyst must view the decision maker's inputs with great care . . . . (since) there are always limited resources and legal restrictions that serve to bound the (solution).[1]

Thus it was determined that it should be necessary to capstone the list of objectives by placing an overall budgetary limitation on the model. The parameter selected for this objective was simply the average dollar amount budgeted, per student from each program area.

Collection and Adaption of Parametric Data

By drawing upon the data base maintained by the Oklahoma State Department of Vocational and Technical Education, through the use of selective sorting processes, it was possible to obtain the majority of the data elements required to finalize the design of the model. However, data relating to program budgets was taken from the "Oklahoma 1980 Accountability Report;"[2] while the data required to ascertain the degree to which adult vocational education graduates migrate out of the state of Oklahoma was adapted from "A Mobility

---

[1] Ignizio, Goal Programming, p. 182.

[2] Oklahoma State Department of Vocational and Technical Education, Oklahoma 1980 Accountability Report (Stillwater: Oklahoma State Department of Vocational and Technical Education, 1981), pp. 131-132.

Study"[3] performed in 1975. Besides assuming that the migration patterns recorded in the 1975 study were applicable to the 1979-80 graduates, it was further necessary to assume that the percentage of the adult graduates from each program area that migrated out of the state, was the same, or nearly the same, as the overall percentage of out-migrating graduates from each corresponding program area.

With regard to the objectives requiring training adequacy ratings from both employers and former students, it was found that the ncessary data from the former group was available from the results of the routinely conducted employer follow-up surveys. On the other hand, no direct data were available to establish indices relevant to student's perception of training adequacy, since similar follow-up surveys are not routinely performed for this group. Curiously enough, this dilemma existed even though the decision makers consistently gave the objective, relating to student's perception of training adequacy, a rating of "very high importance" in each round of the Delphi Technique.

The final formulae that were used to implement the goal programming model are contained in Appendix I. These expressions are the mathemetical representations of the parameters that were selected to associate the adult vocational education program areas to the set of priortized objective statements.

---

[3]J. B. Morton, W. W. Stevenson, and Harold Christensen, A Mobility Study (Stillwater: Oklahoma State Department of Vocational and Technical Education, 1975).

Results of the Goal Programming Model

Once the objective statements had been conformed to the format of the Goal Programming model, and after the parameter values relating the various program areas to each of the objective statements were known, it was possible to finalize the construction and testing of the model. This phase of the research was actualized through the use of a computer program that employed an iterative simplex procedure to derive an optimum solution to the model. The resulting solution was stated in terms of the number of students, from each program area type, that were needed to optimize the attainment of the various objectives in accordance with the pre-established priority structure.

An initial test of the Goal Programming model was performed using the seven prioritized objectives previously established. Table 10 outlines these objectives and their associated pre-emptive priority and achievement levels, as they were entered into the initial test of the model. The achievement levels shown in this table for objectives two through seven represent a 10% improvement over what these same quantities would be, given no change in the number of students per program from the enrollment levels existing in 1979-80.

TABLE 10

GOAL PROGRAMMING OBJECTIVES WITH
ASSOCIATED PRIORITY AND ACHIEVEMENT LEVELS

Priority Level	Objective Statement	Achievement Level
1	Overall budget should not be exceeded	5,724,455
2	Maximize training that supports state and local economic development	6,251,300

TABLE 10 (Continued)

3	Provide upgrade training for individual and industry	426,250
4	Maximize employer's perception of training adequacy	2,308,900
5	Maximize use of current industry equipment for training	2,306,480
6	Students should be placed in training related jobs	395,670
7	Minimize attrition rates	140,220

It was found from this initial test of the model that these conditions would not sufficiently constrain the few programs that contributed the most toward the achievement of these objectives. Thus it became necessary to incorporate a set of constraints into the design of the model to preclude the possibility of any single program in the solution from being forced to unrealistic enrollment levels. To accomplish this the model was restructured to limit the amount by which the enrollment of any single program could be increased. Two computer runs were made under these conditions; the first run constrained the allowed growth of each program to a level of 125% of the 1979-80 enrollment level of corresponding programs, whereas, the second computer run permitted the programs to expand up to 150% of their 1979-80 enrollment levels. Since each of these conditions were specified as constraints, they shared top priority with the first objective shown in Table 10. As with the first run, the achievement levels of objectives two through seven were held at a ten percent improvement over the 1979-80 levels for each of the two runs.

Shown in Table 11 are the results of the first computer run with the 125% maximum enrollment levels for each adult vocational education program area. This table shows that of the 48 program areas that were considered in the model, there were 34 programs in which increased enrollment levels were desired over the 1979-80 levels; and of these, 33 of the program areas were allowed increased enrollments to the 125% level. Also, the table shows that fourteen program areas would be decreased, and of these, eleven would have no adult participation at all.

TABLE 11

GOAL PROGRAMMING MODEL - FIRST RUN RESULTS

Program Number	Program Name	Enrollment Level 1979-80	125% 1979-80	Model Solution
1	Farm Business Management	177	221	221
2	Cashier Checker	455	569	569
3	Dental Office Assistant	16	20	20
4	Health Services	85	106	106
5	Dental Lab Assistant	20	25	25
6	Medical Office Assistant	15	19	0
7	Operating Room Technician	48	60	60
8	Practical Nurse	837	1,046	903
9	Nurse Assistant	100	125	125
10	Clothing Production Management	6	8	0
11	Food Management	58	73	0

TABLE 11 (Continued)

12	Child Care	58	73	73
13	Institution & Home Care	26	33	33
14	Office Assistant	838	1,048	1,048
15	Management	39	49	49
16	Secretarial Training	286	358	358
17	Data Processing	81	101	0
18	Office Assistant (Coop)	24	30	11
19	Bookkeeping and Accounting	76	95	95
20	Bank/Saving and Loan	52	65	65
21	Air Conditioning and Refrigeration	107	134	6
22	Auto Body	32	40	40
23	Auto Mechanics	90	113	0
24	Commercial Art	9	11	11
25	Carpentry	124	155	155
26	Electricity	99	124	124
27	Diesel Mechanic	96	120	120
28	Brick Masonry	36	45	45
29	Plumbing	18	23	0
30	Drafting	61	76	76
31	Electronics	108	135	135
32	Printing	45	56	56
33	Machine Shop	162	203	203
34	Sheet Metal	7	9	9
35	Welding	355	444	444
36	Cosmetology	32	40	40

TABLE 11 (Continued)

37	Upholstery	20	25	25
38	Cabinet Making	10	13	0
39	T & I Horticulture	25	31	31
40	Aircraft Frame	9	11	0
41	Meat Processing	8	10	0
42	Floriculture	15	19	0
43	Heavy Equipment Operator	82	103	0
44	Truck Driver	125	156	56
45	Electrical Lineman	12	15	15
46	Electro-Mechanic	17	21	21
47	Maintenance, Building & Grounds	13	16	16
48	Instrument Repairman	14	18	18

Table 12 shows the results of the computer run allowing maximum enrollment levels up to 150% of the 1979-80 levels.

TABLE 12

GOAL PROGRAMMING MODEL - SECOND RUN RESULTS

Program Number	Program Name	Enrollment Level 1979-80	150% 1979-80	Model Solution
1	Farm Business Management	177	266	200
2	Cashier Checker	455	683	683
3	Dental Office Assistant	16	24	24
4	Health Services	85	128	0
5	Dental Lab Assistant	20	30	0

TABLE 12 (Continued)

6	Medical Office Assistant	15	23	0
7	Operating Room Technician	48	72	72
8	Practical Nurse	837	1,256	1,015
9	Nurse Assistant	100	150	150
10	Clothing Production Management	6	9	0
11	Food Management	58	87	0
12	Child Care	58	87	87
13	Institution & Home Care	26	39	39
14	Office Assistant	838	1,257	809
15	Management	39	59	59
16	Secretarial Training	286	429	429
17	Data Processing	81	122	0
18	Office Assistant (Coop)	24	36	0
19	Bookkeeping and Accounting	76	114	114
20	Bank/Saving and Loan	52	78	78
21	Air Conditioning and Refrigeration	107	161	0
22	Auto Body	32	48	29
23	Auto Mechanics	90	135	0
24	Commercial Art	9	14	14
25	Carpentry	124	186	186
26	Electricity	99	149	149
27	Diesel Mechanic	96	144	144
28	Brick Masonry	36	54	54
29	Plumbing	18	27	0
30	Drafting	61	92	92

TABLE 12 (Continued)

31	Electronics	108	162	0
32	Printing	45	68	0
33	Machine Shop	162	243	202
34	Sheet Metal	7	11	0
35	Welding	355	533	533
36	Cosmetology	32	48	48
37	Upholstery	20	30	0
38	Cabinet Making	10	15	0
39	T & I Horticulture	25	38	38
40	Aircraft Frame	9	14	0
41	Meat Processing	8	12	0
42	Floriculture	15	23	0
43	Heavy Equipment Operator	82	123	0
44	Truck Driver	125	188	188
45	Electrical Lineman	12	18	18
46	Electro-Mechanic	17	26	0
47	Maintenance, Building & Grounds	13	20	20
48	Instrument Repairman	14	21	21

The results of this computer run, as indicated in Table 12, show the need for increasing the enrollments in 27 of the program areas; and of these, 23 would be allowed to increase their enrollments to the maximum level. Conversely, 21 programs showed the need for decreased enrollment levels, of which, 20 program areas would have no adult participation.

By comparing the results recorded in Tables 11 and 12, it was possible to examine the relative change in program area enrollment levels from one computer run to the next. Table 13 shows the magnitude and direction of change from the first and second runs in relation to the 1979-80 enrollment levels, as well as the net change between the second run and the first run. This comparison revealed that 25 program areas would be increased from runs one and two, in relation to the 1979-80 enrollments, however, two of these, program numbers one and thirty-three, would have a lower enrollment level by the results of the second run compared to the first run. Program area forty-four (Truck Driver) showed the need for fewer students from the achievement levels of the first run, than the number of students enrolled in this same program in 1979-80. But by contrast, the achievement levels of the second run allowed for an increase in the number of adult students enrolled in the Truck Driver program above the
1979-80 level.

TABLE 13

COMPARISON OF RESULTS - NET CHANGE IN ENROLLMENT LEVELS

Program Number	Program Name	Net Change in Enrollment 1st Run Minus 1979-80	2nd Run Minus 1979-80	2nd Run Minus 1st Run
1	Farm Business Management	44	23	-21
2	Cashier Checker	114	228	114
3	Dental Office Assistant	4	8	4
4	Health Services	21	-85	-106
5	Dental Lab Assistant	5	-20	-25

TABLE 13 (Continued)

6	Medical Office Assistant	-15	-15	0
7	Operating Room Technician	12	24	12
8	Practical Nurse	66	178	112
9	Nurse Assistant	25	50	25
10	Clothing Production Management	-6	-6	0
11	Food Management	-58	-58	0
12	Child Care	15	29	14
13	Institution & Home Care	7	13	6
14	Office Assistant	210	-29	-239
15	Management	10	20	10
16	Secretarial Training	72	143	71
17	Data Processing	-81	-81	0
18	Office Assistant (Coop)	-13	-24	-11
19	Bookkeeping and Accounting	19	38	19
20	Bank/Saving and Loan	13	26	13
21	Air Conditioning and Refrigeration	-101	-107	-6
22	Auto Body	8	-3	-11
23	Auto Mechanics	-90	-90	0
24	Commercial Art	2	5	3
25	Carpentry	31	62	31
26	Electricity	25	50	25
27	Diesel Mechanic	24	48	24
28	Brick Masonry	9	28	9
29	Plumbing	-18	-18	0
30	Drafting	15	31	16

TABLE 13 (Continued)

31	Electronics	27	-108	-135
32	Printing	11	-45	-56
33	Machine Shop	41	40	-1
34	Sheet Metal	2	-7	-9
35	Welding	89	178	89
36	Cosmetology	8	16	8
37	Upholstery	5	-20	0
38	Cabinet Making	-10	-10	0
39	T & I Horticulture	6	13	7
40	Aircraft Frame	-9	-9	0
41	Meat Processing	-8	-8	0
42	Floriculture	-15	-15	0
43	Heavy Equipment Operator	-82	-82	0
44	Truck Driver	-69	63	132
45	Electrical Lineman	3	6	3
46	Electro-Mechanic	4	-17	-21
47	Maintenance, Building & Grounds	3	7	4
48	Instrument Repairman	4	7	3

Further inspection of the results revealed that both runs achieved all of the objectives except the one ranked at the lowest priority level. The degree of underachievement of the stated objective to "minimize attrition rates" was a function of the amount by which the resulting solution exceeded the corresponding achievement level shown in Table 10. The first run of the model exceeded this amount by 18 percent, whereas, the second run exceeded the same amount

by only nine (9) percent. Table 14 lists the deviations from the specified achievement levels for all of the objectives in relation to the solution derived by both runs of the model. Positive deviations shown for objectives two through six represent the amount by which a resulting solution set overachieved the levels specified in Table 10.

TABLE 14

RESULTING DEVIATIONS FROM SPECIFIED ACHIEVEMENT LEVELS

Priority Level	Objective Statement	Deviation Amount First Run Results	Deviation Amount Second Run Results
1	Overall budget should not be exceeded	0	0
2	Maximize training that supports state and local economic development	+7276	0
3	Provide upgrade training for individual and industry	0	0
4	Maximize employer's perception of training adequacy	+17820	+1883
5	Maximize use of current industry equipment for training	+13872	0
6	Students should be placed in training related jobs	0	0
7	Minimize attrition rates	+25314	+12614

Overall, these results showed the sensitivity of the model to changes in objectives and achievement levels. Also, it was apparent from the two runs that were made, that the model would provide an optimum solution set while taking into consideration the interactive characteristics of the decision variables. Thus, it was demonstrated that the Goal Programming model could be adapted to adult vocational education program planning to provide a non-subjective solution to the

question of determining an optimum program mix, given a valid set of goals and constraints to represent the decision making environment.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

Purpose

This study was designed for the purpose of developing and testing a comprehensive model that could be used to guide the decision making process for adult vocational education at the state-level of planning. To insure the comprehensive nature of the model, the research was directed toward answering these specific questions:

1. What goals, constraints, and parameters enter into the decision making process of the state-wide level of programming planning for full-time adult vocational education?
2. What priority assignment would state-level decision makers assign to the identified goals?
3. How may these data be applied in a multiple objective Goal Programming model designed to yield an optimal program mix?

Subsequent sections of this chapter recount: (1) the procedures that were used to develop the model, (2) the results of the process in relation to the research questions posed above, (3) the conclusions that were drawn from the outcome of the study, and (4) the implications of this study in regard to the need for extended and associated research.

Procedures

In order to answer the first two questions of the stated purpose of this research, four types of data elements relating to full-time adult vocational education program planning were required. These included: (1) the state-wide goals that were perceived to be important for adult vocational education, (2) the relative priority or importance of these goals, (3) the identification of any program related constraints, and (4) the selection and isolation of specific parameters relating the various program areas to the identified goals and constraints. For the purpose of this research, a goal was defined as a quantifiable objective representing a desired, or nonabsolute limit or requirement; whereas, a constraint referred to a quantifiable objective representing an absolute limit or requirement.

Delphi Technique

The Delphi Technique was selected as the primary means for collecting the first three categories of data. A select committee of adult vocational education decision makers were chosen to serve as the Delphi panelists, thus lending credibility to the framework that would later by used to construct the actual decision making model.

Three iterations, or Rounds, were employed in this process to collect the necessary data. The first round was performed for the purpose of establishing the initial set of objectives. In the second round, the Delphi panelists were asked to again rate the objective statements, this time given the first round composite rating for each objective. If a panelist's rating did not agree wih the composite rating given an objective in the first round, he was asked to briefly

state the rationale for this difference. In the third round, the panelists were given a narrowed list of objectives, along with the composite ratings for each objective from the preceding round as well as the rating comments that were given in this same round. In light of these considerations, the panelists supplied a final rating of the objective statements. Also in this final round, the panelists were asked to suggest suitable indices that could be used to select parametric data for certain objectives.

Collection of Parametric Data

The data relating the various program area types to each of the specified objectives was referred to as "parametric data." These elements, representing for the most part historical data from the 1979-80 school term, were collected from the extensive data base maintained by the Oklahoma State Department of Vocational and Technical Education. Various computer sorting techniques were used to isolate the data required for this study.

Formulating and Testing the Decision Model

This phase of the study was performed to provide the answer to the third research question regarding how the data could be applied in a multiple objective Goal Programming model that was designed to yield an optimum decision solution. In order to carry out this process, it was necessary to use the parametric data, previously collected, to formulate linear mathematical expressions of the objectives receiving the highest rating from the third round of the Delphi Technique. The third round objectives were used for this purpose since they

represented those receiving the most thorough consideration from any of the three rounds.

Once the objectives were in a format that was compatible with the Goal Programming model it became necessary to install the appropriate constraints to bound the solution within realistic limits. If this step had not been taken, the Goal Programming model could have forced an otherwise optimum solution by suppressing the enrollments in all but a few of the program areas while increasing the enrollments in these same program areas beyond the capacity or need for such training. The constraint representing the total budget for Adult Vocational Education, together with a set of maximum enrollment constraints for each program area, was incorporated into the design of the decision model.

Two computer runs of the Goal Programming model were then made. In the first run, each program was allowed a maximum enrollment of up to 125 percent of the corresponding enrollment levels during 1979-80. Whereas, the second run permitted a maximum enrollment of up to 150 percent of these latter amounts.

Results

Eight objectives from the final round of the Delphi Technique were selected for constructing the Goal Programming decision model. These eight objectives, which represented the top 33 1/3 percentile ranked subgroup from Round Three, were found to have a high degree of relative convergence in the ratings that were given by the panel of experts. There was less agreement between the panelists in the ratings that were assigned to the objectives of the lower two

subgroups. Also it was shown that there was a higher degree of rating convergence for the top ranked objectives of Round Three than there was for these same objectives in Round Two.

It was found, however, that two of the top ranked objective statements did fulfill the deterministic requirements of the model. That is, there were no historical data available to provide the necessary parametric relationship between the program area types and the achievement levels for either of these objectives. Thus, there were no bases for determining the degree of success by which any of the program area types were capable of achieving these two goals.

The final set of objective statements that were used to construct the Goal Programming model, as listed in the order of their priority included:

1. The overall budget for Adult Vocational Education shall not be exceeded
2. Maximize training that supports state and local economic development
3. Provide upgrade training for individuals and industry
4. Maximize employer's perception of training adequacy
5. Maximize the use of current industry equipment for training
6. Students should be placed in training related jobs
7. Attrition rates should be minimized

As stated in the previous section, an additional constraint was added to this list to form an upper limit to the enrollment levels permitted for any given program area type.

The results of the two computer runs that were made, using the list of prioritized objectives, demonstrated the applicability of

the Goal Programming (GP) model as a decision analysis tool for adult vocational education program planning. The GP model effectively discriminated between the program area types in relation to their ability to contribute to the success of the prioritized objectives. However, it was further demonstrated that the relative sensitivity of the model would require considerable accuracy of the parametric data and the goal achievement levels to insure the validity of the results.

Forty-eight program area types were entered into the design of the model for testing the outcome of both computer runs. In the first run, in which program enrollments could increase by up to 125 percent of the 1979-80 enrollment levels, it was found that 34 of the 48 programs would be allowed increased enrollment levels, while 11 of the remaining 14 programs would have no adult participation at all. By extending the maximum amount by which any given program could increase its enrollment to a level of up to 150 percent of the 1979-80 enrollment levels, the second run permitted increased enrollments in only 27 of the 48 program areas. Also, using the constraint levels of the second run, the results showed the need for no adult participation in 20 of the remaining 21 program areas.

All of the objectives were achieved by both runs of the GP model, with the exception of the objective having the lowest priority level. It was demonstrated, however, that the solution from the second run of the model more nearly achieved this objective than did the solution of the first run. This occurred, however, at the expense of reducing enrollments in some program areas while permitting increased enrollments in others.

Conclusions

The following conclusions, based on the results of this study, were drawn:

1. The use of the Delphi Technique, to establish the desired objectives for adult vocational education at the state-level of planning, is a generally acceptable procedure. Furthermore, this procedure provides an effective means of establishing the priority levels for achieving these objectives in accordance with the requirements of the Goal Programming model.

2. The data base maintained by the Oklahoma State Department of Vocational and Technical Education is sufficiently comprehensive to include the majority of the parametric data elemets needed to relate the program area types to the identified objectives. However, there is a need to expand this data base to include student ratings of program effectiveness similar to those ratings provided by employers.

3. The Goal Programming technique is a suitable tool to assist in the decision making process for adult vocational education program planning. The solution derived from using this technique, however, will only be valid to the point that:

   a. the linear mathematical expressions of the objectives are true representations of the objective statements themselves

   b. accurate data are available relating to program parameters, objective achievement levels, and priority rankings of the various objectives

   c. the major decision making constraints have been established and incorporated into the design of the model

4. The Delphi Technique, used in conjunction with the Goal Programming technique, provides a comprehensive framework for modeling the decision making process for adult vocational education

Recommendations

The results of this study have led to the identification of the need for further related research. Thus, it is recommended that provision be made for:

1. investigating and comparing the results of other comprehensive adult vocational education decision models to the results of the model developed from this research, in an effort to achieve one or more of the following:
   a. a reduction in time and effort required to identify the most important objectives for Adult Vocational Education
   b. an optimum working relationship between the decision maker and the decision analyst during the course of the research
   c. the testing of other multiple objective decision models, besides the Goal Programming technique, in relation to: ease of use, adaptability to the decision environment, reliability of results, etc.
2. upgrading, or supplementing, the data base maintained by the Oklahoma State Department of Vocational and Technical Education to provide the additional data elements needed and identified by this research
3. adapting the paradigm used for this study to investigate other areas of adult education decision making to include:
   a. part-time adult vocational education program planning
   b. the allocation of resources for community education programs
   c. planning for non-vocational, adult short-course programs
4. conducting a follow-up study of an actual adult vocational education program planning event in which decisions were made using the model of this research

BIBLIOGRAPHY

Books

Churchman, West; Achoff, Russell L.; and Arnoff, E. Leonard. Introduction to Operations Research. New York: John Wiley & Sons, Inc., 1957.

Evans, Rupert N. Foundations of Vocational Education. Columbus: Charles E. Merrill Pub. Co., 1971.

Hill, Joseph E. How Schools Can Apply Systems Analysis. Bloomington: Phi Delta Kappa Educational Foundation, 1972.

Hill, Joseph E. and Kerber, Augut. Models, Methods, and Analytical Procedures in Educational Research. Detroit: Wayne State University Press, 1967.

Houle, Cyril O. The Design of Education. San Francisco: Jossey-Bass Publisher, Inc., 1972.

Ignizio, James P. Goal Programming and Extensions. Lexington: D. C. Heath and Company, 1976.

Ignizio, James P., and Gupta, Jatinder N.D. Operations Research in Decision Making. New York: Crane, Russak & Co., 1975

Knowles, Malcolm S. The Modern Practice of Adult Education: Androgogy Versus Pedagogy. New York: Association Press, 1970.

Lee, Sang M. Goal Programming for Decision Analysis. Philadelphia: Auerbach Publishers, Inc., 1972.

Lindstone, Harold A., and Turoff, Murry, eds. The Delphi Method: Techniques and Applications. Reading: Addison-Wesley Pub. Co., 1975.

Pfeiffer, John. New Look at Education: Systems, Analysis in Our Schools and Colleges. New York: The Odyssey Press, 1968.

Plane, Donald R. and Kochenberger, Gary A. Operations Research for Managerial Decisions. Homewood: Richard D. Irwin, Inc., 1972.

Books (Continued)

Shull, Fremond A.; Delbecq, Andre' L.; and Cummings, L. L. Organizational Decision Making. New York: McGraw-Hill, Inc., 1979.

Van Dusseldorp, Ralph A.; Richardson, Duane E.; and Foley, Walter J. Educational Decision-Making Through Operations Research. Boston: Allyn and Bacon, Inc., 1971.

Venn, Grant. "Vocational-Technical Education." In Handbook of Adult Education pp. 473-86. Edited by Robert M. Smith, George F. Aker, and J. R. Kidd. New York: Macmillan Publishing Co., Inc., 1970.

Articles

Becker, Richard J. "What Are the Objectives of Vocational Education?" Phi Delta Kappan 61 (April 1980): 534-536.

Copa, George H. and Irvin, Donald E., Jr. "Manpower Information Versus Decision-Making Needs: A Selective Approach to Collecting Data." American Vocational Journal 50 (October 1975): 41-42.

Eggington, Everett. "Is Vocational Education Meeting Its Objectives?." Phi Delta Kappan 59 (April 1978): 533-534.

Fischhoff, Baruch. "Clinical Decision Analysis." Operations Research 28 (January-February 1980): 28-43.

Hopkins, Charles O. "Statewide Manpower Planning for Vocational Education: The Oklahoma Experience." American Vocational Journal 50 (October 1975): 43-45.

Howard, Ronald A. "An Assessment of Decision Analysis." Operations Research 28 (January-February 1980): 4-27.

McNamara, James F. "A Mathematical Programming Approach to State-Local Program Planning in Vocational Education." American Educational Research Journal 8 (March 1971): 335-363.

McNamera, James F. "Mathematical Programming Models in Educational Planning." Review of Educational Research 41 (December 1971): 421-422.

Morris, Peter A., and Oren, Shmuel S. "Multiattribute Decision Making by Sequential Resource Allocation." Operations Research 28 (January-February 1980): 233-252.

Articles (Continued)

Nickerson, Robert C. and Boyd, Dean W. "The Use and Value of Models in Decision Analysis." Operations Research 28 (January-February 1980).

Swanson, Gordon I. "Vocational Education: Fact and Fantasy." Phi Delta Kappan 60 (October 1978): 87-90.

Published Reports

Atteberry, Jim W.; Miller, William R.; and Pershing, James A. Improving Vocational Education Planning: More Myth Than Reality?, Final Report. Columbia: Department of Practical Arts and Vocational-Technical Education, University of Missouri, [1977].

Hammond, Allen. Mathematical Models in Education and Training. Santa Monica: Rand Corp., [1970].

Hopkins, Charles O.; Ritter, Kenneth L.; and Stevenson, William W. Delphi: A Planning Tool. Stillwater: Oklahoma State Department of Vocational and Technical Education, [1972].

Morton, J. B.; Stevenson, W. W.; and Christensen, Harold. A Mobility Study. Stillwater: Oklahoma State Department of Vocational and Technical Education, [1975].

Oklahoma State Department of Vocational and Technical Education, The Development and Testing of a Linear Programming Technique for Optimizing Occupational Training Program Combinations. Stillwater: Oklahoma State Department of Vocational and Technical Education, 1974

Oklahoma State Department of Vocational and Technical Education. FY 1979-80 Cost Per Program Report of Area Vocational-Technical Schools. Stillwater: Oklahoma State Department of Vocational and Technical Education, 1979.

Oklahoma State Department of Vocational and Technical Education, Oklahoma 1980 Accountability Report. Stillwater: Oklahoma State Department of Vocational and Technical Education, 1981.

Unpublished Reports

Elbert, Dennis J. "Elements in Missouri's Vocational Education System." Ph.D. dissertation, University of Missouri, 1976.

Fendt, Paul Frederick. "Alternative Futures for Adult and Continuing Education in North Carolina: A Delphi Futures Planning Study."

Unpublished Reports (Continued)

Paper presented at the First Meeting of the Education Section of the World Future Society, Houston, Texas, 20-22 Oct. 1978.

Sweigert, Ray L., and Schabacker, William H. "The Delphi Technique: How Well Does It Work in Setting Educational Goals." Paper presented at the Annual Meeting of the American Educational Research Association, Chicago, Ill., April 1974.

Van Dusseldorp, Ralph A.; Iselhardt, Bernard J., Jr.; Gunderson, James O.; Kelley, John R.; Vander Weil, Raymond; and Johnson, William R. "Applications of Goal Programming to Education." Paper presented at the 14th Annual International Convention of the Association for Educational Data Systems, Phoenix, Ariz., 3-7 May 1976.

Microform Reproductions

Bearley, William. Why Systems Fail. Bethesda, Md.: ERIC Document Reproduction Service, ED 157 117, 1979.

Kim, Eun Jin. A Cost-Effectiveness/Benefit Analysis Model for Postsecondary Vocational Programs. Bethseda, Md.: ERIC Document Reproduction Service, ED 151 560, 1977.

Young, Robert C.; Zients, Stanley; Bishop. Albert B. Linear Programming for Vocational Education Planning Columbus, Ohio: ERIC Document Reproduction Service, ED 902 754, 1973.

APPENDICES

APPENDIX A



The
University of Oklahoma at Norman

College of Education

March 5, 1981

Dear Colleague:

We are involved in a process of developing and testing a comprehensive state-level planning and decision making model for adult vocational education. This study will essentially be carried out in two phases, where the first phase involves the determination of objectives which are important to adult vocational education, and the second phase will consist of the design and testing of the decision model based on the set of objectives isolated from the first phase.

Your input, as a vocational education administrator, is being solicited to help us with the critical first phase of this project. Mr. Lonnie Roberts, who is coordinating the study, will be in contact with you by telephone in a few days to give you more details about the study itself, how you can contribute to its success, and how the outcome of the study should be directly beneficial to you in the practice of your profession.

We will deeply appreciate your help in contributing to this project.

Very truly yours,

Lloyd Korhonen
Associate Professor,
Adult Education

LK/sr

820 Van Vleet Oval, Norman, Oklahoma 73019

APPENDIX B

March 24, 1981

Dear Colleague:

Let me extend my thanks to you for agreeing to serve as a Delphi panelist for our study. As you will recall, this involves the development and testing of a comprehensive vocational education planning and decision making model for full-time adult programs.

The instrument contained herein has been designed and tested on a basis of simplicity and clarity, although your careful consideration of each objective is required. Please rank each objective statement according to the instructions given. If you feel that important objectives have been omitted, submit and rank these in the area provided on the last page of the instrument.

Your expedient return of the completed instrument will permit us to quickly analyze the responses of all panelist to obtain the composite results of this first round of the study. Your personal responses will be held in utmost confidence.

If you require further information or clarification please contact me at (214) 272-0515, extension 3789.

Once again, let me thank you for your cooperation.

Sincerely,

Lonnie D. Roberts

LDR/sr

APPENDIX C

ADULT VOCATIONAL EDUCATION
OBJECTIVE RATING SCALE

DIRECTIONS: Please read each objective statement carefully. Then circle the number to the right of each objective that corresponds to your perception of the relative importance of that objective for Adult Vocational Education program planning. Attempt to use as much dispersion as possible to discriminate between objectives. Also be aware that some objectives seem similar when they are in fact different.

ADULT VOCATIONAL EDUCATION OBJECTIVES	NO IMPORTANCE	VERY LOW IMPORTANCE	LOW IMPORTANCE	MEDIUM IMPORTANCE	HIGH IMPORTANCE	VERY HIGH IMPORTANCE	ESSENTIAL
1. Maximize placement in training related jobs.	0	1	2	3	4	5	6
2. Maximize placement in jobs regardless of the training relatedness of the job.	0	1	2	3	4	5	6
3. Maximize placement in jobs within the state of Oklahoma.	0	1	2	3	4	5	6
4. Maximize placement in jobs regardless of the state in which employment is attained.	0	1	2	3	4	5	6
5. Minimize the degree to which manpower supply exceeds manpower demand	0	1	2	3	4	5	6
6. Minimize the degree to which manpower demand exceeds manpower supply	0	1	2	3	4	5	6
7. Manpower supply should be no more or no less than manpower demand.	0	1	2	3	4	5	6
8. Maximize entry-level wages following program participation.	0	1	2	3	4	5	6
9. Maximize the degree of perceived job satisfaction.	0	1	2	3	4	5	6

Next Page Please

ADULT VOCATIONAL EDUCATION OBJECTIVES	NO IMPORTANCE	VERY LOW IMPORTANCE	LOW IMPORTANCE	MEDIUM IMPORTANCE	HIGH IMPORTANCE	VERY HIGH IMPORTANCE	ESSENTIAL
10. Maximize student's perception of training adequacy.	0	1	2	3	4	5	6
11. Maximize employer's perception of training adequacy.	0	1	2	3	4	5	6
12. Maximize social benefits as a result of training.	0	1	2	3	4	5	6
13. Maximize the number of graduates who continue their formal education.	0	1	2	3	4	5	6
14. Minimize student attrition rates.	0	1	2	3	4	5	6
15. Spend no more money than the amounts that are budgeted for programs.	0	1	2	3	4	5	6
16. Spend no less money than the amounts that are budgeted for programs.	0	1	2	3	4	5	6
17. Spend no more or no less money than the amounts that are budgeted for programs.	0	1	2	3	4	5	6
18. Spend no more than the minimum amount required by P.L. 94-482 on disadvantaged programs.	0	1	2	3	4	5	6
19. Spend no less than the minimum amount required by P.L. 94-482 on disadvantaged programs.	0	1	2	3	4	5	6
20. Spend no more or no less than the minimum amount required by P.L. 94-482 on disadvantaged programs.	0	1	2	3	4	5	6
21. Spend no more than the minimum amount required by P.L. 94-482 on handicapped programs.	0	1	2	3	4	5	6

Next Page Please

ADULT VOCATIONAL EDUCATION OBJECTIVES	NO IMPORTANCE	VERY LOW IMPORTANCE	LOW IMPORTANCE	MEDIUM IMPORTANCE	HIGH IMPORTANCE	VERY HIGH IMPORTANCE	ESSENTIAL
22. Spend no less than the minimum amount required by P.L. 94-482 on handicapped programs.	0	1	2	3	4	5	6
23. Spend no more or no less than the minimum amount required by P.L. 94-482 on handicapped programs.	0	1	2	3	4	5	6
24. Maximize the number of disadvantaged students served by special disadvantaged programs.	0	1	2	3	4	5	6
25. Maximize the number of disadvantaged students served by regular adult vocational education programs.	0	1	2	3	4	5	6
26. Maximize the number of handicapped students served by special handicapped programs.	0	1	2	3	4	5	6
27. Maximize the number of handicapped students served by regular adult education programs.	0	1	2	3	4	5	6

On the next page add any objectives you feel are important to adult vocational education that may not have been covered by the above list. Also rate these objectives on the same scale as, and in relation to, the ratings you have already given to the aobve listed objectives.

ADULT VOCATIONAL EDUCATION OBJECTIVES	NO IMPORTANCE	VERY LOW IMPORTANCE	LOW IMPORTANCE	MEDIUM IMPORTANCE	HIGH IMPORTANCE	VERY HIGH IMPORTANCE	ESSENTIAL
1. Objective: _____	0	1	2	3	4	5	6
2. Objective: _____	0	1	2	3	4	5	6
3. Objective: _____	0	1	2	3	4	5	6
4. Objective: _____	0	1	2	3	4	5	6
5. Objective: _____	0	1	2	3	4	5	6
6. Objective: _____	0	1	2	3	4	5	6

Code No. _____
(Used only for follow-up purposes)

APPENDIX D

May 18, 1981

Dear Colleague:

Thanks for providing your input to the first round of our Delphi study. The data from this first phase have been analyzed and we are now in a position to initiate the collection of data for the second round.

Once again you are asked to rate the objective statements for full-time Adult Vocational Education, at the state-level of planning, according to your perception of their relative importance. There are several significant differences between the rating instrument of the first round and the rating instrument contained herein. Please read the directions carefully, complete the instrument, and then return it to me as quickly as possible.

Once again, let me thank you for your cooperation.

Sincerely,

Lonnie D. Roberts
(214) 272-0515 Ext. 3789

LDR/sr

APPENDIX E

ADULT VOCATIONAL EDUCATION
OBJECTIVE RATING SCALE
ROUND II

DIRECTIONS: Please read each objective statement carefully, then circle the number to the right of each objective that corresponds to your perception of the relative importance of that objective for Adult Vocational Education at a state-wide level of program planning. You are also asked to supply a brief rationale for your new rating if it differs from the mean rating (as denoted by an asterisk) given to an objective statement from the first rating cycle.

ADULT VOCATIONAL EDUCATION OBJECTIVES	NO IMPORTANCE	VERY LOW IMPORTANCE	LOW IMPORTANCE	MEDIUM IMPORTANCE	HIGH IMPORTANCE	VERY HIGH IMPORTANCE	ESSENTIAL
1. Place students in training related jobs. Rating Rationale:_____	0	1	2	3	4	5*	6
2. Place students in jobs regardless of the training relatedness of the job. Rating Rationale:_____	0	1	2	3*	4	5	6
3. Place students in jobs within the state of Oklahoma. Rating Rationale:_____	0	1	2	3	4*	5	6
4. Place students in jobs regardless of the state in which employment is attained. Rating Rationale:_____	0	1	2	3*	4	5	6
5. Minimize the degree to which manpower supply exceeds manpower demands. Rating Rationale:_____	0	1	2	3	4*	5	6

Next Page Please

ADULT VOCATIONAL EDUCATION OBJECTIVES	NO IMPORTANCE	VERY LOW IMPORTANCE	LOW IMPORTANCE	MEDIUM IMPORTANCE	HIGH IMPORTANCE	VERY HIGH IMPORTANCE	ESSENTIAL
6. Minimize the degree to which manpower demand exceeds manpower supply. Rating Rationale:_____	0	1	2	3	4*	5	6
7. Manpower supply should be no more or less than manpower demand. Rating Rationale:_____	0	1	2	3*	4	5	6
8. Maximize entry-level wages following program participation. Rating Rationale:_____	0	1	2	3	4*	5	6
9. Maximize the degree of perceived job satisfaction. Rating Rationale:_____	0	1	2	3	4*	5	6
10. Maximize student's perception of training adequacy. Rating Rationale:_____	0	1	2	3	4	5*	6
11. Maximize employers perception of training adequacy. Rating Rationale:_____	0	1	2	3	4	5*	6
12. Maximize social benefits as a result of training. Rating Rationale:_____	0	1	2	3*	4	5	6

Next Page Please

ADULT VOCATIONAL EDUCATION OBJECTIVES	NO IMPORTANCE	VERY LOW IMPORTANCE	LOW IMPORTANCE	MEDIUM IMPORTANCE	HIGH IMPORTANCE	VERY HIGH IMPORTANCE	ESSENTIAL
13. Maximize the number of graduates who continue their formal education. Rating Rationale:_____	0	1	2	3*	4	5	6
14. Minimize student attrition rates. Rating Rationale:_____	0	1	2	3	4	5*	6
15. Spend no more money than the amounts that are budgeted for programs. Rating Rationale:_____	0	1	2	3	4*	5	6
16. Spend no less money than the amounts that are budgeted for programs. Rating Rationale:_____	0	1	2*	3	4	5	6
17. Spend no more or no less money than the amounts that are budgeted for programs. Rating Rationale:_____	0	1	2*	3	4	5	6
18. Spend no more than the minimum amount required by the Vocational Education Amendments on disadvantaged programs. Rating Rationale:_____	0	1*	2	3	4	5	6
19. Spend no less than the minimum amount required by the Vocational Education Amendments on disadvantaged programs. Rating Rationale:_____	0	1	2	3*	4	5	6

Next Page Please

ADULT VOCATIONAL EDUCATION OBJECTIVES	NO IMPORTANCE	VERY LOW IMPORTANCE	LOW IMPORTANCE	MEDIUM IMPORTANCE	HIGH IMPORTANCE	VERY HIGH IMPORTANCE	ESSENTIAL
20. Spend no more or no less than the minimum amount required by the Vocational Education Amendments on disadvantaged programs. Rating Rationale:_____	0	1*	2	3	4	5	6
21. Spend no more than the minimum amount required by the Vocational Education Amendments on handicapped programs. Rating Rationale:_____	0	1*	2	3	4	5	6
22. Spend no less than the minimum amount required by the Vocational Education Amendments on handicapped programs. Rating Rationale:_____	0	1	2	3	4*	5	6
23. Spend no more or no less than the minimum amount required by the Vocational Education Amendments on handicapped programs. Rating Rationale:_____	0	1	2*	3	4	5	6
24. Maximize the number of disadvantaged students served by special disadvantaged programs. Rating Rationale:_____	0	1	2	3*	4	5	6
25. Maximize the number of disadvantaged students served by regular adult vocational education programs. Rating Rationale:_____	0	1	2	3	4*	5	6

Next Page Please

ADULT VOCATIONAL EDUCATION OBJECTIVES	NO IMPORTANCE	VERY LOW IMPORTANCE	LOW IMPORTANCE	MEDIUM IMPORTANCE	HIGH IMPORTANCE	VERY HIGH IMPORTANCE	ESSENTIAL
26. Maximize the number of handicapped students served by special handicapped programs. Rating Rationale:_____	0	1	2	3*	4	5	6
27. Maximize the number of handicapped students served by regular adult vocational education programs. Rating Rationale:_____	0	1	2	3	4*	5	6

The remainder of this survey contains the "write-in" objectives as suggested by you and your colleagues from the first rating cycle. In this case the asterisks denote the ratings given at that time. Also rate these objectives without supplying a rationale for your rating. Please keep in mind that the objectives relate to Adult Vocational Education at a state-wide level of program planning, and the ratings should indicate perceived importance in relation to all objectives.

PREVIOUS WRITE-IN OBJECTIVES	NO IMPORTANCE	VERY LOW IMPORTANCE	LOW IMPORTANCE	MEDIUM IMPORTANCE	HIGH IMPORTANCE	VERY HIGH IMPORTANCE	ESSENTIAL
1. Provide training to cover the full spectrum of manpower needs for all jobs in accordance with the magnitude of those needs across that spectrum.	0	1	2	3	4*	5	6

Next Page Please

PREVIOUS WRITE-IN OBJECTIVES	NO IMPORTANCE	VERY LOW IMPORTANCE	LOW IMPORTANCE	MEDIUM IMPORTANCE	HIGH IMPORTANCE	VERY HIGH IMPORTANCE	ESSENTIAL
2. Maximize the working relationship between public and private training agencies.	0	1	2	3	4	5*	6
3. Maximize training that supports state and local economic development.	0	1	2	3	4	5	6*
4. Maximize the use of current industry equipment used for training.	0	1	2	3	4	5*	6
5. Maximize program offerings which coincide with adult interests.	0	1	2	3	4	5*	6
6. Provide maximum support for new programs that would service emerging manpower needs.	0	1	2	3	4	5*	6

ADDITIONAL WRITE-IN OBJECTIVES	NO IMPORTANCE	VERY LOW IMPORTANCE	LOW IMPORTANCE	MEDIUM IMPORTANCE	HIGH IMPORTANCE	VERY HIGH IMPORTANCE	ESSENTIAL
Objective:_____	0	1	2	3	4	5	6
Objective:_____	0	1	2	3	4	5	6
Objective:_____	0	1	2	3	4	5	6

Code No: _____
Used for (follow-up)

APPENDIX F

July 30, 1981

Dear Colleague,

This is the final and most crucial phase of our three round Delphi study. The first round of the study was used to establish an initial set of objectives for Adult Vocational Education at the state-level of program planning. The second round was used to narrow this list of objectives to include only those rated with medium importance or above. In addition to this, comments were collected from this round to provide perspective for making your ratings in the final round.

In this final round you are asked to carefully consider each objective in the light of the comments provided from the previous round and give your final rating. Also, near the end of the instrument you are asked to provide suggestions for ways in which some of the more abstract objectives may be objectively measured.

Once again let me extend my gratitude for the effort you have expended toward the success of this study. An expedient return of the enclosed instrument will hasten the completion of this project, at which time you will be provided with a summary report of the results.

Sincerely,

Lonnie D. Roberts
Research Coordinator

LDR/sr

APPENDIX G

ADULT VOCATIONAL EDUCATION
OBJECTIVE RATING SCALE
FINAL ROUND

DIRECTIONS: Give your final rating to the reduced list of objectives using the rating scale shown below. The mean score for each item along with any corresponding comments given from the previous round are included for your consideration in making this final rating. Keep in mind that you are rating the relative importance of each objective statement for a state-wide level of program planning in Adult Vocational Education.

RATING SCALE:
0 = No Importance
1 = Very Low Importance
2 = Low Importance
3 = Medium Importance
4 = High Importance
5 = Very High Importance
6 = Essential

		PREVIOUS MEAN RATING	YOUR FINAL RATING
1.	OBJECTIVE: Students should be placed in training related jobs.	5	
	COMMENTS: (1) We can't all agree on "training related," I have a liberal interpretation.		
2.	OBJECTIVE: Students should be placed in jobs regardless of the training relatedness of the job.	4	
	COMMENTS: (1) It is more important to be employed than waiting for a job in an area for which trained.		
	(2) We should stake our reputations on placement, --- employment conditions change, students may have to take non-related employment to be placed in line for a training related job.		
3.	OBJECTIVE: Students should be placed in jobs within the state of Oklahoma.	4	
	COMMENTS: (1) (This) limits opportunity.		
	(2) Okla. $ should be used to strengthen Okla. economy --- not Texas, Arkansas, etc.		

		PREVIOUS MEAN RATING	YOUR FINAL RATING
4.	OBJECTIVE: Students should be placed in jobs regardless of the state in which employment is attained.	3	
	COMMENTS: (1) Same rationale as in #2.		
	(2) Federal funds may be used for training.		
5.	OBJECTIVE: Train no more students in a given career field than there are job opportunities in that field.	4	
	COMMENTS: (1) --- employment is essential.		
	(2) Yes, we don't have a crystal ball.		
	(3) It is unforgiveable to train a student for a job which does not exist --- wastes his time, money and good attitude.		
6.	OBJECTIVE: Train no fewer students in a given career field than there are job opportunities in this field.	4	
	COMMENTS: None		
7.	OBJECTIVE: Training should result in maximizing entry-level wages following program participation.	4	
	COMMENTS: (1) There must be wages as a reward for training.		
	(2) (Wages) should exceed entry-level.		
8.	OBJECTIVE: Students should receive jobs resulting in a high degree of job satisfaction.	4	
	COMMENTS: NONE		
9.	OBJECTIVE: Students should feel that the training has adequately prepared them for employment.	5	
	COMMENTS: None		

			PREVIOUS MEAN RATING	YOUR FINAL RATING
10.	OBJECTIVE:	Employers should feel that training has adequately prepared students for employment.	5	
	COMMENTS:	(1) Interest(ed) in results.		
		(2) Without this satisfied "consumer" there is no need for the product.		
11.	OBJECTIVE:	Training should result in maximum social benefits.	4	
		(1) That is the motivation.		
		(2) Manpower based planning operates on this premise.		
12.	OBJECTIVE:	Attrition rates should be minimized.	5	
	COMMENTS:	(1) Minimize, yes, but provide the student with options.		
13.	OBJECTIVE:	Program budgets should not be exceeded.	4	
	COMMENTS:	(1) Education does not operate in the red --- (we must) request more money.		
		(2) Budget what is necessary.		
		(3) Must try to meet needs --- not budgets.		
14.	OBJECTIVE:	No less than the minimum amount required by the Vocational Education Amendments should be spent on disadvantaged programs.	4	
	COMMENTS:	(1) There is a need for all the training that can be provided to the disadvantaged.		
		(2) If required by law, do it.		
		(3) The amounts spent are too low.		
		(4) Essential for continued funding --- set-asides must be that.		

			PREVIOUS MEAN RATING	YOUR FINAL RATING
15.	OBJECTIVE:	No less than the minimum amount required by the Vocational Education Amendments should be spent on handicapped programs.	5	
	COMMENTS:	(1) The need for training is not being met.		
		(2) Required, do it.		
		(3) Does not include physical.		
		(4) Essential for continued funding --- set-asides must be that.		
16.	OBJECTIVE:	The number of disadvantaged students served by special disadvantaged programs should be maximized.	3	
		(1) This is a large segment.		
		(2) (This is) contrary to mainstreaming concept mandated by federal legislation.		
17.	OBJECTIVE:	The number of disadvantaged students served by regular adult vocational education programs should be maximized.	4	
	COMMENTS:	Mainstream as much as possible.		
18.	OBJECTIVE:	The number of handicapped students served by special handicapped programs should be maximized.	3	
	COMMENTS:	(1) Vocational education is the best opportunity for a large number of handicapped.		
		(2) Contrary to mainstreaming concept mandated by federal legislation.		
19.	OBJECTIVE:	The number of handicapped students served by regular adult vocational education programs should be maximized.	4	
	COMMENTS:	(1) Mainstream as much as possible.		

WRITE-IN OBJECTIVES FROM ROUNDS I AND II

		PREVIOUS MEAN RATING	YOUR FINAL RATING
1. OBJECTIVE:	Provide training to cover the full spectrum of manpower needs for all jobs in accordance with the magnitude of those needs across the spectrum.	4	
COMMENTS:	(1) There are certainly unmet manpower needs which are inappropriate for adult vocational education training (unskilled, low pay, etc.)		
2. OBJECTIVE:	Maximize training that supports state and local economic development.	6	
3. OBJECTIVE:	Maximize the use of current industry equipment used for training.	5	
COMMENTS:	(1) Often times this is too narrowly focused --- not transferrable.		
4. OBJECTIVE:	Maximize program offerings which coincide with adult interests.	4	
COMMENTS:	(1) As long as manpower demand warrants it.		
5. OBJECTIVE:	Provide maximum support for new programs that would service emerging manpower needs.	5	
6. OBJECTIVE:	Provide upgrade training opportunities for individuals and industries.	5	

DIRECTIONS: Below, you are asked to suggest currently available indices that could be used to adequately measure certain factors as they pertain to program areas (eg. welding, carpentry, etc.).

How would you measure:

1. the training relatedness of a particular job? _____
   (eg. by relating job titles to program names)

2. job satisfaction following program completion? _____
   (eg. # of positive follow-up comments)

3. student's perception of training adequacy? _____

4. employers perception of training adequacy? _____

5. social benefits resulting from training related employment? _____
(eg. increased tax revenue resulting from training related employment) _____

6. the extent to which a program area is resolving unmet manpower needs within a particular career discipline? _____
(eg. correlation between the number of students entering a career subfield to the manpower demand of that subfield)

7. local economic development resulting from participation in a particular training program? _____

8. the degree to which current industry equipment is used in a given program area? _____
(eg. number of students participating in industrial co-op programs)

9. adult interest in a particular program area? _____
(eg. initial enrollment levels)

10. program success in servicing emerging manpower needs? _____
(eg. number of graduates versus Occupational Outlook forcasts)

11. program success in providing upgrade training? _____

Code No: _____

(Used for follow-up)

APPENDIX H

LINEAR OBJECTIVES - INITIAL DESIGN

RANK	
I	OBJECTIVE: Maximize training that supports state and local economic development
	PARAMETER: Average yield of state tax dollars, per program area
II	OBJECTIVE: Provide upgrade training opportunities for individuals and industries
	PARAMETER: Employer ratings of employees with respect to relative job preparedness between participants and non-participants of training, per program area
III	OBJECTIVE: Employers should feel that training has adequately prepared students for employment
	PARAMETER: Average rating given by employers of overall training adequacy, per program area
IV	OBJECTIVE: Students should feel that training has adequately prepared them for employment
	PARAMETER: Average rating given by employees of overall training adequacy, per program area
V	OBJECTIVE: Provide maximum support for new programs that would service emerging manpower needs
	PARAMETER: None - no historical data exists for "new program" areas, thus there was no basis for determining the degree of success such programs would have in actually achieving this or any of the other objectives . . . the model was restricted to the use of deterministic data only
VI	OBJECTIVE: Maximize the use of current industry equipment for training
	PARAMETER: Employers ratings for the technical relevance of the training program to the requirements of the job, per program area
VII	OBJECTIVE: Students should be placed in training related jobs
	PARAMETER: Average number of training related placements, per program area

VIII OBJECTIVE: Attrition rates should be minimized

PARAMETER: Average attrition rate, per program area

APPENDIX I

ADULT VOCATIONAL EDUCATION
GOAL PROGRAMMING MODEL
FOR THE STATE OF OKLAHOMA

Determine the solution, $\bar{X}$, from the matrix,

$$\sum_{j=1}^{J} C_{ij} X_j + n_i - p_i = b_i, \text{ for all } i,$$

so as to minimize the vector,

$$\bar{A} = \left\{[g_1(\bar{n},\bar{p})], [g_2(\bar{n},\bar{p})],\ldots,[g_k(\bar{n},\bar{p})]\right\}$$

such that $\bar{X}$, $\bar{n}$, $\bar{p} \geq o$

RANK

I OBJECTIVE: The overall budget should not be exceeded

$C_{ij} = B_j/X_j$ where: B_j = budget for program area j

X_j = number of students in program area j

$$b_i = \sum_{j=1}^{J} C_{ij}X_j$$

II OBJECTIVE: Maximize the training that supports state and local economic development

$C_{ij} = E_jI_jT_j(1 - D_j)$ where: E_j= ratio of average annual earnings of graduates from program area j to average earnings of all graduates

$$b_i = \sum_{j=1}^{J} C_{ij}X_j$$

I_j= percentage of graduates of program area j who are employed in-state

T_j= ratio of state tax paid on average annual earnings of graduates from program area j to that of all graduates

D_j= 10% derating factor for program areas in which a significant amount of cross-district mobility occurred

RANK

III OBJECTIVE: Provide upgrade training for individuals and industries

$C_{ij} = P_j$ where: P_j= percentage of graduates from program area j, who are working in training related jobs, that are rated by their employer as being better prepared than their peers

$b_i = \sum_{j=1}^{J} C_{ij}X_j$

IV OBJECTIVE: Maximize employer's perception of training adequacy

$C_{ij} = A_j$ where: A_j = average overall rating of training for program area j as perceived by employers

$b_i = \sum_{j=1}^{J} C_{ij}X_j$

V OBJECTIVE: Maximize use of current industry equipment for training

$C_{ij} = K_j$ where: K_j = average rating of technical knowledge of graduates from program area j as perceived by employers

$b_i = \sum_{j=1}^{J} C_{ij}X_j$

VI OBJECTIVE: Students should be placed in training related jobs

$C_{ij} = G_j$ where: G_j = percentage of graduates from program area j who are placed in training related jobs

$b_i = \sum_{j=1}^{J} C_{ij}X_j$

VII OBJECTIVE: Minimize attrition rates

$C_{ij} = R_j$ where: R_j = percent attrition rate of of program area j

$b_i = \sum_{j=1}^{J} C_{ij}X_j$