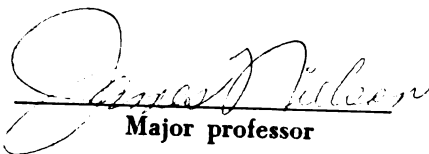




CLASSIFICATION OF FARM MANAGERIAL TYPES:
AN APPLICATION OF PATTERN ANALYSIS

Thesis for the Degree of Ph. D.
MICHIGAN STATE UNIVERSITY
Myron Eugene Wirth
1964

This is to certify that the
thesis entitled
CLASSIFICATION OF FARM MANAGERIAL TYPES:
AN APPLICATION OF PATTERN ANALYSIS
presented by
Myron Eugene Wirth
has been accepted towards fulfillment
of the requirements for
Ph. D. degree in Agricultural Economics


Major professor

Date August 4, 1964



ABSTRACT

Classification of Farm Managerial Types:

An Application of Pattern Analysis

by

Myron Eugene Wirth

The major objectives of this research were to explore the efficacy of pattern analysis in classifying farm managers, and to gain insights on the kinds of information concerning the farm manager that are most significant in differentiating various levels of managerial proficiency.

This research employed pattern analysis as a means of assessing interactive relationships among 60 items of information(antecedents) to classify managers into relatively homogeneous groups. These groups were then tested for consistency with managerial performance criteria.

The results indicated that with certain sets of antecedents, pattern analysis classifications were consistent with managerial performance criteria. With others, they were not.

The significant antecedents included 26 items concerning motivations, goals, and attitudes interacting with 13 items about decision-making processes. Neither the 26 items as a group alone, nor the group of 13 items alone provided significant classifications.

The group of 21 biographical items were insufficient to provide significant classifications when used alone as a pattern-analysis input. Moreover, this group of items appeared to add nothing to the discriminatory capability of the informational input when used with other items. Some evidence suggest that biographical items may even have impaired the discriminatory capability of other information.

Myron Eugene Wirth

In one phase of the research, pattern analysis correctly classified a high proportion of low and high-performance managers using the 39 items discussed above as inputs. Significance tests between these two performance groups with respect to the 39 items, and then additionally on the remaining 21 items, reveal little that would differentiate low from high-performers on an item-to-item basis. This means that the two performance groups were not distinguishable different in terms of typical dimensional analyses of the 39 items. And yet, in terms of patterns, they were.

Pattern analysis as used in this study does not reveal the discriminatory power of each item of input information. However, by experimenting with the input mix, as was done in this study, significant classes of information may be isolated. Subsequent studies may then benefit by research designs that provide greater depth in these significant classes of information.

Some of the information available for use in this research is not usually found in typical farm management survey records. This is the case for most of the 39 items concerning motivations, goals, attitudes, and decision-making found to constitute a significant class of information in this study. But while these items can be said to have tapped the manager's motivations, goals, attitudes, decision-making processes and so on, they cannot be considered in any way exhaustive. Moreover, no capability information (intelligence, aptitudes, abstract reasoning skill, etc.) was available for use in this research.

The results from this study suggest that pattern analysis can be sharpened considerably by including greater depth in the kinds of

Myron Eugene Wirth

information used in this study. And the same seems likely if capability information were added. But this alone is only an intermediate goal. The more important objective is to gain insights into what differentiates a good manager from a poor one. Yet, it is doubtful if this can be accomplished in any meaningful way unless managers can first be identified or classified into relatively homogeneous groups. And these classifications must be based upon the important interactive qualities of management, and not merely in terms of performance criteria. Pattern analysis appears promising in this respect.

CLASSIFICATION OF FARM MANAGERIAL TYPES:

AN APPLICATION OF PATTERN ANALYSIS

By

Myron Eugene Wirth

A THESIS

**Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of**

DOCTOR OF PHILOSOPHY

Department of Agricultural Economics

1964

9/22/72
6/5/75

PREFACE

This is the first in a series of research studies under the Michigan Agricultural Experiment Station project entitled, "The Relationships of Managerial Processes and Personal Attributes to Managerial Performance in Farming." This is a contributing project under NC-59, Regional Research on the Management Resource in Farming in the North Central States under The Research and Marketing Act of 1946.

Thanks are extended to James Nielson, chairman of my guidance committee, for his suggestions on methodology, and for providing the data used in this study.

Thanks are also due Ralph Loomis for his help in conceptualizing the research approach, and to George Irwin and John Hafterson for their help in handling many puzzling computer problems, and to Dave Boyne and John Brake for their helpful comments on an earlier draft.

TABLE OF CONTENTS

	Page
PREFACE.	ii
LIST OF TABLES	iv
LIST OF FIGURES	v
LIST OF APPENDICES	vi
 Chapter	
I. PERSPECTIVE	1
II. THE GENERAL PROBLEM OF RESEARCHING MANAGEMENT	3
A Model of the Farm Manager	3
Measurement Problems	5
Possible Approaches to the study of Managerial Behavior of Farmers.	8
III. PROCEDURES USED IN THIS RESEARCH.	18
Selecting the Data.	18
Pattern-Analytic Procedures	19
Criteria of Managerial Performance.	25
The Research Format	28
IV. EMPIRICAL RESULTS FROM THE PATTERN ANALYSIS	31
Testing the Typal Hypotheses - 109 Farms.	31
A Different Approach - 36 Farms	36
The Problem of Characterizing Patterns.	40
V. IMPLICATIONS	44
 BIBLIOGRAPHY	 47
APPENDICES	49

LIST OF TABLES

Table	Page
1. Group Classification of Farmers by Pattern Analysis, and Group Ranking Based on Managerial Performance Criteria, 60 Antecedent Items, 109 Farms.	33
2. Group Classification of Farmers by Pattern Analysis, and Group Ranking Based on Managerial Performance Criteria, 39 Antecedent Items, 109 Farms.	35
3. Group Classification of Farmers by Pattern Analysis, and Group Ranking Based on Managerial Performance Criteria, 26 Antecedent Items, 109 Farms.	37

LIST OF FIGURES

Figure		Page
1.	▲ Model of the Farm Manager	4
2.	Hypothetical Types.	15
3.	Hypothetical Results From Clustering.	24
4.	The Research Format	29
5.	▲ Classification of Farmers By The Method of "Hierarchical Classification By Reciprocal Pairs," 36 Farm N/K Group	40

LIST OF APPENDICES

Number	Page
A. Recent Research in the Field of Psychology on the Problem Solving Process	49
B. Selected References Concerning Pattern Analysis by Louis L. McQuitty.	53
C. Items of Information (Antecedents) Concerning Each Individual Farmer Used as a Basis for the Pattern Analysis	55

CHAPTER I

PERSPECTIVE

Most students of management agree on the crucial role of the manager. But little is known in a substantive way about managerial behavior. This failure to understand is not because of a lack of research effort on management but rather because of the profound difficulties of conceptualization and measurement.

One of the difficult problems facing the farm management researcher is that of classifying managers into relatively homogeneous groups based upon management ability. This identification of managerial levels is a necessary step if research findings are to have validity and generality not possible with the case-study or single-individual research approach. The research reported here has as a broad purpose the investigation of possibilities for improving the classification of farmers according to management ability. Specifically, the major objectives are first, to explore the efficacy of pattern analysis in classifying farm managers. And second, to gain insights on what kinds of information concerning the farm manager as a person are most significant in differentiating various levels of managerial proficiency. The pattern-analytic technique used is one developed by Louis McQuitty in 1963. It is called, "Hierarchical Classification by Reciprocal Pairs". To my knowledge, this method has not been previously applied to the classification of farm managers.

The data are from a sub-sample of 109 farms used in the evaluation research for the Michigan Township Extension Experiment which covered the 5-year period 1953 to 1958. This report draws from the terminal

survey taken in 1959 although some of the questions asked in that survey referred to the whole 5-year period. A number of other studies were made in conjunction with the Township Extension Experiment and are reported elsewhere.^{1/}

^{1/} James Nielson and William Crosswhite, "The Michigan Township Experiment: Changes in Agricultural Production Efficiency and Earnings," Mich. Agr. Expt. Sta. Technical Bulletin 27r, October 1959; James Nielson, "The Michigan Township Extension Experiment: The Experimental Program and Farmers' Reactions to It," Mich. Agr. Expt. Sta. Technical Bulletin 284, 1961; James Nielson, "The Michigan Township Extension Experiment: The Farm Families, Their Attitudes, Goals, and Goal Achievement," Mich. Agr. Expt. Sta. Technical Bulletin 287, 1962; M. E. Wirth and James Nielson, "Resource Ownership and Productivity on Michigan Farms," Mich. Agr. Expt. Special Bulletin 435, August 1961; Edmund T. Hamlin, M. E. Wirth, and James Nielson, "Financing Agricultural Production on Michigan Farms," Mich. Agr. Expt. Sta. Special Bulletin 445, July 1963.

CHAPTER II

THE GENERAL PROBLEM OF RESEARCHING MANAGEMENT

A Model of the Farm Manager

Before discussing some of the problems concerning managerial research it will be helpful to consider a theoretical construct of the manager. For this purpose, I have used Nielson's model of the farm manager.^{2/} Figure 1, although greatly simplified, presents the essential elements of this model and is sufficient for our purposes here.

The V set symbolizes the manager as a person with a certain configuration of background experience V₁ and presumably a memory of these, and as a person who is directed by certain drives and motivations V₂ which are monitored by a value system, and as one endowed with certain capabilities or talents V₃ such as intelligence, imagination, skills, and so on. The P set signifies the whole complex of activities which are usually referred to as managerial processes. While some outward manifestations of these processes may be recognized, much of the actual process of management is internalized in the mind of the manager. Or as cyberneticists refer to it, the P set is the "black box" of the management model: the thing most difficult to dissect in an analytically meaningful way. Finally, the O set of the model represents the managers' raison de etre -- the outcome.

^{2/}James Nielson, "Aspects of Management of Concern to the Basic Researcher, " Describing and Measuring Managerial Abilities and Services, Report No. 4, Farm Management Research Committee of the Western Agricultural Economics Research Council, Denver, Colorado, October 24, 1962.

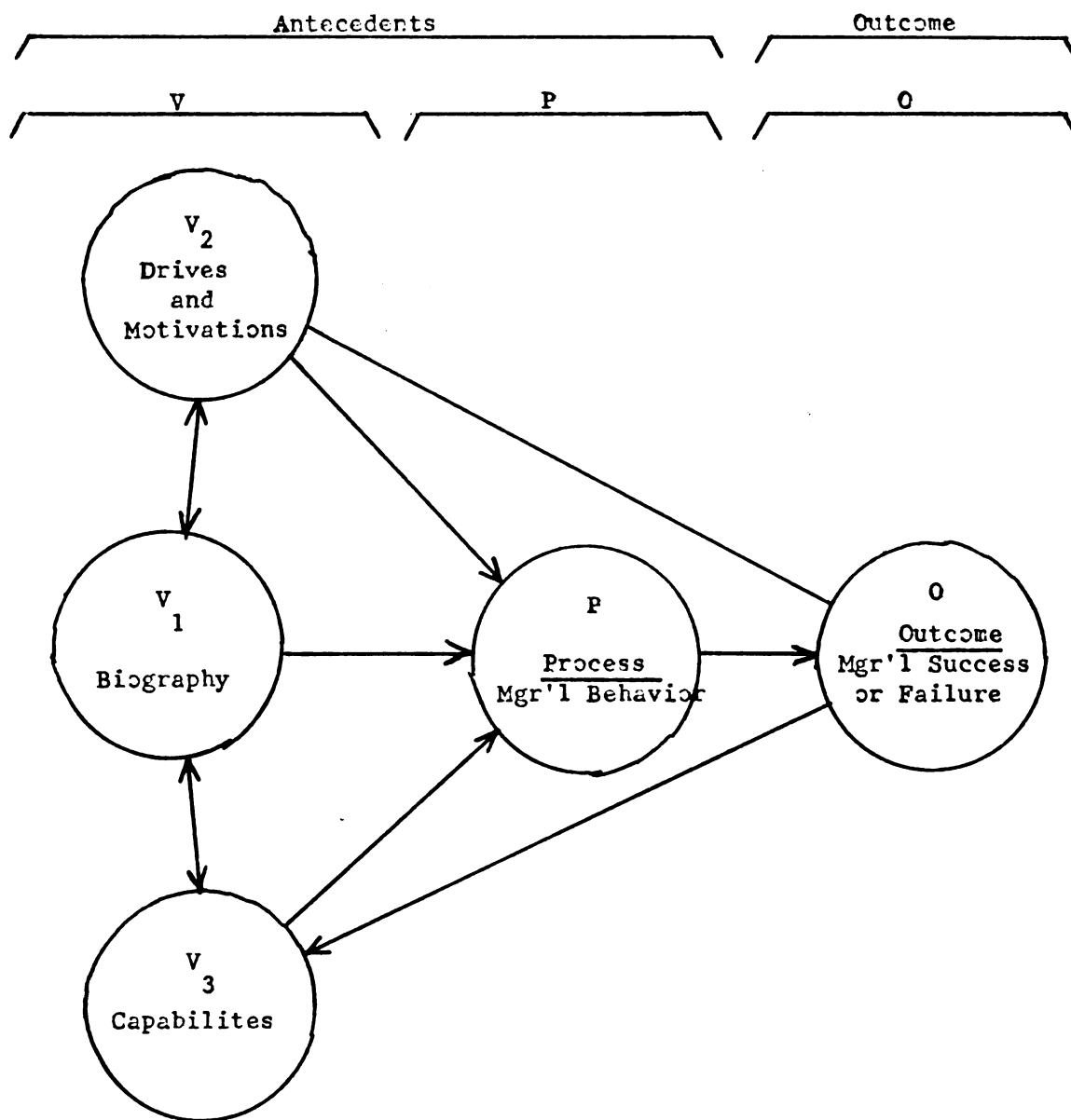


Figure 1. A Model of The Farm Manager

Considering the whole model, the manager is viewed as a behavioral entity or perhaps better, a goal-oriented system seeking to produce a desirable goal-state or outcome. Given certain levels and interactions within the V set, the manager engages in certain mostly internalized processes P which lead him into various activities that produce outcomes O of varying degrees of finality.

Measurement Problems

Serious measurement problems are inherent in all three of these relational sets. In the V set, it's not difficult to obtain reasonably accurate background information (V₁), but motivations (V₂) and capabilities (V₃) are formidable areas of measurement. Many test instruments have been developed, particularly by psychologists, to measure intelligence, aptitudes, abstract reasoning skills, values, interests, attitudes, personality structure and so on.^{3/} But little has been done to test, modify, adapt, or validate these tests for studying managerial behavior of farmers.^{4/}

Measuring or even describing managerial processes (P set) presents a very perplexing array of problems. Psychologists and social psychologists have investigated this area under the rubric of problem-solving behavior. Most of this work is at the very basic or fundamental level.^{5/} It is interesting and in some ways insightful,

^{3/}For example: Wechsler Adult Intelligence Scale, Bennet Mechanical Comprehension Test, and Benreuter Personality Inventory. And there are hundreds of others.

^{4/}As mentioned in Footnote 1, this study is a part of the Michigan NC-59 project. In this project, one of the major objectives is to investigate the possibilities of adapting or developing tests for measuring the V set. This work will be done in cooperation with psychologists and sociologists.

^{5/}See Appendix A for a discussion and selected bibliography of this work.

but it has scarcely advanced far enough to help farm management researchers measure or quantify process as behavioral phenomena.

Some work in characterizing managerial processes has been done by agricultural economists. Prominent among these efforts is the North Central Regional Farm Management project entitled, "Interstate Managerial Survey" (IMS).^{6/} IMS researchers investigated processes using a general model of "functions" which the manager performs or has an opportunity to perform. These functions included: (1) observation, (2) analysis, (3) decision, (4) action, and (5) responsibility bearing. In the conclusions, problem definition was suggested as an additional function that should be added. Although each function was studied separately, it was recognized that they were inter-related parts of a whole process.

The measurement problems inherent in the outcome (O) set of the model are most often referred to as the, "criterion problem." The important questions here are, "How can managerial outcome or performance be most appropriately measured? Should only economic performance be considered, or should noneconomic aspects be included?" What criterion or criteria are most relevant, given certain research objectives?

In an economic context, one possibility for measuring performance is to quite arbitrarily establish limits on some simple measure such as net farm income. Of course, this simple criterion ignores the

^{6/}The results of this project are summarized in: Glenn L. Johnson et al., editors, A Study of Managerial Processes of Midwestern Farmers, Iowa State University Press, 1961.

size difference among farm units. On the average, large units would invariably be judged as higher performers than smaller units.

A more satisfactory approach is to use the equi-marginal and maximizing concepts of static economics. Managerial performance could be gauged with respect to the degree a farm manager deviates from the optimal situation of equalizing the ratios of added returns to added costs among all inputs. But discovering the optimum for each manager is a demanding and complex task. And so, the operational appropriateness of this criterion becomes suspect.^{7/} Moreover, when risk and uncertainty situations typically facing farm managers are introduced, the whole thing is clouded further. And overlaying these complications from the researcher's point of view are the well-known statistical problems of estimating parameters of functional relationships.

If one can somehow surmount these problems, or if he is willing to ignore them, still another important question needs to be considered, "Should the criterion of managerial performance consider the manager as a maximizing or satisficing entity?" If we are only concerned with management as a set of logical rules, then the normative schemes for economic maximizing and optimizing seem appropriate. If we are concerned with management as human behavior then the ideas advanced by Simon^{8/} and others concerning satisficing behavior seem more compelling. As March and Simon point out:^{9/}

^{7/}For example see: Kenneth E. Boulding, Economic Analysis, Harper and Brothers, New York, 1948, pp. 813-840.

^{8/}Herbert A. Simon, "Theories of Decision-Making in Economics and Behavioral Science," American Economic Review, Vol. 49, June 1959, pp. 253-283.

^{9/}J. March and Herbert A. Simon, Organizations, Wiley and Sons, New York, 1958.

Most human decision-making, whether individual or organizational, is concerned with the discovery of satisfactory alternatives; only in exceptional cases is it concerned with the discovery and selection of optimal alternatives. To optimize requires processes several orders of magnitude more complex than those required to satisfy.

While maximizing may be more difficult than satisficing for the manager, the opposite is true for the researcher. To paraphrase March and Simon, "Satisficing behavior is several orders of magnitude more difficult to understand than maximizing behavior." Maxima and optima are objective and easily defined and understood concepts. Satisficing is a more subjective concept. A satisficing level of performance would vary according to each individual's, or perhaps a group of individuals' idea of "satisfactory level."

Another criterion problem implied by the satisficing model of the manager is the inter-relationship between attainment (outcome) and aspirational levels. One could define ideal managerial performance as that point where the aspirational and attainment levels were equal. But how would one make interpersonal comparisons of performance in any sensible way?

When we go beyond economic considerations, the problem of managerial performance criteria becomes even more complex. In this case, an accounting of managerial performance would also need to include consideration of the non-economic outcomes that result from managerial behavior relative to the managers' goals and values.

Possible Approaches to the Study of Managerial Behavior of Farmers

This brief review of some of the measurement problems associated with researching management serves to support the contention that

12

there is no easy approach to the study of the farm manager. Referring again to the management model of Figure 1, four approaches for researching management are suggested: (1) V related to P, (2) V related to O, (3) P related to O, and (4) V related to P related to O.

Little has been done in relating V to P or P to O. And this is probably true in large measure because of the great difficulty in handling processes or functions in analytically useful ways. IMS researchers recognized the relevance of farmers' value concepts as they relate to managerial process functions.^{10/} But this was not one of the principal objectives of this study, and so little data were available to examine these relationships.

The V related to P related to O approach is extremely ambitious and will probably never be fully realized within the confines of any one study. Perhaps the NC-59 project, referred to previously, which builds on IMS and other studies, will provide some progress toward the empirical validation of an integrated model of the farm manager.

The greatest number of studies have taken the V related to O approach. Typically one or several economic outcome criteria have been selected as representing adequate measures of managerial performance. The criterion is then related to certain measures in the V set in order to characterize various levels of performance.

Studies of Two Dimensions

One result frequently found in the V related to O studies is the poor predictive reliability in O of single elements in V. Several problems are bothersome. First the correlative relationship

^{10/}Johnson, op. cit., pp. 140-149

between any single elements in V with O is likely to be low. Or, even if these elements appear highly correlated (often tested by Chi-square) the categoration of the V element may be so gross that adequate predictions of O are not possible. Second, interaction among elements in V may preclude the use of a single element in V as a useful predictor in O. And further, traditional statistical tests of significance often used to test the relationship of a V element to O may produce spurious results. This may be true if the usual normality and linearity assumptions are invalid. And this may well be the case in the V set where we deal with facets of personality. Of course, this problem could also apply to multiple relationships.

Studies of Multiple Dimensions

Improvement in the predictive usefulness of V to O relationships may be obtained by using a combination of V elements to predict O. This might be handled in a tabular analysis by successive subclassifications of several V elements. Or it might be done in a functional context where O is taken as some function of $\underline{V}_1 \dots \underline{V}_n$ and the parameters are then estimated statistically.

- Several problems are apparent here. First, is the obvious one of finding a function that most appropriately fits the data. In the absence of a priori reasons for choosing otherwise, the linear form is frequently used because of its simplicity.

Second, is the problem of selecting the most relevant variables from the mass of data that may be available. Occasionally items of information that might be used as independent variables exceed the number of observations or subjects in the sample. In this case,

statistical estimation of the parameters is not possible. So the researcher must make judgements on theoretical or other grounds regarding what informational items should be deleted. He cannot expect reliable results unless he has at least a reasonable number of observations in excess of the parameters to be estimated with which to estimate each parameter.

A further problem concerns what is typically called qualitative or nonquantitative data. This is not an insurmountable problem. One approach is to use "dummy" or zero-one variables in regression analysis as a means of handling qualitative data. But this involves difficulty in testing the significance of estimated "dummy" variable parameters.^{11/} Moreover, "dummy" variables can be costly in terms of the degrees of freedom that are used up.

Factor analysis is another technique that can be applied to analyze multiple dimensions among the V and O sets of our management model. This technique has been widely used by psychologists and sociologists to handle qualitative data, but has seen only very limited application by farm manager researchers.^{12/} This is essentially a statistical method of isolating from a large mass of items a few constructed variables that will adequately account for the variance of all the

^{11/}For a discussion of this problem see: E. Riensel, "Discrimination of Agricultural Credit Risks from Loan Application Data," unpublished Ph. D. thesis, Michigan State University, 1963, pp. 35-40

^{12/}Two recent examples in the farm management area are: Gordon A. MacEachern, D. Thomas, and L. Eisgruber. "Analysis of Human Attributes and Their Relationship to Performance Level of Farm Tenants," Research Bulletin No. 751, Indiana Agr. Expt. Sta., November 1962; and Donald Huffman, "A Technique for Classifying Farm Managers According to Managerial Ability," unpublished Ph. D. thesis, Ohio State University, 1963.

items. The basic idea underlying factor analysis is the Thurstonian concept of "simple structure."^{13/} That is, of the many kinds of data responses that a researcher may examine, many measure the same thing. Factor analysis seeks to find the few common "factors" or simple structure which account for most of the variance. The relationships among the data items are assumed to be linear and the resultant "factors" are treated as dimensional. They are inferred to account for the linear intercorrelations among the data items, and are considered as dimensions in the sense that every respondent is assumed to possess more or less of each factor.

In their study of tenant farmers' performance, MacEachern, Woods, and Eisgruber conclude that factor analysis may have potential in the study of farm management. They say:^{14/}

...this research also suggests that a procedure such as the one used (factor analysis)^{15/} can aid in isolating basic factors which are considerably more general than biographical data. Such an isolation of basic factors should be helpful in designing more analytical measures of management than biographical data or other information that offers evidence or description of success rather than cause and potential.

However, the factor-analytic notion that a small number of common factors can measure mental abilities has been seriously questioned. Guttman has this to say about it:^{16/}

As for the empirical truth of the hypothesis of a small number of common-factors for mental abilities, evidence constantly being accumulated by factor analysts throughout

^{13/}L. L. Thurstone, Multiple Factor Analysis, The University of Chicago Press, Chicago, 1947.

^{14/}MacEachern, op. cit., p. 13.

^{15/}My words in parenthesis

^{16/}Louis Guttman, "What Lies Ahead for Factor Analysis," Educational and Psychological Measurement, Vol. 18, No. 3, 1958.

the world---notably among them Thurstone's students --- now seems conclusive against it. The growth of the literature on factor analysis in psychology has been accompanied by an ever lengthening list of different common factors.

Studies of Typal Structure

Another possibility for studying the V to O relationships of the management model is the pattern-analytic approaches developed by McQuitty.^{17/} In general, these techniques classify or cluster individuals based upon some index of association among individual patterns of response to test items or questions. The methods are implied from a typal theory of human behavior. And the definitions of typal structure have rather important analytical implications. For example, typal structure is defined in Elementary Linkage Analysis (ELA) as one in which every member of a type is more like some other member of that type (with respect to the data analyzed) than he is like any member of any other type.^{18/}

A more comprehensive definition of types generates Rank Order Typal Analysis (ROTA). Typal structure is therein defined as one in which every member of a type is more like every other member of that type than he is like any member of any other type.^{19/} Figure 2 illustrates the difference between these two typal definitions.

Hypothetical Type I satisfies the first definition of types since each member (A, B, and C) has its highest index of association with some other member, i.e., A highest with B, B highest with A, and C highest with B.^{20/} Type I does not, however, satisfy the second

^{17/}See Appendix B for list of relevant references.

^{18/}Appendix B, Reference 7, p. 209.

^{19/}Appendix B, reference 16, p. 55.

^{20/}Appendix B, reference 13, p. 678

definition of types since B is 3rd most like C. It follows that B must be more closely related (2nd most like) to someone outside of Type I. Type II as illustrated satisfies the second definition of types. For every member (X, Y, and Z) has no rank larger than 2nd with each of the other two members. And therefore, each member is more like every other member than he is like any outsider. Note that the illustration of Type II also satisfies the first definition of types. However, this stringent homogeneity of type is not required by the first definition.

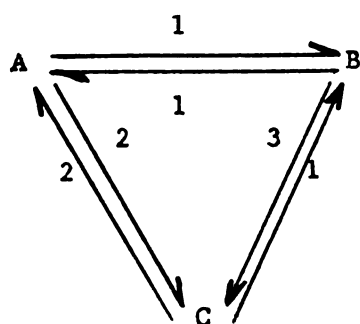
The pattern-analytic technique explored in this research differs in several fundamental ways from all of the analytical methods discussed previously. And perhaps these differences can be more easily seen by contrast with factor analysis. As McQuitty points out, the fundamental difference between factor analysis and ELA (a pattern-analytic technique) is in terms of the assumed structure which is being investigated. Factor analysis is designed to isolate simple structure (a dimensional concept as previously defined) but ELA is designed to isolate typal structure.^{21/} Elsewhere, he says:^{22/}

Dimensional constructs are based on the proposition that individuals differ primarily in their standings on common dimensions. Typological constructs, on the other hand, are based on the assumption that individual differences cannot be adequately assessed in terms of common dimensions. It is assumed that patterns of responses contain some significant information which is unassessed in terms of common dimensions.

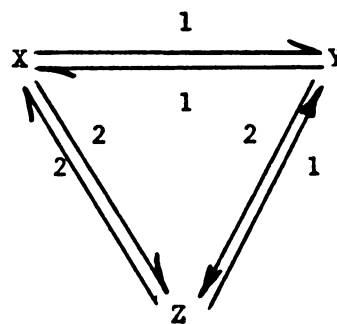
Another fundamental difference between pattern analysis and factor analysis, or for that matter any other methods previously

^{21/}Appendix B, reference 7, p. 212.

^{22/}Appendix B, reference 4, p. 1.

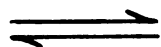


Type I

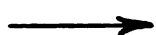


Type II

1 = most like; 2 = 2nd most like; 3 = 3rd most like.



= A reciprocal relation.



= A non-reciprocal relation

Figure 2. Hypothetical Types

discussed, is found in the concepts of invariant and differential validity. An example will serve to define these concepts. If a farmer is questioned about how many yearling Angus steers he owns, we can comfortably assume that his answer of 40 means the same thing as another farmer who gives a like response. We would say that responses to this question have invariant validity. And this would be indicative of the rather large area of objective reality about which most farmers could agree. On the other hand, there is considerable area concerning the reality of the farm manager where this would not be true. For example, the response from one farmer concerning his attitude toward risk, may mean something entirely different than an identical response from another farmer. This item would be assumed to have differential validity, that is, it measures different characteristics among different people. Or in other words, these responses reflect various meanings depending on who give them.

In typal theory, a response has meaning only with respect to the pattern of responses in which it is found. Thus, for items that have differential validity, like responses have different and unique meanings depending upon the patterns in which they are found.

While every person is assumed to be unique with respect to all his characteristics, it is also assumed that significant patterns can be extracted from configurations of many people in such a way that people with the same or similar patterns can be classified together.

Meehl has shown that it is possible for combinations of responses (patterns) to have predictive ability that the responses do not possess if taken separately.^{23/} So from the researchers' point of view,

^{23/}P. E. Meehl, "Configural Scoring," Journal of Consulting Psychology, Vol. 14, p. 165, 1950

pattern similarities may provide predictive information that is unassessable in dimensional terms.

While pattern analysis, as developed by McQuitty, is primarily intended as a method of isolating typical structure, no assumptions are necessary which force data into typical structure. Data may be structured dimensionally, typically, or some combination of both; and these methods permit the data to reveal the nature of the structure. Moreover, no assumptions are necessary concerning the linearity or normality of the data.

Another feature of pattern analysis is the objectivity with which subjects can be classified or clustered. Objectivity in this context means that identical classifications will result for a given set of data irrespective of who conducts the analysis. No arbitrariness is required in making the classifications.

CHAPTER III

PROCEDURES USED IN THIS RESEARCH

Selecting the Data

This study grew out of the Michigan Township Extension Experiment Research where one of the objectives was to gain insights on farmers' managerial processes and how they relate to characteristics, attitudes, and goals. As a consequence, the research design included depth questions concerning the ways in which farmers made important decisions, their formulation of goals, their views toward and use of extension services.

Other data were also obtained. These include standard attributes such as age, education, farm and nonfarm work experience and so on. Moreover, rather complete financial and physical data on the farm business were collected.

The task at hand given the large variety of available data and the study objectives was to choose an analytical technique for handling the data. Pattern analysis was selected because of its capabilities outlined in the preceding section. But pattern analysis, like any research technique, is limited in its usefulness by the relevancy of the input information. Thus, judicious care in selecting the information is of crucial importance. Here the management model of Figure 1 was used as a guide. A total of 60 items of information were selected as the pattern analysis input. In terms of the model the information could be classified as 21 biographical items (V_1), 26 items concerning motivations, attitudes, and goals (V_2), and 13

process items (P) concerned with decision-making. The general rule was to include items that were on theoretical grounds pertinent to managerial ability. Items that were thought to have no relevance were excluded. Details concerning the information used in the pattern analysis are in Appendix C.

Pattern-Analytic Procedures

"Hierarchical Classification by Reciprocal Pairs" is the formal designation of the pattern-analytic method used in this study. This method represents an elaboration of linkage analysis into a hierarchical method. In McQuitty's words:24/

It can incorporate decisions based on theoretical considerations, or clinical insights, or it can proceed on the basis of statistical operations exclusively. It classifies all variables, no matter how fallible, into internally consistent and exacting hierarchical structure without at the same time determining the kind of structure; the data themselves determine the kind of structure, and the results indicate whether the structure is dimensional or typal.

If the data are typally structured, the hierarchical structure produced by this method is analogous to the classification at successive levels of species, genera, families, etc., in the biological sciences. Individuals are first classified into the species in which they "best fit"; species into genera in which they "best fit"; genera into families in which they "best fit"; and so on.

As previously discussed, linkage analysis classifies people, items, or objects into clusters such that every person in a cluster is more like some other person in that cluster than he is like any-

24/Appendix B, reference 18, p. 1. The discussion that follows concerning this method is abstracted from this reference.

one in any other cluster. This means that every person is classified with the one other person most like him.

"Hierarchical Classification by Reciprocal Pairs" converts linkage analysis into a form of typal analysis. In this case, every "member" of a cluster is more like every other "member" of that cluster than like any "member" of any other cluster. The term "member" has a special meaning here. At the first level of analysis it refers to individuals or items. In the second level, to either a reciprocal pair^{25/} of individuals, or an individual with a reciprocal pair, or a reciprocal pair with a reciprocal pair. More generally, throughout the successive levels of classification, "member" refers to the constructs between which the indices mediate at any level of classification.

Even though "members" of every cluster are reciprocal, the individuals included by the "members" may not be more like every other individual in that cluster than they are like any individual in any other cluster.

While this definition of cluster is less comprehensive than that given by "Rank Order Typal Analysis," under certain conditions the solutions reached by both methods are identical.^{26/}

The analysis starts with the calculation of agreement scores. This involves comparing the items of information about each subject (60 items in this study) with those of every other subject. And in

^{25/}A reciprocal pair is a pair of individuals or "members" each having its highest agreement score with the other.

^{26/}Those interested in an elaboration of this statement see: Appendix B, reference 18, pp. 3-7.

the simplest case, this is the number of items upon which they agree.^{27/} Any other index of association could be used provided it holds a one-to-one correspondence to agreement scores when the two sets of indices are ranked in order of size.^{28/} The calculation of agreement scores produces a matrix of interassociations (agreement scores): each individual's score with every other individual.

With the first matrix, one identifies for each individual the one other individual most like him, that is, the one individual having the highest agreement score with him. The next step is to identify reciprocal pairs. And as noted before, a reciprocal pair is a pair of individuals each having its highest agreement score with the other. A reciprocal pair constitutes a cluster at the first level of analysis. And of course, there are as many clusters as there are reciprocal pairs in the original matrix.

After this first level of operations, the original matrix has been reduced in size:

from $(N) (N)$ to $(N-R) (N-R)$

where: N = number of individuals in the original matrix

R = number of reciprocal pairs at the first level.

In the second level matrix, the reciprocal pairs derived from the original matrix are treated as a single constructed item or "member". For example, if A and B form a reciprocal pair in the

^{27/}The index used in this study differs somewhat from the simple agreement score. It is defined as, the number of items any two individuals agree upon divided by the total number of items to which they both responded.

^{28/}Appendix B, reference 10, p. 295.

first matrix, they would be entered in the second matrix as the constructed member AB.

For the second matrix, it is necessary to determine indices of association between: (a) reciprocal pairs and reciprocal pairs, (b) reciprocal pairs with individuals as yet unclassified from the first level of analysis, and (c) unclassified individuals with unclassified individuals. In the case of the latter, the index from the original matrix can still be used since these individuals have not yet clustered with anyone else.

Three alternative indices are available to handle situations (a) and (b) above. They are: (1) the classification assumption,^{29/} (2) the similarity index,^{30/} and (3) the corrected agreement score.^{31/}

The "classification assumption" defines the agreement score (the number of common characteristics) between AB and C as the agreement score for the lowest pair, AB, AC, or BC. This provides an index of the number of characteristics shared by A, B, and C in the cluster ABC.

The "similarity index" is computed as the mean of indices mediating between the individuals involved. In the case above, it would be the mean of the indices AB, AC, and BC.

The "corrected agreement score" results from the adjustment of agreement scores within any type to take account of the agreements that are assumed to have occurred by chance.

In this research, the "classification assumption" was used to

^{29/}Appendix B, reference 10.

^{30/}Appendix B, reference 4.

^{31/}Appendix B, reference 5.

define agreement scores between clusters because the program for the CDC 3600 computer is written to utilize this approach.^{32/}

As pointed out before, the results from this method indicate whether the data are structured dimensionally or typally. An example will serve to illustrate this.

A dimensional structure would result if the only reciprocal pair in the first matrix was AB between two individuals A and B. And if the only reciprocal pair in the second matrix was between AB and C; in the third matrix, between ABC and D, and so on. This is illustrated by figure 3a indicating that C joins the cluster AB at the second level, D joins the cluster ABC at the third level and so on. Note that each successively higher level is at a lower agreement score indicating the level of the agreement score between the reciprocal pairs which yielded the classification.

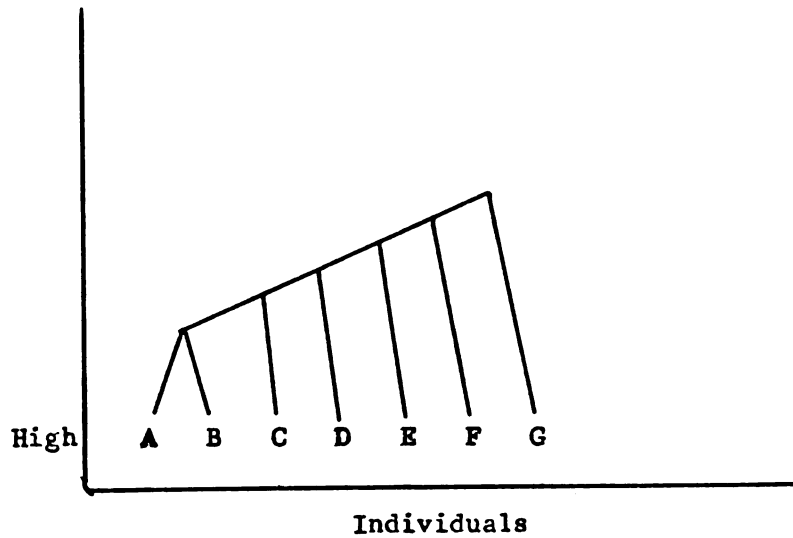
An example of typical structure is shown by Figure 3b. In the first matrix, the reciprocal pairs are PQ, RS, VW, and XY. In the second, reciprocal "members" are cluster PQ with individual O, and cluster XY with individual Z. In the third matrix, individuals T and U join as a reciprocal pair. For the fourth matrix, the reciprocal members are clusters OPQ with RS and VW with XYZ. The final matrix yields one reciprocal pair: cluster OPQRS with cluster TU.

Another problem needs to be considered. This we may call the "level of classification" problem and it has two central aspects.

^{32/}F. Forss, J. M. Hafterson, and F. M. Sim, "McQuitty's Methods of Pattern Analysis (MMPA) on the CDC 3600," Michigan State University Computer Institute for Social Science Research, Technical Report 8, February 17, 1964.

a: A Dimensional Result From Clustering

Index of
Association
(Agreement Score)
Low



Index of
Association
(Agreement Score)
Low

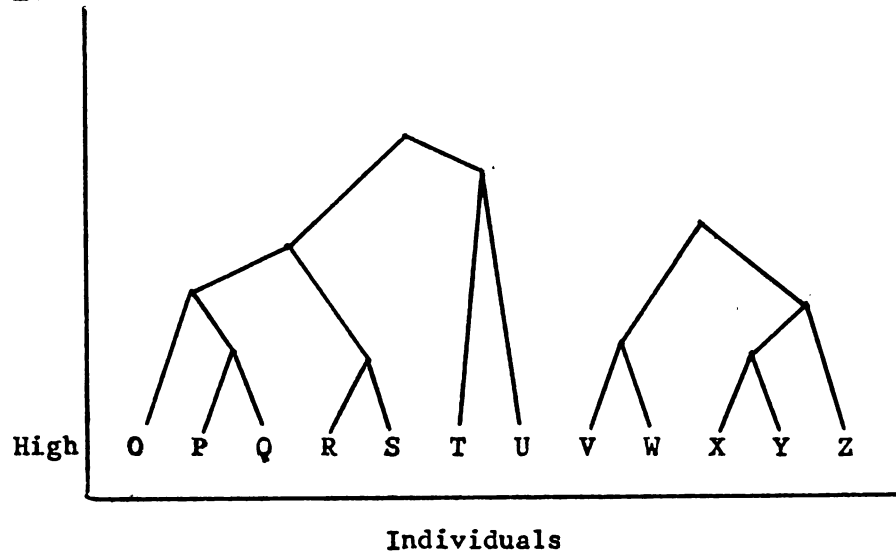


Figure 3. Hypothetical Results from Clustering

First, although the method of "Hierarchical Classification by Reciprocal Pairs" provides for "best" classifications in the context of species into genera, genera into families, etc., it does not insure that each individual will be most appropriately classified at every level. A recent method developed by McQuitty provides a way of handling this problem, at least methodologically.^{33/} This method called "Best Classifying Every Individual at Every Level," best classifies each individual into a group of two persons, then a group of three, then four, and so on. It is also adaptable to a multiple classification system by application of appropriate techniques of "Multiple Hierarchical Analysis."^{34/} However, this approach has not yet been adapted to computer use, and there is some question whether it can be adequately handled even with a high-capacity computer such as the CDC 3600.

The other aspect of the "level of classification" problem is the question of what level of classification is most appropriate for any given research objective. This is essentially the problem of how much aggregation is meaningful, and can only be answered in the context of specific research goals. Even then, the "best" level of aggregation is not likely to be obvious.

Criteria of Managerial Performance

The pattern-analytic technique discussed in the preceding section has the capability of classifying farm managers into types if the input data are typallly structured. However, it is only when these results are consistent with some criterion that

^{33/}Appendix B, reference 17, pp. 337-345

^{34/}Appendix B, reference 15, pp. 513-531

types have meaning. In this study two criteria were selected to assess managerial performance of sample farmers: (1) production function residuals, and (2) the ratio of net farm income to total farm capital.

The procedure for the first was to statistically estimate a standard production function of the Cobb-Douglas form (linear in logs) as follows:

$$Y = f (L_a, L_b, C_m, C_w, E)$$

where:

Y = Output (gross farm income in dollars)

L_a = Land (tillable acres)

L_b = Labor (Man-Months)

C_m = Capital (dollars of machinery investment)

C_w = Capital (dollars of livestock and forage investment)

E = Productive cash expenses (dollars)

This equation is assumed to include all the important measurable variables that influence output. Moreover, the sample was selected to effect homogeneity with respect to farm type and area (and to some extent soil and weather) as a means of further reducing the unexplained residual. Thus, we assume that the only important variable not accounted for is management, and that the largest proportion of the unexplained residual reflects the managerial component.^{35/} An estimate of management (M) can then be derived in

^{35/}For a review of some of the problems of treating management as an input see: A. N. Halter, The Place of the Interstate Managerial Study in Managerial Thought, paper presented at North Central Farm Management Research Committee meeting, Chicago, March 16-17, 1964.

the following way:

$$\begin{aligned} M &= Y - f(L_a, L_b, C_m, C_w, E) \\ &= Y - \hat{Y} \end{aligned}$$

where:

Y = actual gross income

$\hat{Y}$ = estimated gross income

M can be interpreted as an index of managerial performance. When M is large and positive, superior management is indicated. When $M = 0$ or nearly so, average performance is indicated. And when M is large and negative, inferior management is indicated.

The second criterion needs no explanation. It is simply the ratio of net farm income to total farm capital (owned plus rented).

Like any criteria one might choose to measure managerial performance both C-D and N/K, as we will call them, are fraught with difficulties. We have discussed some of the general criteria problems earlier. But to be more specific, C-D suffers from an inability to adequately handle nonquantity variables, the functional form forces constant elasticity, and all important inputs may not be specified. However, recognition of the physical fact of diminishing marginal returns - an important economic concept - is an advantage. The C-D criterion also has the advantage of assessing output in terms of the contribution of several important inputs.

N/K, like any ratio, obscures size differences. It obscures differences in asset mix, and it imputes the residual returns to capital and management. The error in imputing residual returns, however, becomes less serious with N/K because the returns are imputed to inputs which constitute a large proportion of total inputs.

The Research Format

The procedural format used in this study is closely related to the management model of Figure 1. In that context, the format might be called the V interaction P related to O approach.

Briefly this approach, as illustrated in Figure 4, involved the selection of 60 items of personal data which were thought to bear importantly on the farmers' managerial ability. The information was drawn from what we refer to collectively as antecedents. Part of the information is from the V₁ set (biography), some from the V₂ set (drives and motivations), and the balance from the P set, (processes).36/

These informational bits formed the basis for the next step which was the calculation of agreement scores. This provided a measure of the relatedness of every individual with every other individual.

Next, pattern analysis was used to test the hypothesis that no typical structure exists. And then, criteria of managerial performance were used to test the hypothesis that no relationship exists between pattern analysis categories and managerial performance criteria.

A Theoretical Consideration

Like any research which seeks to test substantive hypotheses, the procedural format outlined above requires several important

36/A list of the items of information used in this part of the analysis is contained in Appendix C.

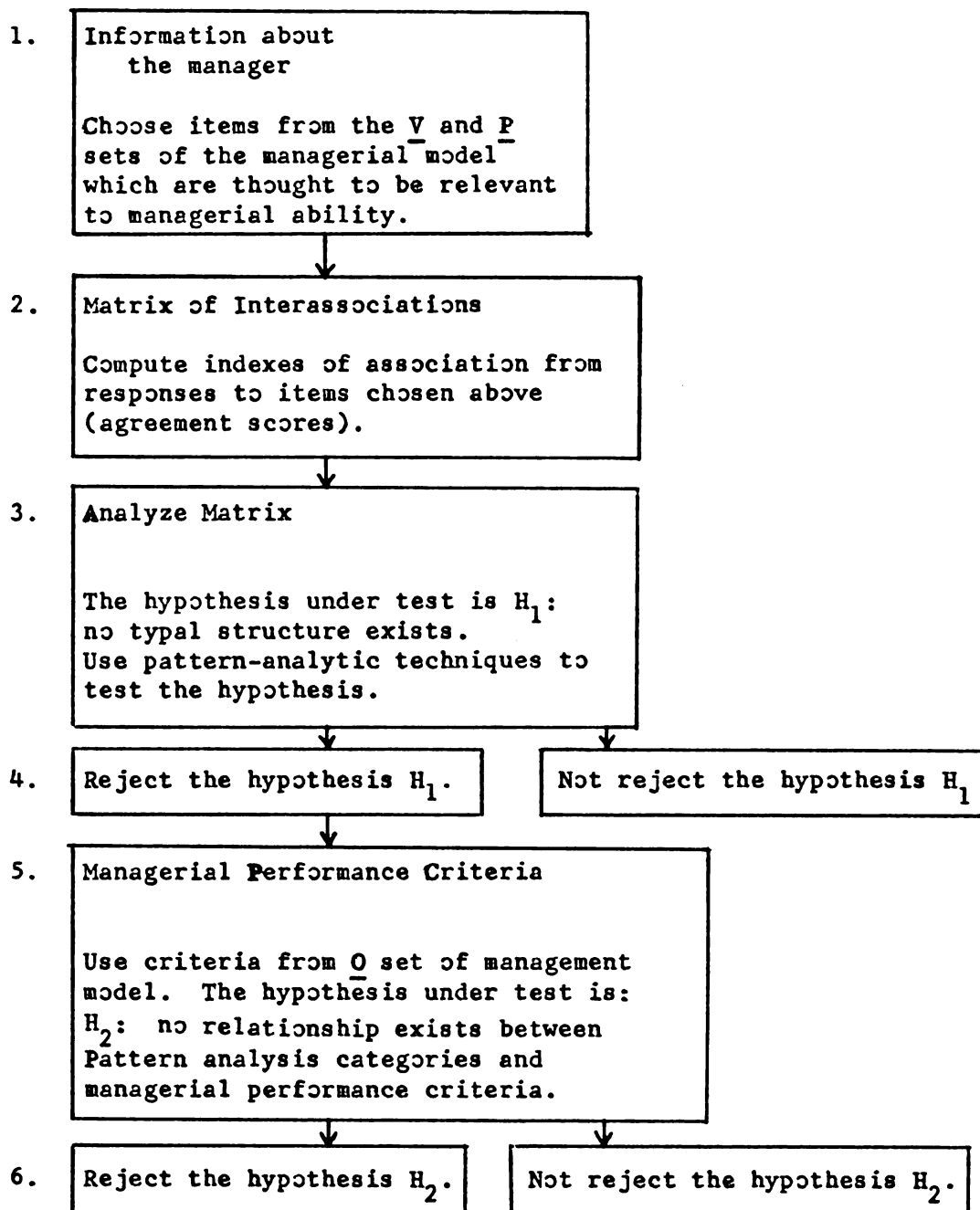


Figure 4. The Research Format

assumptions. And they may be summarized as follows:

<u>Alternative</u>	<u>Assuming the validity of:</u>	<u>Test the validity of:</u>
I	Antecedents and Criteria	Methods
II	Antecedents and Methods	Criteria
III	Criteria and Methods	Antecedents

The alternative one chooses depends upon: (1) the hypothesis under test, and (2) the relative degree of confidence one has in the validity of the antecedents, criteria, and methods. Because we wish to test the adequacy of pattern-analytic methods for classifying managerial types, and since no a priori reasons exist for having more confidence in one alternative than another, the assumptions of Alternative I are required. This means the antecedents must be assumed to tap managerially relevant information. And the criteria must be assumed to adequately measure managerial performance.

CHAPTER IV

EMPIRICAL RESULTS FROM THE PATTERN ANALYSIS

Testing the Typal Hypotheses - 109 Farms

This phase of the study is concerned with testing the hypotheses noted in Steps 3 and 5 of the procedural format (Figure 4).

More formally, the hypotheses are:

H_1 : No typal structure exists.

H_2 : No relationship exists between pattern analysis categories and managerial performance criteria.

Five different pattern analyses were made to test these hypotheses. In these analyses, the total 109 farm sample was used with varying combinations of antecedent items (Appendix C). This procedure is summarized as follows, using the antecedent notations from the model of management (Figure 1).

Antecedents		Hypotheses	
Number of Items	Classification of Items Based on Managerial Model (Figure 1)	H_1	H_2
60	$A = V_1$ plus V_2 plus P	 Reject	Reject
39	$A' = V_2$ plus P	 Reject	Reject
26	$A'' =$ a subset of A' derived by deleting 13 decision-making items (P)	 Reject	Not Reject
21	$A_1 =$ biographical items only	 Reject	Not Reject
13	P = decision-making items only	 Reject	Not Reject

In the 60-item run, all the antecedent information was used as the input for the pattern analysis. The resulting hierarchical structures were typal in nature based upon the definitions of typal and dimensional structure discussed previously and illustrated in Figure 3. This permits us to make the judgement that H_1 be rejected. And this was the case for all five runs.

To say that the data are typally structured means something in a technical sense, but nothing in a substantive sense. We want to know if the classifications or clusterings have meaning or are consistent with some criterion. In this case, we want to know, "Are the classifications derived from the pattern analysis consistent with criteria of managerial performance?"

This is what the hypothesis H_2 is concerned with. And to test H_2 , the classification groups for the 60-item run were analyzed as shown in Table 1.

As this table indicates, the pattern analysis resulted in the classification of all farmers into five separate groups. These groups were then evaluated in terms of frequency distributions and means for the C-D and N/K criteria.

The upper half of the table contains the frequency distributions and means; the lower half, the rankings for each group according to the criteria. These rankings indicate how each group stood relative to the other groups. For example, the managers in Group I ranked second highest on N/K frequency distribution, and highest on the other three measures.

A problem facing the researcher at this point is what basis

Table 1. Group Classification of Farmers by Pattern Analysis, and Group Ranking Based on Managerial Performance Criteria, 60 Antecedent Items, 109 Farms.

Farmer Group as Classified by N/K the Method of (Net farm Hierarchical income per Classification \$1000 of by Reciprocal farm Pairs capital)	Criteria of Managerial Performance							
				C-D (Cobb- Douglas residuals, Y-Y)			N/K Mean	C-D Mean
	Less \$80 or Tot- than more al \$80			Neg- ative	Pos- itive	Tot- al		
	Per.	Per.	Per.	Per.	Per.	Per.	Dol.	Dol.
I	48	52	100	38	62	100	91	552
II	44	56	100	40	60	100	83	322
III	57	43	100	39	61	100	70	550
IV	58	42	100	58	42	100	66	-964
V	72	28	100	61	39	100	59	-781

Ranking of Farmer Groups on Above Criteria
Measures From High to Low (highest=rank 1)

	N/K Frequency Distribution	C-D Frequency Distribution	N/K Mean	C-D Mean
I	2	1	1	1
II	1	3	2	3
III	3	2	3	2
IV	4	4	4	5
V	5	5	5	4

should be used in making judgements concerning the significance of these groups vis a vis the criteria. One procedure that provides useful guidelines involves a rank correlation technique to measure the agreement among criteria with respect to how the groups are ranked.^{37/} The measure used is called a coefficient of concordance. It may vary from 0 to 1, with 0 representing no community of preference and 1 representing perfect agreement. The method also provides a chi-square test of the hypothesis that the criteria have no "community of preference" in ranking the groups.

The rankings in Table 1 for the 60-item run are highly consistent. The coefficient of concordance (W), at .85, is relatively high and is significant at the .01 level of chi-square. Thus, we can feel confident in rejecting H₂ (no relationship between groups and managerial performance criteria).

The 39-item run utilizes only the A' antecedent set as an input for the pattern analysis. These results are shown in Table 2. The same procedures used for assessing the results in Table 1 were also used here.

This analysis produced six groups. The criteria rankings

^{37/}This technique handles the situation where there are n individuals or groups ranked by m observers or measures, and we wish to know if the m rankings are substantially in agreement with one another. The measure used is called the coefficient of concordance which is defined by:

$$W = \frac{12S}{m(m-1)}$$

Where S equals the sum of squares of deviations from the mean. A test of the hypothesis that the observers or measures have no community of preference is given by:

$$\chi^2 \text{ (chi-square)} = m(m-1)W$$

with n-1 degrees of freedom. See B. Ostle, Statistics in Research, Iowa State College Press, 1954, p. 191.

Table 2. Group Classification of Farmers by Pattern Analysis, and Group Ranking Based on Managerial Performance Criteria, 39 Antecedent Items, 109 Farms

Farmers Group as Classified by the Method of Hierarchical Classification by Reciprocal Pairs	Criteria of Managerial Performance							
	N/K (Net farm income per \$1000 of farm capital)			C-D (Cobb- Douglas residuals, $Y-\hat{Y}$)			N/K Mean	C-D Mean
	Less than \$80	\$80 or more	Tot- al	Neg- ative	Pos- itive	Tot- al		
	Per.	Per.	Per.	Per.	Per.	Per.	Dol.	Dol.
I	37	63	100	25	75	100	88	520
II	47	53	100	41	59	100	85	620
III	56	44	100	31	69	100	74	883
IV	58	42	100	45	55	100	68	151
V	60	40	100	60	40	100	67	-753
VI	72	28	100	72	28	100	69	-1204

Ranking of Farmer Groups on Above Criteria
Measures From High to Low (highest=rank 1)

	N/K Frequency Distribution	C-D Frequency Distribution	N/K Mean	C-D Mean
I	1	1	1	3
II	2	3	2	2
III	3	2	3	1
IV	4	4	5	4
V	5	5	6	5
VI	6	6	4	6

indicate consistency and a relatively high W score of .84 (significant at the .005 level of chi-square). Again, we can feel confident in rejecting H_2 .

A comparison of the results of the 60 A and 39-item runs A' suggests that little was lost by deleting the biographical items (V₁) from the pattern analysis input. Apparently the biographical aspects of the patterns analyzed had little discriminatory effect with respect to the managerial performance criteria used. Moreover, to the extent that input information is irrelevant, the discriminatory power of relevant information may be impaired. Some results reported in the next section suggest that this may be the case here.

The third run involved the A'' set of 26 items. This is a subset of A' derived by deleting 13 P items concerning decision-making. These results suggest the deletion of subset P from A' seriously impaired the discriminatory capability of the A' set. Table 3 shows inconsistency and disarray in the rankings of the five groups developed in this run. The W score was relatively low (.55) and was not significant at the .05 level of chi-square.

H_2 cannot be rejected.

The fourth and fifth runs utilizing respectively, the 21 V₁ items and the 13 P items, yield results similar to the 26-item A'' run. H_2 could not be rejected in either case. Apparently these two runs contained insufficient information to yield discriminatory patterns. As suggested above, P is an important part of A'. But even though this is the case, P is insufficient by itself.

A Different Approach - 36 Farms

In the previous section the pattern analysis results indicated

Table 3. Group Classification of Farmers by Pattern Analysis, and Group Ranking Based on Managerial Performance Criteria, 26 Antecedent Items, 109 Farms.

Farmer Group as Classified by N/K the Method of (Net farm Hierarchical income per Classification \$1000 of by Peciprocal farm Pairs capital	Criteria of Managerial Performance							
	Less \$80 or Tot- than more al \$80			Neg- Pos- Tot- ative itive al			N/K Mean	C-D Mean
	Per.	Per.	Per.	Per.	Per.	Per.	Dol.	Dol.
I	49	51	100	46	54	100	83	478
II	56	44	100	44	56	100	76	-120
III	65	35	100	29	71	100	69	-3
IV	58	42	100	42	58	100	68	887
V	62	38	100	57	43	100	66	-376

Ranking of Farmer Groups on Above Criteria
Measures From High to Low (highest=rank 1)

	N/K Frequency Distribution	C-D Frequency Distribution	N/K Mean	C-D Mean
I	1	1	1	2
II	2	3	2	4
III	5	2	3	3
IV	3	5	4	1
V	4	4	5	5

that managers could be classified by patterns of antecedent information alone in a way that was consistent with performance criteria. While this is true in a general sense, some variation exists within each classificational group. This is not surprising. It should be expected because of the obvious variability in adequacy of the antecedents and the criteria.

What can be done to reduce variability? First one might take the 60 antecedent items and try various combinations as pattern analysis inputs hoping to find the "best" combinations. This was done in a limited way in the previous section. And it was shown that the addition or deletion of certain input information had important implications.

Second, one might choose to experiment with the performance criterion in an effort to reduce variability in classifying managers. That criterion failures will occur is obvious because of the multifaceted nature of managerial performance. But these failures can be reduced by making less rigorous demands on the criterion. This can be accomplished by considering only those manager who fall in the extreme ranges of the criterion.

This is essentially what was done in this section. The N/K ratios for all 109 farms were arrayed from low to high.^{38/} The lowest sixth and the highest sixth were chosen for further analysis. This provided a subsample that included the 18 lowest performers and 18 highest performers as judged by the N/K criterion. By using this procedure it is unlikely that those designated as high-performers are in some

^{38/}The N/K criterion was arbitrarily selected for this test. The C-D criterion, or perhaps another, might have worked as well.

5

objective sense low-performers, or vice versa.

We are now in a position to ask the question, "Can the pattern-analytic technique used in this study, given certain antecedent inputs, classify managers into the 'correct' two groups based upon the extremes of the criterion?"

In the simplest terms, this means we mix 18 low-performers with 18 high-performers. Then the pattern analysis is asked to sort the low-performers from the high-performers by comparing patterns of antecedent items.

Five pattern analysis runs were made on the 36-farm sample in exactly the same manner as those of the 109-farm sample.

The results from the 39-item A' run indicated a relatively high degree of effectiveness in correctly classifying low-performers and high-performers. Figure 5 indicates the way in which the 36 farms clustered. The hierarchical structure on the left contains 16 farmers, 12 of which were low-performance managers. The structure on the right contains 15 farms, of which 11 were high-performance managers. Five farmers classified together in the middle group; three were high-performers and two were low-performers.

None of the other four pattern analysis runs produced any meaningful results with the 36 farm sample. This is not surprising with respect to the 26, 21 and 13-item runs. For they provided no significant classifications for the 109 farm sample either. But this was not the case for the 109-farm, 60-item A run where significant classifications were obtained.

The reasons why the 60-item run failed to produce results in

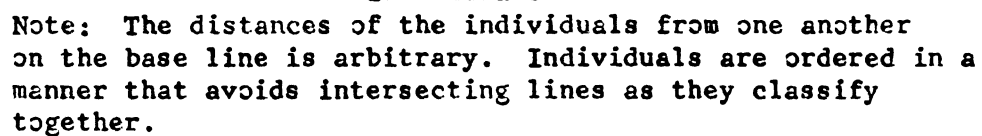


Figure 5. A Classification of Farmers By the Method of "Hierarchical Classification By Reciprocal Pairs," 36 Farm N/K Group.

the 36-farm sample are not readily apparent. One likely cause is that some of the 21 biographical items in the total of 60, even though they may have been irrelevant, tended to produce spurious agreements. This would reduce the discriminatory capability of relevant items. This was suggested in the previous section when the 39-item run was observed to produce results at least comparable to the 60-item run. Moreover, this possible reduction of discriminatory power may be more crucial when the sample size is small and when highly dichotomous subjects are used as inputs.

The Problem of Characterizing Patterns

The results from the previous two sections suggest that certain items of information about the manager as a person can be used with some success to predict or otherwise classify managerial performance. It then seems reasonable to assume that a comparison on these informational items between, say low-performers and high-performers, would provide important insights on how, or perhaps why they differ.

Unfortunately, this is not necessarily the case. As was pointed out previously, items in a pattern context may possess predictive capability jointly, that they lack if considered separately. Thus, patterns which classify significantly different groups may fail to reveal significant differences in item responses for these groups when the items are examined individually. But if this is the case, then how can these significantly different groups be characterized with respect to the antecedent items? The answer is that they cannot: at least not in the usual sense of the word characterize. For instance, if we make a comparison item by item between low-performance and high-

performance managers and we find no significant differences then we can say nothing about how they differ in conventional characteristics.

This is approximately the case for the 36-farm analysis of low and high-performance managers. When these two groups, as classified by the pattern analysis, are compared by chi-square analysis on all 39 A' items used to successfully classify them, only the responses to 3 items revealed significant differences between the two groups. And these 3 items provide little with which to characterize these two groups. One item concerned the individuals attitude toward building future security, another, their attitude toward winning respect of other people in the community. The third item was with regard to whether risk was considered in making decisions.

None of the usual V₁ items such as age, education, experience and so on, that are typically used in characterizing managerial performance levels indicate significant differences between these two groups either.

It is certain then that the 36-farm managers could scarcely have been classified in a way to satisfy the criterion if the typical "characterizing" approach had been used. Yet by considering 39 of these same items as patterns, a high proportion of correct classification resulted.

If the examination of individual items reveals essentially nothing, what then is left? Can we define differences in terms of patterns?

These questions imply no easy and obvious answers. The first complication arises when we realize that there are a fantastically large number of pattern possibilities on 50 or 60 items of information

concerning as few as 20 or 30 subjects.^{39/} Thus, there is practically no chance that any two patterns will be identical. Pattern analysis recognizes this; it searches for pattern similarities not just identities. But there is a question then of what is a typical pattern for any given group.

A further complication to pattern comparison concerns the level of aggregation. Looking back at Figure 5 will help clarify this problem. The first reciprocal pair in the left group agree on 70 percent of the available informational items. But by the time we have completed classification of the group, only about 13 percent of the items are common to the whole group. It's even less than 5 percent for the group on the right. And this may be insufficient to provide much help in gaining insights that characterize.

The value of pattern analysis in the context of this study appears to lie in its capability for assessing a significant relationship between the interaction of a number of informational responses by farm managers and their levels of managerial performance. And also to isolate, in a gross way, classes of information which appear to be most relevant in these interaction relationships (e.g., the 39 A' items on motivations, goals, attitudes, and decision-making).

^{39/A} moment's reflection about the number of pattern combinations that are possible leaves little doubt that a high-speed computer is a necessary ingredient in pattern analysis. An exception is the case when the number of items or the sample is very small.

In this research, 60 items of information are used and there are 4 responses possible, on the average, for each item. This means that each subject who responds to all 60 items could choose the 60 items in--

4^{60} equals approximately 1329×10^{33} different ways. See R. L. Anderson and T. A. Bancroft, Statistical Theory and Research, McGraw-Hill Book Company, 1952, p. 9.

Further insights will have to come from intensive interviewing and testing in the informational areas suggested as most promising by the pattern analysis.

CHAPTER V

IMPLICATIONS

The major objectives of this research were to explore the efficacy of pattern analysis in classifying farm managers, and to gain insights on the kinds of information concerning the farm manager that are most significant in differentiating various levels of managerial proficiency.

This research employed pattern analysis as a means of assessing interactive relationships among antecedents to classify managers into relatively homogeneous groups. These groups were then tested for consistency with managerial performance criteria.

The results indicated that with certain sets of antecedents, pattern analysis classifications were consistent with managerial performance criteria. With others, they were not.

The significant antecedents included 26 items concerning drives, motivation, goals and attitudes (V_2) interacting with 13 items about decision-making processes (P). Neither the 26 items as a group alone, nor the group of 13 items alone provided significant classifications.

The group of 21 biographical items (V_1) were insufficient to provide significant classifications when used alone as a pattern-analysis input. Moreover, this group of items appeared to add nothing to the discriminatory capability of the informational input when used with other items. Some evidence suggests that biographical

17

items may even have impaired the discriminatory capability of other information.

In one phase of the research, pattern analysis correctly classified a high proportion of low and high-performance managers using the 39 items discussed above as inputs. Significance tests between these two performance groups with respect to the 39 items, and then additionally on the remaining 21 items, reveal little that would differentiate low from high-performers on an item-to-item basis. This means that the two performance groups were not distinguishably different in terms of typical dimensional analyses of the 39 items. And yet, in terms of patterns, they were.

Pattern analysis as used in this study does not reveal the discriminatory power of each item of input information. However, by experimenting with the input mix, as was done in this study, significant classes of information may be isolated. Subsequent studies may then benefit by research designs that provide greater depth in these significant classes of information.

Some of the information available for use in this research is not usually found in typical farm management survey records. This is the case for most of the 39 items found to constitute a significant class of information in this study. But while these items can be said to have tapped the manager's motivations, attitudes, goals, processes, and so on (the V_2 and P sets), they cannot be considered in any way exhaustive. Moreover no capability (the V_3 set) information was available for use in this research.

The results from this study suggest that pattern analysis can

be sharpened considerably by including greater depth in V_2 and P information. And the same seems likely if V_3 information were added. But this alone is only an intermediate goal. The more important objective is to gain insights into what differentiates a good manager from a poor one. Yet, it is doubtful if this can be accomplished in any meaningful way unless managers can be identified or classified into relatively homogeneous groups. And these classifications must be based upon the important interactive qualities of management, and not merely in terms of performance criteria. Pattern analysis appears promising in this respect.

BIBLIOGRAPHY

- Anderson, R. L., and T. A. Bancroft, Statistical Theory in Research, McGraw-Hill Book Company, 1952.
- Boulding, Kenneth E., Economic Analysis, Harper and Brothers, New York, 1948.
- Forss, F., J. M. Hafterson, and F. N. Sim, "McQuitty's Methods of Pattern Analysis (MMPA) on the CDC 3600," Michigan State University Computer Institute for Social Science Research, Technical Report 8, February 17, 1964.
- Guttman, Louis, "What Lies Ahead For Factor Analysis," Educational and Psychological Measurement, Vol. 18, No. 3, 1958.
- Halter, A.N., The Place of the Interstate Managerial Study in Managerial Thought, paper presented at North Central Farm Management Research Committee Meeting, Chicago, March 16-17, 1964.
- Hamlin, Edmund T., M. E. Wirth, and James Nielson, "Financing Agricultural Production on Michigan Farms," Michigan Agricultural Experiment Station Special Bulletin 445, July, 1963.
- Huffman, Donald, A Technique For Classifying Farm Managers According to Managerial Ability, unpublished Ph. D. Thesis, Ohio State University, 1963.
- Johnson, Glenn L. et. al., editors, A Study of Managerial Processes of Midwestern Farmers, Iowa State University Press, 1961.
- MacEachern, Gordon A., D. Thomas, and L. Eisgruber, "Analysis of Human Attributes and Their Relationship to Performance Level of Farm Tenants," Research Bulletin No 751, Indiana Agricultural Experiment Station, November 1962.
- March, J. and Herbert A. Simon, Organizations, Wiley and Sons, 1958.
- McQuitty, Louis L., see Appendix B.
- Meehl, P. E., "Configural Scoring," Journal of Consulting Psychology Vol. 14, 1950.
- Nielson, James, and William Crosswhite, "The Michigan Township Experiment: Changes in Agricultural Production Efficiency and Earnings," Michigan Agricultural Experiment Station Technical Bulletin 274, October 1959.
- Nielson, James, "The Michigan Township Extension Experiment: The Experimental Program and Farmers' Reactions to It," Michigan Agricultural Experiment Station Technical Bulletin 284, 1961.

- _____, "The Michigan Township Extension Experiment: The Farm Families Their Attitudes, Goals, and Goal Achievement," Michigan Agricultural Experiment Station Technical Bulletin 287, 1962.
- _____, "Aspects of Concern to the Basic Researcher," Describing and Measuring Managerial Abilities and Services, Report No. 4, Farm Management Research Committee of the Western Agricultural Economics Research Council, Denver, Colorado, October 24, 1962.
- Ostle, B., Statistics in Research, Iowa State College Press, 1954.
- Rienschel, E., Discrimination of Agricultural Credit Risks from Loan Application Data, unpublished Ph.D. thesis, Michigan State University, 1963.
- Simon, Herbert A., "Theories of Decision-Making in Economics and Behavioral Science," American Economic Review, Vol. 49, June 1959.
- Thurstone, L. L., Multiple Factor Analysis, The University of Chicago Press, 1947.
- Wirth, M. E., and James Nielson, "Resource Ownership and Productivity on Michigan Farms," Michigan Agricultural Experiment Station Special Bulletin 435, August 1961.

Appendix A: Recent Research in the Field of Psychology on the Problem Solving Process

In the field of psychology, research efforts directed toward providing an understanding of problem solving may be broadly classified into two groups: (1) those that are concerned with the product of a problem-solving process (the solution) as a response to various stimuli, and (2) those which attempt to study the process itself.

Historically, the greatest emphasis has been given to problem solving as a product. Research which analyzes problem solving in a stimulus-response context provides information that is useful in characterizing efficient problem solvers, and in relating antecedent conditions and situations to the solutions obtained. As interesting as these results may be, they tell us little about what actually takes place during the solution of a problem. The processes used to solve problems may vary widely, and there may be many explanations for failures to solve problems.

The major reason why the product has been emphasized in problem-solving research is that a study of the process itself presents some very pervasive methodological difficulties. Because the process operates within the mind, it must be externalized in ways that facilitate objective and quantifiable measurement. Attempts to understand the process have relied on the introspection of subjects who have completed a problem, or on the verbalizations of subjects while they work-out solutions. This approach has provided some interesting insights

into problem solving behavior, but not unlike research that emphasizes product, it suffers from the inability to develop objective measurement criteria. Within the past decade, several new techniques of analysis have been developed which seem to hold promise for characterizing the problem solving process. These techniques may be broadly classified into three groups based on the emphasis given to the various aspects of process.

Group I - - Studies that utilize a problem solving instrument (PSI) developed by E. Johns and H. Rimoldi.

Group II - - Structured questions and answers. This technique explores the number type and sequence of questions asked by a subject from a given population of questions and answers.

Group III - - Serial analysis of the problem solving process.

Following is a selected list of references with respect to these groups followed by a selected list of general psychological research in the problem-solving area.

Group I Studies

Beckman, F. H., "A Note on the Relationships Between Percent Alpha-Time and Efficiency and Problem Solving," Journal of Psychology, 1961, Vol. 51, 169-172.

Blatt, Sidney, J., "Patterns of Cardiac Arousal During Complex Mental Activity," Journal of Abnormal and Social Psychology, 1961, Vol. 63, No. 2, 272-282.

_____, and M. Stein, "Efficiency in Problem Solving," Journal of Psychology, 1959, Vol. 48, 193-213.

Gyr, John W., "An Investigation Into and Speculation About the Formal Nature of a Problem Solving Process," Behavioral Science, Vol. 5, 1960, p.39.

Johns, E. R., "Contributions to a Study of the Problem Solving Process," Psychological Monographs, Vol. 71, 1957, No. 18, Whole No. 447.

Johns, E. R., and James G. Miller, 1957, "The Acquisition and Application of Information in the Problem Solving Process," Behavioral Science, Vol. 2, 1957.

Group II Studies

Rimoldi, H. J. A., J. Devane, and J. Haley, "Characterization of Processess," Educational and Psychological Measurement, Vol. 21, No. 2, 1961.

Group III Studies

Johnson, D. M., "Serial Analysis of Thinking," Annals of the New York Academy of Science, 1960, Vol. 91, Art 1, 66-75.

_____, "Amount of Material and Time of Preparation for Solving Problems," The Journal of Psychology, 1961, 51, 457-471.

_____, and E. R. Hall, "Organization of Relevant and Irrelevant Words in the Solution of Verbal Problems," The Journal of Psychology, 1961, 52, 99-104.

_____, "Formulation and Reformulation of Figure Concepts," The American Journal of Psychology, 1961, 74, 418-424.

General Studies

Birch, H. G., and H. S. Rabinowitz, "The Negative Effect of Previous Experience on Productive Thinking," Journal of Experimental Psychology, 41, 121-125, 1951.

Billings, M. L., "Problem Solution in Different Fields of Behavior," American Journal Psychology, 46, 259-292, 1933.

Bloom, B. S., and L. G. Broder, Problem Solving Processes of College Students, Supplemental Educational Monograph No. 73, University of Chicago Press, 1950.

Brunner, J. S., J. Goodnow, and G. Austin, A Study of Thinking, Wiley, New York, 1956.

Burock, B., "The Nature and Efficacy of Methods of Attack on Reasoning Problems," Psychological Monographs, 64, No. 313, 1950.

Cartwright, D., "Relation of Decision-Time to the Categories of Responses," American Journal of Psychology, 54, 174-196, 1941a.

_____, "Decision-Time in Relation to the Difference of the Phenomenal Field," Psychological Review, 48, 425-442, 1941b.

_____, and L. Festinger, "A Quantitative Theory of Decision," Psychological Review, 50, 595-621, 1943.

Cohen, J., "Thought and Language," Acta Psychologica, 10, 111-124, 1954.

Cook, T. W., "The Amount of Material and Difference of Problem Solving," Journal of Experimental Psychology, 20, 288-296, 1937.

Duncan, C., "Recent Research on Human Problem Solving," Psychological Bulletin 56, No. 6, 1959.

Duncker, K., "On Problem Solving," Psychological Monographs 58, No. 270, 1945.

Guetzkow, H., "An Analysis of the Operation of Set in Problem Solving Behavior," Journal of General Psychology, 45, 219-244, 1951.

Marks, M. R., "Problem Solving as a Function of the Situation," Journal of Experimental Psychology, 41, 74-80, 1951.

Reid, J. W., "An Experimental Study of Analysis of the Goal in Problem Solving," Journal of General Psychology, 44, 51-69, 1951.

Tresselt, M. E., and D. Leeds, "The Einstellung Effect in Immediate and Delayed Problem Solving," Journal of General Psychology, 49, 87-95, 1953b.

Whitfield, J. W., "An Experiment in Problem Solving," Quarterly Journal of Experimental Psychology, 3, 184-197, 1951.

Appendix B: Selected References Concerning Pattern Analysis
by Louis L. McQuitty

1. "Pattern Analysis Illustrated in Classifying Patients and Normals," Educational and Psychological Measurement, 1954, 14, No. 4, 598-604.
2. "Theories and Methods in Some Objective Assessments of Psychological Well-Being," Psychological Monograph, 68, No. 14 (Whole No. 385), 1954.
3. "A Pattern Analytic Method Derived From a Theory of Individual Differences in Psychological Well-Being," In Sells, S. B., Chairman, Symposium on Pattern Analysis, Randolph Field, Texas, Air University, USAF School of Aviation Medicine, May 1955, 29-46.
4. "A Method of Pattern Analysis for Isolating Typological and Dimensional Constructs," Lackland Air Force Base, Texas. AFPTRC Research Bulletin, 1955, TN-55-62.
5. "Agreement Analysis: Classifying Persons by Predominant Patterns of Response," British Journal of Statistical Psychology, 1956, 9, 5-16.
6. "A Pattern Analysis of Descriptions of 'Best' and 'Poorest' Mechanics Compared with Factor-Analytic Results," Psychological Monograph 1957, 71, No. 17 (Whole No. 446).
7. "Elementary Linkage Analysis for Isolating Orthogonal and Oblique Types and Typal Relevancies," Educational and Psychological Measurement, 1957, 17, No. 2, 207-229.
8. "Job-Knowledge Scoring Keys by Item Versus Configural Analysis for Assessing Levels of Mechanical Experience," Educational and Psychological Measurement, 1958, 18, No. 4, 661-680.
9. "Differential Validity in Some Pattern Analytic Methods," in Bass, Bernard M. and Irwin A. Ber, Objective Approaches to Personality Assessment, Van Nostrand Company, Inc., Princeton, New Jersey, 1959.
10. "Hierarchical Syndrome Analysis," Educational and Psychological Measurement, 1960, 20, No. 2, 293-304.
11. "Elementary Factor Analysis," Psychological Reports, 1961, 9, 71-78.
12. "Substantive Vector Analysis: An Alternative or an Adjunct to Simple Structure," Psychological Reports, 1961, 9, 347-358.
13. "Typal Analysis," Educational and Psychological Measurement, 1961 21, No. 3, 677-696.

14. "Item Selection for Configural Scoring," Educational and Psychological Measurement, 1961, 21, No. 4, 925-928.
15. "Multiple Hierarchical Classification of Institutions and Persons with Reference to Union-Management Relations and Psychological Well-Being," Educational and Psychological Measurement, 1962, 22, No. 3, 513-531.
16. "Rank Order Typal Analysis," Educational and Psychological Measurement, 1963, 23, No. 1, 55-61.
17. "Best Classifying Every Individual at Every Level," Educational and Psychological Measurement, 1963, 23, No. 2, 337-345.
18. "Capabilities and Improvements of Linkage Analysis as a Clustering Method," Mimeographed, November 1963. To be published under the same title in the September 1964 issue of Educational and Psychological Measurement.

Appendix C: Sixty Items of Information (Antecedents) Concerning Each Individual Farmer Used as a Basis for the Pattern Analysis

V₁ -- Biographical Information (21 Items)

Age
Education
Number of persons in the household
Number of children at home
Total years of farming experience
Years of experience as a farm manager
Farm Background
Times moved since starting farming
Nonfarm job experience
Material possession score
Kinds of farm records kept
Extension participation score - reading and listening
Extension participation score - activities and events
Extension participation score - individual contacts
Total extension participation score
General participation score - organized groups (2 items)
Readership index - newspapers and magazines (2 items)
Tenure status
Type of farming

V₂ -- Drives and Motivation Information (26 Items)

Acceptance of new ideas scale
Attitudes toward farming compared to other occupations
Attitudes toward the community
Attitudes toward the use of credit
Attitudes toward opportunities for young men to start farming today
Views on how changes in agriculture affect future opportunities
in farming
Ranking of things regarded as important in farming (7 items)
Ranking of things which give the most satisfaction as a person (8 items)
Farm goal orientation
Emphasis on short-run and long-run goals
Clearness and consistency of farm goal formulation
Family goal orientation
Clearness and consistency of family goal formulation

P -- Process Information (13 Items)

Consideration of decision alternatives
Things considered when making a decision (8 items)
Confidence in decision-making
How decision-making calculations are made
Time used in decision-making
Changes in decision-making ability

1

ROOM USE ONLY

MICHIGAN STATE UNIVERSITY LIBRARIES



3 1293 03178 4733