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AN INVESTIGATION OF ORGANIZATIONAL
EFFECTIVENESS USING MULTIVARIATE ANALYSIS

THESIS FOR THE DEGREE OF M. A.
MICHIGAN STATE UNIVERSITY

BYRON ROBERT BOYLES
1962

THESIS

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ABSTRACT

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by Byron Robert Boyles

Industrial organizations are an extremely important part of our way of life. The decisions made by their management are made on the basis of adequate and relevant information and evaluated against relevant criteria. The complexity of the relationships among measures of organizational performance and the difficulty of identifying relevant criteria make a systematic study seem worthwhile. Correlational and multivariate analysis techniques were employed in such a study.

Twenty-four measures of the performance of a medium-sized manufacturing organization over a sixty-month period were collected. Accounting and personnel records were used in the study instead of the more usual kind of psychological data. This seems appropriate because such data is the basis for the decisions made in the industrial situation. These measures were intercorrelated. Factor analysis was used to simplify the description of data by reducing the number of necessary variables, or dimensions. Six factors resulted. Four of these factors were discussed and interpreted in light

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of experience with the organization under study. Two dimensions were seen to account for most of the variance: (1) Labor efficiency and (2) Contract-production. Two additional factors were interpreted: (1) Disruptive job changes and (2) Company-brand production. Correlation tables involving the variables loaded on each of the six factors were prepared and discussed. These tables were found to be helpful in understanding the relationships among the measures of organizational performance of interest.

The general conclusions reached were two fold: First, four dimensions seem to account for most of the variance among the measures of organizational performance under study. Of particular interest is the fact that two independent factors involving the labor force emerged. These four factors can be seen as dimensions of effectiveness for this organization. Secondly, correlation and multivariate analysis techniques using accounting data and personnel data can be useful in understanding the complex relationships among measures of organizational performance and in identifying relevant criteria against which to evaluate this performance.

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Date

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by

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A THESIS

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

MASTER OF ARTS

Department of Psychology

1962

ACKNOWLEDGMENT

I would like to express my appreciation for the guidance, advice and encouragement given me by Dr. Carl F. Frost and Dr. Terrence M. Allen during the planning and execution of this thesis. My thanks also go to Mr. William B. Eddy for his help and cooperation.

I would also like to express my appreciation to the members of Revco, Inc. whose help and complete cooperation made this study possible.

B.R.B.

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INTRODUCTION

One would be hard pressed to overemphasize the importance of industrial organizations to our way of life. The work force--the bulk of the adult population--spends more than a third of its waking hours in the organizations by which it is employed. The ubiquitousness of organizations is not their sole or principal claim for attention. As social scientists we are interested in explaining human behavior. Taking the social psychological point of view, we are interested in what influences impinge upon the individual human being from his environment and how he responds to these influences. For most adults industrial organizations represent a major part of the environment. Moreover, we would expect industrial organizations to have an even more significant effect upon behavior than is suggested merely by looking at the time spent in them. Organizations in general, and industrial organizations in particular, are important in enabling us to achieve our present way of life. The decisions made by their stockholders, boards of directors and managers are of great importance to what is popularly called the public welfare. So much so, in fact, that the President of the United States has recently seen fit to intervene in the process by which these decisions are made. What criteria are relevant to such decisions? What consideration has been given to their validity?

The modern industrial organization is a complex entity. Buildings, machinery, power, raw materials, and people are all brought together in a number of specific but different ways for a particular purpose: to produce a saleable product or service. However, it must be done in a way that will not lead to the destruction or depletion of the resources of the organization. Caplow (1953) has altered this statement into a formal postulate of criteria of organizational success: "Organizations tend to maintain themselves in continuous operation." However, he adds three related criteria which appear equally essential:

1. "Performance of objective functions as measured by institutionally imposed standards.
2. "The minimization of spontaneous internal conflict.
3. "Maximization of satisfaction for individuals."

Caplow thus emphasizes that organizational effectiveness is multi-dimensional--not unidimensional as is sometimes thought.

In one sense, this complexity makes the study of organizational effectiveness seem a bit discouraging. On the other hand, decisions will be made, courses of action will be chosen and changed in this industrial situation which determines the way of life we know. Therefore, the search for relevance in this complexity is most worth while in determining the criteria of organizational effectiveness necessary to improve the quality of these decisions.

THE PROBLEM

The first purpose of this exploratory study was to investigate the usefulness of correlational and factor analytic techniques in handling the complexity of the variables involved in developing criteria of organizational effectiveness. This is hoped to be a first step in the analyses of organizational data upon which to begin to build a descriptive organization theory developed inductively from facts rather than deductively from assumptions.

The second purpose was to identify the particular combination of measures of organizational performance which would best describe the effectiveness of one particular organization.

The third purpose of the study was to investigate the use of operational accounting data and personnel data derived from organization records in studying the relationships between certain measures of personnel performance and the performance of the organization as a whole. The procedure was to use accounting and personnel records which are available in surprising quantity and completeness in most modern organizations rather than the more traditional kinds of psychological tests, interview or questionnaire data. ,

HISTORY OF THE PROBLEM

Current approaches to organization theory by students of organizational concepts have tended to classify the theories into two broad categories. The first category has been variously labeled traditional, classical, bureaucratic or "theory X." The other has been called modern, human relations, democratic, participative or "theory Y."

The first of these categories has its intellectual roots in two areas. One is the early scientific management and administration school of people like Frederick W. Taylor and Henri Fayol. Taylor (1947) investigated the effective use of people in industrial organizations; he set himself the general task of organization theory: to analyze the interaction between the characteristics of human and the social and task environments created by organizations. The actual area of behavior that was considered by Taylor and his successors in the scientific management movement was much narrower, however. Because of the historical accidents of their positions and training, and the specific problems they faced in industry, Taylor and his associates studied primarily the use of men as adjuncts to machines in the performance of routine productive tasks.

In time and methods study, the scientific management group was concerned with describing the characteristics of the human organism as one might describe a relatively simple

machine for performing a comparatively simple task. The goal was to use the rather inefficient human organism in the productive process in the best way possible. These efforts brought considerable precision of measurement into the organization of the individual employee's production activities. It raised and partially answered a number of fundamental questions in human engineering. It showed that it was feasible to specify precisely the activities involved in routine production tasks. In this respect the work in scientific management is more relevant to mechanization and automation than to the broader psychological aspects of human behavior in organizations.

The second area is the sociological theory of bureaucracy expounded by Max Weber (1947). His major interests in the study of organizations appear to have been four: (1) to identify the characteristics of an entity he labeled "bureaucracy"; (2) to describe its growth and the reasons for its growth; (3) to isolate the concomitant social changes; (4) to discover the consequences of bureaucratic organization for the achievement of bureaucratic goals. To be sure, Weber goes beyond the "machine" model in several significant ways. In particular, he analyzes in some detail the relationship between an official and his office. But in general, he perceives bureaucracy as an adaptive device for using specialized skills, and he is not exceptionally attentive to the character of the human organism (March and Simon, 1958).

The second generation or new school of thought is largely the product of behavioral scientists, having its origins in the work of Elton Mayo and Kurt Lewin, and colored to some extent by the thinking of personality theorists like Freud, Carl Rogers and Kurt Goldstein (Katzell, 1962).

Shepard (1956) has contrasted the modern with the classical theories in the following respects:

1. Wide participation in decision-making rather than centralized decision-making.
2. The face-to-face group rather than the individual as the basic unit of organization.
3. Mutual confidence rather than authority as the integrative force in organization.
4. The supervisor as the agent for maintaining intra-group and intergroup communication rather than the agent of higher authority.
5. Growth of members of the organization to greater responsibility rather than external control of the members' performance of their tasks.

McGregor (1960), after several years of research sponsored by the Sloan Foundation, has undertaken to express the assumptions which seem to underlie each of the two general theoretical approaches to organizations. Though the work is done in a conceptual, deductive way and almost no empirical evidence is cited, it seems worth reviewing. He concludes "theory X" is based on three assumptions:

1. "The average human being has an inherent dislike of work and will avoid it if he can.

2. "Because of this human characteristic of dislike of work, most people must be coerced, controlled, directed, threatened with punishment to get them to put forth adequate effort toward the achievement of organizational objectives.
3. "The average human being prefers to be directed, wishes to avoid responsibility, has relatively little ambition, wants security above all."

"Theory Y," on the other hand, is based on the following assumptions:

1. "The expenditure of physical and mental effort in work is as natural as play or rest.
2. "External control and the threat of punishment are not the only means for bringing about effort toward organizational objectives. Man will exercise self-direction and self-control in the service of objectives to which he is committed.
3. "Commitment to objectives is a function of the rewards associated with their achievement.
4. "The average human being learns, under proper conditions, not only to accept but to seek responsibility.
5. "The capacity to exercise a relatively high degree of imagination, ingenuity, and creativity in the solution of organizational problems is widely, not narrowly, distributed in the population.
6. "Under the conditions of modern industrial life, the intellectual potentialities of the average human being are only partially utilized."

Likert (1961) has formulated a rather more empirical and complete statement of the "new way." This approach differs from McGregor's "theory Y" mainly in that it is based on empirical research. He sets forth a number of principles based on the findings of the Institute for Social Research

at the University of Michigan. Briefly these principles are:

1. "A preponderance of favorable attitude on the part of each member of the organization toward all the other members, toward superiors, toward the work, toward the organization--toward all aspects of the job. These attitudes are those of identification with the organization and its objectives and a high sense of involvement in achieving them.
2. "This highly motivated, cooperative orientation toward the organization and its objectives is achieved by harnessing effectively all the major motivational forces which can exercise significant influence in an organization setting and which, potentially, can be accompanied by cooperative and favorable attitudes." These motives are:
 - a. The ego motives. These Likert defines as "the desire to achieve and maintain a sense of personal worth and importance."
 - b. The security motives.
 - c. Curiosity, creativity, and the desire for new experience.
 - d. The economic motives.
3. "The organization consists of a tightly knit, effectively functioning social system. This is made up of interlocking work groups with a high degree of group loyalty among the members and favorable attitudes and trust between superiors and subordinates. The leadership of the organization has developed what might be called a highly effective social system for interaction and mutual influence."
4. "Measurements of organizational performance are used primarily for self-guidance rather than for superimposed control. To tap the motives which bring cooperative and favorable rather than hostile attitudes, participation and involvement in decisions is a habitual part of the leadership process. This kind of decision-making calls for the full sharing of available measurements and information."

Likert proposes an "integrating principle" by which the above may be achieved.

The leadership and other processes of the organization must be such as to ensure a maximum probability that in all interactions and all relationships with the organization each member will, in the light of his background, values, and expectations, view the experience as supportive and one which builds and maintains his sense of personal worth and importance. (page 103)

Thus, two expressions of the "new way." One conceptual and deductive, the second more empirical and inductive. The authors of these theories feel them to be better than the "old way."

The shortcomings or malfunctions of the classical theory have been pointed out. Such things as restriction of output, low productivity, low job satisfaction, resistance to change, hostility to supervisors, frustration of individual needs are alleged to be the results of the "old way" (Bose, 1957; Kahn, 1956; Katz, Maccoby and Morse, 1950).

The "new way," incorporating the principles of democracy, participation and human relations, has been proposed to correct these shortcomings (Argyris, 1957; Likert, 1961; McGregor, 1960; etc.).

There is, however, enough evidence reported to raise some question about the advantages of the "new way" over the old in every organizational setting. Weschler, Kahane and Tannenbaum (1952), Morse and Reimer (1956) and Leavitt (1951) have found in several different kinds of organizations that, although job satisfaction may be higher under the "new way," production is not and may even be lower.

French, Israel, and Aas (1960) found, in a Norwegian factory, that employees' reaction to participation management were not uniformly favorable.

Three years ago U. S. Rubber abandoned the committee management system and divided the committee responsibilities up among several executives (Business Week, 1960).

Thus it can be seen that simply assuming the "new way" to be a better method of management is a bit questionable. This, in turn, leads us to suspect that all is not well with modern theories of organization. As Bennis (1959) has put it: classical organization theory has addressed itself to "organizations without people" and human relations theory has tended to think of "people without organizations." The two theories just reviewed seem to fall into the second category.

What seems to be lacking is a program of study that will combine the people and the organization. Such a program should make possible a positive or descriptive formulation of organization theory developed inductively from facts instead of a normative or prescriptive one developed from deduction and assumptions (from Katzell, 1962).

One example of the approach to organization theory building that seems promising is that of March and Simon (1958). They have tried to incorporate variables describing the whole organization. Some of these variables are relatively straight-forward and operational, like "cost of changing personnel" or "size of work group." Others are

complex concepts such as "motivation to reduce conflict." One trouble is that they list some 206 variables to be incorporated into their theoretical treatment of organizations.

A second interesting development not yet applied in the industrial field is the "Systems Development" approach. Gagne and others (1962) discuss the aspects of this approach. Nearly all the work done thus far in this area has had to do with military situations and the various man-in-space programs. However, the idea of considering planning, design, development, training, operation, and evaluation of man-machine systems as one integrated system seems to have considerable relevance to the modern industrial setting.

These two approaches to the problem under consideration hold promise. It is hoped that this study can also be a beginning, of a somewhat different sort, toward a better understanding of the relationship among some of the variables which describe the over-all effectiveness of the organization.

Thus we see the need for consideration of the whole organization in all its complexity, and the necessity for developing a body of facts around which to build a theoretical framework.

If this is to be accomplished, the relationship among relevant variables must be discovered. Some method of simplifying the complexity of the situation must be developed and particular combinations of variables or key variables must be found.

In order to approach the problem of the development of a criterion of organizational effectiveness, we must first determine the goals of the specific organization. The ideal might be to specify goals that can be quantified in a way that would allow us to develop criterion scales. In practice, unfortunately, scaleable criteria of organizational effectiveness are extremely difficult to obtain. Dichotomous measurement of criteria is rather more easily achieved. At the very least there must be a general statement of the goals the organization seeks to achieve.

When the goals of the organization have been specified, measurement of these goals becomes the next problem. The methods of measurement can vary from rigorous objectivity to subjectivity. The methods of measurement should be as objective as the particular situation and the particular criteria permit.

A major consideration in the efforts to measure organizational effectiveness is the method to use for obtaining results; i.e., the strategy employed. The extremes are represented by Drucker on the one hand and Georgopoulos and Tannenbaum on the other.

Drucker (1954) states, "The search for the one objective is essentially a search for a magic formula that will make judgment unnecessary" (page 62). He sees the question of measuring organizational effectiveness as unanswerable if effectiveness is considered a unitary dimension. The organization usually has more than one

objective and the goals which it does have are usually of such a nature that they will not lend themselves to measurement. Drucker's idea is that "objectives are needed in every area where performance and results directly and vitally affect the survival and prosperity (of the organization)." Nothing is said about the relationship among these objectives.

Georgopoulos and Tannenbaum (1957) define organizational effectiveness as the " . . . extent to which an organization as a social system given resources and means, fulfills its objectives without incapacitating its means and resources and without placing undue strain upon its members" (page 535). Georgopoulos and Tannenbaum's main objection to the Drucker approach is that it relies on the selection of a priori criteria of effectiveness that seem intuitively right without trying to systematize them into a broader framework. The approach reported here has avoided a priori selection and has instead studied the relationships among available measures.

This difference in emphasis may be attributed to the fact that an industrial organization is an extremely complex entity and it seems unwise to look for one and only one criterion of organizational effectiveness (Blau, 1960). The relevant criterion might seem to be a function of who is doing the looking. Union leaders, government tax auditors, employees and stockholders all are concerned with different aspects of the organization; hence, they have

purpose of industry.

If profit is accepted as the goal of industry, it should be a simple matter to compare organizations, or one organization's over time, by means of a profit index and thus assess their effectiveness. Closer examination, however, indicates that short-run profit figures can be misleading and comparability of profit figures over organizations of different kinds and sizes is difficult to achieve.

Using profit as the sole criterion of effectiveness glosses over too many variables. It ignores the complexity of the problem. Various techniques have been developed to parcel out the effect of size on profitability (Albery, 1954; Bartlett, 1952). No accounting technique has thus far been unanimously accepted.

A somewhat similar problem exists when we try to use productivity or volume as the sole criterion of effectiveness. Both large and small organizations can maintain a high rate of productivity while slipping deeper and deeper into financial deficit. Also our culture has become wary of organizations which seem to be gaining too large a share of the market. Anti-trust legislation is an expression of this feeling.

Drucker suggests the need for a number of criteria, but does not consider the relationship among them nor how to select them. Dent cites that profit is still considered the most important purpose of industry. But no one measure of

organizational performance such as profit or productivity seems entirely satisfactory. These approaches to the problem and that taken by Georgopoulos and Tannenbaum seem to be a sort of "organization without people" approach. The trouble lies in failure to consider the entire situation. As Bennis (1959) has said, either we have "people without organizations" or "organizations without people." What is needed is an empirical rather than conceptual approach involving the organization as a whole which will allow the formulation of a theory of organizations inductively from the data. This is a large order.

A beginning must be made somewhere. That beginning might best be made with measures of organizational "outputs." Measures of "outputs" are of interest for their own sake, but they are also of interest as what seems to be the only way to get at the "process" which goes on in the organization to produce the "outputs." As we begin to understand the relationships among the "output" variables, perhaps we can work back through them toward an understanding of the "process." When we know more about the "process" in an organization, we will be in a better position to determine what combination of "inputs" will lead to effective and efficient "process" and, finally, to desired "outputs."

All that is a long way off; at this stage we will just be concerned with "outputs."

METHOD

The method here employed was to measure twenty-four variables over a sixty-month period in the life of one organization. The organization chosen was a medium-sized manufacturing firm in southern Michigan. They manufacture a nationally distributed refrigeration product requiring approximately four hundred and fifty production personnel. Two general categories of production exist. One is sold under contract and distributed under a nationally known brand-name. The other is sold under the company's own brand-name. Inasmuch as the firm introduces a new model annually, their research and development staff and the engineering group are quite important to the continued success of the product. The hourly people have been represented by the United Auto Workers union for the past ten years. It is a typical medium-sized manufacturing firm whose records are fairly complete and whose managers were willing to allow the author to investigate their operations.

It is felt that comparing one organization over time is superior to comparing several organizations or several departments of one organization. In this way the variation in measures can be more confidently attributed to changes in performance of the organization. Also the exploratory nature of the study requires that it be kept as simple as possible.

The time span employed (60 months, from December 1956 to November 1961) is a compromise between what might be desirable (the whole life of the firm?) and the availability of complete records.

The decision to use accounting and personnel records instead of the more usual kind of psychological data was made for several reasons. Most important of the reasons is the fact that this kind of data has been used by this organization as a guide to operations ever since it began operations. It is the author's belief that such data is an objective representation of the behavior of the organization and the personnel. The occurrence of a grievance in the industrial situation is as objective an indicator of behavior as the lever pressing response of a rat in an operant-conditioning situation.

Other reasons for using this type of data are:

(a) the more usual kinds of psychological data are not available for this period; (b) the gathering of such data would very likely have an effect on the functioning of the organization; and (c) collecting such data whether by questionnaire, interview or whatever, over a long period of time, would very likely influence the variables being investigated.

Twenty-four measures of the performance of the organization and of the personnel employed by the organization were chosen. Their selection was made on the basis of utility and availability according to the judgment of

accounting personnel of the firm and members of the School of Business at Michigan State University; and the judgment of the investigator and those with whom he is working on the research project of which this thesis is a part.

The following is a list of the variables used (each measure is per month):

1. Operating profit
2. Total units produced
3. Sales of units under contract
4. Sales dollars on the above units
5. Sales of units under the firms own name
6. Sales dollars on the above units
7. Units shipped by the entire industry
8. Man hours of direct labor
9. Units produced/Man hours of direct labor
10. Number of direct labor employees
11. Number of indirect labor employees
12. Number of salaried employees
13. Bilt-ins/Total units produced (A measure of the difficulty of production. Bilt-ins are the most complex brand-name product produced.)
14. Actual production/Scheduled production
15. Percent of bonus paid
16. Material variance (Variation of material costs around the amount allowed per unit.)
17. Direct labor variance (Variation of labor costs around the amount allowed per unit.)
18. Number of Grievances Filed
19. Bids for jobs that become available on the basis of seniority
20. Factory overhead variance (Variation in overhead costs--including indirect labor--around the amount allowed per unit.)
21. Bumps (Workers transfers on the basis of seniority as a result of job eliminations.)
22. Number of people who actually change jobs on the basis of seniority as a result of eliminated jobs.
23. Average hourly wage
24. Average hourly wage with bonus

These variables were first intercorrelated. Then a factor analysis using the principle-axis method and a quartimax rotation was performed. Correlation matrices of reduced size were then prepared from the factors resulting

from the factor analysis. A factor analysis was also performed involving two separate sets of the data. One set consisted of the first fourteen variables listed above. The second set was the last ten variables listed above.

RESULTS

The first purpose of this study was to investigate the usefulness of correlational and factor analytic techniques in handling the variables involved in developing a better understanding of criteria of organizational effectiveness.

Table 1/page 22 is the correlation matrix of all twenty-four variables. In some cases the correlation coefficients have no readily-explained meaning and in others they are a function of bookkeeping techniques. Also the fact that these measures are all on the same organization over the same period of time makes it likely that some of the coefficients are artificially inflated.

The interpretation of this table is rather difficult. As this is the first of such studies, it is difficult to determine the significance of a correlation of a given magnitude. None the less, some meaning can be gotten from the relative magnitudes.

For example, it can be seen that Operating Profit correlates rather highly with both Contract Units and Company Units, but not so highly with Industry Units. Then by looking at the correlation between Industry Units and Company Units and comparing it with the correlation between Industry Units and Contract Units we can see where the discrepancy lies.

Table 1. Intercorrelation of organizational variables.

Variables	1	2	3	4	5	6	7	8	9	10	11	12
Operating Profit	-											
Total Units	48	-										
Contract Units	52	76	-									
Contract Dollars	58	76	98	-								
Company Units	51	54	19	25	-							
Company Dollars	56	50	20	24	96	-						
Industry Units	36	49	49	50	18	21	-					
Man Hours Worked	08	51	41	39	10	11	28	-				
Units/Man Hour	40	67	55	55	20	16	46	19	-			
Direct Labor Force	26	56	44	46	46	44	25	32	-08	-		
Indirect Labor Force	08	41	18	23	44	39	04	45	-15	75	-	
Salaries Personnel	-04	19	06	11	37	30	-16	19	-35	70	88	-
Built-ins/Total Units	-18	-16	-45	-45	19	19	-03	-13	-18	-04	15	21
Actual/Scheduled Production	-00	28	19	20	07	-01	11	12	53	-13	-04	-02
Per cent of Bonus	14	21	30	28	-05	-05	45	02	51	-27	-37	-50
Material Variance	-01	24	16	09	06	09	23	15	18	03	-06	-16
Direct Labor Variance	-03	-09	10	03	-34	-28	23	03	37	-55	-56	-67
Grievances Files	-08	32	11	14	37	33	05	03	-16	53	61	60
Bids	10	26	11	09	22	26	13	03	-05	24	27	26
Factory Overhead Variance	55	54	62	59	11	14	56	30	66	-02	-27	-48
Bumps	-36	-05	-18	-17	03	-01	-17	13	-20	10	42	46
Actual Job Changes	-35	01	-16	-15	08	03	-13	17	-19	17	50	52
Hourly Wages	-18	-15	-06	-16	-39	-29	15	-04	19	-49	-11	-80
Hourly wage/Bonus	03	07	21	17	-24	-20	33	-03	35	-40	-57	-70

Table 1. Continued

Variables	13	14	15	16	17	18	19	20	21	22	23	24
Operating Profit												
Total Units	1											
Contract Units	2											
Contract Dollars	3											
Company Units	4											
Company Dollars	5											
Industry Units	6											
Man Hours Worked	7											
Units/Man Hour	8											
Direct Labor Force	9											
Indirect Labor Force	10											
Salaries Personnel	11											
Bilt-ins/Total Units	12											
Actual/Scheduled Production	13	-										
Per Cent of Bonus	14	02	-									
Material Variance	15	-25	31	-								
Direct Labor Variance	16	-04	01	14	-							
Grievances Filed	17	-15	15	40	20	-						
Bids	18	23	-04	-41	05	-51	-					
Factory Overhead Variance	19	21	-01	-23	27	-25	52	-				
Bumps	20	-25	17	50	18	51	-23	-03	-			
Actual Job Changes	21	10	08	-27	-15	-19	25	15	-47	-		
Hourly Wages	22	13	08	-24	-13	-23	32	19	-42	97	-	
Hourly Wage w/Bonus	23	-15	-07	40	29	57	-49	-08	37	-41	-44	-
	24	-30	16	78	24	48	-36	-10	50	-37	-37	71

These correlations do not, of course, indicate exactly what to produce, but they do give an idea of the relationship between the two main divisions of production and the performance of the entire industry. Thus we have an idea of company performance relative to the whole industry. When the industry units are high, the company may be forced into supplying contract units at the expense of their own company units. Given forecasts for the whole industry, we might also be in a better position to determine where it would be best to concentrate future production. Still another use of knowledge of such relationships might be in evaluating the company sales organization and their effectiveness in concentrating on contract or company units in relation to industry trends.

These relationships are rather interesting and add information on the performance of the organization and the relationships among various measures of performance. But by far the most striking feature of a study of Table 1 is the fact that there is too much information there for one to keep in mind and to use effectively. In an attempt to reduce the number of variables necessary to keep in mind, this matrix was factor analysed.

The principal object of factor analysis is to simplify the description of data by reducing the number of necessary variables, or dimensions. In this study sixty measures of twenty-four variables were taken. If by factor analysis

we find that five or six factors are sufficient to account for all the common variance covered by the original twenty-four variables, considerable simplification will have been achieved.

The factor analysis was performed on the MISTIC, Michigan State Integral Computer. The procedure was to use one as the estimate of the communalities, extract factors by the principle axis method and then orthogonally rotate the factors using the Quartimax method developed by Wrigley and Nauhaus (1954). The criterion for choosing the number of factors to rotate was that suggested by Kiel and Wrigley (1962) for the Quartimax method: that is, rotate the highest number of possible factors which will still give at least two variables with their highest loading on each factor.

The Quartimax method was chosen because with the small sample size (60 time periods) a unique analytical solution with orthogonal rotation is preferred to other methods which may be more effected by chance variation. In addition, no prior classification of variables nor assumptions about the presence or absence of a general factor is needed. Its aim is to find the orthogonal transformation which maximizes the variance of the factor contributions (i.e. the squared factor loadings). Since the total variance is constant, an incidental consequence of the method is to increase the number of zero or near-zero loadings as well as the size of the larger loadings. To this extent the method

is an approach to "orthogonal simple structure" (Wrigley and Nauhaus 1954).

Table 2, page 26, shows the six rotated factors and the variables which loaded high on each. Factor loadings of .40 and higher were included. Loadings of .39 are shown in parentheses. It will be noted that factors I and II account for a large portion of the total variance. The Eigen values for the six rotated factors are: 6.58, 5.83, 2.10, 1.68, 1.48, and 1.00.

Table 2. Rotated factors and factor loadings.

Measures	I	II	III	IV	V	VI
1. Operating Profit	--	.55	-.41	--	-.49	--
2. Total Units	--	.84	--	--	--	--
3. Contract Units	--	.94	--	--	--	--
4. Contract Dollars	--	.95	--	--	--	--
5. Company Units	--	--	--	--	-.86	--
6. Company Dollars	--	--	--	--	-.87	--
7. Industry Units	--	.59	--	--	--	--
8. Man Hours Worked	--	.53	--	--	--	-.53
9. Units per Man Hour	-.42	.66	--	--	--	--
10. Direct Labor Force	.73	.45	--	--	--	--
11. Indirect Labor Force	.83	--	--	--	--	--
12. Salaried Personnel	.93	--	--	--	--	--
13. Bilt-ins/Total Units (Difficulty of Mix)	--	-.49	--	--	-.47	--
14. Actual?Scheduled Prod.	--	--	.54	--	--	.54
15. Percent of Bonus	-.66	(.39)	--	--	--	--
16. Material Variance	--	--	--	.71	--	--
17. Direct Labor Variance	-.77	--	--	--	--	--
18. Grievances	.68	--	--	(.39)	--	--
19. Bids	--	--	--	.70	--	(.39)
20. Factory Overhead Variance	-.51	.69	--	--	--	--
21. Bumps	.41	--	.78	--	--	--
22. Actual Job Changes	.43	--	.78	--	--	--
23. Hourly Wages	-.82	--	--	--	--	--
24. Hourly Wages with Bonus	-.77	--	--	--	--	--

A discussion of the interpretable factors and a correlation matrix of the variables loaded on each factor follows.

Factor I indicates that in months when the number of people in the labor force (Direct, Indirect and Salaried), Grievances and the two measures of Bumps (Bumps and Actual Job Changes) are all high, then Units per Man Hour, Percent of Bonus, Direct Labor Variance, Factory Overhead Variance and both measures of Average Hourly Wages will be low.

These relationships can, perhaps, be explained by considering the effect of an increase in the size of the labor force. The people who are added in the production work force are new, inexperienced workers who receive lower than average wages, (Hourly Wages, Hourly Wages w/Bonus). The disrupting effect of adding workers (Bumps, Actual Job Changes) and perhaps a new production line plus the inefficiency of the new workers acts to reduce the efficiency of production (Units per Man Hour, Direct Labor Variance, Factory Overhead Variance).¹ This results in a decrease in Units per Man Hour and in Percent of Bonus paid and an increase in certain costs per unit which show up as negative (Direct Labor Variance, Factory Overhead Variance). All of

¹ This factor includes all three components of the labor force, and not just direct labor. The loadings of the three variables are in reverse order of magnitude from what we would expect on the basis of production needs. Although the differences among the loadings are rather small, this finding could cast some suspicion on the employment practices of the organization. It should at least lead to further investigation of this area.

these changes will demand the accommodation of an increased number of workers resulting in an increase in grievances.

Generally then, this factor is the cost of production or more precisely the direct and indirect "cost" of the labor force necessary for a sustained rate of production. It could also be thought of as the performance of personnel in the organization as opposed to the organization itself.

Perhaps the relationships of the variables in Factor I can be seen more clearly by referring to table 3/page 29. Table 3 is a reproduction of the portion of the original correlation matrix found to be weighted on Factor I.

Factor II indicates that in the months when production of Contract Units, Operating Profit, Total Units, Industry Units, Man Hours Worked, Units per Man Hour, size of Direct Labor Force, Factory Overhead Variance, and Percent of Bonus are high, Bilt-ins/Total Units is low. This factor could be thought of as the performance of the organization, in producing one type of product, as opposed to the performance of the personnel.

All the variables which are high on this factor are related to a high level of production of contract units. The negative loading of Bilt-ins/Total Units follows if we consider that when the company has the demand to produce contract units they do so at the expense of the production of company units. The positive loading of Industry Units points out the relationship between the contract units which are sold

Table 3. Intercorrelation of variables loaded on factor I.

(Loading) Variables	1	2	3	4	5	6	7	8	9	10	11	12
(-.42) Units/Man Hour	1	-										
(.73) Direct Labor Force	2	-08	-									
(.83) Indirect Labor Force	3	-15	75	-								
(.93) Salaried Personnel	4	-35	70	88	-							
(-.66) Per Cent of Bonus	5	51	-27	-37	-50	-						
(-77) Direct Labor Var.	6	37	-55	-56	-67	40	-					
(.68) Grievances	7	-16	53	62	60	-41	-51	-				
(-.51) Factory Overhead Var.	8	66	-02	-27	-48	50	51	-23	-			
(.41) Bumps	9	-20	10	42	46	-27	-19	25	-46	-		
(.43) Actual Job Changes	10	-19	17	50	52	-24	-23	32	-42	97	-	
(-.82) Hourly Wages	11	19	-49	-71	-86	40	57	-49	37	-41	-44	-
(-.77) Hourly Wage w/Bonus	12	35	-40	-57	-70	78	48	-36	50	-37	-37	71

nationally under a well known brand name and the fluctuations of the national market.

It is noteworthy that only Direct Labor is loaded on this factor. This confirms the practice of the company of pricing contract units primarily on direct labor costs. Factory Overhead Variance is favorable in relation to the volume of contract units, i.e. advantageously absorbed by a larger number of units. The high positive loading of Units per Man Hour can be accounted for by the relative simplicity of the production required to fulfill the contracts.

In view of the positive loadings of Factory Overhead Variance, Direct Labor Force, Units per Man Hour and the positive relationship to Operating Profit and Percent of Bonus we can conclude that contract operations are advantageous to the organization--at least with respect to these considerations.

The variables loaded on Factor II have been taken from the original correlation matrix and presented in Table 4, page 31. This will give the reader a better idea of the relationships among these variables.

As was mentioned earlier, Factors I and II account for a large portion of the variance in the original correlation matrix. The following factors are, therefore, loaded on fewer variables and are more difficult to interpret.

Factor III shows that in months in which Bumps, Actual Job Changes and Actual/Scheduled Production are high, Operating Profit is low. The relationship between Bumps and Operating

Table 4. Intercorrelation of variables loaded on factor II.

(Loading) Variable	1	2	3	4	5	6	7	8	9	10
(.55) Operating Profit	1	-								
(.84) Total Units	2	48	-							
(.94) Contract Units	3	51	76	-						
(.95) Contract Dollars	4	58	76	98	-					
(.59) Industry Units	5	36	49	49	50	-				
(.53) Man Hours Worked	6	07	51	41	39	28	-			
(.66) Units/Man Hours	7	40	67	55	55	46	19	-		
(.45) Direct Labor Force	8	26	56	44	46	25	32	-08	-	
(-.49) Bilt-ins/Total Units	9	-18	-16	-45	-45	-03	-13	-18	-04	-
(.69) Factory Overhead Var.	10	55	54	72	59	56	30	66	-02	-24

Profit reflects the effect of the direct work force employees accommodating themselves to new work assignments. Reference to the size of the correlations between Operating Profit and Bumps (and Actual Job Changes) and between Actual/Scheduled Production and Bumps (and Actual Job Changes) presented in Table 5 indicates the need to limit our interpretation to the relationship between Bumps and Profit. This appears to be a specific factor involving personnel changes independent of factor I. The intercorrelations among the variables loaded on Factor III are abstracted from the original matrix and presented below.

Table 5. Intercorrelation of variables loaded on factor III.

(Loading) Variable		1	2	3	4
(-.41) Operating Profit	1	-			
(.54) Actual/Scheduled Production	2	-.001	-		
(.78) Bumps	3	-.36	.08	-	
(.78) Actual Job Changes	4	-.34	.08	.97	-

Factor IV is loaded on only two and possibly a third variables. As there is no apparent reason why Material Variance and Bids should be the sole variables loaded on this factor, no attempt at interpretation will be made.

The variables loaded on Factor IV and their correlation coefficients are presented below.

Table 6. Intercorrelation of variables loaded on factor IV.

(Loading) Variable		1	2	3
(.71) Material Variance	1	-		
(.39) Grievances	2	.05	-	
(.70) Bids	3	.27	.52	-

Factor V is loaded on Operating Profit, Company Units, Company Dollars and Bilt-ins/Total Units. This factor results from the relationship among these variables in months when a large number of Company Units are being produced. Just as in the months when contract units are being produced, profit is made when company units are being produced.

Table 7, page 33 presents the intercorrelations of the variables loaded on Factor V. An examination of this table reveals that Company Units correlate positively with Operating Profit while the ratio between Bilt-ins and Total Units correlates negatively. This suggests that the company product exclusive of Bilt-ins is produced profitably or conversely, Bilt-ins are not profitable.

Table 7. Intercorrelation of variables loaded on factor V.

(Loading) Variable		1	2	3	4
(-.49) Operating Profit	1	-			
(-.86) Company Units	2	.51	-		
(-.87) Company Dollars	3	.58	.96	-	
(-.47) Bilt-ins/Total Units	4	-.18	.19	.19	-

Factor VI is another one with two and possibly three variables loaded on it. No interpretation of this factor will be attempted. Table 8 shows the intercorrelations among the variables loaded on Factor VI.

Table 8. Intercorrelation of variables loaded on factor VI.

(Loading) Variable		1	2	3
(-.53) Man Hours Worked	1	-		
(.54) Actual/Scheduled Production	2	12	-	
(.39) Bids	3	03	01	-

In order to further check the reliability of the method, a factor analysis, employing the same techniques as before, was performed on two separate portions of the data--the first fourteen variables in one set and the last ten variables in the second set. The first set was taken to describe the performance and dimensions of the organization--profit, units of production, size of labor force, etc. The second set describes the performance of the people in the organization--percent of bonus, direct labor variance, grievances, etc.

Although these are rather small numbers of variables to factor analyse, the results are of interest. Inspection of table 9, page 35, reveals a labor force factor (I) a contracts-production factor (II) and a company-production factor (III) much as was found in the original analysis.

Table 10, page 35, is essentially a further breakdown of the variables loaded on factors I and III of the original analysis.

Table 9. Rotated factors and factor loadings for production variables

Measures	I	II	III	IV
1. Operating Profit	--	-.53	-.61	--
2. Total Units	--	-.82	--	--
3. Contract Units	--	-.93	--	--
4. Contract Dollars	--	-.93	--	--
5. Company Units	--	--	-.89	--
6. Company Dollars	--	--	-.91	--
7. Industry Units	--	-.61	--	--
8. Man Hours Worked	.46	-.51	--	--
9. Units per Man Hour	--	-.74	--	.41
10. Direct Labor Force	.78	--	--	--
11. Indirect Labor Force	.93	--	--	--
12. Salaried Personnel	.92	--	--	--
13. Bilt-ins/Total Units (Difficulty of Mix)	--	.49	--	.50
14. Actual/Scheduled Prod.	--	--	--	.79

Table 10. Rotated factors and factor loadings for people variables

Measures	I	II	III	IV
15. Percent of Bonus	--	--	--	-.88
16. Material Variance	.84	--	--	--
17. Direct Labor Variance	--	-.63	--	-.41
18. Grievances	--	.86	--	--
19. Bids	.47	.72	--	--
20. Factory Overhead Variance	--	--	--	-.68
21. Bumps	--	--	.97	--
22. Actual Job Changes	--	--	.97	--
23. Hourly Wages	.49	-.49	--	-.40
24. Hourly wages with Bonus	--	--	--	-.82

DISCUSSION

The results of this study seem to indicate the usefulness of correlation and factor analytic techniques in dealing with the complex relationships among a number of measures of organizational performance.

Industrial organizations such as the one in this study have a wealth of quantitative information compiled for various reasons. This information is used for tax purposes, preparing the budget and the financial reports. With the recent developments in medium priced digital computers and computer service centers who rent computer time, such organizations could very well make additional use of this information. The relatively simple correlation techniques used in this study could be used by managerial personnel to improve their understanding of the performance of their organization.

The correlation analysis reported in this study summarized a great deal of valuable, oft times not so obvious, information about the relationships among these various measures of organizational performance. The extreme complexity of the modern industrial organization, however, leads to a problem. If we include all possible or available measures of organization performance, the correlation matrix becomes too complex to be of very much value. But if we want to understand the whole organization, which variables can be left out? This question cannot be satisfactorily answered

a priori. One solution is to apply multivariate analysis techniques to the correlation matrix in an effort to reduce the number of dimensions to a more manageable size.

Factor analysis was used to gain this advantage. Six factors resulted. Study of the variables loaded on each of these factors leads to a better understanding of the underlying dimensions. Correlation matrices showing the intercorrelations among the variables loaded on each factor help in gaining a better understanding of the relationships among the variables.

The first factor seems to reveal the effects of increasing the labor force to meet increased production demands. It would appear that the increase must be made at the expense of efficiency. The quality of the additional workers plus the disruption of the routine keeps the expanded work force from being as efficient as the smaller group was.

This fact seems important when a temporary increase in labor force is being considered. Increased labor results in increased production--but inefficient and costly production--at least during the period of adjustment. This fact seems to be one important dimension of an empirically derived criterion of organizational effectiveness.

The second factor reflects a type of production. Just as we would expect, an important dimension in accounting for the variance among organizational variables is the level of production. The factor is also positively loaded on Operating Profit and Units per Man Hour. This indicates the need to

consider not just production or just profit but both--plus some measure of efficiency. So the second dimension involves the type of production.

The third factor seems to be the disruption caused by a large number of worker transfers. The disruptive effect of Bumps and job changes seems to result in a reduction of profits--probably through reduced efficiency of production. That this factor involving personnel and job changes is independent of factor I which accounted for most of the personnel variance is interesting. It may indicate an area of particular importance for further study.

The fifth factor, the last one to be interpreted, is company-name production. This factor and factor II are both production factors. The fact that the firm under study usually produces either contract or company units but not both at the same time leads to two factors instead of only one.

Thus we have four factors that are reasonably clear dimensions underlying the variance among the twenty-four measures of organizational performance.

1. Labor efficiency
2. Contract-production
3. Disruptive job changes
4. Company-production

It must be remembered, however, that these results are just for one organization over one rather short period of time. More work using more variables on the same organization and more work using similar variables on different organizations will be necessary before any useful theory-building can be done.

Several changes in the present study would have improved it. More measures could have been included. The most important of which is some measure of time. The months could have been numbered from one to sixty and included in the analysis. This may have resulted in a factor of long-run trends--growth, perhaps. Measures of overtime, voluntary turnover, waste or scrap, engineering changes made on the production line, better measures of various types of production, etc. might have been included. On the other hand, some measures are so similar that perhaps some could have been left out. Two measures of the average hourly wage variable and the bumps variable seem unnecessary.

Other studies of this nature would very likely be of interest. Smaller units of an organization, divisions or departments, could be similarly studied and compared. Comparisons between the departmental dimensions and the dimensions for the whole organization could be made. Studies of this type could be done for "good times" and for "bad times" and the dimensions compared. Most important, however, is to repeat this study on the same organization employing the suggested changes in variables. Then a similar study should be done using appropriate variables on another organization.

SUMMARY AND CONCLUSIONS

The nature and history of present theories of organization were discussed. The conclusion of the discussion was that modern theories of organization are deductive and based on assumptions rather than inductive and based on a body of accumulated facts. For this reason they do not seem to satisfactorily describe the relationships at work in a complex industrial organization. Nor do they act as a guide to behavior in the industrial organization.

The lack of systematic study of the variables which describe the entire organization was pointed out. Correlational and multivariate analysis techniques were suggested as a solution to this shortcoming.

Twenty-four measures of the performance of a medium-sized manufacturing organization over a sixty-month period were collected. These variables were intercorrelated. Factor analysis was used to simplify the description of data by reducing the number of necessary variables, or dimensions. Six factors resulted. Four of these factors were then discussed and interpreted in light of experience and familiarity with the organization under study. Two dimensions were seen to account for most of the variance: (1) Labor efficiency and (2) Contract-production. Two additional factors seemed worth interpretation: (1) Disruptive job changes and (2) Company-name production.

In order to assist the reader in studying the relationships among the variables loaded on each of these factors and to further demonstrate the usefulness of factor analysis in studying this kind of problem, correlation tables involving the variables loaded on each factor were prepared. It is felt that tables such as these can be more useful in understanding the performance of the organization than the larger matrix involving all the variables used in the study.

The data used in this study was operational accounting and personnel data derived from organization records. It is felt that this kind of data describes the performance of the organization more completely and accurately than the more traditional psychological data.

Several changes were suggested which would have improved the study. Certain measures which were included could have been left out and several measures should have been included which were not.

Future studies of this kind seem most worth while. The same organization could be studied employing the recommended changes. Different organizations could be studied using the same technique. Particular periods in the life of an organization could be studied and the dimensions which emerge compared with the dimensions from another period. Studies could also be carried out on smaller units of the organization--divisions or departments. The underlying dimensions revealed at this level could be compared with those for the whole organization.

The general conclusions reached are two fold: First, four dimensions seem to account for most of the variance among the measures of organizational performance under study. Of particular interest is the fact that two independent factors involving the labor force were found. These four factors can be seen as criteria of effectiveness for this organization. Secondly, correlation and multivariate analysis techniques using accounting data and personnel data can be useful in understanding the complex relationships among measures of organizational performance and in identifying relevant criteria against which to evaluate this performance.

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