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ABSTRACT

The purpose of this paper is to identify some critical dimensions in specifying a model of group performance. In the first section, the boundaries of the paper, e.g., work groups that produce some identifiable good or service, are discussed. In the second section some models of group performance are explored in order to illustrate theories of group performance. Commonalities and problems associated with the models in section two are highlighted, e.g., flow chart theorizing, and misspecification problems. Areas to be considered in developing a model of group performance are discussed in detail including use of a single criterion, ideographic production models, production process uncertainty, parsimonious models, construct specification, a refocus on technology, and the ordering of the model's variables. (MCF)

Some Observations on Specifying Models of Group Performance

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The purpose of this paper is to identify some critical dimensions in specifying a model of group performance. The focus is not on presenting the model of effective group performance because there is unlikely to be a model which is generalizable to different criteria and different types of groups. Rather, our interest is in discussing some of the conditions for developing models of group performance. A basic assumption in our work on groups is that one must build models of performance for a specific criterion in a specific type of group. If this is true, the best one can do in a general discussion is to indicate the processes necessary for developing models of group performance

Boundaries

To provide some boundaries for this paper, first, we will examine only work groups that produce some identifiable good or service. There is obviously a very large amount of literature on group problem solving which we are omitting. Second, our interest is in groups in an organization. Although there have been important findings from laboratory research on group performance, our interest is in understanding group performance in a work organization. Also, it is often difficult to integrate findings from the laboratory into the field setting. We feel this may be because laboratory research has focused on a set of variables that are not central to understanding group performance in existing organizations. Our focus is also on permanent, not on temporary groups. Lastly, we are interested in work in which group members exhibit some level of interdependency in producing an identifiable product or service.

One other caveat is probably important before we examine the process in specifying models of group performance. Our thinking about groups is affected by the types of groups we work with. Our own experience is primarily with groups that produce a product, either coal mine crews

(Goodman 1979) or work groups in factories (Goodman and Dean, 1982). The samples have ranged from one group to several hundred. The methodologies have included interviews, observations, and the examination of archival records.

Some Models of Group Performance

One way to think about the process of specifying models of group performance is to examine some models of performance in order to illustrate how people think about group performance. In no way can such a discussion be exhaustive.

The sociotechnical perspective is clearly a dominant intellectual orientation in the group literature (c.f., Trist, Higgins, Murray and Pollock, 1963, and Kelley, 1978). One of the central arguments is that organizations and groups have both technical and social systems, and the fit between these systems will influence organization or group performance. A recent paper (Kolodny and Kiggundu, 1980) in the sociotechnical tradition developed a more specific model of group performance (See Figure 1). Basically that model argues that there is a core of variables -- technical skills, leadership, and group interaction -- which affect group outcomes such as productivity. These core variables are in turn affected by task conditions, the cultural setting and organizational arrangements.

In Cummings' (1981) review of designing effective work groups a different model is proposed. He focuses on the following set of variables: supervisor characteristics, interpersonal relations, technological characteristics, and group characteristics. These affect a set of summary variables which in turn affect individual and group outcomes. Figure 2 is a simplified version of Cummings' view.

He actually regards the variables on the left side of the diagram as a complicated system of interrelationships characterized by recriprocal causation. It is clear that some of the variables in that model, although altered in form, draw from the work of Hackman.

Other perspectives have looked at both the relationships between external conditions, member resources, team characteristics, and task characteristics and their relationship to team performances (c.f., Nieva, Fleishman, Rieck, 1978). The principal focus is on the fit between member resources and task characteristics and its effect on team performance.

In our earlier research on coal mining crews we examined work productivity as a function of the technology, labor and the physical environment of the work group. The R^2 for the estimated production function model ranged from .6 to .8.

There are obviously other models which could have been discussed. Our purpose, however, is only to use these models as a way of thinking about specifying models of performance.

Commonalities

As we examine these models there seem to be some common strategies. First, there is a common set of variables. Technological or task characteristics, human resources, and interactions appear in most models of group performance. Second, the interrelationship among the variables is usually specified by directional arrows rather than by stating the functional form of the relationship. The models relate to outcomes in general rather than to some specific variable such as productivity or satisfaction. Some of the models are tied to specific types of groups while others are postulated for groups in general. For example, the socio-technical model we presented (Figure 1) is unique to woodland harvesting.

Problems

Let's assume that these are representative approaches to specifying models of group performance. What are some of their limitations or problems?

1. Flow Chart Theorizing. Most of the theoretical work is very general. The reader is confronted with a list of variables, yet there is no indication of which variables are really critical. We know little about the functional relationship among variables. It now is a fairly common practice in the organizational literature to draw flow charts and arrows. This can help the writer and reader to understand a system of variables. The next logical step is to develop a more precise understanding of the functional relationships among variables. Unfortunately, much theoretical work stops at the general level of the diagram. The reason for moving toward a more fine grained analysis is twofold: First, it will help uncover non obvious interesting relationships. For example, in one study (Goodman, 1979) we found the relationship between number of workers and labor productivity to be in the form of an inverted "U". Within a certain range, variation in crew size was not related to productivity. After a point, increasing the crew reduced the productivity of the marginal worker. In another analysis, in the same study, the impact of crew cohesiveness on productivity appeared under conditions of high process uncertainty. That is, on a day to day basis, cohesive groups that were positively disposed toward the company did not produce more, on average, than groups low in cohesiveness. However, when there were conditions of high process uncertainty brought about by environmental factors, productivity of the cohesive groups was higher. The point of these examples is to show that there were some unique interection effects

among variables that may explain productivity differences. One can undercover these relationships by more carefully examining the functional relationships among the variables.

The second reason for pushing toward a more fine grained analysis is that it will sharpen our construct specification. Skill or knowledge is available in most group performance models. In the abstract it is hard to know how to use that variable. Are we talking about general education, job experience, or a specific set of activities? In a study by Kolodny and Kiggundu (1980), one factor in distinguishing between high and low productivity crews was the skill of the operator in sensing possible break downs, diagnosing the problem, and being able to override manual controls. Skill was not then the general capacity to operate the machines. Rather, skill as it related to productivity was a unique package of skills relevant to a particular condition of uncertainty. To identify the appropriate meaning of skill requires an intimate knowledge of the production process.

2. Most models attempt to predict general outcomes rather than a specific outcome. This simply does not seem reasonable. The predictors of quantity are probably not the same as those of quality.

3. Most of the models do not distinguish between types of groups. Let's assume we can distinguish between groups that produce an identifiable product (coal mining) versus an identifiable service (sales team). In the former group, the nature of the machinery and technological arrangements will dominate the production process while in the service group, the labor component may be more important.

4. There are misspecification problems in many of the models. These appear in a number of forms. First, there seems to be an over emphasis on the importance of psychological variables. While most models acknowledge the importance of antecedent variables such as the environment, technology,

individual abilities, etc., these models propose that this set of factors only affects performance through some psychological variable such as group interaction. It would seem reasonable to expect that some of these antecedent variables have direct effects (e.g., technology) as well as indirect effects. A second and related point is that the technology-task variable is often viewed as a contingency factor rather than as a main effect. It is true that the effect of group size on productivity is contingent on technology task characteristics. However, variations in technology may also severely affect productivity level. A third point is that we have underestimated the specification of the technology variable. There are at least two components of that variable -- the physical machinery and space used to produce a product or service, and the technological arrangements necessary to produce a good or service. These latter might include inventory policies, maintenance policy, scheduling programs, etc. We think the nature of these policies and their operational form are key in explaining productivity differences. Similarly, variation in type and quality of machinery should have a direct impact on productivity.

Some Considerations in Developing a Model

1. Single Criterion. We advocate "working backwards," that is, selecting a criterion of interest and then developing a model for that variable. It is unlikely we can develop general models of performance. The task is to select specific indicators such as output, output/labor hours, and quality, and then to build a model. The strategy of selecting a criterion and working backwards has been used in research on absenteeism. That is, one builds different models for different

kinds of absenteeism. It also has been used in the organizational effectiveness literature (Goodman, Atkin and Schoorman, 1983).

2. Idiographic Production Models. We need to develop models that are unique to a particular technology, not to a particular organization. This would mean we would generate group performance models for producing "X", extracting "Y", and selling "Z".

In one study we are collecting data on group productivity from 20 organizations that have 10 to 15 work teams each, all producing the same good -- coal. The organizations represent different companies, which have different policies, organization structures, reward systems, etc. However, since the basic production process is the same, we should be able to build a model that will work across companies. However, it is clear that this model will not fit a different technology. To advocate developing idiographic models across organizations requires some mechanism such as a taxonomy to determine which production processes are similar. This taxonomy would be different from some of the classification systems in the group literature on task content or characteristics. Such a classification systems would be designed in terms of the factors of production and output. For example, in our current coal mine study, a model can be built across firms because the factors of production and output are the same. The model would not generalize to other extraction industries where the process and product differ.

3. Production Process Uncertainty. The concept of production process uncertainty may be useful in specifying models of group performance. It refers to the degree of uncertainty inherent in the production process. Uncertainty is determined by the predictability of events in the production process and the availability of dominant strategies that will improve

group performance. A machine breakdown would be an example of an event which is both low in predictability and may or may not involve a dominant strategy to get production going again. If we can think of the production processes as varying in the degree of uncertainty then it may be that models that explain performance in the certain or stable conditions do not explain events on the uncertain or special conditions. For example, we found that cohesive groups had higher productivity in conditions of uncertainty than they did in stable conditions. A related point is that under some conditions of high process uncertainty, one may not be able to develop any model of productivity.

4. Parsimonious Models. One of the problems with many group performance models is the large number of variables they display. This large number in many cases precludes understanding the performance model. One way to reduce the number of variables would be to develop one model that focuses on the stable high certainty production processes and another model for the special processes "high in uncertainty." The simplest specification of the stable model would be that productivity is a function of labor and technology, where labor represents the number and skills of the team member and technology refers to the machinery and technological arrangements. This simple production function has accounted for a reasonable proportion of variation in production in our research (Goodman, 1979). The main point is to begin with a simple rather than a complex model and to select the basic factors of production in the initial model. Once some data is "in hand" it may be necessary to sequentially extend the model. A similar approach could be used for a model of processes high in uncertainty.

5. Construct Specification. A problem in much of the group performance literature is the loose specification of constructs. One way to improve the specification is to examine (1) the production process and (2) the concept of production process uncertainty. Consider a simple variable such as the number of workers present in a given group. This number may vary for a variety of reasons, which in turn, may affect production. However, in a group subject to down time, the number of workers is probably a less powerful variable than the actual labor time (number of workers x actual production time). However, the actual working time variable may not be precise if the crew is subject to over and under manning. In this case the labor variable must be further decomposed into actual working time and standard working time. (See Goodman, 1979, for more details.) The point in this first example is that a detailed knowledge of the production process precedes construction specification.

We also suggest that the concept of production process uncertainty might help. Consider a variable such as skill. Skill that may be important in the stable cases might not be important in special cases. The reverse is also true. For example, the skill involved in correcting a major machine breakdown is probably not the same skill which will account for production increase under the stable condition. By distinguishing between the stable and special cases we might find another way to sharpen our construct specification.

6. Refocus on technology. Much of the group performance literature focuses on traditional variables such as cohesiveness, leadership, group interaction, and so on. One reason for this focus is that most research takes place within an organization where other variables, such as technology or policy, are assumed to be constant. Another reason we focus on these

variables is that we are less comfortable with technical production concepts such as inventory policy, maintenance policy, etc. In our own research these technical policy variables may be more important in affecting stable variations in performance than some of the leadership variables. We think more attention should be given to the technology variable with particular focus on the physical machinery and technical policy variables.

7. Ordering Variables. Many models of group performance trace antecedent variables to intervening variables and then to outcomes. We have already suggested that this may be an incorrect set of links and that some of the antecedents may directly affect performance. It may also be that some of the group process variables affect the antecedents which in turn affect performance. Let's assume that the simple model of productivity as a function of labor and technology explains variations in productivity. One still would like to account for variations in the number of workers present which may be a function of group process variables. The main point is to be more careful in the ordering of variables. A clear understanding of the technological processes will help in this endeavor.

Conclusion

We need to move away from a general model of group performance. We should rather select a simple criterion variable and, by "working backwards," develop a model unique to a particular production process. We should move toward parsimonious models by paying more attention to the basic production process and to the process uncertainty concept. We think that there is also a need to refocus on the technology variable and to pay more attention to the causal ordering of variables. These strategies in model specification are directed to those interested in formally modeling group processes and those interested in action research in groups.

REFFRENCES

Cummings, T. "Designing Effective Work Groups." Handbook of Organizational Design., Volume 22, pp. 250-271.

Goodman, P. Assessing Organizational Change. New York: Wiley, 1979.

Goodman, P and Dean, J. "The Process of Institutionalization." In P. Goodman, (Ed.). Change in Organizations. California: Jossey-Bass, 1982.

Goodman, P., Atkin, R., and Schoorman, D. "On the Demise of Organizational Effectiveness Studies." In K. Cameron and D. Whelten (Eds.). Organizational Effectiveness. New York: Wiley, 1983.

Kelley, John E. "A Reappraisal of Sociotechnical Systems Theory. Human Relations, 1978, 31 (12), pp. 1069-1099.

Kolodny, H. and Kiggundu, M. "Towards the Development of a Sociotechnical Systems Model in Woodlands Mechanical Harvesting." Human Relations, Volume 33, 1980, pp. 623-645.

Nieva, V., Fleichman, E., and Rieck, A. "Team Dimensions." Advanced Research Resources Organization, Washington, D.C. 1978.

Trist, E.L., Higgin, G., Murray, H., and Pollock, A.B. Organizational Choice. London: Tavistock, 1963.

PROBLEMS

1. FLOW CHART THEORIZING

2. GENERAL OUTCOMES

3. TYPES OF GROUPS

4. TECHNOLOGY VERSUS PSYCHOLOGY

TABLE 1

DESCRIPTION	CONDITIONS	DOMINANT STRATEGY
STABLE	PREDICTABLE	KNOWN
SPECIAL	LESS PREDICTABLE	KNOWN
RANDOM	LESS PREDICTABLE	UNKNOWN

TABLE 2

SOME CONSIDERATIONS

1. SINGLE CRITERION

2. IDIOGRAPHIC MODELS

3. PRODUCTION PROCESS UNCERTAINTY

4. PARSIMONIOUS MODELS

5. CONSTRUCT SPECIFICATION

6. REFOCUS ON TECHNOLOGY

7. ORDERING VARIABLES

FIGURE 1

A SOCIOTECHNICAL MODEL

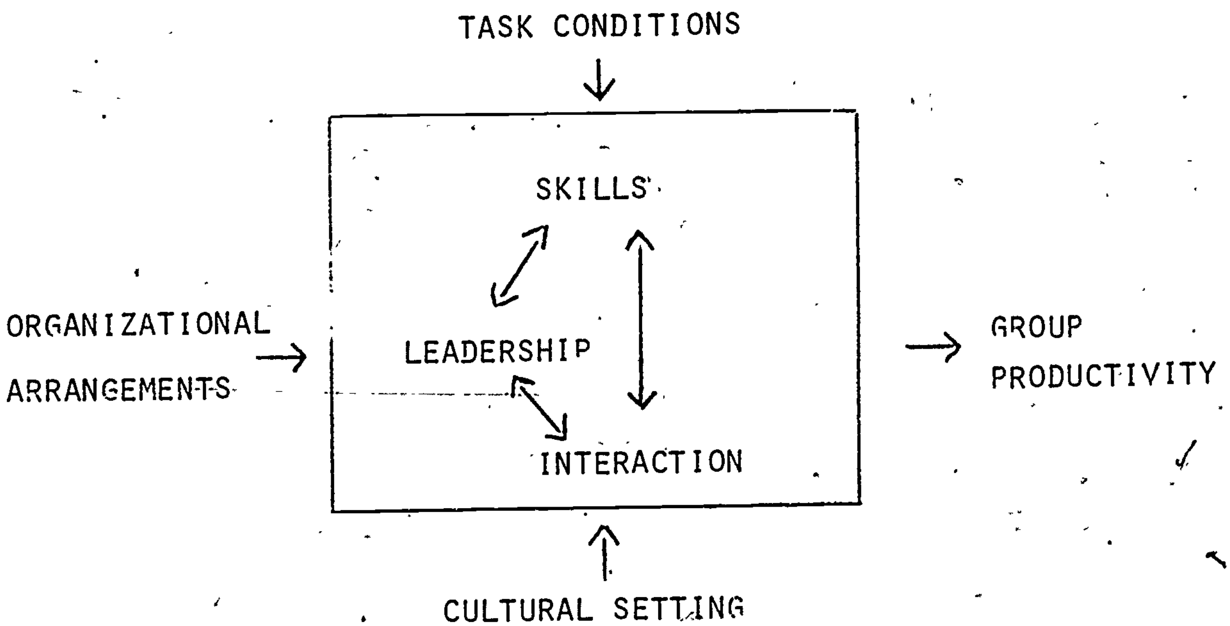

FIGURE 2

AN INTEGRATIVE MODEL

SUPERVISOR ACTIVITIES

INTERPERSONAL INTERACTIONS

SUMMARY VARIABLES

OUTCOMES

TECHNOLOGICAL CHARACTERISTICS

GROUP CHARACTERISTICS

FIGURE 3

PRODUCTIVITY MODEL - COAL MINING CREWS

PRODUCTIVITY = TECHNOLOGY, LABOR, PHYSICAL ENVIRONMENT