On Multiple Goals in Managerial Decision Making Systems

By Svend A. Kræmer*)

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Introduction

A better understanding of managerial decision making and guidelines for improvement of management decisions are the goals sought by management scientists. Lately, research has been published that contributes considerably to our understanding of the managerial decision making process in view of the human factor involved. This paper is intended to investigate the impact of this research on the design of managerial decision making systems. It is desirable to determine whether or not the ability of the decision making system to reach solutions that contribute to the goal or goals of the organization, is changed.

It is convenient as a point of departure to consider two major events which have taken place within the last decades, and which have both contributed to a better understanding and to improved guidelines for decision making in organizations.

The first of these two events is the introduction of *behavioral science* in the investigation of organizational behavior and its impact on the understanding of the conduct of the individual and the groups within the organization. The early contribution of March and Simon (1958) is the first major step in this direction. But the technological developments which have taken place since the second world war, have also caused changes in managerial style and decision making processes. It is argued that the automation in industry has given management more time for managing. However, as the number of employees in the ad-

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ministrative departments have increased absolutely as wel as relatively, the managerial process has grown in complexity as well as in extent. Thus, the need for improved management techniques has grown simultaneously.

The second event, the introduction of *electronic computers* as means of automating administrative processes as well as of providing management with improved information for decision making, has also provided management scientists with a tool which can be used for testing and developing decision making systems by means of techniques such as mathematical programming, simulation, or heuristic search.

In the following chapter we will discuss the literature as to the approaches to new management theories developed by economists and management and behavioral scientists. The second chapter is devoted to a review of a multiple goal model which is supposed to simulate real world decision making systems. In the third chapter the operationality of a multigoal decision making system with respect to the total hierarchical planning system of an organization is investigated. In a final summary the results of the investigation are related to the conventional theory of managerial decision making.

1. New Management Theories

In this chapter a review of the literature which has caused changes in the traditional theory of the firm is given. The following aspects in this literature can be distinguished:

(1) Application of operations research techniques to find optimal solutions of management decision making problems and the ability of these techniques to improve managerial decision making (section 1.1.)

(2) Critique of the traditional overall goal of the firm – profit maximization – and development of alternative or simultaneous goals of the firm (section 1.2.)

1.1. *Operations Research Techniques and the Theory of the Firm*

It has been argued that the purpose of the theory of the firm is to describe and explain entrepreneural behavior (for example, Danø, 1966, pp. 1–2). Thus, the classical economic theory should enable the decision makers of the firm to analyse and conduct the behavior of the single or multi-product firm, selling its products and buying its factors of production in imperfect markets. Furthermore, according to the classical theory, the decision makers will then develop a mathematical model in which the side conditions in form of the production factors, the demand function for the products, and the factor supply functions are well defined at any point in time. The preferred behavior is deduced from the hypothesis that the decision makers prefer that solution which optimizes a given objective function (e.g., short run profit). The analytical techniques used have traditionally been those of marginal analysis.

The application of traditional marginal analysis is, however, limited by its requirement of full knowledge of the above mentioned side conditions which are unlikely to be realized in practice. But new analytical techniques have been developed to solve the problem of decision making under imperfect knowledge (Boulding, 1960, pp. 6–7). *Operations research* or *quantitative analysis* are the terms used for these techniques which comprise linear and nonlinear programming, queueing theory, simulation, inventory theory, etc. There are mainly two ways of looking upon operations research (OR). One is from the applied mathematician's point of view who is mainly interested in developing OR models by applying mathematical analysis. The other is from the management scientist's point of view who is mainly concerned about applying OR models to solve particular decision problems in the real world. It is the latter attitude that is relevant in this context.

The classical theory of the firm seeks an overall optimal solution of decisions concerning price, output, capital investment, and internal resource allocation such as work force and inventory levels. It is, however, characteristic that application of OR implies suboptimization, where each suboptimization will not necessarily add up to the overall optimum for the firm.

OR has been considered to be the most significant development in helping to formulate a theory of the firm which more accurately describes the performance of the large modern corporation (Jenny, 1960, p. 178). Whether this is true or not will depend on the ability of management to implement OR techniques in their organization as well as to adjust the organization to the demands from OR. But another major question ought to be asked, which concerns the desirability of applying OR techniques in the organization. This is the question of whether the general objective or objectives of the firm are in accordance with the objective(s) assumed in OR models.

1.2. *Multiple Goals in the Theory of the Firm and the Impact of Behavioral Research on Decision Making*

Several writers have questioned the classical profit maximization assumption, and alternative goals have been suggested (White, 1960; Cyert and March, 1963). Although such considerations have been going on during the last decade, it seems as if the real world has not responded very much to theoretical research concerning alternatives to the overall profit maximization goal. It may be difficult to verify this postulate objectively, but the continuing social disturbances in the United States as well as in Europe seem to support the idea that private business organizations are not living up to their social responsibilities – i.e. to create satisfactory employment and income for the total population of the society. The event of the computer is, however, considered to be one of the major factors which is able to affect this development in society. Many writers consider the cybernation revolution as creator of social problems on the one hand, at the same time as it creates improved productivity on the other (The Triple Revolution, 1964, Rosenberg, 1966, Bowen, 1966). These social problems must be solved partly by improved educational systems and partly by changes in the business organizations. The cybernation revolution eliminates the routine work in industry, but on the other hand it increases the demand for skilled non-routine workers, which again increases the demand for improved education. The traditional bureaucratic, rational business organization is then undermined by the cybernation revolution, and new forms of organizations must be developed.

The research in the theory of goal studies typically uses the optimization of some function as the overall criterion. However, certain problems arise as to the formulation and solution of optimization problems when two or more goals exist simultaneously. It is then necessary to consider all but one goal as aspiration levels and express these as constraints within which the remaining goal is to attain its optimum level (Bonini, 1964, p. 186). White (1960, p. 187) concludes that multiple goals must then be placed in an ordinal sequence at least to the extent that one is primary and the others secondary in order to reach an optimal solution in terms of mathematical programming.

Johnsen (1968) has extensively studied the formulation and operationality of multiple goals in mathematical programming models. He concludes (*op. cit.*, p. 135) that

> "goals can be defined as an operational expression of a desire or desires expressed by an identifiable individual or individuals, formulated as one or several elements capable of being ranked."

The ranking of the goal elements then leads up to conclude that measurement theory is essential for the operationality of multiple goals. Johnsen (*op. cit.*, pp. 144–149) describes different forms of uni- and multidimentional measurement models with as well ordinal as cardinal scales and in deterministic or stochastic terms. These definition concerned investigations enables him to work with simultaneous multiple goals in his decision models. Further studies in organization theory bring up the concepts of optimal versus satisfactory decisions. It is stated (*op. cit.*, p. 223) "that optimization models are not very frequently applied, and if applied they are usually not followed by the final decision maker." This then of course leads us to suggest that the analyst's job is not to find one unique solution to a given problem, but rather to come up with alternative solutions and their consequences in terms of e.g. expected sales, capital requirements, etc.

To determine whether or not a multigoal decision making system will be operational, the findings of psychological research concerning the ability of the individual to perceive several goals simultaneously are now relevant. Again the concept of goal ordering is of interest. By assigning utility values to the goals a ranking should seem possible. However, since this would require multidimensional utilities, Johnsen (*op. cit.*, p. 357) concludes that measurement theory connected with classical utility studies does not give any appropriate solution to the problem of formulating combination models for the activity and goal universes of an organization.

The findings of organization theory concerning the design of decision making systems yield important results for the operationality of multigoal decision making systems. Thus, the systems approach is used by Johnsen in explaining decision making behavior. That is, by concentrating on explaining the activities being important for the individual decision process and showing how these decision processes are systematically interdependent. Johnsen's main conclusions from studying organization theory are that

(1) Organization theory contributes significantly and explicitly to the activity universe of an organization (*op. cit.*, p. 252).

(2) Organization theory contributes significantly to the model universe of a decision maker in an organization (*op. cit.*, p. 255).

The interpretation of the decision processes in an organization is thus formulated into concepts of an activity universe and a goal universe, which are related by the decision maker's model universe. In saying that as well goals, activities as models can be changed over time, and that this change can be planned, Johnsen accounts for organizational change (i.e. development and innovation). His interpretation of organizational decision making processes seems best expressed by the following citation:

> "the picture of an organization and of organizational change is a network of programs, where each program is linked to a set of criteria of goals. These programs and their related goals can be changed without too much interference with the rest of the network" (*ibid.*, p. 274).

1.3. *Conclusion*

There is no doubt that operations research techniques provide decision makers with powerful theoretical tools for improved decision making.

Through modern computerized information processing systems the necessary and sufficient conditions for an operational optimal decision making process then seems to be present.

We have, however, found that the traditional goal theoretical assumptions in the conventional decision models do not hold according to the findings of behavioral researchers. From their work it is concluded that the real world problems are more complex. Instead of simply finding an optimal solution with respect to one overall goal variable, it is required to satisfy several goals of different dimensions simultaneously. An approach to this problem is given by Johnsen (1968).

2. A Multigoal Decision Model

Johnsen concludes that multiple goals are always present in the minds of decision makers whether they realize it or not (*op. cit.*, ch. 9). However, the problem of formulating operational multigoal decision procedures has not yet been thoroughly investigated. Johnsen attacks this problem by arbitrarily formulating three universes of goals, activities and combination models for combination and transformation of the activity variables into commensurable variables with respect to the required set of goals. This arbitrarily formulated decision system is then tested by simulation. The validation of the model is performed by analysis of the behavior of the model with respect to its ability to reach satisfactory solutions, i.e., to find the combination models which are able to combine or transform the activity variables into goal variables that are within desired limits. If the result is achieved, then Johnsen concludes that his multigoal model does simulate real life decision making.

It seems clear that the practical implications of the multigoal theory will be much wider if we can develop and implement models that include relations between several multigoal systems. Thus, implementation of multiobjective decision systems in the planning and control hierarchy of organizations should improve as well decision making in organizations as our understanding of the interactions between decision processes in the organizational hierarchy. We shall look further into this in section 3 of this paper.

Another important implication of multiobjective decision making is the consequenses to the decision maker of his possible choice of activities. Accepting a multiple goal decision making system will thus decrease the admissible activity space of each decision maker (Lindström and Löfgreen, 1968).

In order to intuitively understand this implication and further results of the multigoal decision making system let us give a brief description

of as well a conventional as a multigoal decision making system:
The conventional organizational decision making system may be described as having only one major goal G, which *the* decision maker d1 seeks to optimize subject to constraints imposed by the total organizational system. Usually these constraints are considered to be deterministic by as well the decision maker d1 as by other decision makers d2, d3, . . ., dn in the organization. Note that d2, d3, . . ., dn may be located in as well a higher level echelon as in lowel level echelons in the organizational hierarchy with respect to d1.
However, through a multigoal decision making system the communication lines between the organizational echelons are activated in both directions between any two decision makers such that d1, d2, d3, . . ., dn all participate actively in finding satisfactory solutions to the goals of the organization. These goals will be related such that goals in one echelon will be connected to goals or activities in other echelons. We may call this property of a multigoal decision making system vertical/horizontal dynamic with respect to the organizational hierarchy.
Let us compare this to the conventional decision making system. Here we are concerned with optimizing one objective subject to constraints which the decision maker d1 is supposed to accept unconditionally. Of course the solution reached by d1 may be identical to the corresponding multigoal solution. But chances are, however, that this will most often not be the case. Furthermore, the conventional solution might very well be non-operational due to the lack of two-way communication between the decision makers.
In order to see that the above propositions do hold in real world decision making systems we will in the following section turn to an analysis of managerial decision and control systems. The analysis will be based on the principles of controlled systems and the development of hierarchies of such systems.

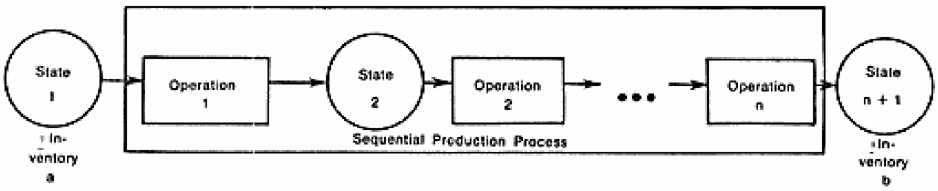
3. Managerial Decision and Control Systems

The previous chapter was all concerned about modeling a decision process at a certain level in the organizational hierarchy. In the conclusion several propositions concerning the relationships of decision making processes throughout the organizational hierarchical system were made. We shall now turn to an analysis of organizational decision making. If we can show that decision making processes in an organization are logically related as outlined in section 2, then we will be able to conclude that the theory of multiobjective decision making is indeed a general theory of managerial decision making.

3.1. *Definition of Systems and System Components*

In order to develop a decision making system we must take a closer look at the individual components of such a system. Beer (1959, p. 9) notes that the definition of any particular system is arbitrary. It is, however, always possible to define a smallest activity that a particular decision maker wants to be concerned with. For example, assembling a certain part in an industrial plant may be the activity that is essential for a tactical decision problem. However, the aggregated result of this assembling operation may be the activity essential to a certain inventory management problem. This relationship is outlined in figure 3.1. as a functional diagram.

Figure 3.1.



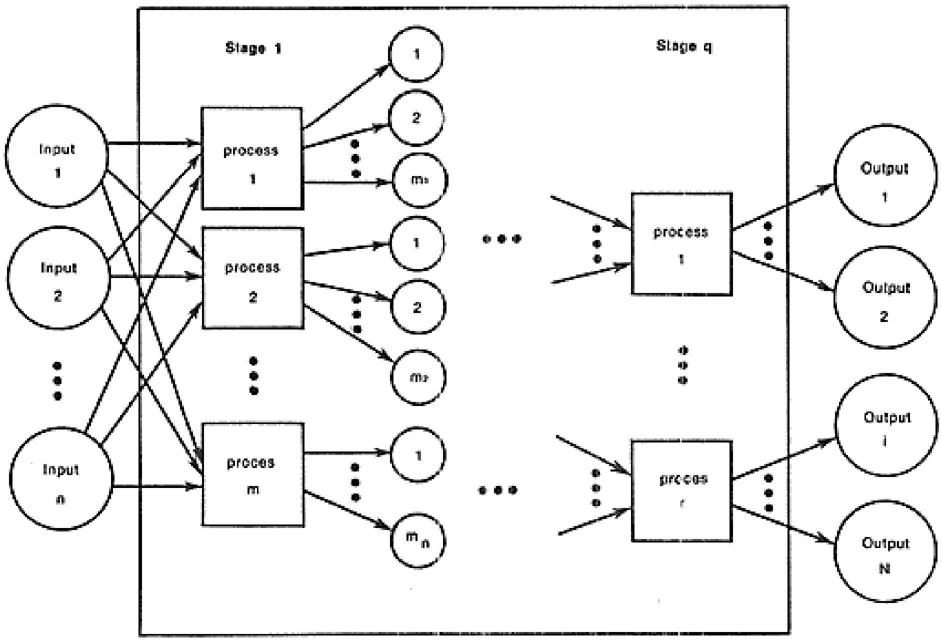
Functional Diagram of a Sequential Production Process.

We note that if we are interested in the individual assembling operations only, then the box illustrating the production process can be considered irrelevant. On the other hand, if we are only considering the inventory management problem (a, b) then what specifically goes on inside the production process box is not relevant. Thus, we may discard the individual operations and look upon the production process as a black box (cf., Beer, *op. cit.*, p. 39).

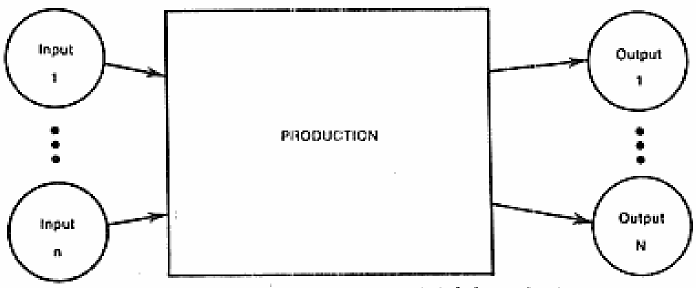
Continuing the process of logically relating and aggregating the production components in an industrial plant leads to the definition of systems of production processes, cf. figures 3.2, a and b.

In figure 3.2.a all the possible relations in a production system which on the basis of n different types of input produces N types of output. Note that the total possible number of relations between the initial input state and the first stage of m processing facilities is nm. Then, if process 1 produces m1 different output types, process 2 m2 different output types, etc., we get $\sum_{i=1}^{n} m_i$ possible output states from stage 1. Continuing in the same way for stage 2 up to stage q quickly complicates the total production process beyond the perception of any human decision maker. On the other hand, in figure 3.2.b, assuming that a decision maker is concerned only with the n input types and the N output types makes the perception of what goes on in the black box labelled production a much easier task.

Systems of Production Processes. *Figure 3.2.*



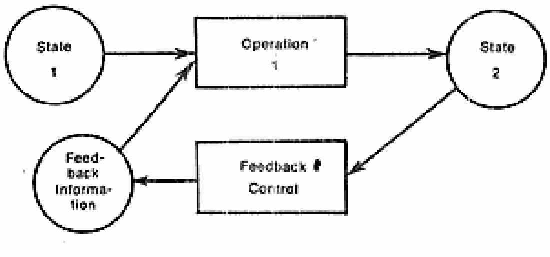
a) Total description of the relationship between the processes.



b) Description of production system when only input/output is relevant.

We have not yet defined how the concepts of decision and control enter these systems of boxes and circles. The key idea behind these two important concepts is that of *feedback.* Consider again the simple production process in figure 3.1. We will now introduce feedlack loops into this system. If each operation is related with a feedback loop, then each operation is controlled. An illustration of a feedback loop connected with an operation is illustrated in figure 3.3.

Illustration of a feedback loop. *Figure 3.3.*



Previously, the operation was carried out "automatically" by transforming input from state 1 to output in state 2. But if we introduce the feedback loop from state 2 to operation 1, then the operator is controlled and may possibly be asked to change or correct the operation through the feedback information. We have thus defined the concept of a controlled operation or, more generally, *a controlled activity*.

By letting the feedback controll activity be able to change for example the speed of the operation, we can furthermore introduce the concept of a decision. If we add feedback loops to the production system outlined in figure 3.2., then the administrative part of the total organization is evident, and a hierarchy of decision systems has been introduced.

3.2. *The Planning System*

We have seen how the decision making system necessary to control a production process is hierarchical of nature. This can be generalized for any type of decision making system. Thus, by turning to a general managerial long range planning system, we will observe that the system can always be decomposed into components of shorter time planning activities. This has been heavily stressed by for example Emery (1969) and Murdick and Ross (1971).

In any managerial decision making system we can thus distinguish between 1) Long range planning (2–10 years), 2) Intermediate time planning (3–24 months) and 3) Short term planning (daily or weekly). Determination of the planning activities is done by decomposing the output of 1) into disaggregated shorter term plans or budgets for (2) and so on for (3). The higher level (longer range) plan will typically constrain the lower level planning activities.

3.3. *Group Theoretical Aspects of Managerial Decision Making Systems*

In section 2 conventional as well as multigoal decision systems were described as being hierarchical of nature. Thus, till now we have only shown that both types of systems may be feasible in operational decision making. It should, however, be noted that the feedback process which links the different planning levels together is of a different nature in the two systems. Thus, in the multigoal system two-way communication is the essential feature of the feedback process. But the conventional decision making system is more characterized by communication only from upper levels to lower levels, which may well cause lack of cooperation between the planning echelons. In his describing the decision hierarchy of a job shop Riis (1970) describes the communication between the vertical levels in the hierarchy by a loop since the decision unit at one level may want to discuss with the decision unit at the next level before final decisions are made. This type of decision making then, is in accordance with our interpretation of a multigoal decision making system, when non-routine decisions are to be made.

A further elaboration on implications of the quality of the decisions by the size of the decision making group is possible. Shull, Delbecq and Cummings (1970) analyse the implications of group size for non-routine problem solving. They conclude (*op. cit.*, p. 151) that in groups of less then five satisfaction tends to drop off due to strains of face to face relationships. In groups larger than five satisfaction also seems to decrease due to such factors as increased aggressiveness, impulsiveness, and competitiveness from the more dominant members of the group. Therefore, a group size of five (and, to a lesser extent, seven) seems to yield the greatest satisfaction and thus quality of decisions when non-routine problems are to be solved.

On the other hand, if routine problems are to be solved, then a manager at the higher hierarchical level should possess sufficient competence to decide alone on routine problems arising in his own echelon. We can easily make this type of decision making fit into our multigoal decision making system, by defining routine problems to be equivalent to single goal problems.

We may now conclude that two-way communication between decision echelons is required when non-routine decisions are involved. This is so, due to the organization of decision making groups for non-routine managerial decisions. Such groups will operate most efficiently if a group size of 5 or 7 is established. The type of decision making performed by such groups corresponds to the type of decision making in a multigoal decision making model.

3.4. *Conclusion*

From section 3 we are now able to conclude that a managerial decision making system is hierarchical in nature and is best designed by organizing groups of decision makers at each planning level in the hierarchy according to the complexity of the decision problems. The decision process is then well described by Johnsen's multigoal decision theory (*op. cit.*, p. 564).

We have argued for this conclusion in a rather theoretical way. It therefore seems of interest to point to some empirical evidence supporting the conclusion. Thorsrud and Emery (1969) have done extensive field research in Norwegian industry on worker satisfaction and productivity when group oriented working procedures were introduced. The results were very encouraging and indeed support the above conclusion with respect to the operationality of multigoal decision making systems also in the lower level hierarchy of the organization.

Shull, Delbecq and Cummings (*op. cit.*) have supported their analysis on the effects of group size on decision making by extensive emperical research evidence. Thus, these results highly support the propositions on the multigoal decision making system being operational and superior to conventional decision making systems.

4. Summary

We set out to investigate the impact of automation and cybernation on organizational decision making. In chapter 1 we concluded that a single goal of an organization could not be operational in real world decision situations. On the basis of this the multigoal decision model of Johnsen (1968) was studied in chapter 2. From this it was learned that multigoal decision making systems can be developed to simulate the behavior of real world decision problems.

In chapter 3 an analysis of the operationality of multigoal decision making systems was carried out. The hierarchical nature of any decision making system was developed and the results of small group research was included to show the validity of the multiple goal decision theory. Thus, it was learned that goals on one level of the organizational hierarchy will not necessarily be operational on a different level of the planning system. But this on the other hand will not necessarily prevent that some goal or goals be common to all levels of the hierarchy. This is indeed an important conclusion when we consider the conventional managerial theory. This theory assumes that only one hierarchical level or set of goals is significant for the behavior of the organization. This is of course the level where top management decisions are made. We have defined these decisions to be the long range strategic decisions. The conventional theory then is not really concerned about lower level decisional behavior, since decisions at such levels are supposed to be automatically executed according to the top level commands.

Let us finally consider one of the most emphasized results of conventional managerial theory which is that of employee devotion to company goals. The result is the following:

Since the lower echelons of white and blue collar workers are only concerned about shorter working hours and higher pay, they are the least devoted to the company goals. Tactical management and middle management due to a higher pay and more relaxed working hours on the other hand, will feel more devoted to company goals. Finally then, top management is supposed to be the most devoted to the company. This result is indeed still taught to be "a fact of life" at business schools in the Western World, although sociological and organizational research has shown that alternative organizational design will typically yield a different goal devotion pattern (cf. for example, Shull et al., *op. cit.*, Chapter 5).

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