Managerial Conflicts in Social Systems: The Ignored Significance of Ethics and Values

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Abstract

A social system is unlike a natural system, because its behaviour is determined by ethics, values and purposes. Yet, it can be compared to a natural system in terms of self-maintenance. To maintain itself, a social system reproduces roles, functions and authorities, not its basic components, individuals. This because social systems are purposely designed by human beings for human purposes. The ethics which guides management of social systems is a kind of rule ethics relying on rules of behaviour, laws and taboos. The rule ethics and its basic value, the rational calculation, disables the possibility of social systems to cope with rapid or severe environmental changes. It also creates managerial conflicts which are difficult to solve within the frame of reference of the rule ethics and its associated values. These conflicts are the results of the tension between: control and semiotic freedom, shared culture and diversity, and command hierarchy and self-organisation. To diminish these tensions, we need another kind of ethics, and an increased development of human consciousness.

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INTRODUCTION

Large social systems, like military organizations, industries, public services, research institutions, etc, are characterized by at least three important aspects. First, the basic components (individuals, Hejl, 1984) of a social system think and feel in terms of ethnics and morality, and also act upon these thoughts and feelings. Second, a social system organizes in different structures purposefully and maintains these structures through a reference to the ethical context and its organizational principles. Third, to maintain itself, a system has to produce or reproduce components which will maintain each other. But, because of social system is unable to produce or reproduce its basic components, the meaning of what its basic components are has to be re-defined. One way of doing this is to define the basic components in terms of roles, functions, and authorities. In this way, a social system can maintain itself through reproducing roles, functions and authorities, rather than individuals. This is a result of the fact that social systems are intentionally designed by human beings for human purposes (cf, Ulrich, 1984). In a general sense, because human purposes are mirrored in the ethics which determines human behaviour, social behaviour can be defined as every behaviour that is generated on the basis of a socially produced definition of reality (Hejl, 1984).

The definition of reality has to satisfy not only the key properties of human intelligence: freedom of choice, free information flow, positive appreciation of change, the ability to adapt to the unpredictable and the ability to unlearn (Driver and Humphries, 1988), but also the behaviourial demands created by the technological progress: formalization, specialization, control, rationality, and hence, predictable behaviour (cf, Driver and Humphries, 1988; Jantsch, 1980). Because the properties of human intelligence and the behaviourial demands emerging from technological progress are difficult to unite to one definition of reality, the splitting up of the world into two realities turned out to be necessary. A world of quantity (working reality), basically generated by modern science, and a world or quality, basically generated by mysticism, art, etc. The splitting up of our world into two realities, makes it possible and also necessary to develop different ethics for different realities. The main interest in this paper is focused on the ethics applied in the working reality.

In general, today's social systems put a major emphasis on integration, synergy, motivational order, organizational goals, strongly shared cultures and highly concentrated power (Stacey 1991). This emphasis results in control systems relying on rules and procedures, centred decision making, and rigid managerial models. Conclusively, contemporary managerial models are built upon, which I would like to call, a rule ethics, which by definition excludes behaviourial flexibility. Nonetheless, a social system managed by the rule ethics can be effective and profitable given the absence of severe environmental change. But, a social system which one-sidedly adopts the rule ethics is almost incapable of coping with rapid or severe environmental change. An incapability which is further enhanced by: (a) the neglected significance of values in policy capturing and decision-making, and (b) the focus on a particular goal in long-term planning.

ETHICS

Ethics can be understood as a set of rules of behaviour which is valid in an absolute sense or at least given as a logical a priori (ie, a rule ethics). This ethics comes to expression in terms of laws, rules of behaviour, taboos, and the like. The only legitimate attitude in this view on ethics is then adaptation (Jantsch, 1980).

If we would define adaptation as an ability to learn, it would follow that the basic behaviourial significance in relation to this kind of ethical guidelines would be to learn the rules of behaviour. To adapt in this sense means a simple reaction to stimuli on receipt to the set of rules of behaviour. In other words, it would mean zero learning (Bateson, 1972; Wilden, 1980). Furthermore, such a kind of adaptation counteracts evolution and innovative behaviour. Evolution and/or innovative behaviour always requires destabilization, freedom of action, and systemic interdependence (Jantsch, 1980). That is to say, evolution and/or innovative behaviour requires semiotic freedom (flexibility, possibility to manipulate, freedom within constraints), between as well as within systems.

Nonetheless, ethics can also be understood in terms of system dynamics, ie, as the capability to cope with the unexpected. In this case, ethics cannot be given a priori, but emerges with evolution and follows a development which, in principle, is wide open (Jantsch, 1980). In this interpretation of ethics, the only legitimate attitude is then flexibility and creativity. Such an ethics comes primarily to expression in a number of non-working activities, eg, in sporting activities, gambling, games, art, some kind of criminality, and the like.

Considering that a social system can only change, ie. evolve, through a change in behaviour of the components that realize it (cf, Maturana, 1980), ethical behaviour should be, in accordance with Jantsch (1980), understood as behaviour which enhances evolution. But, the rule ethics regularizing behaviour in social systems obstructs the possibilities of the components to change their behavioural pattern. A change occurring in a social system is therefore many time a result of a revolution or an outer pressure. Yet, a forced change is always very costly and dramatic for many individuals as well as for the society. A forced change in social systems could be avoided by adopting a different kind of ethics (eg. an evolutionary ethics) in the working life. An evolutionary ethics, explicitly includes the main principles of evolution, such as openness, non-equilibrium, the positive role of fluctuations, engagement and non-attachment (Jantsch, 1980).

None of the principles of the evolutionary ethics is guiding management of contemporary social systems. Rather social systems are managed in accordance with the principles suitable, at the best, within the machine frame of reference. Quoting from Stacey (1991):

> Rational, entrepreneurial and the most conscipious power models all interpret effective business behaviour in terms of orderly step-by-step procedures which lead to an orderly outcome. None of these models sees the observed messiness of actual business life, lack of consensus and different cultural norms as central to the explanation of business success. All these models treat the dynamics as a drive towards equilibrium - the equilibrium of internal harmony and adapting to the external environment... They all maintain that it is possible to say something useful about long-term future.

In the perspective of rational, entrepreneurial and power model, the forces of confirmation and rule adaptation are maximized, ie, the semiotic freedom of the system and its components is heavily restricted.

The pressure in social systems to confirm and adapt to rules is further enhanced by the use of all kind of tests which have little if any predictability of future performance. Rather, they create or fabricate the traits they allegedly measure (Hanson, 1994). Rule-following, confirmation and testing leads many times to counter-productivity (Illich, 1978) in social systems, and also to counterintuitive behaviour (Forrester, 1969), with respect to decision and policy-making.

VALUES AND SOCIETY

Each society has few influence points, eg some executives, researchers, politicians, to which the societal behaviour is sensitive (cf, Forrester, 1969). If then these influences points plead for some particular values, the probability that the rest of the society will follow their example is very high. However, values should not be understood in terms of strategies or tactics, but a "power fields", which act as injunctions (Lewin, 1936). In general, three social influence processes are working for this phenomenon: conformity, compliance and obedience (Baron and Byrne, 1991). The adoption of values delivered by the influence points will inevitably use up the social possibility to adopt other, and even less, conflicting values. The resulting decrease in the semiotic freedom strengthens the principle of counter-adaptability.

That is to say, there is an absolute limit to the possibility of adaptation, because as long as the phase-space in which the adaption took place has not been shifted or renormalized, the adaptive and behaviourial flexibility of the system is reduced (Wilden, 1980). The powerful influence of societal values like, eg. the freedom of movement, on human behaviour can be seen in the difficulty to change the travelling behaviour. This because the phase-space in which the value of freedom of movement was adopted neither has been shifted, nor renormalized. The decrease of the semiotic freedom, together with the requirements emerging from the technological progress itself (specialization, formalization, and control), results in even more strictly regulated system behaviour. Therefore, it is not surprising that even models for how to manage social systems are determined by the values pleaded by the significant influence points of society.

One of the basic values associated with the working reality is the rational calculation by which expectations about future consequences are used to choose among current alternatives (March and Olsen, 1988). The rational calculation in management comes to expression as a priori formulated activities like; planning, decision-making, organizing, leadership of people, controlling etc, (cf, Ulrich, 1984), and the gateways to policy-making are planning, analysis, forecasting and hence, the paraphernalia of decision theory and management sciences (cf, March and Olsen, 1988). The circuit is closed.

In such a view on management, the responsibility and/or creativity of the individual human beings to design their work, or the human world is excluded. Consequently, creativity and responsibility is located to few people in contemporary Western societies. Nonetheless, because the creativity of the few is tied to values like; to become bigger and more profitable, to beat the competitor, to be rational, to meet customer requirements, there is nothing more left than the responsibility of managers to plan, to make decisions, to organize, to lead people, and to control.

GOAL AND LONG-TERM PLANNING

A new understanding about the efficiency of long-term planning is taking a shape in the Western societies. This understanding tells us that many actions set out in plans are simply never carried out and many others turn out to be different from the plan expectation (Stacey, 1992). This happens primarily due to the future containing too many unknowns to be predictable. Although it is essential for social systems to have plans, long-term plans fail if they are about outcomes and goals rather than about, eg. mission, strategies, action steps required to develop, etc. Another reason for the failure of long-term plans is the use of short-term rational techniques on long-term issues. To plan for an uncertain future cannot be done by means of a purely rational process. Finally, long-term plans fail if structural rather than process planning is considered. This is so because the focus on a particular outcome or goal presupposes a fixed structure within which the outcome or goal can be realized, and hence, alternatives will be excluded from the further planning process (cf, Jantsch, 1980).

At the first glance, it seems that an industry should be able to plan for a long-range outcome, eg, a new aircraft, or a goal, eg, to produce twice as much in a certain future. Nonetheless, there is always uncertainty inherent in the long-term future in terms of costs, market demands, political situations, etc, which can make the plan to pure fiction (cf, Stacey, 1992). Yet, to make long-term plans in terms of outcomes or goals within, eg, public services or military organizations, is simply not appropriate. Even if the outcome or goal would be expressed in terms of an ability or a result to be achieved in the future, such plans cannot end in other behaviour than competition, interdepartmental rivalry, and political maneuvering. To plan for a future outcome or goal in such kind of social systems leads many times to, what Kanter (1983), called *bureaucratic trap,* ie, the powerlessness and the need to defend established territory lead people to resits other people's good ideas, and *entrepreneurial trap,* ie, the need to be the source and the originator leads people to push their own ideas single-mindedly.

In the perspective of structural long-term planning, a system retains some degree of predictability, and inflexibility. That is to say, the number of possible arrangements and actions of the system components will be restrained by the structure of the system, and the increased need of control to check that the steps prescribed in the long-term plans are followed. Consequently, long-term plans which are about a particular goal can be done only in the light of some here and now thought structure within which the goal can be realized, and upon the contemporary cognitive state of the individual planner. In this sense, long-term plans restrain the ability of the system to cope with rapid or severe environmental change.

MANAGERIAL CONFLICT

Given that ethics and values guide the affairs of human beings, ethics and values should also exert influence on not only which principles concerning management will be adopted, but also to what extent performance and learning norms will be shared.

Today's managerial principles are based upon a rule ethics which satisfies values giving an account of the demands created by the technological progress, rather than the cognitive needs of human beings. Consequently, the resulting tension between the managerial principles and the cognitive needs of human beings, leads to managerial conflicts which are difficult to solve in social systems dealing with open-ended change situations. These conflicts arise from the tension between: (a) control and semiotic freedom, (b) shared culture and diversity, and, (c): the command hierarchy and self-organization.

Control and semiotic freedom

This managerial conflict, which is not always conscious or apparent in social systems is about how to resolve the tension between convergency (control), which makes the system and its components inflexible and, many times, unable to cope with environmental change, and divergency (constrained flexibility) which is a necessary condition for innovative behaviour.

As early as 1956, Ashby has pointed out that no system can produce anything new unless the system contains some source of the random. This is still true, even if it would be expressed in other words today. Although different social systems use different control methods and hence, develop different strategic direction even in the same environments, the impact of the control requirements emerging from the technological progress, the rule ethics and its associated values, produces rather convergent than divergent social systems.

According to Ulrich (1984), the concept of control is understood as the determination of goals and the establishment, execution and supervision of purposeful activities of a system or of is components. In this sense, control is a function which has to be carried out. As such, control causes the system to select and realize very specific behaviourial modes within a behaviourial field defined and bounded by the system design. Stated differently, control as a function directs attention to the processes by which behaviourial and action rules are created, changed and followed. Although rule-following behaviour increases a system's competence at things it does often, it simultaneously decreases its competence at things it does infrequently (Levinthal and March, 1981). Thus, a convergent system is badly prepared for changes.

The concept of control, used as a steering process of behaviour and activities, restricts with necessity the semiotic freedom of the system and its components. As pointed out above, the semiotic freedom should be basically understood as a constrained flexibility. Constraints do not define or indicate what the system or its components must or ought to do, but rather what they cannot do (cf, Wilden, 1980).

To use an excellent analogy, introduced by Bateson (1972), the constrained flexibility of a social system and its components, can be compared to an acrobat on a high wire.

> To maintain the ongoing truth or his basic premise ("I am on the wire"), he must be free to move from one position of instability to another ie, certain variables such as the position of his arms and the rate of movements of his arms must have great flexibility, which he uses to maintain the stability of other more fundamental and general characteristics. If his arms are fixed or paralysed (isolated from communication), he must fall.

Figuratively speaking, the control function fixed or paralyses the behaviour and activities of many social systems and their components. As a result, the system behaviour become "up-tight" to the control function (cf, Bateson, 1972). But, because of the system consists of many interlinked functions, to be up tight with respect to one function commonly means that other functions cannot be changed without pushing the up-tight function higher, which means a tougher "up-tightment" to the control function. Hence, the system looses it flexibility.

The concepts of control and constraints as used here, lead to a dilemma. To create conditions for innovative creative behaviour, presupposes a restriction in the control function. But, the control function is a consequence and also a prerequisite for the technological progress and its demands of standardization and predictable behaviour. This dilemma cannot be resolved in the light of the rule ethics and values guiding management of social systems in the Western world.

Shared culture and diversity

The second managerial conflict existing in a body of contemporary social systems is the tension between the demands to share the culture of a system, and the necessary diversity of ideas, perceptions, values, etc, essential for coping with an ambiguous future. This is particularly important for systems (eg. public service, research institutions, military organizations), which cannot control or forecast the future consequences of their decisions and actions, because they are dealing with open-ended change situations. That is, to paraphrase from Stacey (1992), because the open-ended change situations are ill structured and accompanied by inadequate information, we do not know the consequences of what we are doing until we do it. Furthermore, these kinds of social systems tend to adopt an important characteristic of bureaucratic organizations, ie, a delimited authority which not only creates incentive for territorial protection and fighting among groups, but also creates the illusion that managers are able to act alone, maximizing the value of their own areas (cf, Kanter, 1983). In other words, a delimited authority leads often to the development of competing groups within the same system. This development, together with the emphasis on individual roles and functions, makes the cooperation within the system increasingly difficult.

Usually, a system develops its behaviour on basis of previous experiences. But, as people very often learn under ambiguous or conflict conditions in which the causality of events is difficult to untangle, the previous experiences require some kind of interpretation (cf, March and Olsen, 1988). An interpretation is commonly done upon the body of basic assumptions that the components of the system share on how to proceed, on how things are to be done, on what is important and what is not (cf, Schein, 1985) ie, upon some adopted norms. The stronger the pressure to hold on those norms, the deeper they are submerged in the unconscious, and the less we are able to examine and question them (Stacey, 1992). Although it is important to share some performance norms (how to treat people and how to control different activities), learning norms (how to behave in relation to open-ended situations), should be only weakly shared to get the system dynamics, ie, the questioning that is vital for a successful handling of open-ended change (cf, Stacey, 1992).

The delimited authority, rule ethics, and value existing in the working life, require not only strongly shared performance norms, but also learning norms. For example, within research institutions or military organizations, a particular research paradigm or military doctrine cannot survive without strongly shared learning norms. That is, neither an adopted paradigm, nor an adopted doctrine, allows the questioning of its grounds during some period of time. This may be one of the basic reasons for the inability of such systems to cope with and creatively adapt to rapid or severe environmental changes. Neither this tension can be resolved within the frame of reference of contemporary ethics and values guiding management of social systems.

Command hierarchy and self-organization

Social systems which have to operate in rapidly changing environments (eg, military organizations), and/or which production processes are not highly interconnected (eg, research institutions), are dealing with a special managerial problem if they are organized in command hierarchies. In principle, this conflict mirrors the tension between the hierarchical information processing and a creative adaptation, or the ability to cope with complex and ambiguous tasks.

In general, in command hierarchies, each individual has a job description which sets out the task to be performed and a set of precise task related objectives which are to be achieved (cf, Stacey, 1992). In command hierarchies, information flows upward and orders downward. Now, to survive and/or to be efficient, a social system must constantly adjust and adapt a large number of factors. This can be done along two lines.

First, the highest levels of a command hierarchy should be widely open to novelty, ie, they should be highly sensitive to new ideas and new perceptions, especially at some critical points of the system development. Nonetheless, the highest levels in a command hierarchy guided by the rule ethics, are very seldom open to novelty. On the contrary, they are preserving rules, procedures and their own power. This preservation leads inevitably to the decrease of the system's adaptability to new situations (cf, Jantsch, 1980; Malik and Probst, 1984). That is to say, because the behaviour of the system if up-tight to a particular path, the ability to process more information, to perform mutual adjustment, and to adapt creatively to new demands is very low. Being closed toward novelty and geared to confirmation, command hierarchies cannot solve the adaptation problems with which they are confronted in complex open-ended situations (Malik and Probst, 1984).

Second, to be able to constantly adjust and adapt a large number of factors, a social system can make use of the dynamics of self-organization. It has been shown that self-organizing systems display considerably greater adaptability than the command hierarchies, ie, they are able to process much more information and to perform mutual adjustment of a large number of relations (Malik and Probst, 1984). Thus, instead of dividing the labour between individuals and to prescribe what each individual has to do, the managers of the system should give just a general frame, ie, a vision or meaning, and leave to the individuals to split labour and cooperate in a maximally efficient way (cf, Haken, 1984).

Nonetheless, the problem is not to decide upon either a command hierarchy or self-organization, but to utilize both in an intelligible way. A command hierarchy is necessary to guide the day-to-day activities, ie, to exercise short-term control. Yet, such control should not be built upon the power of one person or a group to reward or punish another with respect to prestige, status or career progression (cf, Stacey, 1992). Rather, such control should be aimed at, eg, quality control, resource allocation, inventory control, order handling and the opening of communication channels. But, in turbulent times, when the environmental demands upon the system are changing, or when the system is to make long-term strategic choices, to utilize the dynamics of self-organization is most superior. In this context, self-organization should not be understood as a self-organized formation of structures (Haken, 1984), because the structure of a complex social system is maintained not only by its hierarchical organization, but also by its history. Rather, self-organization should be understood as a model for creative learning processes which presupposes conditions of contradiction, conflict, confusion and ambiguity in order to produce qualitatively different behaviour (cf, Stacey, 1992).

The problem is that although a command hierarchy can make use of the rule ethics to guide the day-to-day activities, the rule ethics and values cannot guide the dynamics of self-organization. Self-organization should be guided by the evolutionary ethics.

DISCUSSION

In the perspective of what has been said, a social system should be unable to evolve. Nonetheless, nobody can remain uninfluenced by the accelerating technological progress, modernization, and innovation emerging at almost all levels of the social life.

Irrespective of the fact that every social system shows resistance against its evolution, no system can stabilize itself forever. The higher the resistance against change, the more powerful the fluctuations which ultimately break through (cf, Jantsch, 1980). Unfortunately, the fluctuations which nowadays break through are the fluctuations created within the domain of technology and economics, not any ethical fluctuations. Therefore, the changes which we are experiencing in our lifes are the technological changes and the oscillations in economics, not any crucial changes in the evolution of human consciousness. This is so not only because that the evolution of human consciousness take longer time to be pragmatically perceivable, but also because that only very few and powerless instances in the Western societies realize the importance of an evolution of that sort.

Without a doubt, the technological progress has improved, at least, the material and health standard of many people. In principle, the technological progress should permit the decoupling of labour and production processes, the dismantling of bureaucracies and the administrative apparatus (cf, Beck, 1992), the completion of organization and autonomy of power and decision-making processes, the termination of the alienation of man from a world whose increasingly fast change is felt as Kafkaesque threat (Jantsch, 1980), and the sharing of knowledge with others, ie, the increase of human consciousness.

But, in reality the technological progress, viewed in relation to the ethics and values of the Western world (to get more of everything, to make money for its own sake, to be successful, to be better than others, to be somebody), leads not only to the monopolization of decision-making authority, but also to an increased bureaucratization. The unchanged managerial principles and ethics which were perhaps suitable for an industrial society cannot result in anything else then in the monopolization of information flows in an information society. Thus, it becomes a key question who gets what information, by what means, and in what order, about whom and what, and for what purpose (Beck, 1992). Hence, the authority to make decisions will be concentrated to people who will possess the control over the manageability of information and information networks. It is also very likely that new kinds of bureaucracies will emerge. Bureaucracies which will administer the flows of information.

A tragedy of civilization, as pointed out by Boulding (1964) is that the conscious autonomy of the few was purchased at the expense of the enslaved drudgery of the many. Yet, any increment of the complexity on the collective level is as much dependent on individual humans who are more conscious as it is the cause of their consciousness (Artigiani, 1991). That is, nobody is outside the society we organize and the future we plan, all of us are always and inevitably a part of it. Therefore, the kind of ethics which is implicitly expressed in any future plan, is more decisive for the world we will shape, than the plans themselves.

Although it is necessary to fulfil some determined needs in any particular stage of social development, it is unsatisfactory to continue and intensify past trends towards material growth and technological progress (cf, Malaska, 1991). We have to establish the balance between material and mental development, so that people can wake up and feel like the Yellow Emperor: "When the Yellow Emperor woke, he was delighted to have found himself" (Leih-Tzu).

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Mental Models and Dynamic Decision Making in a Simulation of Welfare Reform[1]

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Abstract

This paper is the second in a pair presented in this volume. The first paper presents a theoretical view of mental models appropriate for carrying out empirically-based research on system dynamics modeling interventions. Mental models consist of three types of measurable sub-models--ends models, means models, and means-ends models. The means-ends models may be thought of as containing either detailed "design" logic or much more simple "operator" logic. This paper presents an empirical test of the impact of interventions intended to improve design versus operator logic for 53 participants in a dynamic learning laboratory with a task centering on implementing welfare reform over a simulated twenty year period. Results suggest that providing managers with high level heuristic results from modeling interventions is a necessary condition for achieving improvement in system performance. Focusing on operator logic is key to improving managerial performance of dynamic tasks.

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Mental Models and Dynamic Decision Making in a Simulation of Welfare Reform

System dynamics literature has paid a great deal of attention over the last decade to the importance of aligning mental models with the systems people are trying to control or change. This focus on alignment is particularly critical in training programs which employ systems thinking and seek to impart understanding of the structure of a system to mangers who are undertaking simulation-based training in management laboratories or computer "microworlds."

Several questions about the efficacy and design of such workshops need to be explored. Does detailed understanding of structure and the dynamic behavior resulting from that structure help managers to perform dynamic tasks better in uncertain environments? Is structural understanding the most important understanding to impart or should trainers place greater emphasis on the development of key heuristics which managers can use to operate the system in question? And finally, what is the generalizability of such training? This paper presents a preliminary empirical investigation of these questions.

I. Theoretical Foundations

The concept of managers' mental models as the key intervening concept between system dynamics modeling interventions and managerial behavior designed to improve system functioning was introduced at an early date by Forrester (1961) and remains a powerful organizing concept even in recent literature (Senge, 1990). However useful this concept may be for guiding the practice of system dynamics modeling, we believe that the construct of mental models as used in the present systems intervention literature is often still discussed as a pre-scientific construct. Within much of the tradition of the system dynamics intervention literature, the concept of mental models has defied careful and precise description, has not yielded a consistent set of measurable attributes from one study to the next, and for the most part remains undescribed and unmeasured. However, other recent work more carefully grounded in the psychological literature has made better progress in terms of defining and measuring what one means by mental models (e.g. Sterman 1989,1994, Brehmer 1988, Vennix 1990, and Diehl 1992).

In work related to this paper, Andersen, Maxwell, Richardson, and Stewart (1994) have proposed a marriage of a cybernetic view of decision making with the Brunswickean lense model (Brunswik 1956, Hammond 1955, Hammond, Stewart, Brehmer and Steinman 1975, Brehmer and Joyce 1988) to produce a more conceptually complete view of what one might mean by a mental model when used to describe system dynamics modeling interventions. We posit that mental models must be viewed as a specific and well-defined subset of all types of mental activity used to support managerial decision making. More specifically, three types of constructs combine to create useful and measurable mental models--means models, ends models, and means-to-ends models.

This expanded theoretical framework was used to derive competing hypotheses concerning what is important in mental model research. Four such competing hypotheses were sketched--(1) the outcome feedback hypothesis, (2) the cue selection hypothesis, (3) the design logic hypothesis, and (4) the operator logic hypothesis. Each of these four views highlights different aspects of the overall decision-making process, predicts that differing managerial interventions will be effective in improving managers' ability to manage complex situations, and yields empirically verifiable propositions that may be used to test these sometimes competing predictions.

Our related theoretical work also appearing in this volume (Andersen, Maxwell, Richardson, and Stewart 1994) suggests that the design logic versus operator logic hypotheses yield quite different predictions concerning how a systems intervention will act to improve managerial decision processes. The design logic proposition emphasizes the need to create more elaborate, causally sophisticated, and feedback-sensitive cognitive models of means-ends effects. Only by understanding the complexity of the systems that they are managing will managers be better able to improve system performance.

On the other hand, the operator logic perspective predicts that causally sophisticated and feedback oriented cognitive understanding of means-ends effects are not effective ways to intervene to improve performance. The key to improving performance is to support management's strategy selection process directly by giving management key strategic insights in the form of highly "chunked" heuristics.

II. An Empirical Test of Using Design Versus Operator Logic to Improve System Performance

Between September 1992 and December 1993, we have been engaged in an empirical exercise designed to test the relative power of the designer logic versus operator logic hypotheses in terms of their ability to predict the performance of human decision makers in a complex and dynamic decision-making situation.

The task that these decision makers must face is the management of welfare reform in a large county over a twenty year period. The simulation model upon which this task is based was first published in 1990 (Andersen, Richardson, Lurie, and Ratanawijitrasin 1990) and has subsequently been converted to a four person management laboratory for training MPA students (Maxwell, Andersen, Richardson, and Stewart 1991). The present version of the exercise is a one person lab that runs for a full day. The first half of the day consists of orientation to and training in the simulation and the task. As a part of the first half day, participants are given a training module representing one of three treatments as described below. The second half of the day requires participants to actually manage the system over a twenty year period (after training, this exercise usually takes between one and two hours) and then to complete an extensive set of debriefing exercises designed to measure participants understanding of many aspects of the lab. The details of the design, instruments, and overall approach and results--sketched briefly below--are discussed in more detail elsewhere (Maxwell, Stewart, Richardson, and Andersen 1994).

Research Design. 58 students, including mostly masters candidates in public administration and social welfare at the Rockefeller College, participated in the lab. Five cases were removed because of technical difficulties in model simulation and debriefing, leaving 53 cases for analysis. All participants were paid $40 for their participation and a bonus of an additional $40 was offered for best performance associated with each treatment group. Approximately half of the students (we refer to these as "experts") had been through a two-day management lab focusing on the four player version of the JOBS simulation. They had completed previous readings on the simulation, had worked in groups before coming to the lab, and spent two full days working with the four person model with about half of the two days spent in debriefing discussions. The other half of the students came to the one day lab "cold" and were classified as "novices" with respect to this task.

The novice and expert groups were randomly assigned to one of three treatments. The first treatment, **causal loop training,** gave students detailed information about the causal structures underpinning the simulation. Causal structures were explained in terms of key feedback loops with increasingly complex views of system structure being provided on a HyperCard interface. Students were given complete hard copies of all key system structure during and after their training. They had access to the hard copy during the graded performance of the exercise. This treatment was intended to provide detailed design logic-type of information to participants.

Participants receiving the second treatment were given a summary analysis of five strategies that might be used to manage the system. For each strategy, participants were given full information concerning how the whole system behaved over time in response to the five strategies. Well-crafted graphs of system performance over time were explained to participants through a hypercard interface. In addition, participants were given hard copy of these training modules and allowed to keep and refer to them during practice runs as well as the final graded run. This treatment was referred to as the **strategic time plots training.**

Finally, in the third treatment, participants were given the same five strategies with a summary table of overall system performance for each of the five strategies. In addition, simple rules of thumb for interpreting how each strategy would affect the system were explicitly given out to participants. These participants did not get any detailed causal information nor any information concerning how the whole system behaved over time in response to the five policy packages. We refer to this treatment as the **strategic heuristic treatment.**

After receiving training appropriate to their treatment, all participants were allowed to practice their strategies for 90 minutes. During the practice runs they were free to stop the simulation and restart it at will to practice various strategies. After the practice runs and a lunch break, participants returned to a single graded run of twenty simulated years where they were not allowed to restart. A data collection debriefing then followed.

Performance Measures. The overall goal of the simulation was to minimize the costs of welfare reform. The cost score included actual costs of providing Aid for Families with Dependent Children (AFDC) plus the costs associated with job training minus a bonus for each welfare client taken off the welfare rolls. All scores were normalized so that a normalized score of 100 meant that overall welfare costs were the same as in the initial condition.

A good final score at time period 20 could be as low as 50, indicating that the total costs of welfare had been cut in half by the reform after 20 years. In addition to the final score at time period 20, participants were given information on their 20 year average costs. In general, at the end of 20 years these costs were greater than 100 since the system exhibited "worse before better" behavior requiring large expenditures in the early years in order to achieve substantial savings in the out years.

The performance score that was used to award the prize was a cumulative score (CUMMSCOR) -- a weighted average of the final period score and the 20 year average costs.

Measurements. During the graded run of the task, unobtrusive measures of participant approaches to the task were measured. For example, the number of clicks requesting additional information from other cards in the hypertext stack was recorded along with measures of amount of time spent on task. After the run, a first debriefing module asked a number of open-ended questions to which the participants typed answers directly into a recording system. Next participants returned to the main screen for the game and were asked to click on all fields that they found to be important in playing the game. For each field so highlighted, participants were asked to explain why that field was important. Participants were then led through 56 forced response scales that measured their causal knowledge, knowledge of appropriate strategies, knowledge of system goals (these were given at the start), perception of model training clarity, self-report of management learning, and self-report of previous task-related experience. Finally, participants were administered a standard short form of the Meyers-Briggs personality test to be used in subsequent dissertation research associated with the overall projects. Full details of the data collection procedures and results are given elsewhere (Maxwell, Stewart, Richardson, and Andersen 1994).

III. Preliminary Analysis of the Data and Results

Performance vs. Training and experience with JOBS simulation. For preliminary analysis, the measure of performance described above (CUMMSCOR) was used as the dependent variable in a 3 (training condition) X 2 (level of experience with the JOBS simulation) analysis of variance. The main effect for treatments was statistically significant ($F=3.69$; $df=2,46$; $p < .05$). Post hoc comparisons revealed a statistically significant difference between treatment 3 and the other two treatments, but not between treatments 1 and 2. The main effect for experience and the treatment X experience interaction were not significant. The means and standard errors for the treatment main effect are given in Table 1.
Table 1. Means and standard errors for performance (CUMMSCOR) by training condition

Training condition	Mean	Standard error	N
Causal loop training	105.3	2.96	20
Strategic time plots	104.3	3.12	18
Strategic heuristics	94.9	3.54	14

Performance vs. Knowledge. Three knowledge tests were used to measure goal knowledge (6 items), causal knowledge (18 items) and strategy knowledge (10 items). The score on each test was simply the number of items correctly answered. There were no significant correlations between scores on the knowledge tests, indicating that they did in fact measure different types of knowledge.

Table 2 presents correlations between three measures of performance and scores on the knowledge tests. These correlations indicate that strategy knowledge correlates with the final performance score but not with the average score. Since lower scores indicate better performance, the negative correlations indicate that a higher strategy knowledge score was associated with better performance. Goal and causal knowledge were not related to performance.

Table 2. Correlations between knowledge scores and performance measures

	Performance measure		
Knowledge test score	Average score	Current (final) score	Cumulative (combined) score
Goal Knowledge	.07	-.10	-.03
Causal Knowledge	.18	.14	.18
Strategy Knowledge	-.07	-.36 **	-.28 *

** $p < .01$ * $p < .05$

These scores indicate that only strategy knowledge correlates with performance, but only with the final end point reached, not with the average score. Strategy knowledge is also not correlated with the other knowledge test scores.

Training vs. Knowledge. The mean percent correct for each knowledge test by training conditions is presented in Table 3. Goal knowledge differs little across training conditions (goal training did not differ across conditions). Causal knowledge score is highest for training conditions 1, which focused on causal knowledge. Strategy knowledge was highest in condition 3, which consisted of strategy training. However, condition 2, which also included strategy training, has the lowest strategy score. With the exception of the low strategy knowledge for condition 2, the mean knowledge scores conform to expectations, but none of the differences between treatments is statistically significant.

Table 3. Mean knowledge scores by treatment

	Knowledge scores		
Training Conditions	Goal Knowledge	Causal Knowledge	Strategy Knowledge
Causal loop training	83.3	74.4	58.0
Strategy time plots	80.5	67.6	545.4
Strategy heuristics	86.6	63.9	61.4

Decision process, training, and performance. Two measures related to decision process were measured: the number of buttons pushed, which indicates how much information was requested during the test run and the time (in seconds) taken to complete the test run. Both can be considered indicators related to the use of analytic thought processes which typically take longer and consume more information. The two variables were significantly, but weakly correlated ($r = .32$, $p < .05$), indicating that they do not measure the same construct. It may be that they measure different aspects of analytic/intuitive processes. Table 4 shows the correlations between decision process variables and performance.

The means of the decision process variables by training condition are shown in Table 5. Subjects in condition 1 selected, on average, nearly twice as many buttons as those in condition 3 and took an average of nearly 10 minutes longer to complete the test run. These differences were not statistically significant, however.

Table 4. Correlations between decision process variables and performance.

	Performance measure		
Decision process measure	Average score	Current (final) score	Cumulative (combined) score
Number of buttons selected	.27	.17	.24
Time to complete test run (seconds)	.30*	.14	.23

*p <.05

Table 5. Means of decision process measures by training condition

Training condition	Number of buttons selected	Time to complete test run (seconds)
Causal loop training	41.7	2681
Strategy time plots	28.9	2235
Strategy heuristics	20.9	2089

IV. Conclusions

These results are preliminary. We have not yet had time to determine the sensitivity of the results to distributions of the variables and outliers. We plan a detailed structural analysis to examine alternative models to explain the covariance structure of the variables.

The preliminary results are both tantalizing and frustrating. A number of intriguing, non-intuitive relations were found, but all are weak and on the border of statistical significance. Our tentative conclusions are:

1. Experience with the JOBS simulation was not related to performance.

2. Causal knowledge was not related to performance.

3. Greater strategy knowledge was related to improved performance.

4. In comparison with the other groups, the group with causal training (Condition 1) had greater causal knowledge, took longer to complete the test run, requested more information, and did not perform as well.

5. In comparison with the other groups, the group with strategy training (Condition 3) had less causal knowledge, greater strategy knowledge, took less time, requested less information, and performed better.

If these results are confirmed and generalize to other situations, they will indicate a clear superiority of strategy knowledge over causal knowledge for both efficiency and effectiveness in managing dynamic systems.

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