LOOP-BASED STRATEGIC DECISION SUPPORT SYSTEMS
- THEORY AND APPLICATION - *)

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During the last few years we have witnessed the development of two main lines in computeroriented strategic decision support - quantitative simulation approaches und qualitative knowledge based (expert-) systems. As we will show in this paper the process of strategy making can be improved by combining the two approaches within loop-based strategic decision support systems.

The potential of the loop-based strategic decision support approach is demonstrated with the "know-how transfer model" which explains the evolution of multinational corporations in less developed countries and which helps to improve the strategic internationalization and know-how transfer decisions.

1. STRUCTURES OF ORGANIZATIONAL DECISION MAKING AND CORPORATE EVOLUTION

Companies basically use two kinds of decision rules to reach their goals: rule-setting (strategies) and rule-fulfilling (policies)

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(Ashby, 1952, 79-83; Beer, 1959; Pask, 1972, 49-63; Powers, 1973, 54, 78, 183; Riedl, 1980, 99). The rule-setting decision rules are typically developed and applied centralized at the higher hierarchical levels of corporations. The rule-fulfilling decision rules are normally specified and applied decentralized at lower hierarchical levels (Miller, Galanter & Pribram, 1960, 90-91, Röpke, 1977, 40). All types of companies consist of a combination of both types of decision rules (Riedl, 1980, 106; Simon, 1981, 48-52).

Functionally, the centralized <u>strategic decision rules</u> generate decisions to keep or to change a given system structure (Miller, Galanter & Pribram, 1960, 90-91). The structure of an organization basically can be changed by adding or deleting system elements with their feedback connections or by changing the causal relations between existing system elements (Powers, 1973, 180; Eigen & Schuster, 1979; Jantsch, 1979). Typical strategic decisions are, for example, decisions to enter a new market, diversification decisions, internationalization decisions, aquisitions, mergers, mayor R&D decisions and desinvestment decisions.

<u>Rule-fulfilling policies</u> are established or changed with a strategy and generate actions that continuously change the resource system of the company. As long as the decentralized policies of the company generate actions which keep the actual system behavior close to desired system behavior (i.e. close to an equilibrium), no further structural changes will be generated by strategy making. If, however, the actions generated by the policies create or are expected to create a behavior of the organization which is strongly conflicting with the desired behavior of the organization, i.e., a given policy set cannot adequately react to a given or expected situation, then the process of strategy making becomes activated one more time (Beer, 1972, 253; Maruyama, 1963; Power, 1973).

The <u>hierarchical feedback connection</u> between these two types of decision making is seen as one necessary condition in the process of company evolution (Ashby, 1952, 80; Beer, 1959, 145; Pask, 1972, 49).

The <u>interaction of corporate systems</u> structured in this way with other corporations or social systems which have the same generic decision structure, is seen as a second condition for company evolution (Ashby, 1962, 268; Röpke, 1977, 24-35).

This interactive feedback structure of corporate systems can generate two types of behavior modes: structure-preserving behavior modes ("morphostasis") and evolutionary behavior modes ("morphogenesis") (Maruyama, 1963, 304-305; Jantsch, 1979, 67; Eigen & Winkler, 1985, 87-121).

The behavior of a company is <u>structure-preserving</u> if it is generated by a given strategy, i.e., a given policy set, and a given number of integrations which represent its resource system (Maruyama, 1963). Typically, morphostatic behavior modes are growth, decay, adaptation, stabilization, and oscillations of all kinds (Forrester, 1971). Morphostatic behavior modes can be described as changes in the quantitative dimensions of a given set of system variables. Structure preserving behavior modes do not change the quality of a system, i.e., its structure (Maruyama, 1963; Jantsch, 1979, 190).

<u>Evolutionary behavior modes</u> of corporate systems are generated by changes in the strategy and policy sets of interacting corporate systems which are normally accompanied by changes in the number of integrations of their resource systems. Morphostasis changes the quality of a company system by adding or deleting system elements with their feedback connections or by changing the feedback connection between existing system elements (Powers, 1973, 180). Different types of evolutionary behavior modes of companies can be separated. Autopoiesis is an evolutionary behavior where a system produces or reproduces itself (Maturana & Varela, 1980, 4-9). Dissipative self-organization is an evolutionary behavior mode generated by situations of severe disequilibrium in company systems (Prigogine & Stengers, 1984, 12-15). The driving forces of dissipative self-organization are basically imperfections in the interaction of a system with its subsystems and/or with its environment, "wrong" expectations about actions of interacting systems and conflicts between interacting automous systems (Eccles & Zeiher, 1980). Co-evolution is an evolutionary behavior mode where the interaction of two companies causes structural changes

in both (Jantsch, 1979, 130). Evolution by learning is a morphogenetic behavior mode which allows companies to improve their knowledge bases and thereby to reorganize themselves (Powers, 1973, 180; Riedl, 1980, 106).

2. LOOP-BASED STRATEGIC DECISION SUPPORT METHODOLOGY

In order to support the process of strategy making in companies and to simulate evolutionary behavior modes of corporations we combine the system dynamics approach (Forrester, 1961; Richardson & Pugh, 1981) with intelligent logical loops, which we call spiral loops (Merten, 1985, 401-408, Merten, 1986). The continuous feedback loops of system dynamics, with their level-rate and policy substructures, are used to represent the decentralized rule-fulfilling decision rules (policies) and the resource systems of the lower levels of a social system at a given stage of system evolution. Spiral loops represent the logically structured and timedependent information-processing mechanisms of strategic decisions at the top management level of organizations that are responsible for structural change and evolution.

Figure 1 shows how the structure of companies can be represented with the loop-based strategic decision support approach.

>> Figure 1 <<

To understand the loop based strategic decision support methodology in detail, it is useful to look at how the spiral loops represent the "bounded rational" information processing mechanisms of strategic decision making.

Spiral loops portray feedback processes which exist between the structure and the behavior of a system ("evolutive feedback") (see also Jantsch, 1979, 77-81). Spiral loops govern systems in a centralized way and have the ability to change the structure of systems qualitatively when there are severe discrepancies between the actual or expected behavior and the desired behavior of a corporate system. A severe discrepancy between the desired and the actual behavior of a system normally exists when important system variables go out of bounds, i.e., when a given policy set cannot adequately react to a situation. In the long run the desired behavior of a system only can be one which is close to an equilibrium, therefore a severe discrepancy between the actual and the desired behavior of a system is a situation of severe disequilibrium. Severe disequilibriums are caused either by the system itself (i.e., the policies of different subsystems do not harmonize) or by outside pressures, which are often the result of the interaction of the system with other autonomous systems with totally or partly conflicting goals. Spiral loops represent the ability of goal-oriented corporate systems to recognize complex and problematic behavior patterns, to generate and select strategies that will create structural changes and to implement and redefine strategies. Spiral loops, therefore, contain the strategic knowledge base of corporate systems, which allows these systems to reflect upon their own behavior and the behavior of interacting systems.

Spiral loops portray the strategic decisions of corporate systems to keep a systems structure or to change an existing systems structure. There are two kinds of spiral loops depending on the kind of structural change generated:

1. Spiral loops that add or delete system elements with their feedback connections.

2. Spiral loops that change feedback connections between existing system elements.

Spiral loops are always composed of three sets of rules, which sometimes may be interwoven (Merten, 1985, 407-408):

1. A decision rule, which assigns when the critical load of a system is attained (rule of critical load).

2. A decision rule, saying what to do if the critical load of the system is attained (rule of strategy generation and strategy selection).

3. A decision rule describing how to implement the new strategy (rule of strategy implementation).

If we look at spiral loops as higher-level information-processing mechanisms, then their connection with the system dynamics concept, in retrospect, can be categorized as an attempt to reunite the two lines in feedback research - the cybernetic thread and the servo-mechanistic thread (Richardson, 1984). In the extended approach, the servomechanistic feedback loop concept of system dynamics is used to simulate the decisions at lower hierarchical levels of corporate systems in a given phase of system evolution (Richmond, 1981, 291a); the spiral loop concept contributes the ability to model the strategic decisions at the top management level of corporate systems which are responsible for structural change and evolution (Miller, Gallanter & Pribram, 1960, 90-91; Merten, 1986a). The spiral loops normally become activated, when positive feedback loops of a system are expected to dominate or actually dominate its negative feedback loops for some time or when delays in negative feedback loops are expected to create or actually create instabilities. Every qualitative change in a system, therefore, is determined by a corresponding (expected) quantitative change (Maruyama, 1963, 305). The spiral loops activate a new set of feedback loops which govern the system at the new evolutionary stage until another servere disequilibrium is reached or expected.

3. APPLICATION: THE KNOW-HOW TRANSFER MODEL

In this section a brief sketch will be given of a recent application of the loop-based strategic decision support methodology - the "know how transfer model" (for other applications see Merten, Löffler & Wiedmann 1987; Merten 1988).

The know-how transfer model has been developed to explain the process of technology and management transfer to less developed countries (LDCs) and to support the strategic internationalization decisions of multinational corporations (MNCs) of the assembling industries (Merten 1985, 1986).

The know-how transfer process is an <u>evolutionary process</u> which predominantly is determined by three simultaneous interaction processes:

1. The interaction of the multinational corporations and the less developed country.

2. The interaction of the competing multinational corporations within the LDC market.

3. The interaction of the strategic group of multinational corporations with the strategic group of local corporations in the LDC market.

The generic structure of the <u>quantitative model of know-how transfer,</u> which has been developed with the loop-based strategic decision support approach and can be explained as follows:

1. There are four activity levels of the model which represent the four evolutionary stages of the system. Each activity level is composed of a set of positive and negative feedback loops which have a level-rate and policy substructure.

2. There are three spiral loops of the model which represent the evolutive decision rules (strategy making) at the top management level of the multinational corporation. Each spiral loop is composed of a rule of critical load, a rule of strategy generation and strategy selection, and a rule of strategy implementation.

The four activity levels of the model represent the <u>four evolutionary stages</u> of internationalization and know-how transfer: the home market supply stage, the export stage, the foreign production stage, and the foreigen R&D stage. Each activity level of the model can be looked at as a complete system dynamics model for one evolutionary stage of development. At each activity level a different set of continuous loops with the corresponding level-rate and policy substructures is active. The higher activity levels of the model are part of the knowledge bases of the interacting autonomous systems at the lower activity levels.

The "jump" from one activity level to another, which is called system evolution, is generated endogenously by the three internationalization spiral loops of the model. These loops represent the ability of corporate systems to change their structures qualitatively themselves. The knowledge stored in the three spiral loops represents the knowledge of the management of the MNC which is normally used to derive internationalization decisions in reality. All the information processed within the inference nets of the spiral loops (i.e., their data bases) is either generated by the feedback loops of the model or it is represented by constants.

The loop-based strategic decision support model allows us to analyze the evolutionary processes of internationalization and know-how transfer in their qualitative and quantitative dimensions. The model can additionally show the implications of these processes for the multinational corporation (affiliated company, parent company, and conglomerate), the markets in the developed and less developed countries, and the economies of the less developed and developed countries.

In Figure 2 the know-how transfer process to the Philippines is shown together with the strategic internationalization decisions of the multinational corporation over a 30 year period. Figure 2 neatly visualizes the know-how transfer volumes and additionally shows that it takes more than 25 years until the affiliated company in the LDC is able to develop, produce, and sell its own products.

>> Figure 2 <<

To identify strategies and policies which make the know-how transfer process faster and simultaneously more efficient for the interacting MNC and the LDC, we made several sets of strategy and policy tests (see Merten 1985). The model tests indicate that the loop-based strategic decision support model allows us to test the sensitivity of strategic parameters, and the model also helps to make their importance explicit to the strategic decision makers in corporate systems.

4. CONCLUSION

The work reported here demonstrates the potential of the new strategic decision support approach in internationalization and know-how transfer planning. More work needs to be done in the areas on which the loop-based strategic decision support approach is methodologically based, such as the research fields of pattern recognition, strategy generation, strategy selection, and the learning of corporate systems. To determine the method's strengths and limitations, more work also needs to be done in applying this general methodology to specific problems in corporate evolution and strategic decision making.

The loop-based strategic decision support approach is one more step toward "intelligent" simulation models of corporate systems. At the end of this methodological line of development we will be able to develop corporate models which can endogenously generate qualitatively new structures and behavior modes of corporate sytems which did not exist before. These kinds of simulation models, which will be realized within the next few years, will have the capability of learning from their own experience, deriving decisions from numerical as well as from written knowledge bases, and, further, they will have the capability of rewriting their initial model structures.

This work opens a line of research that could contribute further to broadening the applicability of simulation models in management science. The loop-based strategic decision support approach makes it possible to look at problems in corporate systems from an evolutionary and conservative perspective, from a strategic and operational perspective, from a discrete and continuous as well as from a quantitative an qualitative point of view.

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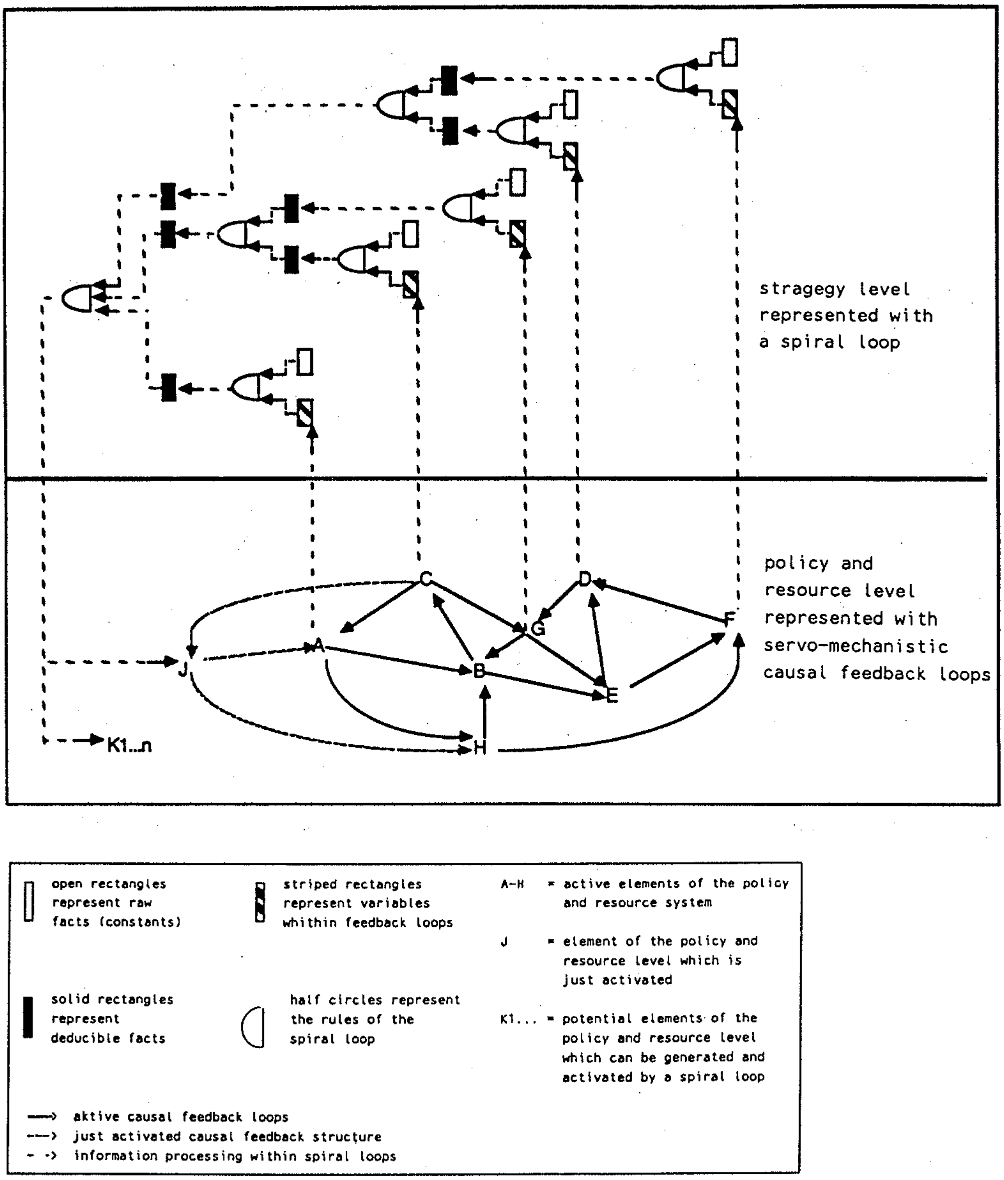
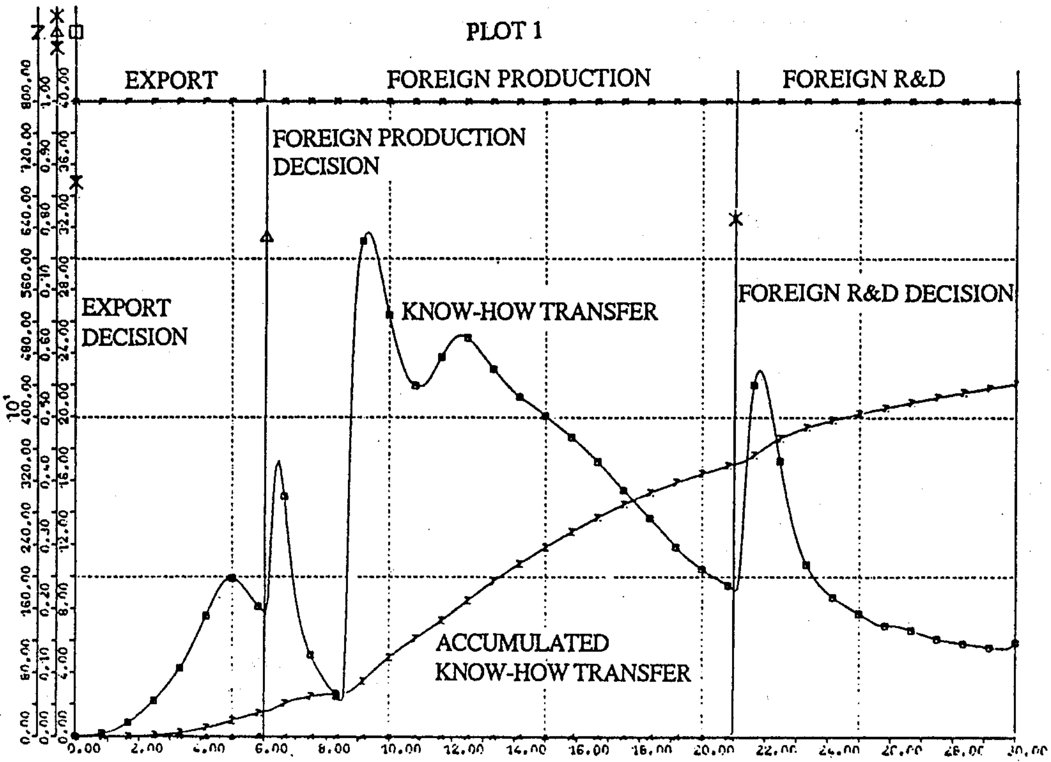


FIGURE 1: The Representation of a Corporate System with the Loop-Based Strategic Decision Support Approach.



FIGRUE 2: The Know-how Transfer Process to the Philippines (Basic Run Results).