Strategies by System Dynamics

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ABSTRACT

System provides methods for Strategic Planning and Management. Lyneis (1980) presents robust ways to achieve time based strengths by minimizing delivery delays. Accumulations of matter and information conform the logistics and intelligence of Strategic Planing. Policies and Strategies are both rules to manage the system. The interaction with the environment is common to both fields and the inclusion of the decision makers within the system enhances the strategic scope of the analysis. Feedback loops are new elements for Strategic Thinking Now, they come packed in archetypes that are basic components of strategy formulation. s expand methods traditionally used by Strategic Planners, for instance the BCG matrix used to allocate investments. Peter Senges(1990) Fifth Discipline is a good example of a combination between the System Dynamics and Organizational learning, a traditional component of strategy development. Dynamics can also profit from Strategic Management. Managers are more familiar with Strategic Planning than they are with Dynamics. So, It is a way to call the manager's attention. Besides, the organizational use of Strategic Planing at the top of the organization opens the door of company headquarters to System Dynamicist. However, some caution is necessary to improve the use of the discipline by the learning managers.

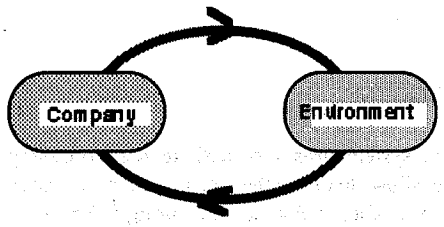
Dynamics can deliver much of the promises made by Strategic Management. Therefore, there is a need to open more channels of communication between both fields.

INTRODUCTION

Some System Dynamics tools used in Strategic Planning are analyzed. A part of the paper discuses uses and misuses of archetypes. There is also a description of how Information Systems builds strategy intelligence and how to invest in strategic business units.

SYSTEM, ENVIRONMENT AND FEEDBACK LOOPS

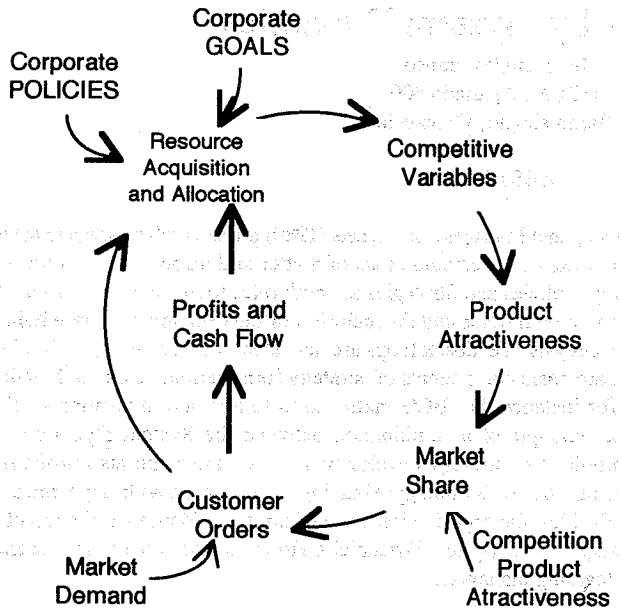
Strategic Planning studies the relationship between companies and environment. Because the environment is a part of the system, the causes and effects are internal.



Therefore, Causal Loops is the thinking structure required to design strategies, because the linear thinking comes back to the origin through the environment. The non existence of feedback loops put in evidence an incomplete choice of the environment.

Figure 1. The system and the Environment

System Archetypes represent the thinking structure, see for instance Peter Senge(1990). Archetypes, Kim(1992), represent well-studied System Dynamic Models. The managers, hopefully, identify the archetype within his company and apply the corresponding strategic management rules.



James Lyneis(1980) introduces the following archetype. This archetype is a reinforcing loop leading to market penetration. The presence of each accumulation, each link, in any company is an outstanding exercise for organizational learning.

Lyneis established an archetype for corporate market share growth. In his book Lyneis studies how to maintain market share by an inventory system together with a set of policies aimed to diminish delivery delays. The identification of the variables, links and structure is a remarkable experience for any manager. It changes the vision they hold about how their company operates.

Figure 2. James Lyneis Strategic Loop

Morecroft(1979, 1982, 1985) expands Lyneis ideas to deal with missing files, links or feedback's in an information system. A frequent missing file is the unfilled orders. The company buys what it sells, and sells what it has. So, company buys what it has. By the this mechanism the company loses market share. This is also an archetype that helps to identify the strategic value of inventory system, to support market share growth.

Accumulations of information are the Intelligence in the formulation of strategy. Morecroft introduces the transformation of a System Dynamics model into information systems structures. Levels turn into files. Rates turn into programs. In the entity relation representation of information systems the entities are the levels, the accumulation of matter or information in the system. Relations match with links. Rates depict the process that operates upon the databases.

SYSTEM DYNAMICS INTELLIGENCE

The SD model turns into an information system, or the information system turns into an SD model. Portraying the way the information supports decision making of the corporation, allows to derive their strategic consequences. Morecroft(1979) uses this transformation to evaluate the strategic role of a popular Manufacturing Information System like the MRP.

He found that by using those manufacturing systems the companies substitutes costly, physical inventories by free orders to receive. However, the strategic consequence of such a practice is: many orders received at factories of raw materials, where production capacity expands to meet demand; then, costly idle machine substitutes inexpensive inventories, at the suppliers' levels.

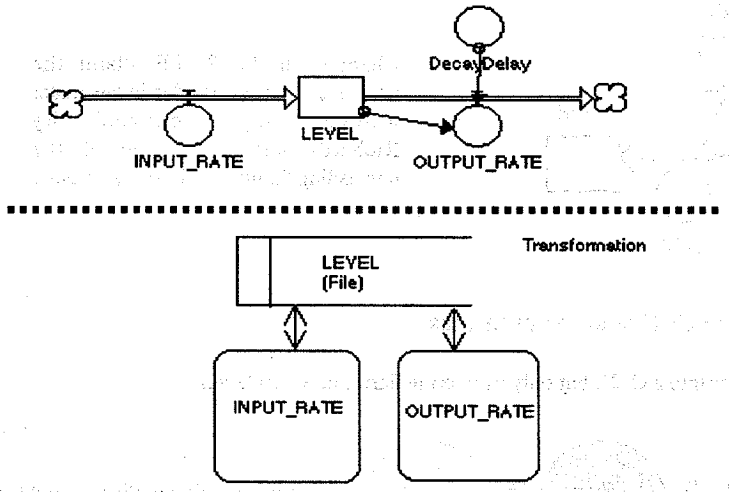


Figure 3. System Dynamic Models and Information Systems

There have been many good papers dealing with the value of Information systems using SD Models, but the evaluation of the strategic consequences of Information Systems has received scarce attention.

MISLEADING ARCHETYPES

The Causal Loop diagram pictures the feedback structures almost since the beginnings of System Dynamics, see for instance Forrester(1967). Now, the structures, depicted in the System Archetypes, are Causal Loops Diagrams of many well-studied System Dynamics models.
Causal Loops Diagrams, even those derived from well-proved dynamic models, can mislead a learning manager. The manager may associate the wrong variables to the archetype. For instance, think of an econometric model, where the relation between the variables is a pure statistical coincidence, as a System Dynamic Archetype.

To avoid the misuse of archetypes some rules have to be followed:

1) Only levels should enter a Causal Loop Diagram
The accumulations of matter, energy and information are the fundamental elements of the causal relationships that conform the causal structure.
f rates are allowed in the diagram, then a second order interaction is present,

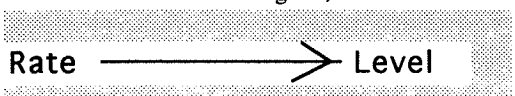
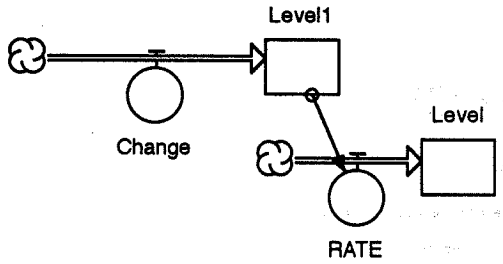


Figure 4. Rate to Level Causal Interaction

A change in Cause, leads to a change in Effect in the same direction, or in the opposite direction if influences are opposite.
In the diagram of Figure 4, a change in the cause is a change in the **Rate**, and a change in the rate is a second order change

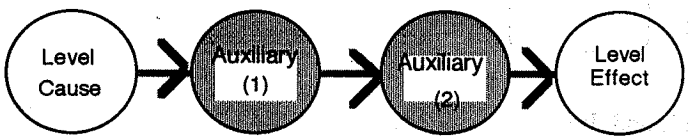
Therefore, a change in the Rate Cause, initiates a change in the Level Effect, in the same or in the opposite direction. Second order changes are nor allowed directly in System Dynamic models because they hide levels. The change of any rate requires an additional level:



Changes in the RATE, claim the presence of level1. Hidden levels make hidden loops reported by Richardson(1986) as one of the misleading features of Loop Diagrams.

Figure 5 Rates allowed in the CLD lead to obscurities.

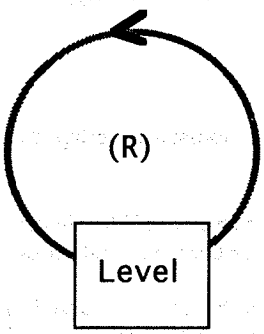
Auxiliary variables may also enter into a CLD, but only as intermediaries between levels.



Loops of only auxiliary variables represent simultaneous equations.

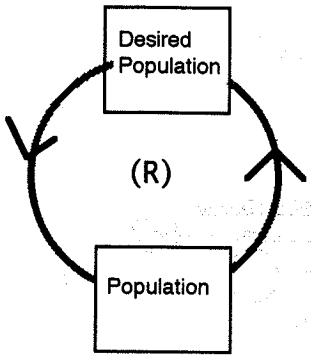
Figure 6. Causality Transmission by Auxiliary Variables.

DYNAMO compilers rule out Loops of auxiliary variables. However, Causal Loops Diagrams of auxiliary variables may appear when using archetypes as guiding structures. Econometric models, especially the simultaneous equation models, where the relationships among the variables may be pure statistical coincidence, are typical cases of loops of auxiliary variables. Those models have been with the corporation for a long time. There is a tradition to do econometric analysis.
Sometimes, a level's feeds back to itself. There may be a temptation to write selfloops upon levels. So,



Self loops hide other levels or auxiliary variables. For instance, a common reinforcing loop is the one associated with population growth.

Figure 7. The apparent self loop

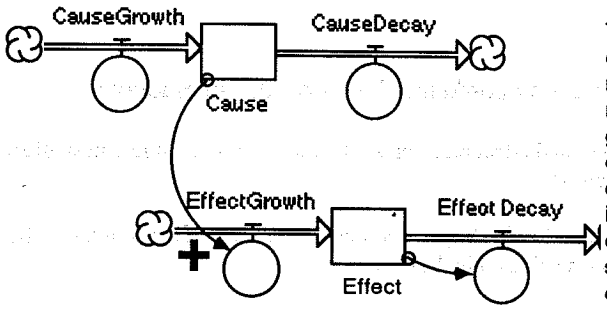


People desire to have children, so the desired population increases as population increases, besides, the higher the desired population the more population that will be. Desired population accumulates in the head of human beings. That level is responsible for the population growth. The omission of this level misleads the definition of a positive loop, being labeled as not goal seeking, opposite to balancing.

Figure 8. Self Loop is uncover

Making explicit the hidden level, then clearly positive or reinforcing loops are also goal seeking, but the goal, as the desired population, increases over time. Balancing loops are also goal seeking, but the goals are either constant or decreasing over time.

The idea of archetypes expressed as Causal Loops Diagrams of well-known System Dynamics cases, is extraordinary. Causal Loops are necessary but not sufficient to plot the dynamics of systems. Level to Rate diagrams, even simplified, are essential to show the logistics aspect of strategy. Now, CLD transforms into Level-to-Rates representation by the process described next.



The sole presence of the cause or Stimulus, makes the effect grow, no matter if the stimulus goes up or down. The cause activates the effect. When the interaction is the opposite, inhibition, the sole presence of the cause inhibites the rate.

Figure 9. Activation, the element of a level to rate interaction

Richardson (1986) describes the characteristic of level to rate interaction. Naturally, the interaction can also take place between the cause(level) and the output rata of the effect. An activation, to the Effect output rate, decreases the effect. Inhibition makes the Effect to grow. The Level Cause_Effect relationship of CLD, expressed with activation and inhibition of level_to_rates, conform the following diagrams:

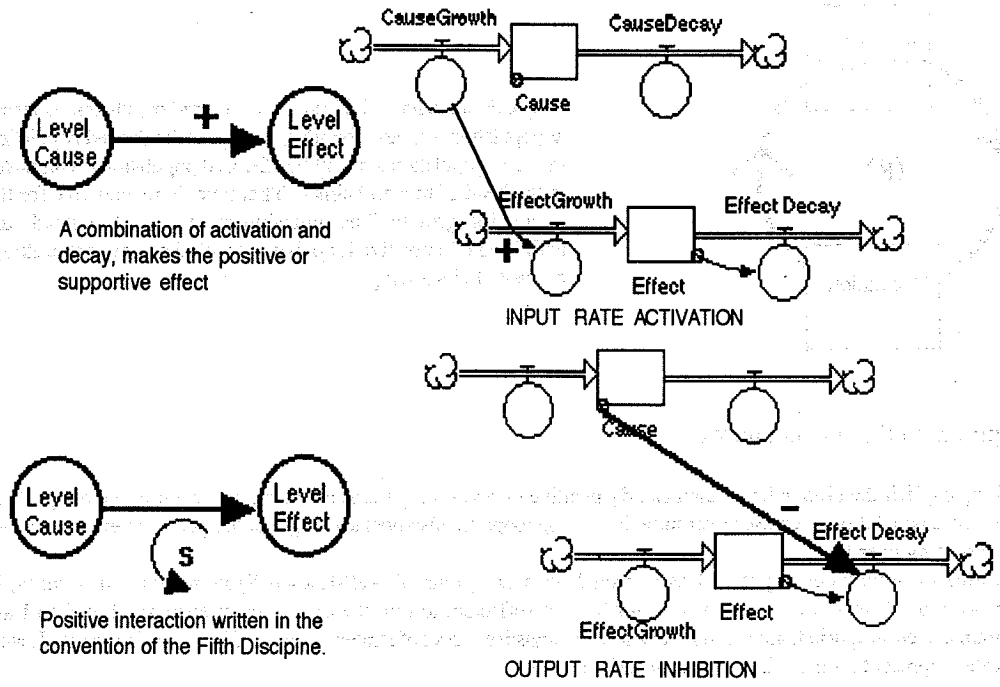


Figure 10. Positive interaction in CLD is decomposed into level-to-rates interactions

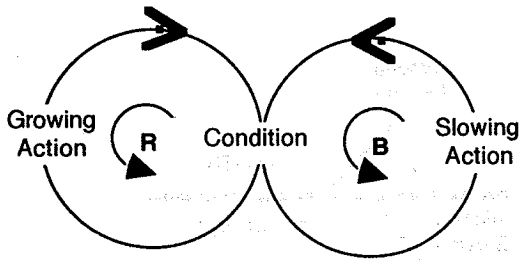
The negative or opposite influence between cause and effect represents inhibition of the input rate plus effect growth, or by activation of the output rate plus growth.

It takes modeling to know the right path form Causal Loops Diagrams to Level_to_rates structures. It takes also purposes, because there are hundred of other things going on in the company.

To analyze all Senge´s archetypes goes beyond the allowed pages of this paper. However, one archetype serves to illustrate some of the suggestions to facilitate organizational learning.

LIMITS TO GROWTH LOGISTICS

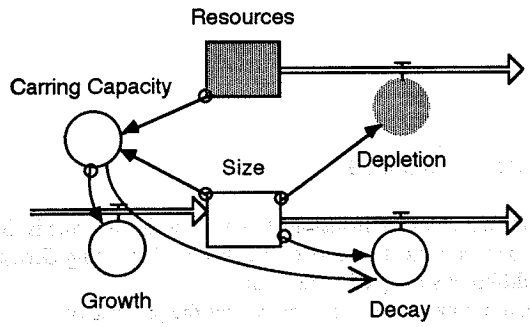
Senge characterize the archetype of Limits to Growth as two parallel loops, one reinforcing and the other balancing.



This structure reflects very the information processing associated with the LTG situation. However, the material flows that used to represent the limits to growth are absent.

Figure 11. Limits to Growth Archetype

Jorge Randers (1976), used to represent this archetype, approximately, by the following diagram:



The availability of resources determines a carrying capacity. The system grows into more resource hunger. As requirement of resources increases, then there is a point where the size of the system needs more resources than available, so it collapses. The decay of the system pushes the scarcity of resources and the decay process.

Figure 12. Limits to Growth Logistic

The management principle, Senge (1990), to overcome the LTG archetype, is not to push on the reinforcing process but to remove the sources of limitations, either by renewing the resource base (recycling), or by diminishing depletion (conservation).

The Double-Q diagram serves to design policies to remove limitations, Tool N° 1 in The Palette of Kim(1992). It is analogous to the Fish Bone diagram used in t total quality.

For instance, an insurance company faces growth in a saturated market. Market as well as product limitations was present. Double Q diagram shows the bones of these limitations. To remove the limitants conforms the action. After an expensive advertising campaign reinforcing growth has failed, the Double Q diagram helps to design a program to remove the limitations, and by this process to promote growth.

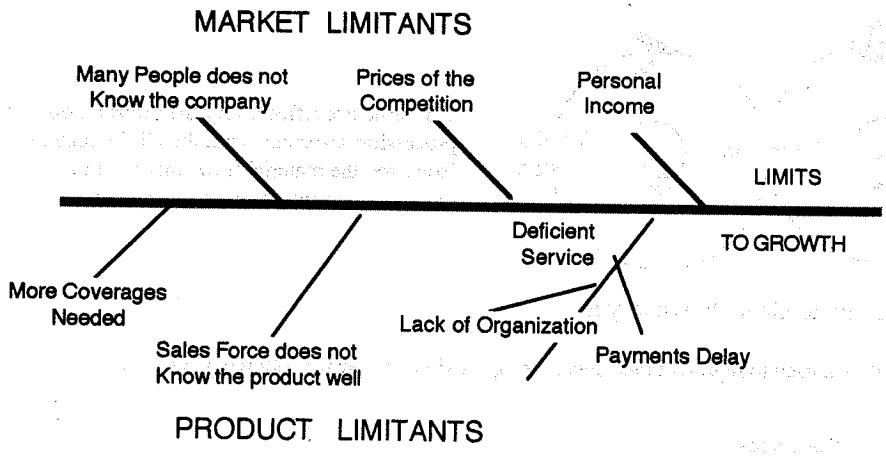


Figure 13. Limitants to Growth

SYSTEM DYNAMICS AND BCG

One of the methods used in strategic planing to guide the allocation of investment in multibusiness firms is the BCG, see for instance Hax, Majluff (1984), the portfolio management process of the Boston Consulting Group. In the BCG method the growth-share matrix plots the different strategic business units
When data of the market is not available, then a matrix of Growth.Vs.Cash_Flow serves the purpose of classifying the different business units.

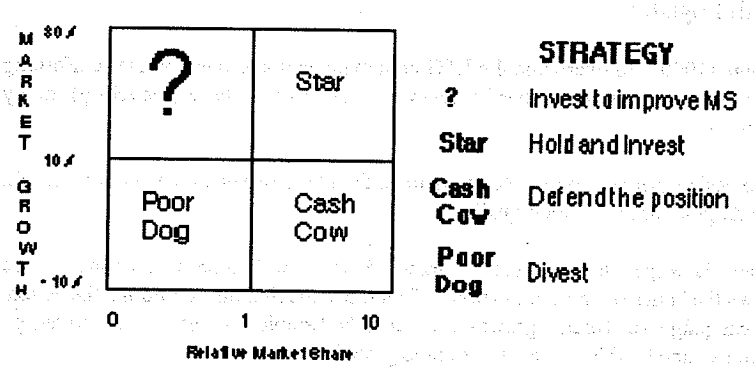


Figure 14. The Growth- liquidity matrix of the Boston Consulting Group.

Merten, Reiner Wiedman (1987) presented a System Dynamic model that enhances the BCG methodology, in fact, their work corrects some of the drawbacks found by considering the competitors and the general economic conditions. They have shown that BCG can be misleading under depression, and under certain reactions of competitors. System Dynamic model incorporates the feedback's between the firm, its competitors, and the general economic conditions. Therefore, System Dynamic improves portfolio management.

CONCLUSION

System Dynamics is a fundamental discipline to design strategies. Recent evaluations, leaded by Peter Senge and his Fifth Discipline, opens the doors of corporate headquarters to System Dynamics. The introduction of archetypes has focused structure rather than parameter manipulation, as emphasized by games. However, some caution is necessary, to improve strategy formulation.

Besides, adding the flows preservation enriches the archetypes. The idea is not to sacrifice the simplicity of the archetype, but to enhance the manager learning by incorporating rates_to_flows diagram. The vision of material flows makes the logistic. The vision of information flows makes the intelligence. Logistic and intelligence comprises strategy. They are both bases of the fifth discipline.

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