New Planning Methodologies in Strategic Management; An Inter-Paradigm System Dynamics Approach

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Abstract

The main concern of strategic management today is the controlling of the interactions between the organization and its environment as this constitutes a highly complex system of interrelated parts. The solution to this problem lies on understanding the underlying structure of the organizational-environmental system with all its possible observable manifestations in constructs and quantifiable variables as well as the steering possibilities or decision rules that this structure allows. This requires the drawing of the patterns of interaction of a large number of important variables. In this paper we argue that by combining the strengths of two prominent planning methodologies, which belong to different and to somewhat conflicting paradigms and modeling schools, we may indeed produce a single more effective planning framework. We proceed by outlining the strengths and limitations of the two approaches namely PIMS and System Dynamics and then integrate them in a single composite planning framework. The PIMS/SD inter-paradigm composite planning model is finally evaluated across theoretical conditions and practical relevance criteria.

Keywords: Planning Models, System Dynamics, Composite Models, Strategic Management

Introduction

Strategic management aims at filling up the gap between the organization’s capabilities and its environmental opportunities in order to secure the organization's transformation into an homeo-static adaptive control system. In such an attempt finding the favorable or unfavorable configurations of the structural elements, which have high intrinsic steering capacity becomes a high priority task. Determining what really matters decreases the complexity of the system under study and focuses attention on the few important parameters that have high impact on performance.

Different configurations of constructs and structural variables produce various patterns of interaction and give rise to different values of the various performance indices. As shown in this paper, modeling the relevant structures and undertaking experimental simulations capable of producing these patterns becomes an appropriate methodological tool for developing strategies and steering the system in such a way that the organization becomes capable of securing its survival and growth. It should be realized though that the organizational structural elements are in continuous interaction with their external environment. Therefore any static perspective to planning should be abandoned, and instead emphasis should be given to link structure and behavior as a dynamic system of continuous interaction. This is carried out by constructing and analyzing satisfactory approximate models of the real system behavior with respect to time.

Different modeling schools, following their own perspectives, embark on research having the intention to enhance our diagnostic and design capabilities. Regardless of the perspective adopted, the effort is always to learn, in most cases through a generation of simulated variations of behavior to select and retain the most promising patterns that secure an orientation to viability. Two problems appear in all modeling schools: First, the problem of validity, that is, the degree of correspondence of the model to the real system and second, the problem of reducing cognitive overload, that is, holding the variables and steering levers of the model within manageable boundaries. The main concern here is that all key factors are considered and the system under study does not enter a strategic drift caused by selective perception of the actors involved in the process. Further, the concern is to stay within the limits of the human information processing capacity without, however, omitting essential bits of information. Both problems are of immense importance and have to be resolved for the development of a reliable, effective planning methodology.

Our approach, which attempts to address both of the above problems, combines System Dynamics with the Profit Impact of Market Strategy of the Strategic Planning Institute (PIMS/SPI), (Buzzell, 2004) (Buzzell and Gale 1987). PIMS/SPI aims at determining "favorable" configurations of design variables, prone to lead to higher performance. PIMS based-research aims at revealing the "Laws of the Marketplace" which define the general empirical relationships between the independent strategy-design variables such as Relative Quality and Investment Intensity and the dependent financial performance indicators such as ROI and Cash Flow.

In the PIMS/SPI paradigm, instead of proceeding from a research framework to the database, the effort is to build a unifying theory based on the exploration of a large database. This is in contrast to the System Dynamics (SD) (Forrester 1967) approach, in which researchers have sought to develop broad research frameworks and identify sets of hypotheses prior to constructing large-scale databases. Critics of the PIMS approach claim that PIMS researchers have failed to satisfactorily account for "soft" system endogenous factors, such as effectiveness of the planning system and internal organizational processes. This has resulted in always attributing a system's failure or malfunction to external factors and not to the vulnerability inherent in the system itself. On the other hand, the SD modeling paradigm with its focus on causal structure depicts adequately most endogenous factors.

As it will be shown here the proposed integration effectively removes the individual drawbacks of the two approaches, builds on their complementarities and offers new possibilities for effective and efficient planning. It is necessary to examine in the subsequent sections the strengths and weaknesses of both approaches.

PIMS as Strategic Planning Tool

There are two basically different ways that PIMS results can be used to facilitate strategic market planning.

- By taking into account a series of general observations about the relationship between business performance and strategic and market variables.
- By submitting data of a particular business to the PIMS models for detailed analysis of its performance relative to "PAR" (i.e. the should be performance) and for assessing the implications for strategic changes.

The reader is referred to Abell and Hammond (1983) and Buzzell and Gale (1987) for a detailed account of applications of PIMS instruments to specific management problems. The stand taken by these authors is that the invariable character of the "laws of the market" can be translated into context-specific assumptions. To this effect, data is collected regarding competition, market characteristics and capital and production structure in order to determine the ROI (Return on Investment) position of the SBU (Strategic Business Unit).

The PIMS approach offers a sound methodology - backed by instruments for diagnosing and analyzing the existing value potential. The experience gained from this comprehensive body of findings can also give valuable clues as to how to configure new value potential, with increased success probabilities. In order to understand more fully what PIMS has to offer, it is necessary to briefly discuss the models used. The first is the Profit Assessment Model (PAM), which indicates the normal, or "PAR" (term taken from golf meaning “should be”) profitability for the business, given the characteristics of the market, competition, production, cost structure, etc. In effect, it assesses the strategic potential of the business, showing whether the business unit, given its characteristics, can be expected to earn a high or a low profit, judged by the experience in the database. In addition, to the full PAM model there is a Limited Information Model (LIM), designed to be used in planning situations where data collection is difficult. It requires only 18 data items as input and although the report lacks some of the refinement of the full report, it can give nevertheless considerable insights (Wakerly, 1984).

There is also a series of somewhat similar models incorporating operating parameters, which, given the strategic structure of the SBU, provide normal or PAR levels of productivity, working capital, marketing and so on. Obviously, these models are highly valuable in allowing comparison of the actual achievement against what can be expected, judged by the shape of the business and the "knowledge" in the data base. This represents a much more effective way than the commonly used comparison of one business with another in a corporate portfolio, particularly when little similarity exists between them.

The second major set of models is directed at changes in strategy and their consequences. The Strategic Analysis Model (SAM) simulates strategic changes like market share increase, in terms of not only the advantages of reaching the goal, but also of the cost of the enabling steps. Cash flow implications and projected profits are predicted, and an indication for an effective strategy is drawn. A further major method used by the Strategic Planning Institute (SPI) is an analysis of structurally similar businesses (Report on Look Alikes, ROLA). The foundation of the two previous methods of analysis is an empirical computer model originating from database experience, which predicts the average expectation for a business given its strategic and structural form. ROLA does not have an associated model; it goes straight into the database and selects directly businesses which have similar important structural characteristics to the one under study. It focuses on the differences between the similar business that succeeded in achieving a specific objective ("winners") and those who did not ("losers"). The method uses specific objectives such as market share or ROI increase for a period of time.

Two other reports, the Value Map and the Quality Profiling Worksheet, used in combination, play a central role in the so-called PIMS Quality Management Process (Hadjis, 1995), which results in an economical development of product/market strategy. The Value Map shows the relative position of the SBU under study against its four major competitors in terms of customer perceived quality/price (value for money) combination of the unit's offerings, across a market average line. The Quality Profiling Worksheet gives the ratings of importance in terms of product attributes or purchase criteria, which were established during the Quality Management Process. In this way the SBU under study can assess where it stands in comparison to competitors and what it can improve in order to achieve a better "value" position on the value map.

Combinations of the above reports are commonly used in PIMS-consulting projects. Very often the following steps are applied:

- LIM to investigate the strengths and weaknesses of the SBU as well as those of main competitors ROLA to develop strategies to increase operating efficiency
- A quality management process (with seminars) for the improvement of customer-oriented quality

Companies often use PIMS for diagnosing the current problem situation, benchmarking, to examine corporate portfolios and as a means of allocating investment capital and other resources between businesses. In this way, allocation can be based on strategic potential rather than historic performance, proved in many cases to be misleading for the future.

In addition, the following benefits are often mentioned in the relevant literature (Wakerly, 1984).

- Introduction of a "common language" and a congregating terminology by the discussion of planning problems (PIMS-constructs and measurable variables).
- The planning-process acquires a meaningful structure, while the actual logical assembly of data and information for carrying a PIMS analysis is found to classify the minds and bring problem areas into a sharper focus.
- As a result of the above, people learn to ask the right question at the right time and make their planning priorities transparent.

PIMS has repeatedly proved its usefulness; however, it has also been criticized. The next section summarizes the major points of the critique against PIMS. As a result we may assess the areas for improvement of the proposed integration of PIMS and System Dynamics methodologies.

The Limits of PIMS - Survey and Critique

The PIMS program has stimulated the most extensive research in the field of strategic management and has produced the most comprehensive set of findings available in the field of strategic planning. It is therefore hardly surprising that PIMS has also attracted critique in both the conceptual and the methodological domains. Some excellent conceptual critiques of PIMS are offered by Buzzel (2004) Mintzberg (1998), Anderson and Paine (1978), Wensley (1982), Jacobson and Aaker (1985) and indirectly by Porter (1983). Most of this conceptual critique puts the market share / ROI relationship in question. Venkatrarnan and Ramanujam (1984) give an overall assessment of the body of research. This body of research identifies an emerging trend and a six-stream categorization. The trend identified is that PIMS-based research is seen to be moving away from its distinct "practitioner orientation" at the beginning of the program towards a "theory development and testing" orientation. Although the original goal of the PIMS-program was to find the determinants of SBU profitability, research studies of later streams have gone beyond the original goal and focused on theoretical issues (see for example (Porter, 1981), (Woo and Cooper, 1982), (Prescott, 1983).

Theoretically-oriented research requires a careful adjustment of the methodology to the research question. More importantly, the ultimate test of theory in a discipline such as strategic management must definitely be its practical relevance. A most appropriate framework for the evaluation of practitioner relevance is the one proposed by Thomas and Thymon (1982). The framework addresses three major methodological issues:

- Data limitations affecting the choice of research topic

- Data limitations affecting operationalization of constructs
- Induction and generalizability allowed, an issue closely related to validity of results.

In the following lines we briefly discuss the critique, deriving the implications for the "composite model-builder". The attention is focused particularly on the model validation tests necessary in the new approach, that would determine the model's usefulness as a policy making tool.

The original critique was that the PIMS database does not cover an adequate time period to allow longitudinal studies. Although the database consisted (up to 1983) primarily of businesses that are in growth and maturity stages of the life cycle, many studies have focused on the concept of product life cycle and failed to identify for instance the existence of the introduction and decline stages. Moreover, the few research attempts undertaken on topics such as innovation, diversification, decline and turnaround, which require analysis of time series data, have failed to produce conclusive results. The existence of suitable complete data series nowadays and the creation of the new database in 1985 that includes start-up SBUs has alleviated the above shortcomings and drastically extended the number of management problems that can now be examined.

The quality of any empirical research is largely determined by the degree of suitability of identifiable, quantifiable indicators and variables derived from hypothetical theoretical constructs, in our case the strategic value potentials. Critics like Chrubasicand Zimmermann (1987) point out that selection of dependent performance variables and independent strategy design variables as well as the operationatization and measurement by PIMS, is unsatisfactory.

Although researchers have displayed a remarkable degree of creativity in working within the limitations of the database, content issues have dominated. Operationalization of variables may have been unsuitably narrow or even forced. For example, the conceptualization of technology in one-dimensional technological categories derived from Woodward (1965) has hindered researchers to consider later multidimensional typologies.

These later conceptualizations emphasize characteristics of task unit structures. Such task structures were the foundations of the later evolution and revolution of process management and business process reengineering (Harrington, 1991). The PIMS database is deficient in data on task or structure related variables and it appears doubtful that PIMS can stimulate process orientation research to any significant extent (Ramanujan/Venkatraman, 1984). The deficiency was later well understood by PIMS/SPI, as the creation of the OASIS database indicates. The purpose of this venture is to include process-variables such as organizational settings etc. First publications of research findings show that probably organizational setting constructs, such as size, levels, autonomy, and organizational culture, explain a greater percentage of ROI variants than the "traditional" content variables (Luch and Cowerd, 1988).

The generalization of PIMS-findings has been a point of controversy. Many of the earlier PIMS studies compare findings to prior PIMS research and report consistency of one with the other. This is hardly surprising given the commonality of the database and the considerable overlaps in the samples chosen. However, few of the PIMS studies have reported consistency with other studies using non-PIMS data sources. One research theme, which has benefited from a cross-fertilization of databases, is the study of exit strategies. The concept, first developed by Porter who used the PIMS database, was later extended by Harrigan (1982), who derived empirical support for her hypotheses on exit strategies from data in COMPUSTAT and the Census of Manufactures databases.

Most of the above reservations originate by the fact that a large portion of PIMS studies move from the database towards theory. This makes it imperative that concepts and models be formally tested on a database other than the one that was used to generate them. However, as no comparable databases exist for testing hypotheses at the business level, the modeler has to operationalize constructs and concepts in a way that makes validation-testing possible with PIMS datasets. Another source of this critique is obviously the rather static perspective of PIMS-methodology, which uses mostly correlational analysis in line with its underlying epistemology of the econometric modeling paradigm.

The next section presents the strengths and weaknesses of SD concerning the framework in which the integration of the two planning methodologies can take place.

System Dynamics as Modeling and Planning Tool

System Dynamics was developed at MIT during the 1950's by Jay W. Forrester. By combining ideas from three fields, Forrester developed a guiding philosophy and a set of techniques for simulating complex, non-linear, multi-loop feedback systems. The ideas originally combined were brought together from control engineering with the concepts of feedback and system self-regulation, cybernetics with the nature of information and its role in control systems, and organizational theory with the structure of human organizations and mechanisms of human decision making (Meadows and Robinson, 1985). It should be mentioned here that System Dynamics has been recently incorporated in strategic management textbooks by Kim Warren (2007) and John Morecroft (2007).

If econometricians and PIMS researchers see the world as a collection of economic variables correlated and contained in statistical databases, the system dynamicist sees it as a conglomeration of interacting feedback loops that generate the nature of the dynamic characteristics that are of interest. The primary assumption of the system dynamics paradigm is that the persistent dynamic tendencies of any complex social system arise from its internal causal structure. Thus, if a model is to indicate the effect of real system changes, there must be a correspondence between the parameters and structure that could be changed in the system, and the parameters and structure of the real system.

The mechanisms of the model must represent mechanisms of the real system, so that the model is capable of generating the direction of the major changes in system performance. In this case, performance is not taken to mean the prediction of the future system state and the exact numerical values of variables, but generation of behavior, patterns and dynamic tendencies, such as stable or unstable, oscillating, exponentially growing, self-correcting or in equilibrium. For instance, a system dynamicist will rather be interested in profitability trends and cash position variations than the exact numerical values of a projected cash flow. Emphasis will be given in the pattern of behavior (oscillating, declining, etc.) and degree of market penetration and not the exact market share of the company at a future point in time. In general, the system dynamicist focuses on those characteristics, belonging to a meta-logical level (meta to the operating system) that indicate which of the system states, generated by a simulation, are desirable.

The central idea that system dynamics uses to understand system structure is the two-way causation or feedback. It is assumed that social or individual decisions are made on the basis of information about the state of the system or the environment surrounding the decision-maker. The decisions lead to actions that are intended to change the undesirable state or maintain the desirable state of the system. The emergence of new information about the system produces, then, further decisions and changes. The circle is continuous and each such closed chain of causal relationships forms a feedback loop. By definition then, system dynamics models are made up of many such loops linked together, and are basically closed-system representations in which most of the variables that occur in feedback relationships are endogenous.

The system dynamicist recognizes that noise, that is random events whose source is outside and independent of the real system represented, such as the uncertain influence of weather, local, national or international political news, measurement error etc., may take an unpredictable form and may have unknown influences when compared with orderly forces, like observed regular time-series events. Thus every decision function has, at least in principle, a noise uncertainty component. By definition the exact time pattern of this noise is unknown or there exists useful estimates of its magnitude and statistical characteristics. The sensitivity to noise inputs can be experimentally established by changing the noise seeds for simulation. In this way we may account reliably for the most unknown influences on model behavior.

Feedback processes do not operate instantly, that is, the timing of system behavior depends on elements that create inertia or delays. Information about action is not immediately available. Decisions do not respond instantaneously to available information and time is required for executing actions indicated by a decision. These accumulations or inertial elements that describe the state of the system are referred to as levels or stocks, which contain material or information. Typical material levels are capital stock, inventories and cash balances. Levels of information can be constructs like perceptions, quality indices, or knowledge and cumulative learning. In enabling and inhibiting actions, levels function both as resources and constraints.

System elements representing the decisions, actions, or changes in a levels are called rates. A rate is a flow of material or information to or from a level. Examples are investment rate, rate of hiring, rate of potential customers becoming interested and so on. Rates define the present instantaneous flows between the levels of the system. They correspond to activities, while the levels measure the resulting state to which the system has been brought by the activity. The rates of flow are determined by the levels of the system according to rules defined by the decision functions. In turn, the rates determine the levels. The levels determining a particular flow rate will usually include the level from which the flow itself comes from.

The representation of a system by means of feedback, levels and rates requires a careful distinction between stocks and flows of real physical quantities and of information. In the system dynamics paradigm physical flows are constrained to obey physical laws such as conservation of mass and energy. On the other hand, information does not need to be conserved, and it may be at more than one place at the same time, it cannot be acted upon at the moment of its generation and it may be biased, delayed, amplified or attenuated. Since information is the raw material of decisions, information distortion must be included in the model, if we are to represent decisions properly. The principle of independence of decisions, applicable in practice, makes possible a formulation that is free of simultaneous algebraic equations and strongly enhances planning effectiveness.

Two kinds of feedback loops are distinguished by the system dynamicist: positive loops, which tend to amplify any disturbance and to produce exponential growth, and negative loops that tend to negate any disturbance and to move the system towards an equilibrium, point or goal. Combinations of these two kinds of loops appear very frequently and allow system dynamicists to formulate a number of useful theorems or generalizations connecting the structure of a system which constitutes a network of interconnected interacting feedback loops, to the system's dynamic behavioral tendencies, ranging from exponential growth to oscillatory or sigmoid patterns (Gomez, 1981).

This simple realization has fed SD researchers to isolate and describe generic structures, invariably appearing in many management contexts (Senge, 1995). These theorems permit identification of isomorphism in very different systems that can be expected to have similar behavioral patterns. Time delays can be crucial determinants of the dynamic behavior of a system. System dynamics emphasizes the consequences of different lagged relationships in real systems and modelers search carefully for such lags. Non-linearity can cause feedback loops to vary in strength, depending on the state of the rest of the system. Linked non-linear feedback loops thus form patterns of shifting loops dominance that generate most of the observable behavior, making their proper identification a necessary prerequisite for the systems dynamicist, for understanding how a system works.

A final distinguishing characteristic of the system dynamics paradigm is its emphasis on underlying causal mechanisms whether directly observable or not, and not on observed correlations. The development of modern software (Powersim, Vensim, Stella etc.), which can easily handle the problem of non-linearity, facilitates at the same time the representation of correlations within causal structures.

Problems and Limitations of the System Dynamics Approach

In a fast-growing field such as SD, it is always very difficult to make an inventory and critique describing the stand of research and findings. Donella Meadows (1985) attempted first a critique of the SD methodology and a comparison with the econometric modeling paradigm, the recognized rival at the time. We first give below a summary of the major points identified by D. Meadows and then discuss the in between developments up to date. In this way, the reader has a framework to assess and evaluate the evolution of SD during the years. We focus our attention on management applications. Major limitations originally cited by Meadows can be summarized as follows:

1. Emphasis on simplicity, tendency of discounting and hence danger of slipping into inaccuracy.
2. Ease of software packages in adding new elements, entails the danger of creating complex, opaque, incomprehensible structures, instead of carefully designed simulation experiments.
3. Parameter estimation is less important in SD models than for example in econometrics, and statistical estimation procedures are used less.
4. SD lacks rigorous theory or procedures for performing sensitivity analysis that is suitable for testing the full range of uncertain parameters.
5. The SD paradigm handles the problem of validity qualitatively and rather informally.
6. Lack of databases that would enable comparisons of model behavior with real world observations.

We discuss briefly below every point separately, giving the reader an account of major developments up to date.

Regarding points 1 and 2 the emphasis on simplicity in SD was consistent at the time (early eighties) with the purposes for which this technique was applied, mainly to questions that involved the behavior of aggregate quantities. The argument was that a modeler striving for clarity and simplicity would try to avoid desegregation as much as possible and thus slip into the trap of discounting, avoiding or not perceiving questions of accuracy. In the meantime, two major developments have changed this picture. Those are the development of better conceptual management models and the evolution of powerful modeling and simulation software. Mature models have become available, enabling safe disaggregating of steering and output variables in a reversible and recursive manner within a network of a continuous interaction structure. Apart from the PIMS models, Probst (1985), Galweiler (1987), Piimpin (1991), Bleicher (1992), Schwaninger (1994), and several other authors have furnished frameworks, which enable for better conceptual models. The proposed inter-paradigm planning approach benefits from this development, adequately dealing with the question of accuracy. On the issue of software availability a tremendous progress has become visible. Modern modeling and simulation software like STELLA, POWERSIM, VENSIM allow a "clean" separation between analytical activities, disaggregating of modeling activities and activities of synthesizing, grouping and presenting information generated. In this manner, information and knowledge acquired through a detailed modular experimental approach can be synthesized and communicated in a compact form. Management flight simulators become easy to construct vehicles of communication and in-depth discussion of results (Sterman 1989, 2000). These has also made possible the construction of bigger, complex models capable of addressing problems at the detailed as well as at the aggregate level, (see for example (Lyneis, 1999)).

Regarding points 3 and 4, the SD methodology reports a great progress in using formal methods, both in the model building, parameter estimation and model validation in general. Depending on the purpose of model, parameter estimation procedures are finding more and more their place in SD. For instance, Clemson at al. (1995) already demonstrated the use of Taguchi methods of parameter design and efficient sensitivity analysis in SD engineering models. In another publication (Hadjis and Papageorgiou, 2007), has showed convincingly how the same approach can be applied in a corporate management model for achieving a rigorous formal testing of a full range of uncertain parameters.

Regarding points 5 and 6, the SD validation literature reports an enormous progress as far as conceptual-methodological aspects of formal validation are concerned (Barlas and Carpenter 1990). However, the problem of lack of suitable databases remains unresolved. This is how System Dynamics will especially be benefited from PIMS. The integration of the two approaches bridges the gap of lack of suitable data.

The implications of this critique for the composite model builder of the integrated approach, are mainly centered on the choice of model boundaries and hence the type of management problems to investigate. If validation of model output requires comparison with time series of data, these must be available. A System Dynamics (SD) model can, for instance, easily undertake the study of long- term evolution of "generic structures" appearing in substitution-diffusion processes (Marchetti, 1985) (Anderson and Tushman, 1990). Variables and constructs extracted from other theory-building approaches could then be included and simulated in the SD model. We must, though, be careful to select such variables that enable behavior reproduction tests, and thus require the availability of suitable data series. The combined methodology fulfils this requirement. Obviously, the SD modeler has the freedom to operationalize any content or process-oriented construct in his model. The selection of such constructs should follow a disciplined path of reversible "disaggregation" that facilitates first, causal tracing as in reality, and then re-aggregation for the purpose of validation.

A Framework for Integration: Leveraging the Complementarities

From the discussion in the previous section we may conclude that system dynamics provides a theory of casual structure and its relation to dynamic behavior that is a powerful guide to model specification. PIMS on the other hand offer numerous techniques for finding empirically based parameters and for formal comparison of model results with real-world observations. SD is particularly applicable to long-term analysis of possible changes in important trends while PIMS is best suited to precise short-term predictions in situations that do not differ much from those that have occurred in the past. Thus, the integration is expected to produce models that combine realistic structure with precise parameters, models that could be useful at every stage of the decision-making process and particularly capable of attacking the ever-widening middle-term span of the spectrum of strategic problems, not easily analyzed by either method on its own. Successful strategies are essentially of meta-character both logically and temporally. The hope to influence the functioning of the system at the object level is limited to the extent that we can detect the long-term patterns generated by the system's configuration. The planning tool proposed here contains exactly these "links" between the meta-object levels that produce the necessary steering information.

Composite models such as the one proposed in this paper should be useful for orientation of a general character. That means it should contain invariants responsible for generating persisting patterns. The next step is to find out the most favorable configurations capable of reducing the vulnerability of our system to internal-external stress. Thus, diagnosis and design should be synthesized in any effective planning tool, a condition that composite models easily meet.

There is a basic difference between systems in nature and systems in a social context that has implications for the proposed methodology. In the solar system for example, inertia and gravitation, in contrast to "noise", are the predominant forces ruling the system's "destiny". In social systems though, the noise components play the dominant role, at least in the long-term. Thus, a composite model should contain the noise components affecting the decision functions, because the behavior of variables and hence values of parameters will be decisively affected by these noise components. This observation invalidates any static view of the matter, because the behavior of the whole over time cannot be evident from the examination of the parts separately. An effective planning model should thus generate interactions over time.

Since many of today's strategic problems are transient in nature - i.e, market development, new product introductions, capacity additions, etc - a dynamic model should be able to describe these one-time phenomena changing the character of the system. This is achieved through computer simulation. A composite dynamic model is capable of simulation and hence enables controlled experimentation. This means that such models should be of a mathematical nature. A mathematical model is more specific than a verbal model. It is less ambiguous, it can be more easily manipulated (through experimentation) and it can be more readily used to trace assumptions to their resulting consequences, capturing the dynamics of time-varying and non-linearity, which characterized activities in social systems.

The last realization puts the issue of validity under a new light: dynamic composite models are not necessarily correct or false. They are models to substitute in our thinking for the real system that is being represented. Thus, validity of such a model should be a matter of agreed utility and usefulness, decided by the objectives of those involved. We may conclude that different attitudes towards data and their accuracy corresponding to the degree of correspondence of the model to the real world will only be determined by the different objectives ascribed to the model. As John Sterman (2002) states, “All Models are Wrong”. Instead of the absolute accuracy of the model we should evaluate the usefulness of the model for the specific application.

In real practice the manager deals continuously with mental and verbal abstract models of the firm. All the participants have their assumptions about how things work around the firm. There are many, frequently not coinciding descriptions of activities. How do we then incorporate any sort of discipline into the process of building the model, so that the resulting planning platform is solid and not anybody's guess? We return, in other words, to the methodological aspects of the proposed integration.

The solution to this problem can be found in two steps. First, the process is one of translating an implicit informal thought model of the people involved (a derivative of their up-to-now path of evolutionary cognitive and social processes) into a formal verbal model (shared and understood) with explicit dear statements. The reason is that we always begin a modeling process (for example in a strategy workshop) with a verbal model of descriptions and conversation. The second step is to translate the now formal verbal problem into a mathematical model.

The first step of converting the existing individual-idiosyncratic thought-model into one with clear statements is rather difficult. It is at this point that inaccurate statements can creep in. The problems of going from the verbal to the mathematical statements arise when the initial verbal model is not an adequate description of the system under study. PIMS offers a comprehensive methodology, backed by workshops, data collection instruments and variable descriptions dealing effectively with this issue. SD can be very much benefited in this way by PIMS. On the other hand SD presents a powerful methodology for translating these verbal models into mathematical models capable of computer simulation. Thus the integration of PIMS and System Dynamics into a composite planning model represents a very attractive proposal.

In summary, the combination of PIMS with System Dynamics is expected to show synergistic effects for more effective planning models, in the following areas:

- Eliminating the problem of lack of relevant data banks allieviating the relevant weakness of system dynamics
- Dealing effectively with the problem of reduction without loss of important information allieviating the relevant weakness of system dynamics
- Dealing effectively with the problem of "accuracy" and aggregation-desegregation of variables, hence enabling diagnosis and design to coexist
- Giving valid first orientations on the direction and magnitude of variables' interactions (strength of PIMS), defining thus model boundaries and objectives (combined strength).
- Bridging the gap endogenous-exogenous variables, internalizing important external factors in a model capable of simulation and enabling like this the diffusion of ideas and discussion of hypotheses developed outside the two paradigms (combined strength).
- In freeing form structural restrictions (weakness of econometrics) in a rigorous disciplined manner (combined strength)
- Enabling the exploration of conditions that significantly differ from the historical past (strength of system dynamics).
- Connecting Meta (strategic) and Object (operational) levels in a way of making visible the otherwise obstructed steering information (combined strength)

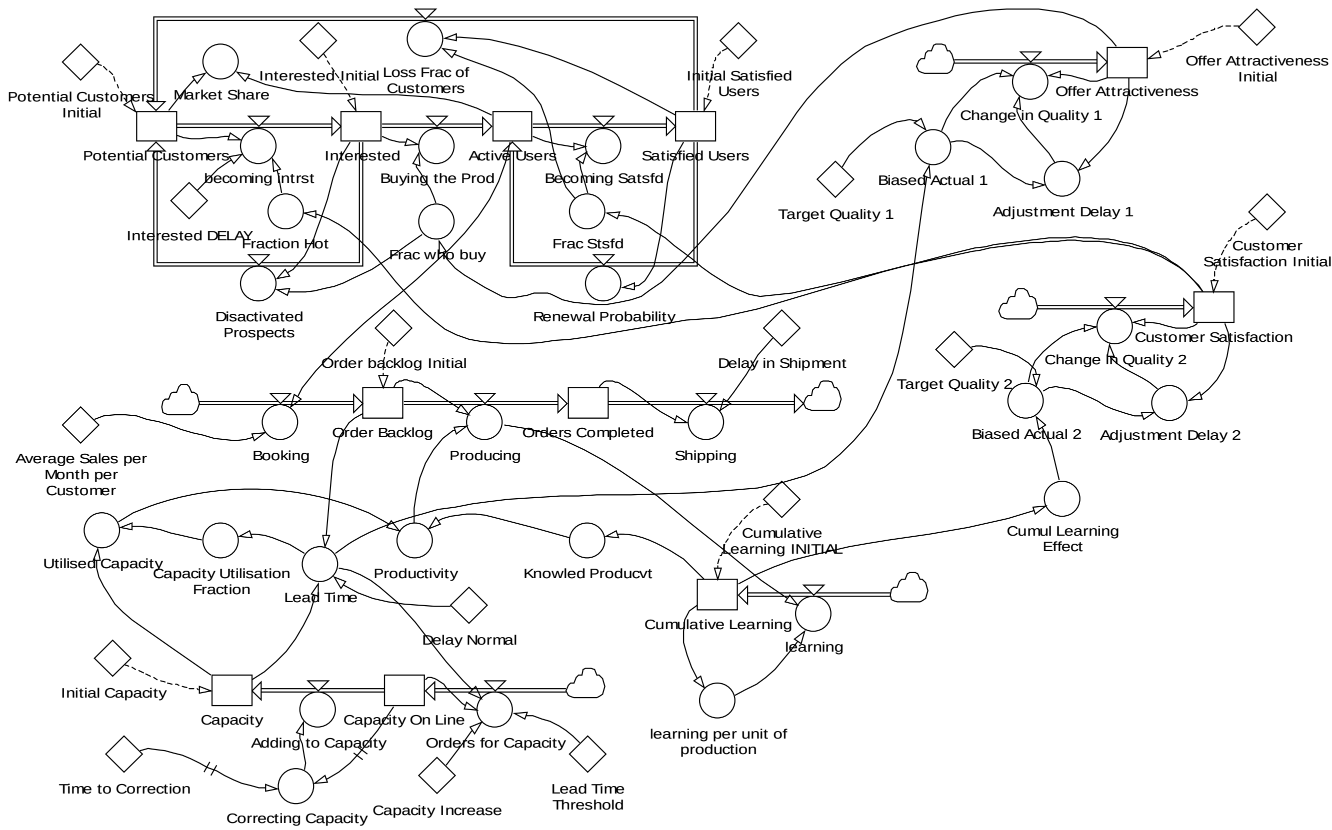

Figure 1: An SD Model developed using the proposed integrated approach

The proposed PIMS/SD integrated approach has been applied by the authors in order to develop strategic management plans for a number of businesses. Figure 1 depicts the stock and flow diagram for a specific Strategic Business Unit of a German corporation operating in the semi-conductor industry. The model was successfully applied in envisaging the organizational and market dynamics as well as drawing a number of effective strategies for the business. For more details on the development of the model for the specific SBU please see Hadjis and Papageorgiou (2006).

Discussion, Conclusions and Future Work

In the maze of current available planning instruments, recipes and approaches, it seems that we have forgotten the characteristics of an effective planning methodology. That is to ensure that sustainable plans are produced and that plans should be flexible enough so that it is possible to abort them if necessary and redevelop them. This demands that the process of self-reference, in the sense of sharpening and increasing an organization's awareness, has to be effectively organized and kept in action. This imposes both theoretical and practical conditions to any serious suggestion for a new planning methodology, which has the major task to manage this process and significantly contribute to the design of the strategy producing mechanism. An organization's constant adaptation cannot be ensured with a single strategy but with a mechanism capable of continually producing strategies for survival and development. Below we evaluate the proposed composite PIMS/SD Model on a number of theoretical conditions and practical criteria.

The first theoretical condition demands that all key variables (external and internal) and structural elements, that define a special business system, should be considered. The issue here is one of adequate model specification that ensures a problem oriented structuring and steering of the individual and collective thinking processes. The use of PIMS findings which describe the laws of the market ensures that model objectives, boundaries, interacting variables with clear indications of the direction and magnitude of the effect of interaction, are considered. The composite planning model adds to this rather static view the dynamics of behavior over time. However more research is needed particularly in the field of validating behavior with data of real companies over larger periods and the field of "reality tests".

The second theoretical condition pertains to the coaching of the social-learning process of strategy developing. Planning is a process happening at more than one level. It is first a thinking process for the participating individuals. Second, it is a social and political process for the planning group and the organization as a whole. An effective planning heuristic has to enable processes and methods that promote the inherent self-organizing forces of the social planning system to unfold, and it has to support the system's cognitive processes and capability for self-reference and correction. The issues involved here are the ones related to the possibilities to influence contexts such as strategy workshops and planning systems that lead to a cultural of productivity enacting creativity, ownership and commitment to an agreed line of action.

Our experience from strategic management consulting shows clearly that building a composite system dynamics model at the end of a PIMS Quality Management Process project fulfils the above requirement. Inter-paradigm models, constructed and simulated in workshops, can become "management flight simulators", drastically enhancing learning about one's business. The issue of knowledge management and the concept of the learning organization are directly related to the research proposal here.

The third theoretical condition refers to time aspects, which involve the important factors of perceiving and identifying observed patterns generating reliable if possible real time information for timing of strategic actions. Present growing discontinuities force managers to acquire foresight and to decisively shorten their reaction times. The composite planning model proposed here can very effectively fulfil the task. The only problem is that the developed planning models have to be validated with real data. Hence our proposal future research is in the field of test taxonomies and computerization of the validation environments, as well as in the development of new databases and suitable data collection methods.

Finally, with respect to relevance for practitioners we evaluate the proposed integration according to the five criteria by Thomas and Tymon (1982). The five criteria are given as follows.

- Descriptive Relevance, defined as accuracy of findings in capturing phenomena encountered by practitioners in his/her organizational setting.
- Goal Relevance, defined as the correspondence of outcomes or dependent variables in a theory to the things the practitioner wants to influence.
- Operational validity, i.e. the ability of the practitioner to implement action implications of a theory by manipulating its caused independent variables
- Non-obviousness, defined as the degree to which a theory meets or exceeds the complexity of common sense theory already used by practitioners.

- Timeliness, defined as the requirement that a theory be available to a practitioner in time to use it to solve problems.

Most PIMS studies have little difficulty in meeting the criterion of descriptive relevance. Indeed, research efforts strive for descriptive accuracy through the cybernetic principle of modeling complexity via complex models showing requisite variety. However, permitting participants of PIMS-Consulting projects to offer subjective estimates of some key variables and construct happens in a limited way. Aggregation and desegregation of these constructs in the context of composite models can ensure correspondence to validatable variables in the PIMS or other databases.

Similarly, the second criterion, goal relevance, is partially satisfied by some more recent PIMS-based studies, which attempt to describe performance using multiple outcome measures rather than profitability alone e.g. change in market share, cash flow, value added and generation of employment and so on. Structural freedom in terms of model objectives, boundaries and so on offered by the proposed integration, allows participants to include management problems of their concern in a disciplined manner.

The third criterion, timeliness, is also an easy test to pass for PIMS studies, which have always addressed contemporary concerns of managers, such as the role of market share, vertical integration, product quality etc. The modeling approach proposed here leverages the complementarities of the two modeling paradigms offering the advantage to experiment with generic and invariant structures.

The final two criteria, operational validity and non-obviousness pose challenges to PIMS research. The danger lies in the increasing theoretical orientation of PIMS-based generalizations. This may be taking place at the cost of operational validity that requires actionable in-sights on causal structures and steering sequences under dynamic conditions, where cause and effect may be reversed. In this sense, the composite System Dynamics model accounts for the proliferation of complexity and complements PIMS. As for the non-obviousness, it has been mentioned that few of the PIMS-findings have a counter-intuitive quality.

Therefore, we may conclude that the PIMS/SD composite model presented in this paper represents a very attractive proposal for strategic management planning. The proposed integration could envisage the organizational and market dynamics via computer simulation experimentation, where the interactions between the interrelated parts of the organization and its environment, take the form of explicit knowledge, whereby strategies may be developed and evaluated prior to their implementation in a computer simulated environment.

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