INCREASING THE EFFECTIVENESS OF CORPORATE POLICY MODELS

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ABSTRACT

System Dynamics modeling has not had an impact on the corporate decision-making process commensurate with its potential. Models have been constructed, corporate attitudes and philosophies changed, and some decisions made based on model results, but only infrequently have these efforts had a continuing impact on internal company decisions. I believe this problem is largely caused by the failure of system dynamics models to provide appropriate input to the budgeting and resource-allocation decisions that often determine company policies. Many significant decisions are made in the context of developing one- and three-to-five-year resource-allocation plans. Other decisions -- major capital expenditures, for example -- must be supported by detailed plans that correspond to the one- and three-year plans. Yet most system dynamics models do not provide the information necessary to support development of such detailed plans. As a result, model impact on corporate decisions tends to be only short-term.

To increase long-term implementation of system dynamics models in corporate planning, Pugh-Roberts Associates, Inc. is evolving an approach to corporate planning, and a philosophy of constructing models, which injects the appropriate kinds of information into the planning process on a regular basis.

The approach to corporate planning entails a process called "strategy management," in which the analysis that led to the intitial policy recommendation is reviewed on an annual or semi-annual basis. As conditions change, the recommendations can easily be updated. Moreover, a comparison of actual company performance with that projected by the model can serve to forewarn of these changing conditions -- or of structural changes, errors, and omissions -- which might warrant a revision of the model.

The philosophy of constructing models requires that the models be sufficiently detailed in order for them to have a significant impact on the development of detailed corporate plans. Although dynamic behavior may adequately be captured by a "simple" model, our experience in preparing models for a number of corporations indicates that detail is useful to facilitate initial acceptance of the model, and is often essential in assuring the model's continued use by the client.

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INTRODUCTION

System dynamics modeling has not had an impact on the corporate decision-making process commensurate with its potential. Models have been constructed, corporte attitudes and philosophies changed, and some decisions made based on model results, but only infrequently these efforts had a continuing impact on internal company decisions. I believe this problem is largely caused by the failure of system dynamics models to provide appropriate input to the lower-level decisions which ultimately control corporate behavior.

Corporate decision-making processes are generally classified into three categories: (1) Strategic Planning; (2) Management Control; and (3) Operational Planning. Anthony defines each of these processes [1]:

> Strategic planning is the process of deciding on objectives of the organization, or changes in these objectives, on the resources used to obtain these objectives, and on the policies that are to govern the acquisition, use, and disposition of these resources.
>
> Management control is the process by which managers assure that resources are obtained and used effectively and efficiently in the accomplishment of the organization's objectives.
>
> Operational control is the process of assuring that specific tasks are carried out effectively and efficiently.

In theory, the decisions made in the process of exercising management and operational control are guided by the objectives, strategies, and policies established in the strategic planning process. This belief is reinforced by the periodic major efforts that corporations put into developing a new strategy. During the seventies, these efforts were principally focused on portfolio anlysis, but a number of system-dynamics policy-oriented studies also were conducted.

In practice, however, I would argue that, while these efforts have initial impact on management and operational control, this impact fades as personnel, the competitive business climate, and the economy all change. The strategy effort comes to be viewed either as belonging to someone else, or as being less relevant to present conditions. Management and operational control are increasingly influenced by other inputs -- primarily senior management intuition and those modeling approaches (e.g., econometric forecasts and financial planning models) that directly support the development of the one- and three-to-five-year plans which are the primary vehicles for exercising management control. Therefore, to the extent that we view system dynamics models as appropriate only for strategy analyses, we are destined to lose impact over time, until management decides that another modeling effort is warranted.

Attitudes Limiting the Applicability of System Dynamics Models

There are a number of attitudes with regard to the construction of system dynamics models which effectively limit their applicability to strategy analyses, and which may even limit their usefulness and acceptability. Chief among these attitudes are: (1) that the models should contain only sufficient structure to capture the essence of the problem; (2) that system dynamics models can and should recreate only the behavior mode of interest, and not 'fit' historical data with any degree of precision; and (3) that system dynamics models cannot or should not be used to forecast. These attitudes tend to produce models which, while potentially yielding valuable policy prescriptions, are highly general. They do not provide output at the level of detail necessary for developing

three-to-five-year plans. Moreover, the numerical output produced is likely to be only roughly similar to actual corporate data, and therefore of no consequence in detailed planning.

In addition to providing useful output for detailed planning, making the effort to improve the historical accuracy of the model is valuable for other reasons. First, in analyzing descrepancies between simulated and actual data, one often discovers structural omissions and simplifications that might otherwise have gone undetected. Second, while not the sole criteria for model validity, improving historical accuracy certainly builds management confidence in the model. And third, people not directly involved in the modeling effort cannot have the conceptual confidence in the model necessary to accept its policy prescriptions, and therefore fit-to-data becomes an important test of validity. Improving a model's historical accuracy helps to achieve overall acceptance of the model and improves its chances for implementation.

The belief that system dynamics, or any modeling system, can or should be used only for forecasting the general direction and magnitude of policy change is perhaps the most serious stumbling block to constructing models that can be used for more detailed planning. This belief may, in fact, embody the attitude which reinforces the tendency to avoid building detailed models and improving the historical accuracy of the model. I think that, in the long-run, we do a disservice to managers by rigorously adhering to such a policy.

Managers will always use forecasts to develop business plans. We should recognize this fact and ensure that the forecasts they use, and the way they are used, are consistent with our philosophy. In the first place, since they contain high structural detail, system dynamics models offer the

potential for producing more accurate forecasts than do other modeling approaches. But, more importantly, because the model used to produce the forecast is the same model that produced the policy prescriptions, it is easy to ensure that policy considerations are evaluated on a regular basis.

Increased Use of System Dynamics Models

To increase the use of system dynamics models in corporate decision-making, Pugh-Roberts Associates, Inc. is evolving an approach to corporate planning and a philosophy of constructing models which injects the right kind of information into the planning process on a regular basis. The approach and philosophy are particularly suited to the development of three-to-five-year business plans.

As an aside, I should point out some other approaches which have been designed to increase the permanence of policy change. The first of these is the concept of a formal decision rule, designed using the model, which controls budget and resource allocations in lieu of decision-makers. However, except in the case of repetitive inventory reordering and production-level decisions, formal decision rules are impractical: price change and capital investment decisions are too discrete and too important to be left to formal rules.

A second approach is to alter the reward structure so that the desired policy occurs naturally. This approach serves as a useful complement, but alone does not have the potential for producing consistent results because of the uncertainty of human responses.

Our approach to corporate planning entails a process called "strategy management" in which the analysis which led to the policy

recommendations is reviewed on an annual or more frequent basis. As conditions change, the recommendations can easily be updated. Moreover, a comparison of actual company performance to that projected by the model can serve to forewarn of these changing conditions, or of structural changes, errors, or omissions which might warrant a revision of the model.

The philosophy of constructing models states that the models must have enough detail to impact on the development of detailed corporate plans. Although dynamic behavior may be adequately captured by a simple model, our experience with a number of corporations indicates that detail is useful in initial acceptance of the model, and useful -- if not necessary -- in achieving continued use of the model.

This paper will discuss the type of detail we have found to be most useful, drawing on examples from our experience. The paper also will discuss a model-building strategy which facilitates the development of detailed models by assuring that the model captures the essential feedback structure, and that it minimizes the risk of developing a model with excessive detail.

STRATEGY MANAGEMENT

Strategy management is a process of constructing and implementing system dynamics models. A brief overview is given below; a more detailed description can be found elsewhere. [3]

The overall strategy management process can be divided into three components: analysis, planning, and control. Analysis denotes the iterative structuring, testing, and refinement of an organization's understanding of its strategic problems and the options open to it; planning denotes the evaluation, selection, and implementation of one of these options; and control denotes the regular and systematic monitoring of performance, and effectively feeding back into other components of the strategy management process the successes, problems, threats, opportunities, experiences, and lessons learned.

Feedback is essential for effective strategy management. Obtaining information about aspects of organizational performance is the essential input to problem structuring and diagnosis. As strategies are implemented and additional information becomes available, the definition and diagnosis of strategic problems may well change. In planning, feedbacks from the control component are also critical. Evaluation of alternative strategies depends not only on the projected accomplishment of organizational goals, but also on the realities of current performance. The existing strategy and goals are subject to refinement as required, based on the successes and problems encountered, and in response to changing conditions.

A system dynamics model plays an important role in all three components of the process. First, the process of developing a model can contribute substantially to one's structuring and understanding of

problems. Once the model exists, assumptions can be varied in a series of simulation experiments to reveal which are really sensitive, thereby highlighting areas of business risk or areas where policy leverage exists.

Other forms of testing reveal the consistency between a model at any stage of its development and actual historical information about the organization. Inconsistencies reveal where the model is wrong, and contribute directly to the refinement of problem diagnosis.

Simulation experiments can be used to explore the performance of alternative strategies under various future scenarios. Different scenarios can be tested regarding competitors' strategies, government policies, economic conditions, social trends, and other important external factors. This is critical to the evaluation of possible strategies in an uncertain business environment.

The final role of the model in strategy management is the one which assures its continued impact. On a regular basis, and in conjunction with the development of business plans, the actual company performance should be compared to forecasted performance. Discrepancies should be traced back either to incorrect assumptions about the environment or to errors in the model's structure. If incorrect environmental assumptions were the cause, a reassessment of the assumptions must be made. If the assessment indicates a permanent change in the environment, the strategy may need to be refined. In the case of structural errors, a reassessment of alternative strategies is warranted. At the end of this evaluation is another projection of corporate performance, to be used in subsequent control phases.

PHILOSOPHY OF CONSTRUCTING MODELS

The philosophy of constructing models requires that the models be sufficiently detailed in order to have significant impact on three-to-five-year business plans. Since these plans generally consist of detailed resource acquisition and allocation decisions, the model must contain:

1. A level of structural detail that corresponds to the major subdivisions of the company;
2. A financial sector that accurately estimates the profitability of alternative strategies and produces output at a level consistent with business plan financial reports;
3. A level of accuracy that gives output directly comparable to company data; and
4. Output to which managers can easily relate, including summary reports of key performance measures and detailed financial statements.

Each of these is discussed below in greater detail.

Level of Structural Detail

The level of structural detail in the model should correspond to the major components of the company or division. This may require disaggregation by profit center, product line, and/or production stage, even where such disaggregation would not be warranted purely for reasons of understanding behavior and designing policies. It is warranted since the model produces output that corresponds more closely to the conceptual models of managers and the company's numerical data bases, making it easier for them to evaluate structural and parametric assumptions. The model also produces output which corresponds to the level of detail in business plans (i.e., by product line, profit center, production stage). Let us illustrate with some examples.

(1) Technical Services Company. Several years ago, we conducted an analysis of growth strategies for a division of a major technical services company. In its basic feedback structure, the model has many characteristics of Forrester's classic "Market Growth as Influenced by Capital Investment". [2] The analysis was successful and led to policy recommendations for capital investment, sales force growth, and pricing -- all of which were largely adopted.

Nevertheless, the model was not particularly detailed. It did not, for example, distinguish between the division's two major product lines, nor between the three major stages of production. As a result, when one year after the end of the study the division decided to become more sophisticated in its planning by developing a five-year business plan, the issue of the model's role arose. The division concluded that the model had no real role in their new plan because it was not detailed enough. Fortunately, it was decided to disaggregate the model so that it had the necessary detail. Unfortunately, the effort to disaggregate was begun too late to have any impact on the development of that particular plan. In addition, several decisions were made in conjunction with that plan which were inconsistent with the orginal policy recommendations (our key contact and supporter was temporarily on another assignment).

In summary, the lack of sufficient detail prevented the model from being used in the client's new business plan, and thus its input to several key decisions was prevented. We anticipate that future plans however, will use the model's input.

(2) Insurance Company No. 1. We recently concluded a major effort which enabled an insurance company to develop a new marketing strategy. In

this model, the major product lines and profit centers were disaggregated. The disaggregation was done partly for dynamic reasons -- the product lines had different competitive positions, commission structures, and cost-bearing capacities (so that changes in sales mix affected the company's ability to grow, which in turn affected commissions, and further altered sales mix). In reality, however, the major impact of the disaggregation was to provide more detailed and more accurate information with which to evaluate alternative strategies.

As in the services company model, this effort had substantial impact on strategy management immediately following completion of the project. In contrast to the earlier effort, however, when one year later the company wanted to develop a five-year plan, this model had sufficient detail and was used in the plan development.

(3) Electric Utility Model. Several years ago, we constructed a strategic planning model for a public utility. In contrast to our normal consulting work, our objective here was only to construct a model and then to turn it over to the client for their own use, rather than to analyze alternative strategies for them. Therefore, I cannot say much about its use other than that I know it has been used to perform specific analyses, and that the utility continues to train personnel in system dynamics.

The distinguishing aspect of this model was that it represented the initiation and completion of new capacity, and the granting of rates as discrete events. Early versions of the model followed our more traditional approach, in which these elements were represented as continuous processes (using third-order delays). This approach was unacceptable, however, because the output did not look right -- capacity increased in steps, not continuously; profitability fluctuated widely, jumping with the granting of

higher rates, then falling until the next rate case, rather than floating around some average level. Even though we argued that this discreteness would not influence the relative performance of alternative strategies, we complied in order to gain acceptance of the model.

(4) Insurance Company No. 2. This example illustrates again the need to add detail to gain management acceptance. In this company, salesmen were classified into five categories, according to length of service and level. For simplification, our initial formulation of the model lumped two of these categories together (with their concurrence). However, when it came time to parameterize the effects of commissions, opportunities for advancement, and other factors on the turnover of each category, they insisted that the two categories needed to be separated because the effects were different for each. Adding this level of detail in mid-stream proved to be a considerable effort, even though it had no impact on model behavior.

Financial Sector Detail

The financial sector of a model should be particularly detailed. Not only do corporate plans tend to be detailed in this regard, but bottom-line results are extremely important in evaluating policy options. The model must, therefore, accurately reflect the nature of cost and revenue relationships, and how they change with the size or scope of the company. Also, the phasing of cash flows can be particularly important.

Detail in the financial sector was the crucial factor in determining the usefulness of the first insurance company model mentioned above. This effort highlighted the need to accurately reflect cost and revenue relationships, particularly the way in which they change with

company size. Initial output of the model, from a relatively simple financial sector as compared to what we ended up with, showed little bottom-line difference among alternative strategies. We concluded that this was because too many costs were assumed to be variable with the volume of business. Then we went too far in the other direction -- alternative strategies showed unbelievable differences because too many costs were assumed to be fixed. In order to reduce the sensitivity of results to this assumption -- and to add some credibility to the results -- we had to disaggregate expenses sufficiently to be able to accurately estimate their true variability with the volume of business.

In the case of the second insurance company mentioned above, the cash flow was so important to company viability that we needed to estimate not only the magnitude, but also the timing of different cash flows under alternative strategies.

Model Accuracy

Model detail alone is not sufficient for providing a useful input to the development of business plans. Model output must also correspond to actual company data over the historical period -- within $\pm 10\%$ over the entire period with even better accuracy in recent years. Otherwise, model projections are useless for planning resource acquisitions, allocations, and financial plans.

Model Output

It has become increasingly clear to me that once the modeling effort has progressed past the debugging and tuning stages, plotted output becomes less important to corporate managers. Rather, they tend to focus

on a number of key performance measures in a specific year or years. Comparative plots of these measures from different strategies are useful, but in addition to them we have begun to make use of what we call Summary Reports of key performance measures.

Table 1 provides an example of one such report (this output is produced by DYNAMO with a little help from Bill Silverman). It compares the 1985 and 1990 performance of the "Base Case" to that of the "1/80 Strategy" along a number of performance dimensions. The Base Case represents a projection of company performance, assuming a continuation of present trends, and a most-likely set of assumptions about the environment. It provides a benchmark against which to evaluate the results of alternative strategies or scenarios. The percentage change of 1990 "1/80 Strategy" to Base Case Total Sales and Total Operating Earnings are given at the far right; 1990 sales, agent compensation, and operating earnings in 1979 dollars are also given.

In addition to these Summary Reports, effective use of system dynamics model requires that they produce traditional balance sheet and income statement output. We are presently working on these capabilities.

FIGURE 3.10 COMPARISON OF 1/80 STRATEGY TO BASE CASE

			BASE				PERCENT	1990
		1979	1985	1990	1985	1990	CHANGE	DSCNTED
SALES:	TOTAL		252.0M	430.0M	360.4M	584.2M	1.359	244.2M
	PRD 1		71.00M	114.0M	73.18M	119.6M		
	PRD 2		76.00M	126.0M	76.78M	129.3M		
	PRD 3		105.0M	191.0M	210.5M	335.4M		
CAREER	AGENT PRDTVTY	27.90T	41.50T	61.60T	49.60T	86.01T		
BRKRAGE	PRODCER PRDTVTY	5700.	9170.	13.70T	9051.	13.46T		
CAREER	MID MGR PRDTVTY	256.3T	474.6T	700.8T	573.2T	992.2T		
BRKRAGE	MID MGR PRDTVTY	283.6T	490.4T	737.9T	483.9T	730.6T		
CAREER	AGENTS	1800.	2032.	2237.	1775.	1779.		
BRKRAGE	PRDCERS	13.00T	16.00T	18.70T	16.02T	18.81T		
AVERAGE	AGENT COMPENS	10.75T	16.33T	23.30T	19.43T	32.34T		13.52T
CAREER	MID MGR COMPENS	25.50T	42.00T	61.30T	34.01T	58.24T		
BRKRAGE	MID MGR COMPENS	24.60T	43.50T	64.50T	28.71T	42.89T		
CAREER	MORALE	.90	.92	.94	.89	.96		
OPERAT.	EARNNGS TOTAL		81.00M	115.0M	88.26M	139.3M	1.211	58.22M
	PRD 1		57.00M	71.00M	56.29M	73.78M		
	PRD 2		8000.T	14.00M	7398.T	13.68M		
	PRD 3		17.00M	30.00M	24.57M	51.84M		
EARNNGS	ON PREMIUM		.090	.079	.082	.072		
MRKTING	UNIT COSTS	.49	.41	.39	.28	.28		
RATIO STNDRD	ACT TO EXPENSE	1.070	1.050	1.060	.9195	.944		

MODELING PROCESS

The effort to make models sufficiently detailed so they can impact on business plans raises the risk of building models with excessive detail. Not only are these models costly, but they tend to obscure the essential feedback structure and render communication with management difficult. To reduce the potential for excessive detail, we have developed an approach to model construction which is iterative, uses building blocks and modules, and entails significant management involvement.

On all large modeling projects, we now develop the final model in two or three distinct phases. During the first phase, a relatively simple model which captures the essential feedback strcture is built, tuned to give rough historical fit, and some preliminary policy analyses conducted. Development of this model allows us to learn enough about the situation to ensure that the right kind of detail is put into the Phase II model. It also allows us to "educate" management about system dynamics modeling, and about the essential feedback structure which is at the root of their problems. During the second phase, we develop the detailed model and perform an extensive series of policy and scenario analyses. Sometimes we plan a formal third phase in which we make refinements to the model and additional policy experiments.

To facilitate the detailed modeling, we often make use of building blocks or modules which can easily be replicated using DYNAMO III to represent different product lines, production stages, or even finer categories.

Finally, our approach entails significant management involvement at all stages of model construction by means of a project Task Force. Causal

hypotheses, key parametric assumptions, model output, and policy results are all reviewed by the Task Force. This not only assures that the model produces results useful to management, but also builds management confidence and commitment to the results.

SUMMARY

System dynamics models have not had the continuing impact on corporate decision-making that they are capable of providing because, historically, the models have been neither sufficiently detailed nor accurate enough to support three-to-five-year business plans, despite the many significant corporate decisions made in the preparation of such plans.

To increase long-term implementation of system dynamics models, Pugh-Roberts Associates, Inc. is evolving an approach to use, construct, and develop models which inject the appropriate kinds of information into the planning process on a regular basis. This approach -- strategy management -- entails the construction of detailed models with high historical accuracy, and an iterative approach to development involving a company management Task Force.

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