

## CORPORATE STRATEGIC THINKING: THE ROLE OF SYSTEM DYNAMICS

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### Introduction

System Dynamics began thirty years ago as a bold attempt to apply engineering analysis concepts to *business* systems. But from the late 1960s onward, most System Dynamics research focused on public policy problems. Business applications have grown steadily, though less visibly and primarily outside academia. For example, over the past twenty-five years, Pugh-Roberts Associates has completed hundreds of management consulting assignments using System Dynamics for clients in the financial services, aerospace, electronics, telecommunications, computer, chemical, shipbuilding, transportation, electric power, energy, and natural resources industries. Some of the best-known, most successful businesses throughout the world have used System Dynamics.

Despite this substantial base of experience, very little has been said about *how business organizations actually use System Dynamics*, or why they use it, and what value they obtain. These important questions bear on the practice, technology, teaching, and even the definition of System Dynamics. With the recent emphasis in System Dynamics research on management decision-making, systematic thinking, organizational development, and related topics, it is essential that such questions be addressed in a practical, "real world" manner.

We shall discuss how businesses use System Dynamics, in the context of our sixteen years of professional collaboration as consultant and client. Over that time period, we have worked together on five major business applications of System Dynamics. Those assignments gave rise to a series of publications regarding the issues we analyzed, our working relationship, the problems of implementing strategy changes, and a client's view of the modeling process. This paper is both a synthesis and an update. It contains a series of general observations, illustrated by a recent "case study," on:

- \* Why do businesses use System Dynamics?
- \* How does the model fit into Pugh-Roberts Associates' consulting process?
- \* What types of models do business clients want, and why?
- \* How do managers come to accept results from our projects, and what is the model's role in this process?

- \* Why is System Dynamics not more broadly used by business organizations?
- \* What can the field of System Dynamics do to increase its success and influence in the business world?

What follows is, clearly, personal opinion. Having said this, we hasten to add that these opinions were shaped in an intensely competitive and pragmatic marketplace for methodologies, consulting services, and solutions to business problems. Take heed you people up in the ivory towers. You may not like what we are going to say, but ignore it at your peril.

### Why Do Businesses Use System Dynamics?

On occasion we are asked by colleagues "How do you convince real world business organizations that System Dynamics is a useful methodology?" The short answer is that we do not even try. In general, business people are highly results-oriented. They are not interested in methodologies *per se*; they are looking for solutions to problems.

Pugh-Roberts Associates' marketing materials do not mention System Dynamics. We are not, respectively, selling and buying methodology. Instead, clients buy a much more defined professional service or system product, e.g., business strategy advice, market analysis, project management systems, management training systems. Each of these services and systems is based on a combination of simulation modeling, industry and problem expertise, and a distinctive process of working with clients. In other words, System Dynamics is part of a larger package. Very few clients think of themselves as "using System Dynamics."

It is the problem-focused services and systems that appeal to most business organizations. They are not presented to a prospective client in methodological terms, but rather in terms of how they were used by other comparable organizations. For example, the types of problems which have been addressed and the results achieved. This approach has two virtues:

- \* The examples demonstrate the relevance of the service or system to various business problems; and
- \* They also establish credibility by showing that many well-respected businesses have used the service or system.

Business organizations decide to work with Pugh-Roberts Associates because they are convinced that the service or system can help them to deal with an important problem. They need to have confidence that a substantial payoff will be obtained in return for the time, effort, and money invested. Such confidence may come from a successful prior working relationship. Otherwise, the client must be impressed with the consultant's references and "track record."

We shall use our case study to illuminate this decision process. In 1986, Aetna International's Chilean subsidiary faced a particularly complex strategic situation. One might think of it as the "General Motors problem." Specifically, the Aetna subsidiary was operating in a market where there were a few large competitors (including themselves) with a combined share of about 75%, plus a number of much smaller companies. For political reasons, Aetna neither wanted to significantly increase its

market share nor to see many of the smaller companies squeezed out. At the same time, Aetna wanted to protect its market position, upgrade its products and customer service, adapt to major changes in government regulations, and achieve satisfactory profits.

Easier said than done! How does a financially strong market leader improve its products and service without triggering a competitive war that leaves the smaller companies as casualties? How do you avoid the costly game of salesmen "churning" customers from one company to another, thereby ruining profitability and, in the longer-term, the quality of service? How should management behave under new regulations which aim to make the market much more competitive? In a situation where the risks, pressures, and opportunities for serious mistakes were great, local Aetna managers had to formulate a business strategy that the boss at headquarters would accept.

Aetna decided to involve Pugh-Roberts Associates in this situation because of their prior experience with the firm and its approach. It is important to realize that good things spread by word of mouth in the business community. Based on this past experience, it was apparent to Aetna that:

- \* They were dealing with a complex system where all of the key variables were in feedback loops; and
- \* Mental models often are unable to deal with the composite result of such systems, even though they are accurate enough in defining one-on-one relationships between any two variables.

In other words, Aetna's decision was purely *pragmatic*. They knew from past experience that a System Dynamics approach would be more useful in this case than a "most likely scenario" in a fixed model. System Dynamics had worked before in similar situations.

### How Do Models Fit into the Consulting Process?

Management consulting is a combination of objective analysis, expert advice, and facilitation. Pugh-Roberts Associates has created a distinctive approach to management consulting which relies on the development and use of System Dynamics models. These models play important roles in all three aspects of the consulting process.

Simulation has proven to be an extremely effective aid to both strategy formulation and implementation. First, the model imposes a strong intellectual discipline on the process: assumptions must be explicit; alternative assumptions can be tested and validated; projections are the clear result of the assumptions used; and the model provides an explicit picture of how the business works. The effect is to "rigorize" how managers think about their business.

In addition, the model permits a more thorough evaluation of strategic alternatives: various goals can be tested for consistency, feasibility, and adverse side-effects; many permutations and combinations of strategy elements can be analyzed; and a wide range of scenarios for competitive, economic, and regulatory factors can be examined.

Perhaps most important, the consultants work very closely with a team of managers in each client organization to develop and use these models. This collaborative relationship produces a high level of understanding, confidence, and commitment within the management team. The approach provides a mechanism for management

participation. It stimulates discussion of strategy issues and consideration of alternative ideas. The model becomes a framework for achieving agreement about assumptions, for resolving conflicts, and for negotiating a strategy that all team members can accept. Thus, this process is a valuable form of management development.

The model provides the focus of the project, while the consultants act as facilitators. The model is *of the system that has the problem that the project is all about*. It organizes thought and discussion in a rigorous way. What things are important? How do they relate? These are defined in terms managers can understand. System Dynamics consultants are good at quantifying intangible variables, something managers are loathe to do themselves but which they readily accept when consultants do it for them.

By comparison, traditional corporate strategic thinking involves neither the rigor nor the thoroughness of the model-based process. Managers brainstorm a problems until someone comes up with a proposed solution that makes sense and resists challenge. Then the numbers are tested under "most likely conditions" in a fixed (i.e., non-dynamic) model, with a few upside/downside tests as a sensitivity check.

Returning to our case study, in the summer of 1986 a project team was established consisting of the six senior managers of the Aetna subsidiary, the authors, and two other consultants from Pugh-Roberts Associates. The subsidiary's President was team leader. The first step was to expand the list of issues to be addressed by the project (a preliminary list formed the basis for the consulting agreement between Aetna and Pugh-Roberts Associates). It is crucial that the modeling process be focused sharply on an agreed upon agenda of high-priority management problems. We believe that successful projects of this type always *model problems*.

The issue list guided model design and development. It indicated the factors and relationships which should be in the model, the appropriate level of detail, and standards of model performance. The consultants prepared an initial model design over a period of about one month, drawing heavily on Pugh-Roberts Associates' prior work for the financial services industry. The model represented market development, competitive dynamics, market shares, salesforce growth, pricing, service levels, payment of benefits to customers, and company finances.

This initial design was reviewed thoroughly by the project team. The team agreed on many changes. Some changes resulted from the local managers' in-depth knowledge of their business; others, from further refinements to the issues list; and still others from a discussion of the various ways current and future regulations might impact this market. The improved model design provided a clear indication of priorities for information gathering. The local Aetna managers took responsibility for assembling the required company, competitor, and market data. We also conducted a round of interviews with industry leaders, present and former government officials, and academic experts.

Over the following two months, the consultants developed a working computer model. The process of programming this model and estimating its parameters led to additional changes to its design. Those design changes, the key cause-effect relationships, the assumptions (e.g., about macro-economic conditions, regulatory changes, competitors' policies) inputted to the model, and the model's behavior were carefully examined by the project team. The discussion was very spirited, with much give and take. It drew out some important differences in views. By the end of that meeting, the team agreed on a series of high-priority model refinements, assumptions for a "Base Case" future projection, and some initial tests to perform with the model.

The next team meeting (about a month later) involved a further review of the model, plus the results of various simulations. Some interesting preliminary conclusions began to emerge. For example, it became evident that a "service emphasis" strategy substantially outperformed one based on price and salesforce growth, and that certain regulatory changes actually worked against customer interests. It then was possible to

return to the issues list and say that certain questions seemed most important. These became the focus of the subsequent round of analyses. Several team members requested that specific tests be performed with the model.

The final team meeting was a detailed discussion of simulation results and the business strategy conclusions to be drawn from them. Numerous strategy elements had been tested individually and in various combinations. Promising strategies had then been tested under alternative scenarios for economic and competitive conditions, and regulatory changes. Once again, there was a large amount of discussion.

Some of the conclusions were unexpected, and were counter to the *a priori* feelings shared by the Aetna managers. Most important, it was clear that Aetna should worry less about being "too big" and "too profitable," and instead become more aggressive. Yet no one rejected those conclusions. As we shall discuss below, the modeling process prepared the team for this situation. The model provided an intellectual framework for explaining, understanding, challenging, and ultimately accepting some startling ideas.

### What Types of Models Do Business Clients Want?

As we have discussed, business managers generally view a model as a means toward problem solving, not an end in itself. Thus, it should not be surprising that these clients have a very pragmatic view of what constitutes an "adequate model." The basic requirements are that the model addresses their problem in a useful way, and that they can have confidence in the results.

The type of model a business client wants depends on the focus and objectives of our work. For example, a model to support business strategy development often is both broader and more aggregated than a model for market analysis. The latter typically represents multiple categories of products, customers, and suppliers; multiple stages or channels of distribution; and multiple inter-acting sub-markets (e.g., new and used aircraft).

Despite such differences in model content and complexity, business organizations have quite similar concepts of "adequacy." They want models that are:

- \* realistic, i.e., they produce historically accurate numbers and behavior;
- \* recognizable, i.e., variables and relationships are familiar, not too abstract;
- \* reliable, i.e., the model has been carefully reviewed and tested, is sound and can be taken seriously; and
- \* relevant, i.e., the level of detail and focus are appropriate for the issues and decisions being considered.

These concepts are inter-related. For example, a numerically realistic model can be evaluated in terms of its ability to recreate historical time series data. This evaluation often reveals weaknesses in the model, which then can be corrected. A recognizable model is easily reviewed, critiqued, and refined by the client, thereby ensuring that the client's expert knowledge is fully and faithfully incorporated in the model. Hence, both realism and recognizability facilitate processes which contribute to a model's reliability.

For the business manager, "model adequacy" is achieved when the model reasonably reproduces the past and generates projections which can be explained rationally. They do not expect models to pass exacting statistical tests. If the shapes and magnitudes of the curves are about right, managers usually are happy.

Business clients are most comfortable with models that are easily compared with the "real world" as they know it, and which produce results that are easily translated into decisions and actions. Our case study model illustrates this point. It focused on the determinants of Aetna's market share and profitability, representing for Aetna and its competitors:

- \* the growth, experience, productivity, and time allocation of the sales force;
- \* pricing;
- \* service levels;
- \* sales;
- \* customers, and the benefit liabilities associated with them;
- \* loss of customers to competitors;
- \* premium revenues received;
- \* payment of benefits;
- \* marketing, administrative, and other costs;
- \* investment performance;
- \* assets and reserves; and
- \* various measures of financial performance.

The business environment was represented in terms of overall market size and growth, macro-economic factors, and government regulations.

This model produced as outputs many of the variables required for the subsidiary's five year plan, for example, staffing levels, various income statement and balance sheet items, investment requirements, dividends to the parent corporation, and, of course, market share. In general, the model results were understandable and actionable in a straightforward, practical way.

### How Do Managers Come to Accept the Results?

As, respectively, a professional management consultant and a business executive who buys consulting services, we both operate in a marketplace where *value for money* is expected. Specifically, clients are not patrons; they are customers. They should obtain a very significant return on their investments in consulting services. This is a shared responsibility. Neither consultant nor client can ensure that value is obtained without the assistance and support of the other. They must work together in a way that:

- \* Produces results which are both technically

sound, and sensible from a practical business point of view;

- \* Develops among managers a shared understanding of, confidence in, and commitment to these results; and
- \* Transfers to the client the capability to use the model on which the work is based.

The question above implies a situation wherein a model is developed, analyses are performed, various business strategy conclusions are reached, and *then* the consultants somehow convince their client that the results are sound. All of the System Dynamics literature on implementation dismisses this sequential process as ineffective and unlikely to lead to significant change. The basic message from those papers is that implementation must be considered in the initial design of a modeling project (e.g., the project's focus and objectives, who is involved, the roles of the participants) and at every stage along the way to completion.

We described earlier how Pugh-Roberts Associates' consultants work very closely with a team of managers from a client organization. This team includes managers who "own the problem," that is, they are responsible for the strategy issue, market, program, or training requirement which is the focus of the assignment. The team also includes one or two people who are designated to be the actual model users.

Involvement of client *managers* (not just the planning staff) in every phase of a modeling project is essential! The realism and validity of a simulation model depends on numerous information inputs from knowledgeable managers, and on their detailed evaluation of model structure and behavior. Without this in-depth involvement, clients will view the model as a "black box," and the results as the consultant's rather than their own.

Acceptance of results does not happen at the end. It arises from the overall process we follow. This participative process builds the required client understanding, confidence, and commitment. The model itself is an essential part of the process. The model facilitates agreement about assumptions, behavior, and conclusions. It allows clients to investigate and confirm surprising results.

As managers gain experience and sophistication with System Dynamics models, they realize that what is really important is to identify significant *directional* changes, particularly those which are counter-intuitive. If they can be explained in terms of management's underlying assumptions, the model has justified its cost.

In our case study example, some quite unexpected results were produced. Going in to this project, Aetna managers had strongly held views that their strategy should be fundamentally *defensive*. That is, Aetna should not seek any greater market share and should bend over backwards to avoid being too aggressive, especially towards its smaller competitors. Our project showed that such a strategy would lead to a steady decline in Aetna's market share and profits.

Specifically, our analyses showed that Aetna should:

- \* Aggressively go for market share;
- \* Expect to have a large and growing sales force, both to get new customers and protect against "poaching" by competitors; and
- \* Try to shift the basis of competition from selling effort and price to service.

Aetna managers were surprised by the results. They had been so concerned about the political fallout if they took an aggressive stance and gained market share, it never occurred to them that the biggest risk was *losing market share*. The Chileans had wanted to follow such a strategy, but previously believed it was unacceptable because of political risks.

While these results were surprising, it was possible for the team to delve into the model to see exactly how they arose. For example, it became evident that you could not "tread water" in a market where many competitors were aggressively seeking to increase their shares at your expense. You either fought or died.

It also became clear in analyzing these results that some of the views of the government agency responsible for regulating the market were naive. The agency had not recognized the possibility of a highly competitive, but inefficient market, i.e., where a large fraction of sales effort went to getting customers to transfer from one company to another, with this "churning" producing higher costs for everyone. Once again, it was possible to trace through the model's structure and the simulations to see what lay behind these results. The model helped the team to formulate arguments for explaining this counter-intuitive finding and a set of specific ideas for changing the regulations to reduce such problems.

Through their participation in its design, parameterization, testing, refinement, and use, the team acquired a conceptual and technical fluency with the model. They became increasingly quick to understand the model's behavior and confident in the conclusions being drawn. In fact, following Pugh-Roberts Associates' assignment the local Aetna managers have continued, *on their own*, to refine and use the model.

### Why isn't System Dynamics More Broadly Used by Businesses?

We warned you that some people might not like what we were going to say. Well, damn the torpedoes; full speed ahead!

The main obstacle to greater use of System Dynamics by business organizations is that for more than twenty years the field turned its back on business. From the late 1960s onward, the visible focus of System Dynamics and the research of its academic leaders concerned major public policy issues. This is where the excitement was. There was a concurrent de-emphasis of business issues and applications within the field. These developments led to an adverse stereotyping of System Dynamics. Over and over again, we have heard: "System Dynamics is only suitable for analyzing broad public problems over a period of decades or even centuries;" and "System Dynamics is anti-business."

Moreover, a perverse feedback turned perception into reality. The reputation of the field attracted people who were concerned with public policy questions; people who had little knowledge of business and no interest in business problems. The field of System Dynamics became increasingly ideological. For many, System Dynamics was more than a methodology. It was a *movement* of people out to change the world.

Along the way, System Dynamics lost the pragmatic value set which characterized the first ten years. There were passionate debates over what constituted "good practice," and in some quarters a feeling that non-conformists should either mend their ways or be cast out. In short, there has been too much emphasis on methodology for its own sake and not enough on *problem solving*.

All of this is, in a word, *off-putting* to the business world. As we repeatedly emphasized, businesses are looking for solutions to their problems. They are not especially interested in methodologies, *per se*, and are highly suspicious of ideologies



out to change the world. Business organizations want help from competent professionals, experienced in business problem solving, who know their situation and "speak their language."

Adding insult to injury has been a chronic shortage of competent System Dynamics practitioners. If you subtract from the population of System Dynamicists those who have no interest in business problems and, from the remainder, those who lack a reasonable level of expertise, the result is amazingly small. It is quite difficult for a business organization seeking to build a System Dynamics capability to hire even one competent business-oriented practitioner. Pugh-Roberts Associates regularly recruits bright engineers and trains them in System Dynamics and professional consulting skills. Such training probably is not possible in other firms.

Yet despite the obstacles business applications of System Dynamics are growing steadily. Most of these applications have been undertaken by private consultants and business-based practitioners. We are delighted to see the resurgence of interest among our friends in academia.

### How can the Field be More Successful in the Business World?

For System Dynamics to have more success and influence in the business world, the field must change its image and attract more people who are interested in business problems. The feedback that shaped the field over the past twenty years must work in a different way.

Basically, System Dynamics needs to join the mainstream of business education. System Dynamics has been too much of a field apart. At present, it is unlikely that top business students would be attracted to System Dynamics. This must change.

Business-focused courses, texts, and exercises are badly needed. They should be relevant, challenging, and exciting for business-oriented students. They should show how System Dynamics deals with the richness and complexity of real business problems, rather than trivializing them. It is time for the field to accept that business students are not interested in reindeer and flu epidemics. They want to hear about market shares, profits, and stock prices.

Two examples will illustrate what we mean. Dr. James M. Lyneis's Corporate Planning and Policy Design -- A System Dynamics Approach stands apart as the best, and perhaps only, business-relevant book in the field. Managers can easily appreciate how the model and analysis approach presented in this book relate to their business problems. And Professor John Sterman's "Peoples Express Game" is a winner. It has demonstrated an ability to excite business students and teach important lessons about management. More published case studies are needed to spread the word about the types of business problems System Dynamics can address.

Most important, the field of System Dynamics should view business students -- whether young MBA candidates or experienced managers returning to school -- as *client*. You should expect and accept their pragmatic values. This means de-emphasizing abstract issues of methodology and presenting System Dynamics as a problem solving tool in the context of important business situations, e.g., competitive positioning, new product development, growth strategy, large-scale project management, dispute resolution.

And don't forget the crucial notion of "value for money." As we indicated earlier, System Dynamics exists in a competitive marketplace of methodologies and solutions to business problems. Why should a business school student invest some of his or her

precious time in System Dynamics courses? What is the return? Right now, the field does not have persuasive answers to these questions. It's time we did.

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