WHAT IS AN ADEQUATE MODEL?

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ABSTRACT

Much of the literature on model evaluation focuses on what amount to absolute measures, that are independent of the context in which a particular model is used. This paper argues in favor of situation-dependent measures. Whether or not a model is "good enough" depends on the job it is being asked to do and the mind set of the people who must use the results. The relationships between model adequacy and successful implementation of model-based recommendations are discussed. While rejecting the classical paradigm, the author emphasizes model realism and historical accuracy as important determinants of implementation. The life of a model involves many evaluations of whether it is "worth the costs", "believable", "useful", and "right". Issues surrounding these judgements are explored. How differences in circumstances can lead to different, but in each case quite adequate, models is illustrated by contrasting two models developed five years apart for the same organization. The paper concludes that successful models are persuasive, not simply to modeling technicians but to high-level decision makers.

I. INTRODUCTION

The question "What is an adequate model?" is important to modeling professionals and their clients. Throughout the selling, development, and use of any model, both the idea of modeling and the specific product repeatedly are evaluated in terms of: "is it useful"; "can we believe it"; "is it worth the costs". Models have to payoff, in order to build and sustain an organization's commitment to modeling.

Moreover, there is lack of agreement on this question among modeling professionals. Some say a "valid" model is one which very accurately conforms with historical time series. Others argue that the ability to reproduce "reference modes" of behavior is key. There is a "consumerist" school, which says that a good model is one that a user will accept. Still others maintain that the acid test of any model is whether or not its predictions come true. Hence, established wisdom does not provide clear answers.

Nor does one usually have the luxury to find the answers through trial and error. The professional model builder operates within a tight set of constraints. Perhaps the most obvious of these are schedules and budgets, but equally important are the attitudes of the client: initial expectations; patience while waiting for results; confidence in the model builder and his technical approach. While there certainly is latitude for "mid-course corrections", producing an adequate model within the usual

time, financial, and relationship constraints requires good economy of motion and a sense for the jugular. In other words, the professional model builder's a priori judgement regarding what constitutes an adequate model (i.e., at the outset of an assignment) must be approximately on target.

One is faced with a choice between two fundamentally different views of the world. The traditions of classical statistics emphasize what amount to absolute measures of model adequacy.[1] While they differ in their technical details, all of these measures indicate the correlation between simulated and historical values of model variables. The dual messages of this paradigm are: (1) the correlation measures are to be maximized; and (2) there is a threshold of significance for these measures below which a model lacks "validity". The resulting philosophy of model building and evaluation relies on concepts of adequacy that are independent of the context in which a particular model is used. This is what I mean by "absolute" standards or measures. In essence, the methodology determines the product.

The field of decision theory offers an alternative view.[2] The concept of the "value of information to a decision maker", applied to the evaluation of models, leads to situation-dependent assessments of adequacy. The basic ideas of the paradigm are: (1) decision situations differ; (2) the specifics of a decision situation determine its sensitivity to the quality of information available to the decision maker; (3) one can quantify the value to the decision maker of having "better" information (e.g.,

additional and/or more accurate inputs); and (4) beyond some point, diminishing returns argue against continued investment in the quality of decision inputs. With this approach, the context determines the product.

I have concluded from nearly twenty years as a professional model builder and management consultant that the first paradigm -- absolute measures of model adequacy -- is narrow, rigid, and misleading. Whether or not a model is "good enough" depends on the job it is being asked to do and the mind set of the people who must use the results. In other words, an adequate model is the right tool for the job at hand.

This paper argues in favor of situation-dependent measures. In Chapter II, the concept of model adequacy and model implementation are interrelated. While rejecting the restrictive classical paradigm, the paper in fact emphasizes "realism" and "validity" as important determinants of implementation. Chapter III makes the case for situation-dependent criteria of model adequacy. Both results-oriented considerations and technical arguments are presented. Then, a number of factors which define "the right tool" for a given job are discussed.

In Chapter IV, the ideas of situation-dependent model evaluation are illustrated by contrasting two conceptually similar models that were developed under quite different circumstances. How different circumstances call for different -- but, in both cases, adequate -- models is shown via a pair of models developed five years apart for the same organization. Chapter V concludes

that successful models are persuasive, not simply to modeling technicians but to high-level decision makers.

II. MODEL ADEQUACY AND IMPLEMENTATION

A. How These Two Concepts Interrelate

The professional model builder must establish and maintain a good track record for "success". A private corporation that hires a consultant generally expects results of immediate value which can and will be implemented. In public policy analysis, too, projects that have a definite impact on people's thinking and actions are more valuable than those which don't. Implemented results are the key to client satisfaction.

I have a highly pragmatic definition of successful modeling: the tool is used; and the tool produces value many times its cost of development and use. Success in those terms is not only a matter of good business, but also of professional satisfaction, the credibility of our methods, and the field's ability to attract top people.

Working backward from this definition of success, there are several important tests that a model must meet in order to be "successful":

1. Are the costs of developing and using the model consistent with "what's at stake" in the decisions it is intended to support?
2. Do managers have sufficient confidence in the model to be willing to base important decisions on it?

3. Does the model "speak" to users at a level of specifity consistent with the managerial actions required to implement indicated decisions?

4. Are the decisions and outcomes indicated by the model correct?

These are recurring questions as a model is developed and used.

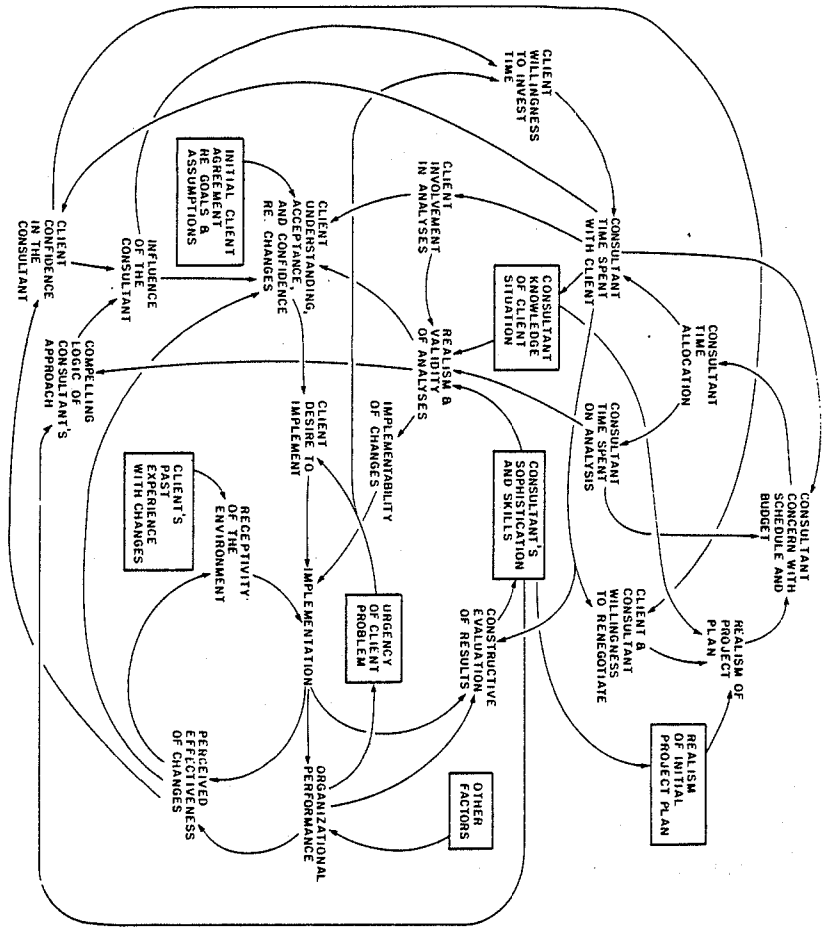
A model which is not "worth the costs" will not be built and/or used. A model which decision makers do not "believe in" wlll not be taken seriously. A model which does not produce "actionable results" will be labeled impractical or academic. And a model which, over a period of time, does not prove that "it is right" will be suspect. Unless a model passes all of these tests, it never will be built, used initially, and, then, institutionalized.

In very pratical terms, an adequate model is one that passes the four tests enumerated above. Hence, I believe that "success", "implementation", and "adequacy" are highly interrelated (though not synonymous) concepts. Specifically, model adequacy is an important cause of implementation success (or failure). This can be seen best within a comprehensive conceptual framework of the factors determining implementation.

B. The Role of Model Adequacy in Successful Implementation

Implementation success (or failure) is determined by a complex feedback system of relationships. Some of these relationships are shown in Exhibit 1.[3] This conceptualization re-

EXHIBIT 1 A CONCEPTUAL MODEL OF IMPLEMENTATION



flects my experience in corporate strategy consulting. For example, it assumes a defined client, who has substantial power to implement and some ability to evaluate the effectiveness of actions taken.

Roberts[4] and Weil[5] have argued that success occurs only when all of the essential ingredients are present:

1. The results of a project must, in fact, be implementable;
2. Those who will have to take action must have a clear desire to implement; and
3. The environment must be properly receptive.

These factors lie at the center of Exhibit 1.

In my experience, project results -- to be implementable -- must be sufficiently detailed that they can be acted upon within the client's established management system. By this I mean within their structure of managerial responsibilities, resource allocation and control processes, and corporate resources (e.g., personnel, facilities, technologies, customer relationships). Furthermore, if the recommended changes are too extreme, or too unconventional, or too inconsistent with the client's social/political structure, they do not have a high likelihood of being implemented.

The implementability of recommended changes depends on the "realism" and "validity" of analyses performed during the project. I use the terms as shorthand for the level of detail,

practicality, sensitivity to client needs, thoroughness, completeness, and correctness inherent in the consultant's technical work. These characteristics are the consequence of:

1. The consultant's overall sophistication and skills, i.e., his professional experience, his technical competence (primarily brought to the project in question as the product of past work, but also enhanced by any constructive evaluation of this project's results as they are being achieved);
2. The consultant's knowledge of this particular client's situation (primarily the result of time spent with the client -- either during the current project or its predecessors -- but also aided by the consultant "having seen the problem before"); and
3. The amount of time the consultant spends on the project's analysis tasks.

Let us return to the center of Exhibit 1. Roberts[6] emphasizes that a client's desire to implement is strongly affected by the urgency of the consulting project's problem focus. Without this clear motivating force, implementation generally is thwarted by some combination of indifference, inertia, cost, and fear. An important feedback loop can exist here. To the extent that the project's recommendations (or other unrelated factors) improve organizational performance, the sense of urgency and, hence, the client's persistence in completing the job of implementation will lessen.

Given the necessary urgency, a client's desire to implement recommended changes is the result of his understanding of, acceptance of, and confidence in those proposals. In several papers, Weil[7] discusses the critical importance of two factors in this regard:

1. Active client involvement in all aspects of the project's analytical tasks (so that he understands the technical approach, agrees with all significant assumptions, sees "where the results came from", and takes the lead in formulating the strategy recommendations); and

2. A high level of realism and demonstrable validity in the analyses (i.e., model structure and behavior which are highly consistent with all available data about the client system).

Frohman and Kolb[8] discuss the effect of power on the relationship between consultant and client. The consultant's influence on his client is a type of power that enhances the client's acceptance of and confidence in the recommended changes. This influence derives from the consultant's technical/professional authority, and from the trust and confidence between client and consultant which develop during the project.

In my experience, the basis of a consultant's influence shifts over the course of a project. Initially, it is more a function of the compelling logic of the consultant's approach -- his credentials, methodology, problem diagnosis, and project plan as presented in early meetings and documents. Later in a project, the consultant's influence (or lack thereof) is primarily the consequence of the client's confidence in him. That confidence arises from the time spent working together and, later on, from client perceptions of the effectiveness of the consultant's proposed changes.

The consultant's influence, along with the urgency of the problem focus, determine a client's willingness to invest time in the project. Here we have another important feedback loop: The

self-reinforcing nature of client participation. Moreover, client involvement enhances the realism and validity of the consultant's analyses, thereby strengthening his technical authority with the client. These related feedbacks are shown on the left in Exhibit 1.

In summary, model adequacy is an absolutely critical determinant of implementation and project success. It is central to the development of client understanding, acceptance, and confidence. It reinforces the consultant's influence on his client (for example, to invest time in the modeling project). Almost by definition, a more "adequate" model produces results which are more implementable. The last point refers to both the appropriateness of the results and their actionabililty.

III. THE RIGHT TOOL FOR THE JOB AT HAND

A. The Case for Situation-Dependent Criteria

As described above, the life of a model involves may evaluations of whether it is "worth the costs", "believable", "useful", and "right". These critical tests must be passed within reasonable time and financial constraints. In light of that, several points should be considered:

1. Like it or not, such evaluations involve elements of taste, psychology, and emotion.
2. Different decision situations do have different sensitivities to the accuracy of information inputs.
3. Efficiency is important, both because urgent problems demand action and because virtually all clients are sensitive to the absolute costs of modeling projects.
4. A modeling project is usually undertaken with some objectives in mind; it is entirely possible to create a model which is "correct" and at the same time not very useful.
5. It is unlikely that numerical time series will exist for all important variables which should be included in a correct model.

The first point means that each group of people judging a model is likely to have a somewhat different concept of "adequacy". For example, whether one views the world as deterministic or probabilistic; one's willingness to take intellectual, organizational, and financial risks; and one's commitment to Cartesian concepts of rationality all come into play.

The second point raises the prospect misjudging the payoff from making a model better. The mistake can be in either direction -- either unjustifiable perfectionism or overconfidence that a "rough cut" is adequate. The third point underscores the importance of doing an adequate job, but not an extravagant one. Most of us work for clients, not patrons. We create tools, not monuments.

This leads to point four. Models are tools; they are created and used for specified purposes. Like any other tools, they must fit the capabilities and needs of their users. The last point indicates that a correct model must exploit a wide range of information, includng data about variables which are important to the model's purpose but are very difficult or impossible to directly measure. That necessity raises additional model evaluation issues.[9]

The classical tradition of model evaluation does not address those points. Any fixed standards are likely to be too high in some cases and too low in others. If, for safety, they are set very high, then most modeling will be wastefully perfectionistic. The fact that clients must have confidence in models before they will base decisions on them is treated as a technical rather than a human problem. Concepts of usefulness and usability do not seem to be part of this paradigm. Perhaps worst of all, the classical paradigm leads model builders to exclude factors of obvious importance for the rather lame reason that "there are no

data available" in the desired form. All too often, the result of this approach is failure.

In pursuit of successful models, I have rejected absolute concepts of model adequacy. That does not mean that I reject or down-play the importance of historically accurate models. Far from it! As indicated in Chapter II, the realism and historical accuracy of a model are critically important determinants of a client's understanding of, acceptance of, and confidence in model-based results. Moreover, Peterson[10] shows that a historically accurate model is much more likely to be correct.

However, in creating the "right tool for the job at hand" I strive to take a broad, pragmatic view of adequacy. Although quite important, historical accuracy is one of several key factors. Various degrees of perfection are possible. What is really called for in a particular situation? And within time, financial, and client relationship constraints, how should this dimension of model adequacy be traded off against the others? This perspective leads me to favor situation-dependent criteria.

B. Judging Whether a Model is "Good Enough"

The most important judges of model adequacy are high-level decision makers. If they are not "sold", a model will not be successful. The next most important judges are the people involved in building a model. They have to anticipate the decision makers' criteria and be approximately on-target; they usually

have the technical knowledge and opportunity to more fully evaluate the model; and their understanding, acceptance, confidence often is a key determinant of the decision makers' attitude toward the model.

Third in importance is the judgements of the technical "fraternity" of model builders. This may sound like heresy, but I believe that the peer review process is a "mixed bag". On the one hand, it is part of valuable scientific tradition which stimulates high quality work, the exchange of ideas, and scholarly debate. On the other hand, it encourages out-of-context evaluations and reliance on absolute standards. We should never forget that the client comes first. Pleasing ourselves and our professional colleagues is no substitute for client satisfaction.

What characteristics of a model determine whether it is the "right tool for the job at hand"? I believe that the relevant factors include the model's scope; the amount of detail in the model; the amount of data collection underlying its development; its historical accuracy; and the amount of model testing that was done. The required scope, detail, data collection, accuracy, and testing depend on the specifics of each situation:

1. the types of questions being addressed;
2. The attitudes, experience, and organizational position of the client;
3. Who, beyond the people involved in developing and using the model, must be "sold" on the results;

4. The institutional systems and processes through which implementation of model-based decisions must take place; and

5. Perceptions of "what's at stake".

The ideas of situation-dependent model adequacy are best illustrated through specific examples.

IV. A PAIR OF ILLUSTRATIVE EXAMPLES

How differences in circumstances can lead to different (but, in each case, quite adequate) models is clearly illustrated by contrasting two models developed five years apart for the same organization. The first was built in 1974-75; the second, in 1980. In both case, the client was the Life Insurance Division of a very large diversified financial services company.

A. The 1975 Model

This project focused on the Division's variable annuity products group.[11] In the years preceding the project, the variable annuities group had grown dramatically in sales, booked business, capitalization, and personnel. However, by the end of 1973 management became concerned with certain aspects of this phenomenal growth. For one thing, the group was not yet producing operating profits, despite (or, as some people seemed to feel, because of) the growth. This condition was significant as a deviation from earlier expectations, but took on real urgency as a result of the large amount of corporate capital involved.

Furthermore, inflation and a prolonged stock market decline were beginning to take their toll. It was becoming harder to sell. "Persistency" (the ability to keep customers, once they are sold a policy) was worsening steadily. Costs were rising even as service declined. Management was concerned about this

situation. When would the variable annuities group become profitable? When would it stop consuming corporate capital and generate cash surpluses instead? Could the group absorb additional growth in the short-term? What if the stock market didn't turn around soon? Discussion centered on the desirability of a "pause" -- a 1-2 year slowdown during which the group could "catch its breath". There seemed to be good arguments both pro and con.

It was evident that the issues surrounding growth strategy for variable annuities were highly complex. The objective of the project was to develop an analytical tool for sorting through all of those complexities and efficiently testing a broad array of strategic options.

While the resulting model was quite comprehensive, it was designed to focus on a particular set of strategic issues. It was this problem focus that dictated what to include in the model, and what level of detail was required in each portion. The specific issues which this model addressed were:

1. Rate of growth;
2. Control of costs;
3. Service adequacy;
4. Improvement of persistency;
5. Evolution of the marketing organization;
6. The effect of stock market performance; and
7. Achieving profits.

Exhibit 2 shows an overview of the 1975 Model. It represents the variable annuity product group and the divisional marketing organization (which sells all of the Division's product lines). The key exogenous inputs describe performance targets for the group (e.g., sales, costs, persistency, profits); the availability of corporate capital; economic conditions (e.g., inflation, stock market performance); and the characteristics of competitors' products. This model has approximately 600 variables.

The principal sectors of the 1975 Model can be seen in Exhibit 3. Many aspects of the variable annuities group are simulated within the model. The Product Line Sector gives an overview of the generation of new products, including their requirements for computer systems and administrative support. The Service Sector represents the servicing of new sales and business on the books. It includes manual clerical operations, computerized service functions, and the interplay between the two. The hiring, turnover, and efficiency of service staff are explicitly modeled, as is the impact of automation. The initiation of new computer system developments and the maintenance of existing computer systems also are represented in the Service Sector.

As its name suggests, the Sales Sector represents the determinants of variable annuity product sales. It is a rich, detailed formulation, combining the effects of: salesforce size, composition, and experience; product characteristics; pricing; service adequacy; commission levels; managerial concerns and

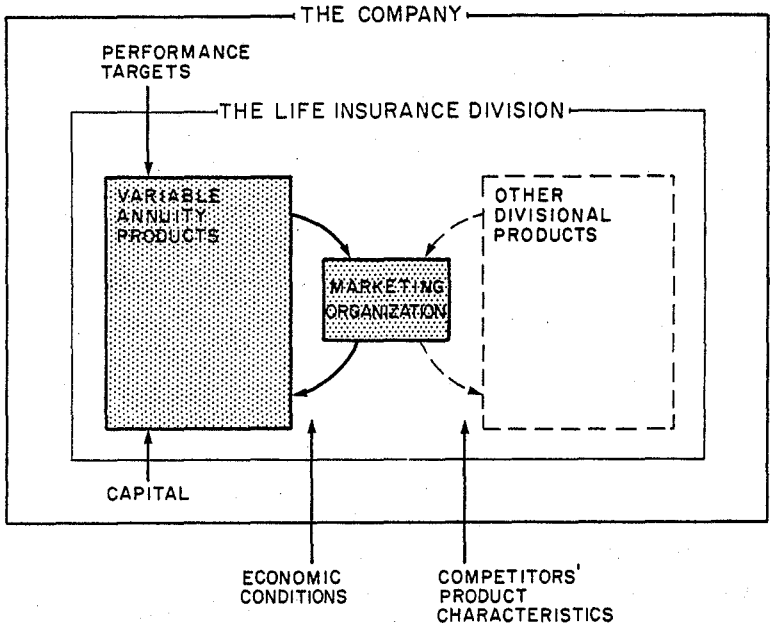


EXHIBIT 2

THE 1975 MODEL

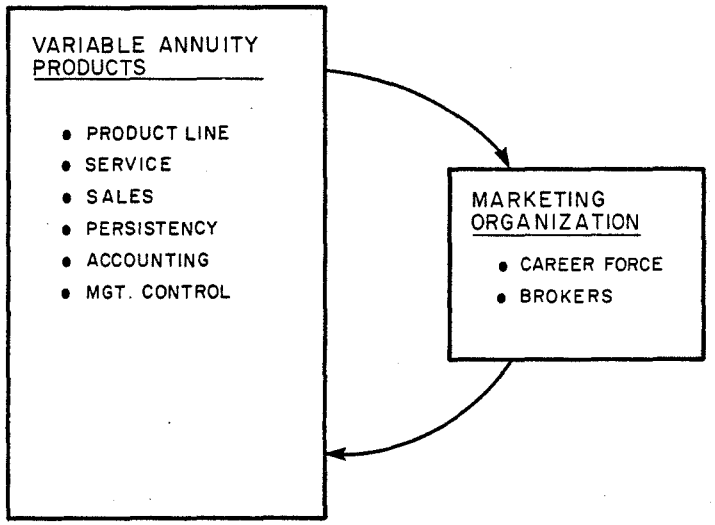


EXHIBIT 3

PRINCIPAL SECTORS OF THE 1975 MODEL

priorities; and external factors (e.g., inflation, stock market performance, competitors products). The Persistency Sector models the "quality" of sales and the factors which cause customers to cease paying policy premiums. Many of the factors which determine sales also affect persistency: e.g., sales force experience, service adequacy, managerial concerns, and external conditions.

There are two aspects to the Accounting Sector. One part represents the entry of newly-sold policies onto the company's books, and their subsequent aging, persistency, and payment of benefits. This is done in considerable detail, to give reliable financial results from model simulations; it is central to the calculation of variable annuity revenues and cash flows. The other part of the Accounting Sector assembles various revenues and costs, and produces income statements and balance sheets.

The Management Control sector describes the allocation of managerial attention and influence in response to various dimensions of performance, e.g., sales, profits, costs, and persistency. This sector represents the existent management control system, and is easily modified to test alternative structures. It is quite conceptually rich, showing how changing managerial priorities react to, and feedback to affect, group performance.

The Division's marketing organization was broken down into two components. The Career Force Sector models the recruiting, training, experience level, time allocation, and attrition of salesman who work exlusively for the Division. The Brokerage

Sector parallels the Career Force Sector, but represents independent insurance brokers who sell several companys' products.

The 1975 Model was used both to diagnose the causes of existent problems and to reveal fundamental "truths" about the variable annuity business. In particular, much time was devoted to explaining the inter-relationships between sales growth and profitability. Opportunities for performance improvement were examined in such areas as:

1. Adequacy of service and systems;
2. Managerial priorities in controlling the various (somewhat conflicting) dimensions of group performance;
3. Mix of sales between career agents and brokers;
4. Control of persistency;
5. Sales growth targets; and
6. Recruitment and allocation of personnel.

During this project, we worked with a small Task Force that was led by the Vice President in charge of the variable annuities group. The Vice President proved to be an extraordinarily astute and motivated client. He maintained a very high level of personal involvement, immersing himself in the project down to the smallest technical details. Moreover, he was by nature a strategic thinker. He was prepared to challenge "conventional wisdom" and to champion new ideas.

Several members of the Task Force took the time to scrutinize the equations and simulation results. They wanted to satisfy themselves that the model was reasonable on a detailed level

and to understand "where the simulation results come from". Of great importance, though perhaps surprising, the Vice President and his comptroller were part of this group.

We devoted a considerable amount of effort to improving the historical accuracy of this model. Simulated values for a large number of variables were explicitly compared with historical data over the period 1970-1974. The historical accuracy of the 1975 Model is illustrated by the two examples in Exhibit 4. The model generally produced results within 10% of historical values; in some areas, the accuracy was consistently within 5%. We achieved a consensus that the base simulation was historically valid, and the best existing estimate of what the future held in store.

The general conceptual framework provided by the model, the initial analysis results, and our best forecast for 1975 through 1980 became inputs to management's determination of near-term growth targets. The major company decision was to slow down growth in variable annuity sales in order to improve profitability. The question then became: what is the best set of policies for achieving this goal?

The model's credibility was significantly enhanced when, late in 1975, it became evident that model-generated forecasts of sales, persistency, and profits were much more accurate than estimates produced by "conventional methods". Especially in the eyes of managers who had not participated in model development, this was a critical test.

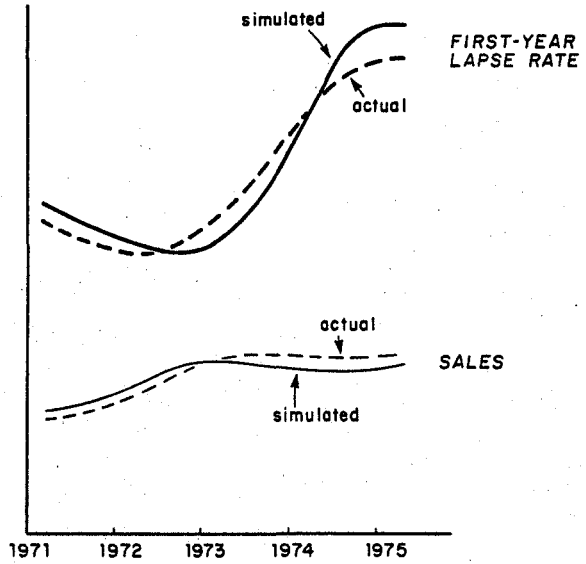


EXHIBIT 4
HISTORICAL ACCURACY OF THE 1975 MODEL

At that point, the model was expanded in several sectors where more detailed answers to the strategy implementation question were required. Policies in the areas of product mix, pricing, salesforce compensation, salesforce size, customer service expenditures, and persistency control were analyzed with the model. The results of these analyses significantly influenced key managers' perceptions of the issues, and shaped the policy decisions which ultimately were made. We consider this project a success.

B. The 1980 Model

Four and a half years later, we undertook another project for the same organization. We were invited back because of the perceived success of the 1975 Model. As we were discussing the new assignment, I was told: "The model was even more correct than we were willing to accept at the time".

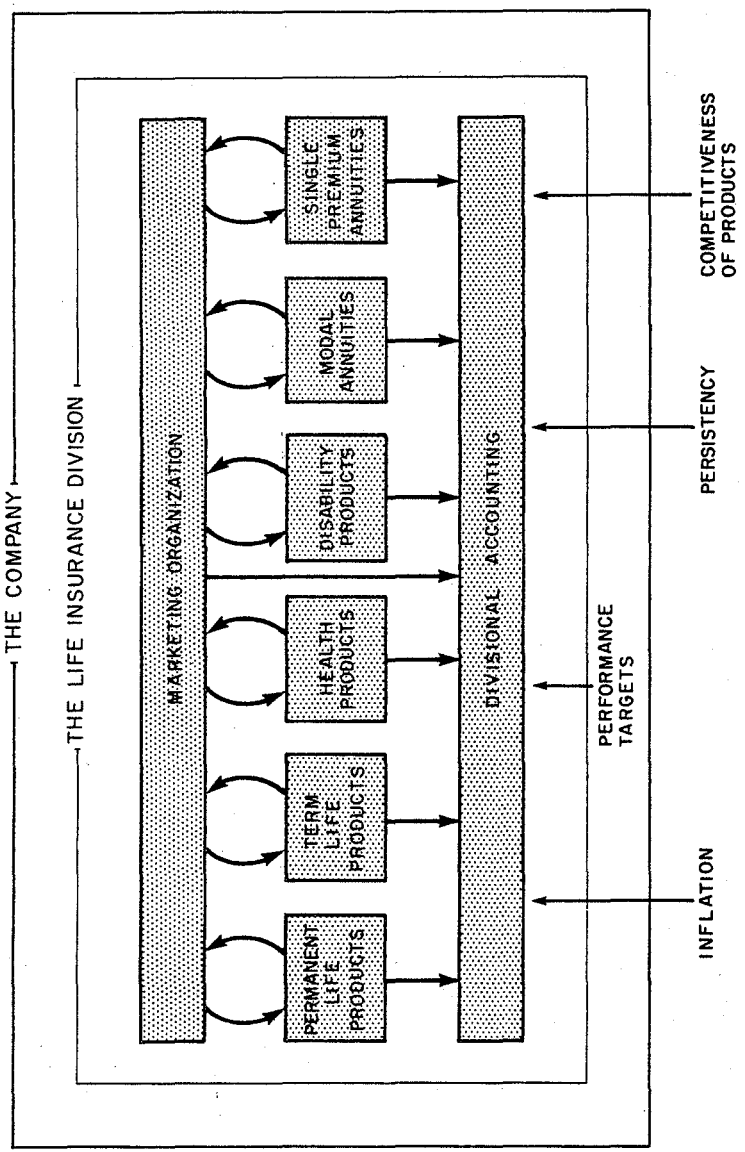
This project focussed on marketing strategy for the entire Life Insurance Division.[12] It was the culmination of a process of strategy development and evaluation which had been underway throughout 1979 and reached a significant plateau with a draft strategy paper in January 1980. In general terms, the objective of this project was to clarify, test, and refine the 1/80 strategy. To be somewhat more specific, the goals were:

1. To more precisely define the elements of the 1/80 strategy, e.g., growth targets for both career agents and brokers; the number of people involved in each proposed distribution system change; the cost and productivity impacts expected from each change; the intended allocation of selling effort among products; the timing of distribution system and product changes.
2. To develop and test a set of explicit assumptions about the functioning of the Life Insurance Division as a business "system", e.g., the impacts of inflation on costs and on sales productivity; the sensitivity of field personnel (in terms of recruitment, retention, and time allocation) to compensation, product competitiveness, and their own morale; the effect of distribuiton system growth and turnover on sales productivity.
3. To develop and test various assumptions about the external environment, e.g., the competitive position of each major divisional product in each market where it might be sold (in terms of price, service, and features); future economic trends (inflation rates and business cycles); the maximum profit margin sustainable on each major product (given competitive and economic conditions); the future salability of permanent life insurance.
4. To project the specific impacts of the 1/80 strategy, and many other prospective changes, on divisional financial performance (profits, sales, and costs) and on the "health" of the marketing field organization (as indicated by compensation per person, morale, and turnover).
5. To refine the 1/80 strategy wherever possible, taking into account the risks posed by adverse conditions, e.g., lower than expected inflation; declining profitability and/or salability of permanent life insurance.
6. To forge a consensus among senior divisional managers about the marketing strategy and its implementation.

To all those involved in the project, the last objective was paramount. The organization and conduct of the project were carefully designed to bring people with different points of view toward consensus.

Exhibit 5 presents an overview of the 1980 Model. Its structure reflects the purposes enumerated above. Unlike the

EXHIBIT 5
THE 1980 MODEL



1975 Model which focused on one product group, this model represents the full range of divisional products (aggregated into six groups). Similar to the 1975 Model, it includes the Life Insurance Division's marketing organization. In the 1980 Model, accounting is for the entire division. The important external inputs describe performance targets for the division (e.g., sales, costs), inflation, persistency, and the competitiveness of each product. This model has approximately 1000 variables.

The principal sectors of the 1980 Model are indicated in Exhibit 6. The Marketing Sector determines the size and composition of the division's sales organization in response to recruiting and assignment policies, and the turnover of personnel. Four alternative distribution channels are explicitly modeled: the career agent force, life insurance brokers, casualty insurance brokers, and direct selling from the home office. For each distribution channel, the model represents the number of "producers", their experience, and the amount of staff support and supervision they receive. Salesforce time allocation and attrition depend on such factors as commission levels, product competitiveness, support and supervision, and morale.

The Sales Sector determines sales for each of six product groups in three different markets. Sales are calculated for each combination of product, market, and distribution channel, as a function of producer time allocation and productivity. The productivity of time allocated to a product depends on product competitiveness, price, inflation, and salesforce experience. As

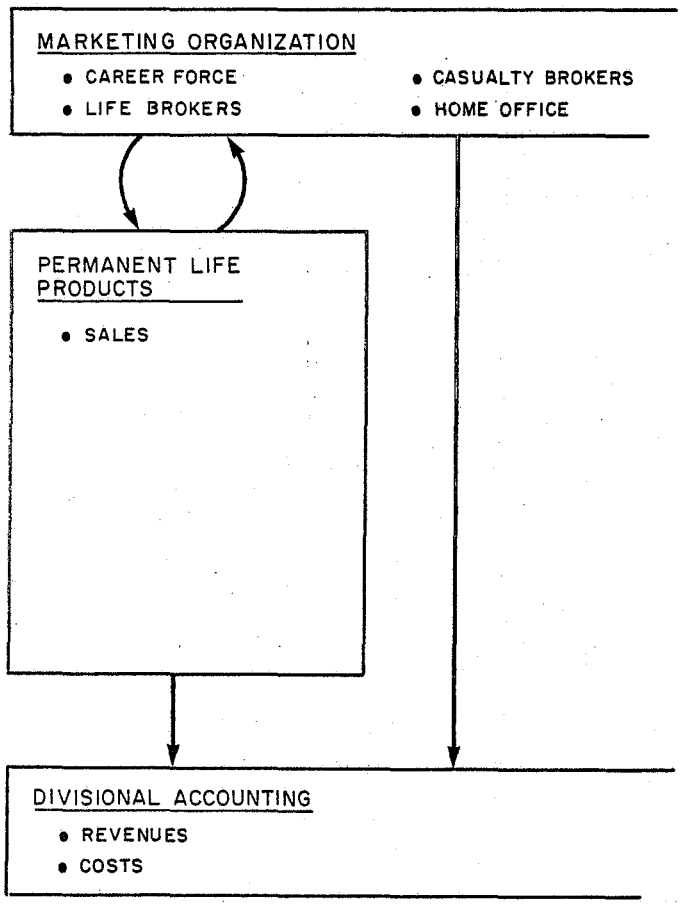


EXHIBIT 6
PRINCIPAL SECTORS OF THE 1980 MODEL

noted above, the first three of these causal factors are external inputs to the model. However, their impacts are quite complex and differentiated by distribution channel, product, and market.

The Accounting Sector computes revenue and costs by product group, to yield operating earnings. Two sources of revenues are considered -- investment income and policy premiums. The latter is calculated from the cumulation of new business sold, decreased by lapses and maturities. A very detailed breakdown of expenses occurs in the 1980 Model. Many categories of head office and field costs are calculated, based on fixed and variable components. This degree of financial detail was necessary for several reasons:

1. To examine how shifts in product, market, and/or distribution channel emphasis would affect divisional profits;
2. To determine the existence of "economies of scale";
3. To accurately portray the timing of investments and returns under various scenarios; and
4. To analyze the overall effect of inflation on divisional profits.

The 1980 Model was used to structure an important debate about assumptions and strategy alternatives. It forced people to be very explicit. The need to specify, initially to flow diagrams and later in mathematical equations, a theory of how the division functions and how its financial performance is determined caused managers to spell out, argue about, and ultimately agree upon dozens of critical assumptions and hypotheses. A-

chieving a consensus about assumptions was a major step toward a consensus regarding a marketing strategy.

Moreover, the model facilitated the testing of a wide range of strategy alternatives and economic/competitive scenarios. Approximately five hundred tests of this kind were performed with the 1980 Model to evaluate possible elements of a marketing strategy (singly and in many combinations). Among the areas examined were:

1. Mix of sales among alternative distribution channels;
2. Recruitment and allocation of personnel;
3. Emphasis of various combinations of products and markets;
4. Establishment of new distribution channels;
5. Sales growth targets;
6. Alternative budgetary constraints;
7. Methods for establishing future manpower requirements;
8. Actions to increase productivity; and
9. Risks posed by adverse conditions.

This project was organized to engage many senior managers in the process of defining assumptions, designing a model, evaluating the model, specifying tests to be performed, interpreting the results, and formulating a recommended marketing strategy. The emphasis was on detailed strategy design and strategy implementation planning. We worked with a larger and more diverse Task Force than in the earlier project. It was chaired by the Vice President in charge of marketing -- an outstandingly successful life insurance salesman and sales manager; a very dynamic, action-oriented person. The other twelve members of the Task Force included five additional Vice Presidents from the home office (one of whom was our client for the 1975 Model, by then in a more senior position) and two regional marketing Vice Presidents; the remaining members were planning managers. Overall, this was not a group of abstract thinkers. They were deeply interested in the details of products, markets, and distribution channels.

As the project progressed, several Task Force meetings were devoted to a very detailed review of the model's structure and the assumptions which went into it. Many significant additions and refinements came from those meetings. In particular, much effort was invested in reviewing and refining the model's financial structure. This was necessary to ensure that comparisons of projected financial performance from one experiment to the next were valid.

The historical accuracy of the 1980 Model is illustrated in Exhibit 7. For the variables shown and most other model variables, simulated values for the period 1970-1980 were within 5-10% of actual historical data. This was an important check on the model. It meant that model relationships, which seemed reasonable individually, collectively produced performance which was consistent with actual history. It indicated that no important relationship existent over the historical period was omitted.

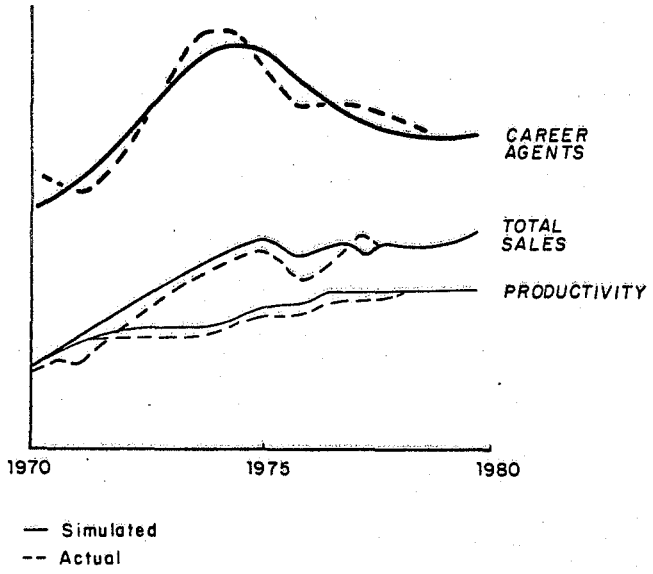


EXHIBIT 7
HISTORICAL ACCURACY OF THE 1980 MODEL

This gave the Task Force confidence that the model was useful for projecting divisional performance into the future.

A detailed list of conclusions and recommendations resulted from this project. Most were incorporated in a Life Insurance Division marketing strategy document which was issued at the end of 1980. The final product was greatly superior to the 1/80 draft in terms of its specificity, actionability, organizational commitment, and projected performance. In the interim, as a direct result of the project, senior managements' thinking on several key strategic issues had been reversed. Once again, we consider this project a success.

V. CONCLUSIONS

The preceding chapter described the "right tool" for two different jobs. Because the two models were developed for the same organization, with many of the same people involved (both as client representatives and model builders), the comparison is reasonably controlled. The following table summarizes the key differences between the two projects:

		1975 Model	1980 Model
A.	The Situation		
1.	Problem Focus	overall growth strategy strategy	marketing
2.	Issues	problem diagnosis; fundamental "truths"	strategy refinement and implementation
3.	Client Attitudes	strategic thinking; analysis-oriented	action-oriented; concern re. details
4.	Who Else Had to be Sold	corporate management	corporate management
5.	Avenues of Implementation	sales targets; personnel actions, budgets; system development; mgt. controls	sales targets; personnel actions; budgets
6.	What's at Stake	urgent problem; very large financial risks	urgent problem; very large financial risks

B.	The Model		
1.	Model Structure	one product; rich internal dynamics	many products, market, and distribution channels; more exogenous inputs
2.	Size	600 variables	1000 variables
3.	Type of Detail	breadth re. determinants of sales and profits	depth re. marketing
4.	Model Evaluation	detailed review; historical accuracy; correct forecasts	detailed review; historical accuracy
5.	Data Collection	interviews; some numerical data	interviews; large amount of numerical data
6.	Model Use	diagnosis; policy evaluation; forecasting	policy evaluation; risk analysis
7.	Principal Outputs	detailed diagnostics	financial summaries
8.	Significant Simulations	100	500

These differences are instructive. The 1975 Model focused on a fundamental question of system behavior; the principal clients were analytically-oriented strategic thinkers; strategy implementation involved changes to all important subsystems. The 1980 Model was created to guide refinement and implementation of an existent strategy; the client's mindset was quite different; because the subject was "marketing strategy", not overall busi-

ness strategy, implementation involved a more restricted set of variables (i.e., those over which marketing managers had control).

Little wonder that the resulting models reflected those major differences. The 1975 Model had rich internal dynamics, encompassing all subsystems which significantly affected sales and profits; it was used for detailed problem diagnosis and, because of its robustness, forecasting. Ther 1980 Model was narrower (it focused on marketing variables), but far more disaggregated; many factors which had been endogenous to the 1975 Model were external inputs in this case; because of its disaggregation, much more numerical data gathering was required for the 1980 Model; a very large number of policy tests were performed; because there were many exogenous inputs, forecasting was less meaningful than "risk analysis" with respect to variation in the external scenarios.

The different tradeoffs between breadth and depth produced models of roughly comparable size. The two models achieved about the same degree of historical accuracy, but under different circumstances and, hence, with different implications. With its richer endogenous dynamics, the 1975 Model was more self-contained and more valid for forecasting. The 1980 Model produced highly reliable indications of the relative financial performance of policy variants.

The two examples show that successful models are persuasive, not simply to modeling technicians, but to high-level decision

makers. These executives repeatedly ask themselves: Is this model worth the costs? Is it believable? Does it tell me important things I don't already know? Does it give me answers I can use? Is it an effective weapon for getting what I need to be successful? The two case examples demonstrate how technically different products can be entirely adequate for their respective situations. They illustrate why I concluded that successful modeling results from applying situation-dependent criteria of model adequacy.

REFERENCES

1. See, for example, Theil, H., Principles of Econometrics, John Wiley and Sons, New York, 1971.

2. The basic reference is Pratt, J.W., H. Raiffa, and R. Schlaifer, Introduction to Statistical Decision Theory, McGraw-Hill Book Co., New York, 1965.

3. A more complete discussion of this conceptual model can be found in Weil, H.B., "The Dynamics of Strategy Implementation", Dynamica, University of Bradford (U.K.), Vol. 9, Part I, Summer 1983.

4. Roberts, E.B., "Strategies for Effective Implementation of Complex Corporate Models", in Managerial Applications of System Dynamics, E.B. Roberts, ed., M.I.T. Press, Cambridge, Ma., 1978.

5. Weil, H.B., "Achieving Implemented Results from System Dynamics Projects: The Evolution of an Approach", in Elements of the System Dynamics Method, J. Randers, ed., M.I.T. Press, Cambridge, Ma., 1979; Weil, H.B., "Effecting Strategy Change with System Dynamics", presented at the 1981 System Dynamics Research Conference, Rensselaerville, N.Y., October 1981, copies available from the author.

6. Roberts, op cit.

7. Weil, op cit.

8. Frohman, A.L. and Kolb, D.A., "An Organization Development Approach to Consulting", Sloan Management Review, Vol. 12, No. 1 (Fall 1970).

9. The problems of indirectly estimating model relationships are discussed in Peterson, D.W., "Statistical Tools for System Dynamics", in Elements of the System Dynamics Method, J. Randers, ed., M.I.T. Press, Cambridge, 1980.

10. Ibid

11. This model is described in more detail in Weil, H.B. et al. "Growth Strategy in a New Business Area: A Simulation Analysis" presented at the 1974 Summer Computer Simulation Conference, Houston, Texas; copies available from the author.

12. The process followed in this project is discussed in Weil, "Effecting Strategy Change ....", op cit.