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Strategy Support Models

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Summary
A major challenge in strategy development is to deduce the consequences of the interacting programmes underlying strategy. The paper argues that behavioural simulation models can help meet this challenge by acting out the consequences of strategy proposals in their full organizational setting. However, the real key to effective strategy support is not simply having a model, but using it in a structured dialogue with executives. To illustrate the idea, the paper presents a system dynamics simulation model used to aid executives of an advanced office equipment firm in setting their marketing strategy. The paper describes the process by which the model was created and brought to the attention of executives. Several examples are provided of the dialectical use of the model, showing how differences in management intuition and model-generated opinion led to improved insight into the consequences of strategy.

INTRODUCTION

The concept of support

Over the past decade considerable attention has been given to advanced computational aids used in support, rather than replacement, of managerial judgement. Here, computational aid includes not only rapidly advancing computer hardware but also the algorithms and numerical methods that have become feasible with the existence of the hardware. Underlying the concept of management support is the recognition that the human mind is itself a very powerful, flexible, and agile problem-solving and decision-making 'machine', and should remain an integral part of the decision-making process. The key to support is to identify the activities in which our built-in, flesh-and-blood computers are weakest and remedy the weakness with our new, chip-and-board computers.

The field of management information systems has clearly identified one weakness of our flesh-and-blood computers — their ability to collect and process information. Decision support systems (Keen and Scott-Morton, 1978) come to the rescue by massaging business information, making it more compact, easy to access and absorb so that managers can be better informed and therefore, presumably, better able to make decisions.

This paper extends the notion of support to strategy support, in which a man/machine combination is used to provide more effective assessment of strategic proposals.[1] But what

[1] The term strategy support was coined by my colleague Dr. Alan K. Graham of the M.I.T. System Dynamics Group.

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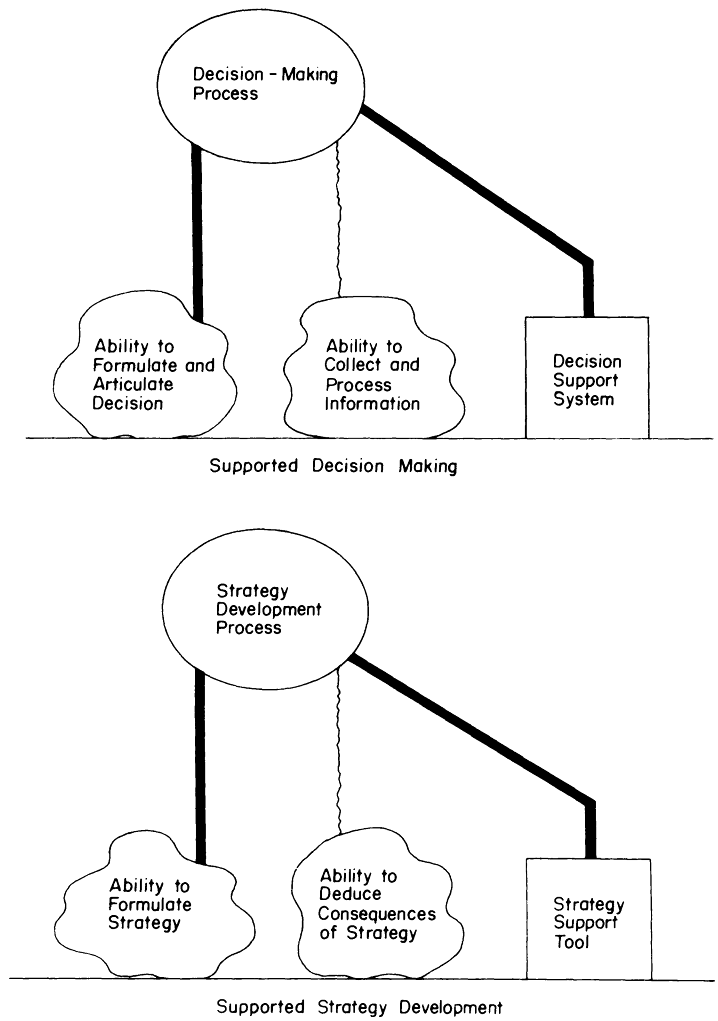

Figure 1. The analogy between decision support and strategy support

kind of support can be usefully brought to bear on highly unstructured strategy questions? Here we suggest that management intuition and experience must serve as the primary architects of strategy, to bring form and substance to otherwise unstructured issues. The initiative for defining alternative markets to be served, resources to be deployed, organizational responsibilities, and allocation of budgets must lie with senior management. Strategy support can be provided by a tool that provides sharper insights into the *consequences* of pursuing strategy proposals once formulated.

Figure 1 illustrates the analogy between decision and strategy support. The Figure shows both the human and machine components of decision making and strategy development. The decision-making process is depicted as being strongly supported by natural human ability to formulate, articulate, and communicate a decision. However, it is much less strongly supported by the ability of the human mind to collect and process information (Simon, 1971). A decision-support system provides reinforcement by storing relevant information, reworking and condensing it, indexing it and providing easy access. By analogy, the strategy development process is depicted as being supported by natural managerial ability to formulate strategy, to set a course for the corporation, and create the administrative structure necessary to implement strategy. But it is much less strongly supported by the ability of the human mind to deduce the consequences of the strategy (Cyert, Simon and Trow, 1956). A strategy support tool should reveal flaws and inconsistencies in proposals that might not otherwise come to light until the proposals are implemented and under way.

Strategy support, the dialectic method and the role of models

A common approach to the evaluation of strategy in business and government institutions is argument and debate. From this method we can learn much about the way a strategy support tool should interact with executives. If the consequences of a given proposal are difficult to assess, it is certain there will be widely differing opinions on the outcome. Debating these opinions in a meeting will force people to scrutinize and justify their reasoning and will provide clearer insight into the viability of the proposal. This process may be usefully summarized as the dialectic method, defined in *Webster's Twentieth Century Dictionary* as

> The art or practice of examining opinions or ideas logically, often by the method of question and answer, so as to determine their validity.

Successful formalizations of the approach have been described by Mason (1969) and Mitroff and Emshoff (1979) for corporate planning, and by Schon (1983) for urban planning.[2]

A most natural extension of the dialectic method is the introduction of a formal model into the discussion with which to temper the prevailing opinions. In the standard dialectic method, debate and discussion draw on opinion from the 'mental models' of a management team. A formal model merely adds another viewpoint, which, though perhaps more carefully formulated, is nevertheless an opinion.

To be effective, the model must be seen as a vehicle for extending argument and debate—quite different from the customary role of models. The model must be brought down from the pedestal of the infallible black box (where it is often ignored) to occupy a more modest position as a complement to the thinking and deducing powers of management. The model must be seen as a generator of opinions, not answers. Executives must be encouraged to challenge and debate model conclusions, and members of the modelling team must be capable of engaging in executive, non-technical argument.

The use of system dynamics

The remainder of this paper will illustrate the use of system dynamics simulation modelling (Forrester, 1961; Lyneis, 1980) as a strategy support tool. System dynamics is an appropriate tool for a number of reasons. First, it provides effective graphic display methods for illustrating the policy structure of an organization. A management team can easily relate to these graphics. They can see the range of interlinked policies that constitute their organization. They can see the complex network of communication and control through which strategic initiatives must filter to bring about change in organizational performance.

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[2] Some recent theoretical advances in the formal analysis of the logic of policy are described by Mitroff, Mason and Barabba (1982).

A system dynamics model is descriptive of the way a company functions; it does not contain idealized decision-making processes (Morecroft, 1983). It shows the division of responsibilities, the goal and reward structure of the organization, as well as the inconsistencies of policy that are a part of any real organization (Hall, 1976). It reveals the limitations on information flow that can produce distorted or even conflicting images of performance at different parts of the organization. Together, these descriptive features of the model lend a realism necessary to good communication as the model comes to be used in a discussion.

The simulation analysis methods of system dynamics are very effective in argument and debate. Simulation can be used to create clear strategy scenarios to challenge the collective intuition of a management team. Simulation runs create time charts of important business variables that bring to life the consequences of policy change and bring discipline to the subsequent discussion (Probert, 1982).

CREATING A STRATEGY SUPPORT MODEL—AN EXAMPLE

A strategy support model is intended to influence executive opinion in a company. To do this it must be aimed at a problem that engages the executives' attention, it must have political support within the organization, and its structure and insights must be widely communicated (Roberts, 1977).

In this section we will use a case study to illustrate how a strategy support model is created. The example is based on the analysis of marketing strategy for a supplier of advanced office equipment.[3] To retain anonymity the company is referred to as Datacom Corporation.

Starting the project

At the start of the modelling project a small project team was assembled that included a senior and a junior manager, an M.I.T. consultant, and several staff analysts. The managers involved in the project both had some prior exposure to system dynamics modelling.

Preliminary discussions between the managers and consultant revealed that Datacom was faced with an important strategic problem, common in high-technology industries, of managing a market conversion from a base of old-technology equipment to a new generation of more advanced equipment. This issue certainly had executive attention. The company had experienced loss of market share during the early stages of the transition. There was uncertainty over how rapidly the conversion should take place and over the combination of sales efforts and price incentives that would be most effective at bringing about the conversion. The modelling project was, therefore, addressed to this problem.

The next step was to sketch a conceptual model showing key elements of the existing decision-making structure of the market and the sales organization. In the market, we wanted to understand what induces customers to switch from old- to new-technology equipment and how they make the choice between equipment offered by Datacom and the competition. In the sales organization, we wanted to look at factors affecting selling effort and its allocation to different activities in the market. At an early stage we ruled out the need to consider factors such as product development, production, and delivery. The new-

[3] For a more detailed account of the case study and subsequent policy analysis, see Morecroft (1982).

technology equipment was already developed, and there was adequate capacity to meet projected market needs.

Round-table meetings were held by the project team and subject area experts. On the table we had our sketch of the decision-making processes in the market and sales organization. We discussed how these processes worked and how they are linked, using the descriptive knowledge of company participants and the structuring principles of system dynamics.

The diagram served as the focal point for meetings. It was very useful as a communication tool to management and staff, pointing out internal linkages between company programmes and procedures, and external linkages to the market. There were frequent revisions to the diagram as our understanding of the system improved. The diagram also served to generate a feeling of involvement and commitment in the project by the numerous people who contributed to its construction, thereby aiding the communication process. Finally, the diagram served as a valuable interface between the formal mathematical model ultimately developed, and the mental models of the various project participants.

Policy structure of the market

Figure 2 shows the conceptual model of the market that was arrived at in meetings with the project team and subject area experts from the sales force and marketing staff. Notice first the heavy black lines showing the installed base of systems. The installed base is divided into three categories shown as system levels. At the top of Figure 2 there are old systems, all of which have been sold by Datacom and reflect the company's strong initial market position. As times goes by, old systems are upgraded until, eventually, all have been converted either to new Datacom or new competitor systems. Ownership of the installed base is, therefore, gradually redistributed between Datacom and the competition. Notice that in this particular market (uncharacteristic of many high-technology markets) the size of the total installed base is fixed. All business customers who need the equipment offered by Datacom already have it, at least in its old-technology form. Thus, the only way to sell new equipment is to exchange it for old. Finally, the reader should also note that Datacom leases much of its equipment to the market. Sales revenues are, therefore, generated both by the base of installed systems (old and new) and by the conversion from old to new systems.

The remainder of Figure 2 shows how a customer decided to convert. By talking with members of the sales force, we learned that the first step is simply one of making the customer aware of the new technology. Customers must be contacted, talked to, and convinced that the switch to new technology is worth while. In Figure 2 this process is called acceptance. The number of acceptances depends primarily on proactive sales effort, where the sales force takes the initiative in contacting the customer. Acceptances depend also on price. If old prices are low in relation to new-equipment prices, acceptance will be less likely. Acceptances further depend on the number of old systems that remain to be converted. As the base of old systems is depleted, there are fewer and fewer customers to contact, until only the diehards are left.

Customers convert to new systems only after they have accepted the usefulness of new technology. Figure 2, therefore, shows conversions dependent on acceptances. Interestingly, Datacom conversions depend not only on acceptances generated by Datacom sales effort, but also to some degree on acceptances generated by competitor sales effort. Customers who are aware of the new-technology option may choose to obtain their equipment from any of the system vendors in the market. Some cross-talk between

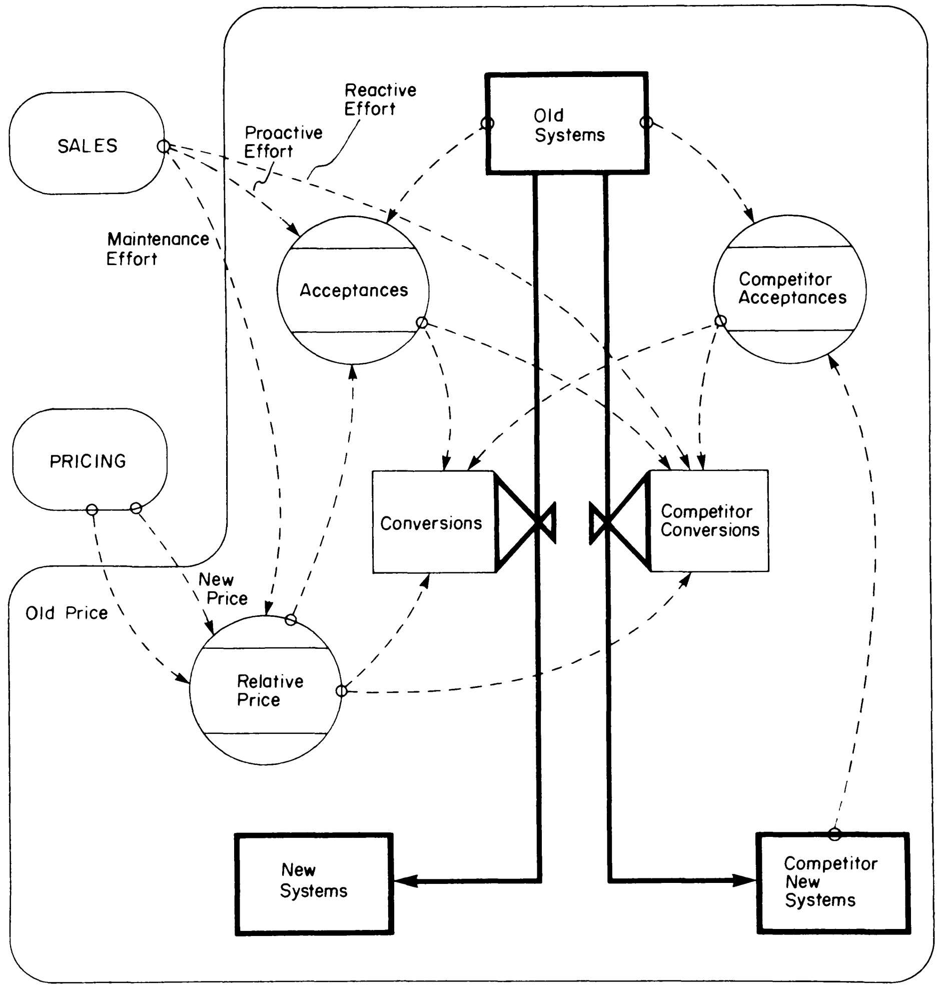

Figure 2. Policy structure of the market

competitor sales effort and Datacom, and vice versa conversions is, therefore, a natural and very important feature of the market. The degree of cross-talk depends on the relative price of Datacom and competitor systems. If Datacom prices rise in relation to competitor prices, the company wins fewer conversions, and a correspondingly greater number go to the competition.

Discussions with the sales force indicated that relative price should be viewed as a rather subtle decision-making process in its own right. Price perception in the office-equipment market is quite complex. There are lease and purchase options to consider. There are price/performance characteristics to judge. There are new, old, and competitive prices to consider. The customer does not make price judgements in a highly objective way but is swayed by general sales effort (labelled maintenance effort in Figure 2), by price reputation, and by other subjective factors. Figure 2 captures these intangibles in price perception by showing that old and new prices first pass through a decision-making process labelled relative price before they affect acceptance or conversion.

Competition is treated in a simplified way that focuses on the growth capability of competitive firms as a whole. Competitor acceptances depend, in the aggregate, on the installed base of competitor systems. In general, the more installed systems there are, the greater the revenue base and the greater the competition's ability to support marketing effort. Competitor conversions depend on competitor *and* Datacom acceptances modified by relative price and Datacom's reactive sales effort. If competitor prices are relatively low, competitor share of conversions will be high. Such price advantages can be counteracted to some extent by Datacom's reactive sales effort. Datacom knows about competitor attempts to win customers and can respond by putting in sales time to lure customers away from the competition.

Policy structure of the sales organization

The conceptual model of the sales organization focuses on policies that can affect sales capability and its allocation among three principal market activities: proactive sales effort, reactive sales effort, and market maintenance. Figure 3 shows the structure that emerged from round-table discussions between the project team and subject area experts from the sales force and the market planning area.

The size of the sales force is a key determinant of overall sales capability. The sales force, which is shown by heavy black lines at the top of the figure, is increased through hiring and

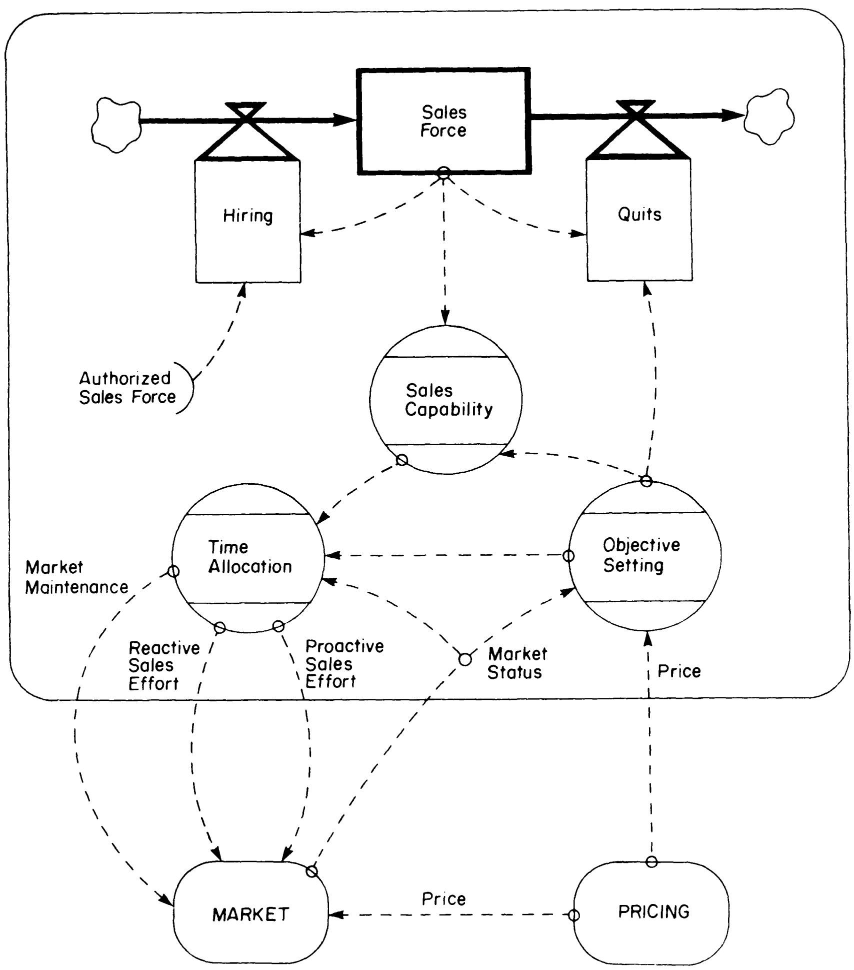

Figure 3. Policy structure of the sales organization

decreased through quits. Hiring adjusts the sales force to an authorized level, which can be varied experimentally in the formal model. Sales capability is also affected by overtime and by the motivation of the sales force, which in turn depend on sales objectives. By raising objectives, overtime and sales capability may be increased. But sustained periods of high overtime or poor performance that result from overly ambitious sales objectives can lower motivation and ultimately lower the capability of the sales organization. Our conceptual model shows this fluid, variable nature of the output of the sales force.

Sales capability is a measure of the total effective effort that the sales organization can bring to bear on the market. This total effort is allocated among different marketing activities according to the time-allocation policy of individual salesmen. Discussion with salesmen revealed that there is a natural hierarchy in the allocation of time. The highest priority goes to reactive sales efforts, the process of responding to competitor attempts to win Datacom customers. The rest of the time is split between proactive sales effort, the process of converting existing old-technology customers, and general market maintenance. Second highest priority goes to proactive effort, unless the product sales objective has been completely satisfied.

This allocation of time is probably not optimal in an economic sense, but it is a very natural and powerful hierarchy from the salesman's viewpoint within the sales incentive system. Reactive sales effort gets high priority because a competitive loss is a direct threat to revenue and a very visible form of loss. By contrast, proactive effort, which is highly effective at bringing about conversion, gets lower priority, because a reduction in proactive effort will result in a loss of opportunity, not a highly visible competitive loss. Market maintenance, the process of keeping in touch with the entire customer base, naturally receives lowest priority, since it produces the least tangible pay-off in terms of revenue or sales.

The final policy shown in Figure 3 is the setting of objectives. The sales organization is motivated through objectives for revenue and for product sales. In reality, these objectives are quite difficult to set. There are many customers, a variety of products and different types of price contracts. Consequently, objectives tend to depend strongly on historical performance. The current year's objectives are set by looking at last year's objectives and negotiating a 'stretch' or challenge that is intended to sustain high productivity. Setting objectives by negotiation around an historical standard is a natural and effective way to deal with the complexity that underlies sales performance.

USE OF THE STRATEGY SUPPORT MODEL

Once a formal simulation model has been created, it is then the responsibility of the project team to ensure that model-generated opinion gains the attention of the executives involved in formulating and implementing strategy.

In the Datacom case the senior manager in the project team was aware of the issues being debated in the market conversion strategy and of the key executives who should be influenced. He played a very important liaison role, arranging meetings, sounding out executive response and generally creating an environment where model-based opinion would be taken seriously. The liaison role must be filled by a person who has political insight, the respect of colleagues and higher-level executives, and a high level of comfort with modelling methods.

The project team should arrange meetings in which the model is used for debate and argument, in order to challenge the preconceptions of management. This dialectic use of the model is at the heart of strategy support, but does not happen automatically. It is essential that model runs be organized around clear scenarios, that executives be encouraged to challenge and debate model conclusions, and that members of the project team be capable of engaging in executive, non-technical argument. With these conditions satisfied, it is possible for both executives and modellers to clarify their understanding of the consequences of strategy.

Steps in the dialectic

Figure 4 illustrates the use of a model as practised at Datacom for six high-level meetings. The first step is to select a proposal that is already under active discussion in the company. The former model is then run and analysed to render an opinion on the consequences of the proposal. This kind of analysis should not be done at the meeting, but rather beforehand, when there is adequate time to diagnose and understand the simulation runs. It is essential to develop a clear intuitive explanation for simulation runs, and this always takes time.

In the next step managerial opinion and model opinion are brought together in debate and discussion. Meetings can last as long as 2 or 3 hours. Modellers should be expected to provide a clear explanation of why the model behaves as it does and why it differs from executive expectation (if it does). Executives should feel free to point out when their intuitive opinion on the proposal differs from model-generated opinion. The explanation of

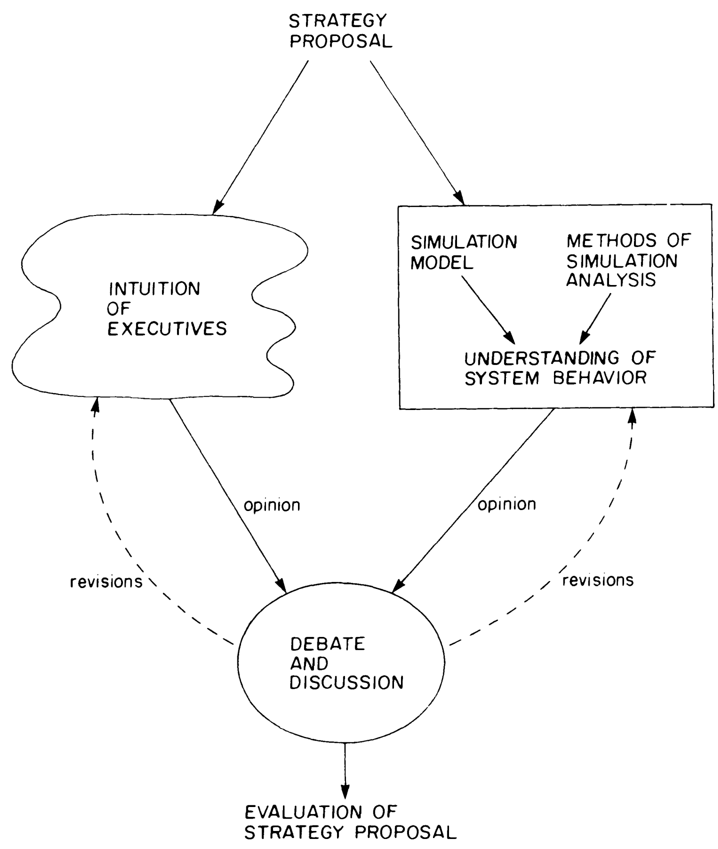

Figure 4. Using a system dynamics model to evaluate strategy proposals

differences will lead to revisions and clarifications in both executive intuition and the formal model that will ultimately improve the evaluation of the strategy proposal. The central role of the model, then, is to clarify the consequences of the proposal and to anticipate surprises. As Mass (1981) has pointed out:

> Some of the most important insights into real system behavior can arise from model results that at first appear to be at odds with knowledge of the real system, but which in fact suggest important new interpretations of perceived facts.

THE PROCESS IN ACTION—INSIGHTS FROM THE MODEL

The conceptual model described above was translated into a formal simulation model using the DYNAMO simulation language. It took 4 months to assemble and test a first model worthy of executive attention. The model was then used for about 8 months, first to examine the effectiveness of force additions in the market conversion strategy, then later to explore pricing policy. It is interesting to note that, during the 8 months of model use, time spent on the project was about equally divided between model development and the elucidation and communication of results.

To illustrate the use of the model, we will concentrate on the evaluation of the proposal to change sales force size. We compare two alternatives: a 20 per cent force addition versus a 10 per cent force reduction. What would the market and financial consequences be of pursuing the conversion strategy under these alternative scenarios? The formal model was run for 40 months, and it showed a number of controversial outcomes that became a focus of discussion in meetings with executives. We will review some of these outcomes to show how they contributed to understanding and consensus on the proposal. (Note that numerical values in the simulation runs have been modified for the sake of confidentiality. For the same reason, no financial results are shown, although the model did include a full set of accounting equations.)

Sales force reductions lower sales productivity

The left half of Figure 5 shows the alternative sales force scenarios. The right half of Figure 5 shows the corresponding behaviour of total sales effort, which is measured in thousands of hours per month and includes the effect of both overtime and sales force motivation. A comparison of the two simulation runs clearly shows that total sales effort is not perfectly correlated with the number of salesmen. During the first 6 months of the reduction scenario, sales force falls, but total sales effort actually increases slightly and only then begins to fall. After month six in the same scenario, sales force remains constant, but total sales effort continues to fall. Comparison of the shaded areas in the two runs shows that the force reduction causes a loss of sales effort that is much greater than can be accounted for by the smaller number of salesmen. In other words, force reductions cause the productivity of individual salesmen to fall, whereas additions sustain high sales productivity. This result ran counter to the opinion of some members of management and, therefore, demanded further explanation.

The model suggested that the behaviour of sales productivity could be explained in terms of sales force motivation, which was in turn related to the performance of the sales force against sales objectives. To illustrate this point we examined a simulation run of performance against product and revenue objectives, as shown in Figure 6. Under both scenarios performance against revenue objective falls as the size of the revenue-generating

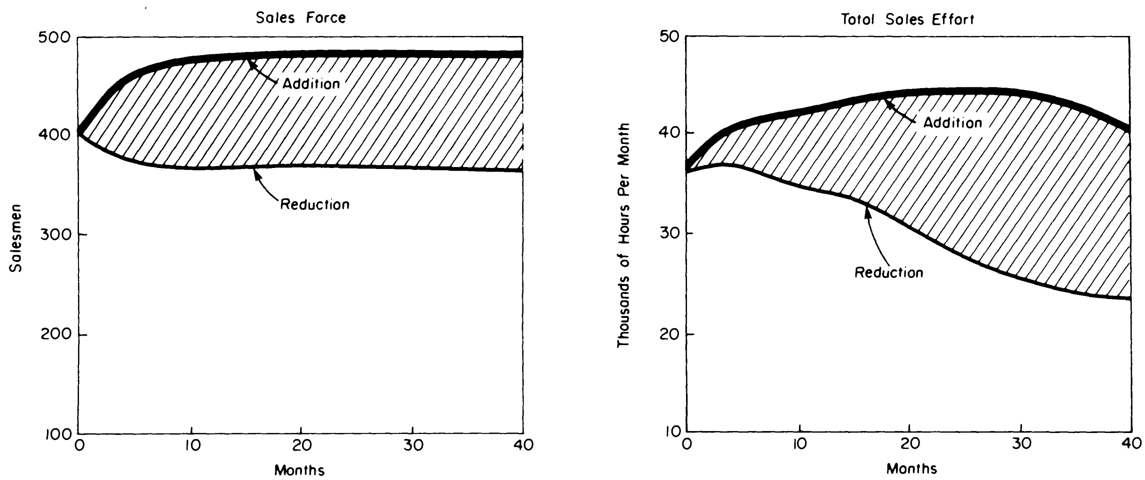

Figure 5. Force size and sales effort

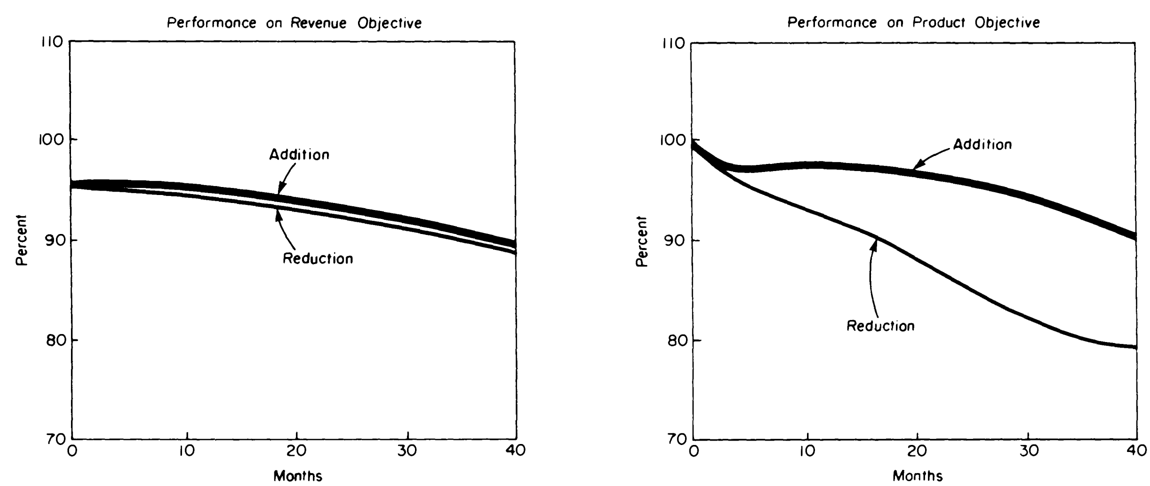

Figure 6. Performance against product and revenue objectives

base is eroded by competition. Erosion makes it progressively more difficult to repeat the revenue performance achieved in the past, thereby creating the potential for demotivation and lowered productivity. Force reductions exacerbate the motivation problems. Not only is it difficult to attain revenue objective but also product objective. Poor performance on both measures leads to a decline in motivation, a decline in sales effort, and a further deterioration in performance. By contrast, force additions relieve the danger of becoming trapped in this downward spiral by making it easier to attain the product objective.[4]

Sales force additions encourage the growth of competition

This result was particularly surprising to management, who had intuitively expected that sales force additions would act as a brake on competitive growth. Figure 7 shows the

[4] The lesson from the simulation runs has one subtle twist. It says, *given* that objectives are set on past performance, and *given* that the revenue-generating base is being eroded, force reductions will precipitate spiral decline in performance and motivation. However, changes in the objective-setting procedure introduced simultaneously with force reductions may overcome the difficulty, but that is another issue and was not an explicit part of the force reduction plans.

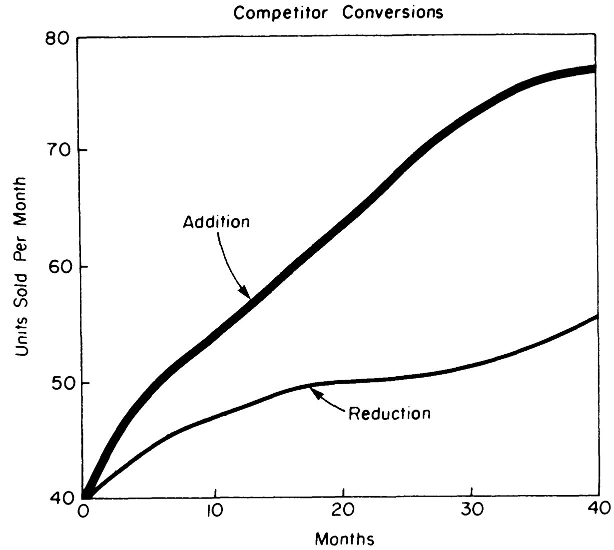

Figure 7. Competitor conversions

number of competitor conversions (by all competitor companies), starting at 40 systems per month. Under the force additions scenario conversions nearly doubled by the end of the run. Under the reductions scenario competitor growth is much more gradual, showing an increase of less than 40 per cent by the end of the run.

The reason that sales force additions lead to an increase in competitor conversions is a consequence of the structure of the market. Force additions increase proactive sales effort, which has the initial impact of informing customers of the existence and advantages of new-technology equipment. These customers can choose to convert to Datacom *or* competitor equipment. By supplying more product information to the market, the additional sales force gives a boost to the sales of competition (except in the extreme and unlikely situation that every customer is loyal to the company that informed him of the new equipment).

The behaviour has a simple and compelling explanation based on the decision-making structure of the market. Once the explanation has been given, it seems almost trivially obvious. Yet in the real strategy-evaluation process, it was surprising at first. The explanation provided sharper insight into the role of the sales force in market conversion.

Sales force additions depress market share

Market-share behaviour was another surprising result that ran counter to initial management intuition. Figure 8 shows Datacom's market share under the two sales force scenarios. Share starts above 90 per cent and in both cases declines to below 70 per cent by the end of the simulation run. With force additions, market share actually declines more quickly, because additions *accelerate* the conversion process. Customers convert sooner to new-technology equipment, and inevitably some of them go to the competition.

Intuition suggests there should be a market advantage from additional sales effort. The advantage, however, is one of completing the conversion process rapidly and, thereby, gaining a larger share of the new-technology base. Total market share (share of old *and* new systems) hides the advantage because it obscures the larger share of the *new* base resulting from force additions. Only when the conversion process is complete under both scenarios will market share properly reflect the advantage of the additions scenario. But the

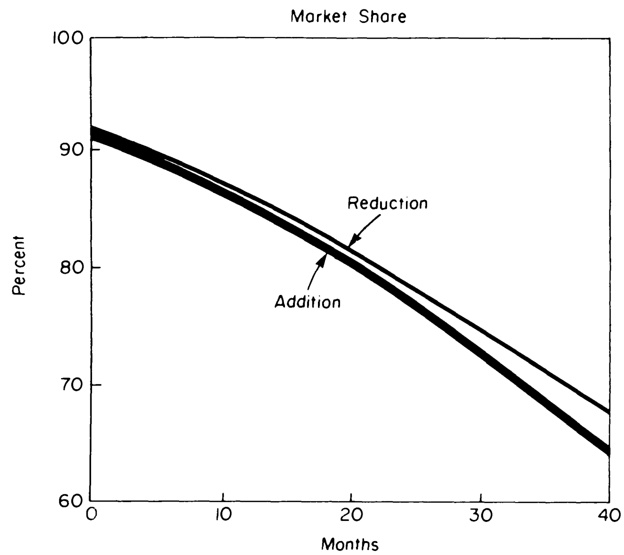

Figure 8. Market share

conversion takes more than 3 years! The simulation brings this fact to life, and dispels the expectation that force additions and market share are closely correlated.[5]

ASSESSING THE IMPACT OF THE MODEL

The impact of a strategy support model is often intangible. It is an insight generator and, therefore, differs from many common business models such as financial-planning and econometric models. The model does not get implemented in the sense that it is run weekly or monthly to produce a particular report or to execute a particular decision. By its very nature a strategy support model is involved in the amorphous to-and-fro of managerial and political debate. If it generates an insight, the insight can often quickly be absorbed into managerial thinking (mental models are, after all, much more agile than any formal simulation model, which is, by comparison, a rather cumbersome piece of intellectual infrastructure). The insight becomes part of intuition, particularly if it was backed with clear simulation analysis. Sometimes the model will form the basis for a specific recommendation but, usually, it will not contain the detail needed to state precisely how the recommendation should be translated into operating procedures. Like any strategic recommendation, it will need to pass through the usual communication and administrative channels to be fleshed out and receive operational identity.[6]

In the market-strategy case it was clear that the model had an impact on management opinion in a number of areas. For example, the insight that force reductions can precipitate a spiral of declining productivity and motivation eroded executive enthusiasm for such a

[5] It should be added that neither scenario shows very attractive market-share behaviour. Further simulation experiments show that combination policies involving price initiatives, force additions, and more flexible objective setting can restrict market-share erosion to less than 10 per cent.

[6] Lyneis (1981) has made the point that system dynamics models used for strategy purposes should be constructed at a level of detail that enables them to interact with the detailed planning procedures of an organization. In that way they become more tangibly integrated into company operations and are in a sense implemented. Although there is satisfaction in such tangible outcomes, the formal model loses its agility and becomes less effective as a basis for argument.

measure. In fact, a moderate increase in sales force was approved. The insight that force additions depress market share served to sharpen understanding into the short- and long-run trade-offs involved in accelerating the market conversion. This new understanding brought into question the desirability of rapid conversion as a goal in its own right, and led to further work on combination changes in force size and product price.

There are other, less direct indications of the impact of a strategy support model. Since the model becomes an integral part of the strategic dialogue in the company, it is, like any other member of the management team, judged useful if it continues to hold the interest and attention of management. Admittedly this is not a very tangible or scientific measure of impact, but it is a valid political measure of impact. The market-strategy model received ample attention from senior management. It was used in numerous high-level meetings, spanning 6 months, and its range of strategic enquiry was gradually expanded to include pricing and objective setting.

CONCLUSION

Strategy development remains an intuitive, intangible activity that is still a long way from yielding to formal analysis. Executives must be the primary architects of strategy. Where formal analysis can play a role is in strategy support—providing support in deducing the consequences of particular strategic proposals. It is in deducing consequences that the human mind is often inaccurate and misleading, even when starting from a clear understanding of the organizational elements of the strategy.

We have suggested that a valuable tool for strategy support is a formal simulation model that can act out the consequences of a new strategy in its full organizational setting. The formal model should contain the policies and communication and control structure of the organization through which strategy will be implemented.

However, the real key to effective strategy support is not simply *having* a formal model, but using it in dialogue and discussion with the managers responsible for the strategy. The formal model is used in interactive support or challenge of managerial intuition. In this dialectic role, the model is removed from the pedestal of the infallible black box to occupy a more modest (and appropriate) position as a complement to the powers of deductive thinking of a management team. The formal model should be used to set up scenarios. Managers should be challenged to think through the consequences of the scenarios for themselves. Their intuitive deductions and the formal deductions of the model can then be played off one against the other in discussion. Any differences in deduced outcome should be seized upon as opportunities for improving insight or correcting the formal model.

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REFERENCES

Cyert, R. M., H. A. Simon and D. B. Trow. 'Observations of a business decision', *Journal of Business*, **29**, 1956, pp. 237-248.

Forrester, Jay W. *Industrial Dynamics*, The MIT Press, Cambridge, 1961.

Hall, R. I. 'A system pathology of an organization: the rise and fall of the old Saturday Evening Post', *Administrative Science Quarterly*, **21** (2), June 1976, pp. 185-211.

Keen, P. G. W. and M. S. Scott-Morton. *Decision Support Systems*, Addison-Wesley, Reading, Massachusetts, 1978.

Lyneis, J. M. *Corporate Planning and Policy Design—A System Dynamics Approach,* The MIT Press, Cambridge, 1980.

Lyneis, J. M. 'Increasing the effectiveness of corporate policy models', *Proceedings of the 1981 System Dynamics Research Conference*, Rensselaerville, NY, 14-17 October 1981, pp. 204-213.

Mason, R. O. 'A dialectical approach to strategic planning', *Management Science*, **15** (8), 1969, pp. B403-B414.

Mass, N. J. 'Diagnosing surprise model behavior: a tool for evolving behavioral and policy insight', *Proceedings of the 1981 System Dynamics Research Conference*, Rensselaerville, NY, 14-17 October 1981, pp. 254-272. Also available as *M.I.T. System Dynamics Group Working Paper D-3323*, M.I.T. Sloan School of Management, Cambridge, MA 02139, 1981.

Mitroff, I. I. and J. R. Emshoff. 'On strategic assumption-making: a dialectical approach to policy and planning', *Academy of Management Review*, **4**, 1979, pp. 1-12.

Mitroff, I. I., R. O. Mason and V. P. Barabba. 'Policy as argument—a logic for ill-structured decision problems', *Management Science*, **28** (12), December 1982, pp. 1391—1404.

Morecroft, J. D. W. 'System dynamics: portraying bounded rationality', *Omega*, **11** (2), March 1983, pp. 131-142.

Morecroft, J. D. W. 'Aspects of marketing strategy in the office equipment market', *System Dynamics Group Working Paper D-3352*, Sloan School of Management, M.I.T., Cambridge, MA 02139, August 1982.

Probert, D. E. 'System dynamics modeling within the British telecommunications business', *Dynamica*, **8** (Part II), Winter 1982, pp. 69-81.

Roberts, E. B. 'Strategies for effective implementation of complex corporate models', *Interfaces*, **8** (1), November 1977.

Schon, D. A. 'Conversational planning', forthcoming in Bennis, W. G., K. D. Benne and R. Chin (eds), *The Planning of Change*, Holt, Reinhart and Winston, New York, 1983.

Simon, H. A. 'Designing organizations for an information rich world', in Greenburger, M. (ed.) *Computer Communications and Public Interest*, The John Hopkins Press, Baltimore, 1971, pp. 38-52.