Helping Management Teams to Model:

A Project in the Consumer Electronics Industry.

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Abstract

We have been using system dynamics with the management team of a consumer electronics company to investigate problems in training, inventory control and debt handling. In this paper we describe how the modelling approach was introduced to the company and subsequently used to support management team decision making. A small model of a direct mail campaign shows how the modelling process improved team understanding of inventory and demand dynamics. Building on experience from the project we comment on conditions for model building (training, team make-up, facilitation, model size, role of the computer)that encourage the active participation of management teams.

Introduction

Recently modellers has been experimenting with ways to involve management teams closely in all stages of modelling from conceptualization to simulation (among others Richmond 1987, Morecroft et al. 1989). These experiments have raised the question of how models improve decision making and organizational learning (De Geus 1988, Vennix et al 1990a, Senge et al. 1990, Senge 1990). One result has been to emphasize the importance of knowledge elicitation, facilitation and group work - in short, the social process in which the model is embedded (Vennix et al. 1990b, Morecroft et al 1990).

In this paper we describe a case where a number of very small models were built for managers of a consumer electronics retailer. We comment on the training of team members and report their group work for mapping and what-if simulation. We describe a small model of a direct mail campaign created by the team.

The start of the project

The project took place in a division of a UK electronics company. The division has a large number of retail outlets throughout the UK. The main business of the division is leasing of TV's and VCR's. The company has hundreds of thousands of customers who have leased one or more items. There is a wide range of sets with combinations of features that are almost unlimited. Over the past few years the company has grown rapidly.

The project started when the financial manager from division headquarters took part in a one week course in Strategic Modelling at London Business School. The course, which is designed for senior managers, introduces the participants to systems thinking and feedback modelling. During the week the participants see the broad application of modelling in cases that deal with growth management, human resource policy, technology transitions, competitive strategy and manufacturing policy. They learn about feedback loops, mapping and problem structuring. They experiment with STELLA or Ithink in small group workshops, and spend two days structuring and modelling their own strategic problem with a team of fellow participants. The program include lectures, case discussions, models, games and workshops.

Shortly after the course, the financial manager decided that he would like to introduce the approach to other members of his division. Therefore he arranged a two-day training workshop for the headquarters management team comprising 8 people. Day 1 of the workshop consisted of an introduction to modelling and simulation, followed by a team conceptualization exercise on recruitment and training of the sales force. The team created a shared 'map' on a whiteboard showing stocks and flows of sales/service staff and the 'logic' of recruitment. Most of the second day was used in participative computer workshops to explore a full-fledged algebraic simulation model of recruitment and training, (developed in the late evening of day 1 by the workshop leaders, based on the map) and to try-out scenarios and what-ifs. In addition participants had more hands-on experience with STELLA.

Two months later the financial manager arranged a series of problem focused workshops addressing current management problems, mainly in the areas of inventory control, distribution and retailing. A small team devoted three short meetings to each issue. Most of the team members had attended the training workshop and were assisted by one experienced modeller/facilitator. Some participants took part in the entire set of meetings covering all issues, while others concentrated on a particular issue.

Background for one of the models

The model we discuss here represents a part of the business known as fleet management. Fleet management deals with the flow of models through the customer base. Here's how it works. Let's imagine that the company receives a number of sets of a new model. There are two ways in which the sets can be leased out. A new customer, who has not rented before, may visit a store and rent one. Alternatively the company can write to people who already have a one or two-year old model. Some of these people will find the new model more attractive than their current model, and decide to upgrade. The company will then receive in exchange a number of one to two year old models. So the marketing department writes to customers who have three to four year old models and asks whether they are interested in another model, not a new one this time, but the return model. This process of exchange may continue into four or five different 'age' segments of customers. Each segment will get an upgrade i.e. a newer model, and pay a little more rental.

This exchange system can be difficult to manage. One of the fundamental problems is to balance the supply from one customer segment (say owners of one to two year old sets), with demand from the adjacent customer segment (owners of three to four year old sets). Often the company writes to all segments of the market at the same time. This means that company managers have to guess the response in one segment (the percentage of customers who are likely to upgrade), then use this estimate to decide the scale of the direct mail campaign in the succeeding segment, including an estimate of this segment's response rate and so on!! An incorrect estimate of response rate can have trickle-down consequences in the form of set shortages or surpluses.

The model focuses on the dynamics of a direct-mail campaign and the possible effects of error in an estimate of a response rate in one segment. Interestingly this focused model arose during broad ranging discussion about inventory management. During the discussion the specific issue of direct mail campaigns surfaced and seemed worthy of closer scrutiny.

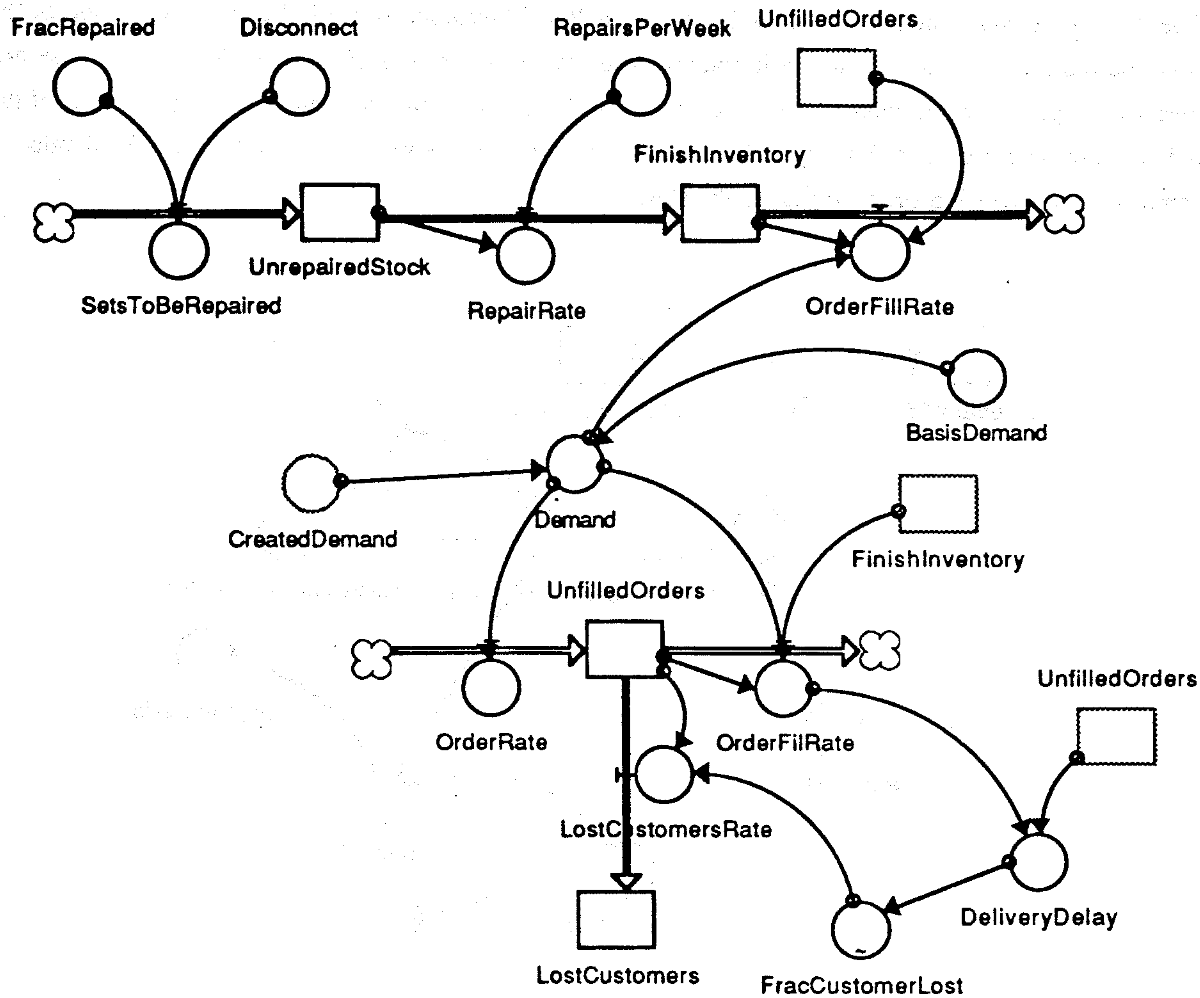

Figure 1: A STELLA map to help understand the dynamics of a direct mail-campaign. The diagram shows inventory and 'customer' control. The map used in actual team meetings was slightly more complex, but still small enough to allow for fast and easy communication.

The team consisted of six people from the company and one model builder. The team members used two half-day meetings to discuss mail campaigns. During the first half-day the team discussed the decision to launch a campaign: what information is the decision based on, how do customers react to a campaign, how do you choose the right campaign size?

The mail-campaign model

Figures 1 and 2 show the STELLA map developed during the meetings. Imagine that each week a number of sets (i.e. TV's or VCR's) are disconnected, and arrive at a service centre. Such disconnections are a consequence of ongoing fleet management as well as customer choice. Some of the sets are not worth repairing, some need major improvements, and others need painting and cleaning. The parts of the sets which are going to be repaired are stored in Unrepaired Stock. As soon as a technician has time, the sets are repaired and are then ready to be rented out again. Since it is only old models that are disconnected it is difficult to rent them out again without a special promotion through a direct-mail campaign.

The decision to run a campaign is made by looking at Total Inventory, which in Figure 2 is the sum of the repaired old sets (shown as Finished Inventory), and old sets (shown as Unrepaired Stock). As these two inventories grow, a small number are rented out (called Basic Demand in Figure 1), but only a few of the old sets can be rented out this way. When the total number of sets in stock exceeds a threshold value, a campaign is launched in order to reduce the stock.

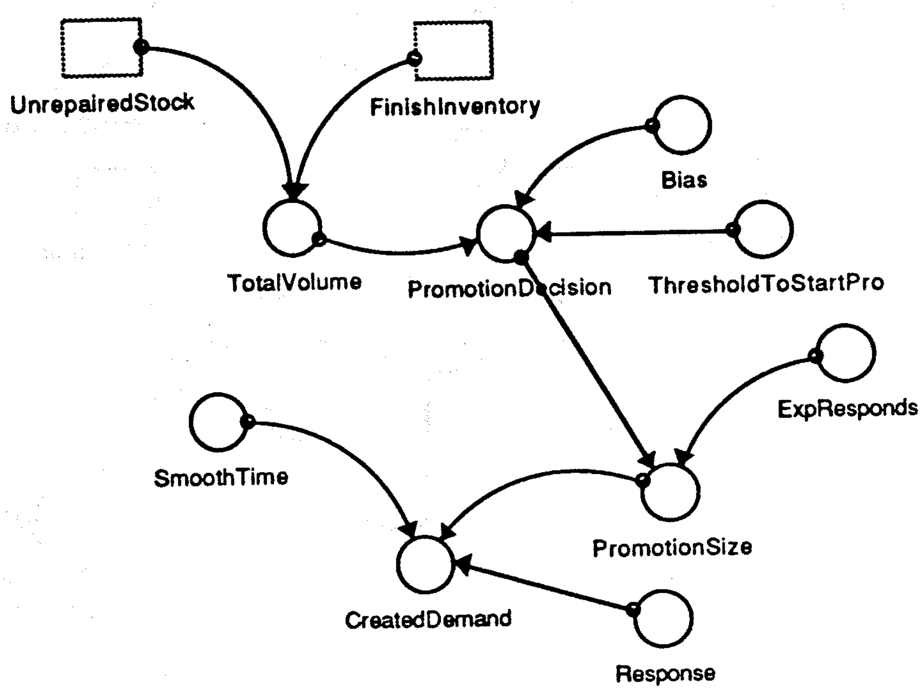

Figure 2: This map represents the decision to launch a direct mail campaign. The decision is based on the total inventory and a threshold inventory size.

A campaign manager may be more or less optimistic in applying the threshold, depending on his knowledge of incoming sets in the near future. The degree of optimism is represented by a 'bias' factor. The promotion size depends on the expected number of customer responses (shown as Exp Response) which represents the proportion of people who will say yes to the offer of an upgrade. This expectation is based on past experience of promotion campaigns and also takes account of the kind of equipment on offer - TV's or VCR's.

The campaign creates a demand, which is particularly high in the first week, and then falls gradually during subsequent weeks. This surge in demand will empty or almost empty the inventory of sets of the campaign model. But stockouts can easily occur if the response rate is higher than expected. A customer receives a letter, decides that he/she wants the campaign model, goes to the shop, and then discovers a set is not available on that day or even next week. Because of the delay, the customer loses interest and the company loses an order. In the model this loss effect is captured using a graph-function that shows how fewer and fewer customers are willing to rent a TV or VCR as delivery delay rises. The formulation prompted a long but useful discussion of the shape of the graph. The team finally agreed on two kinds of customers with different preferences: new customers who are reluctant to wait and old customers who are more patient in getting their 'new' model. The graphs are shown in Figure 3.

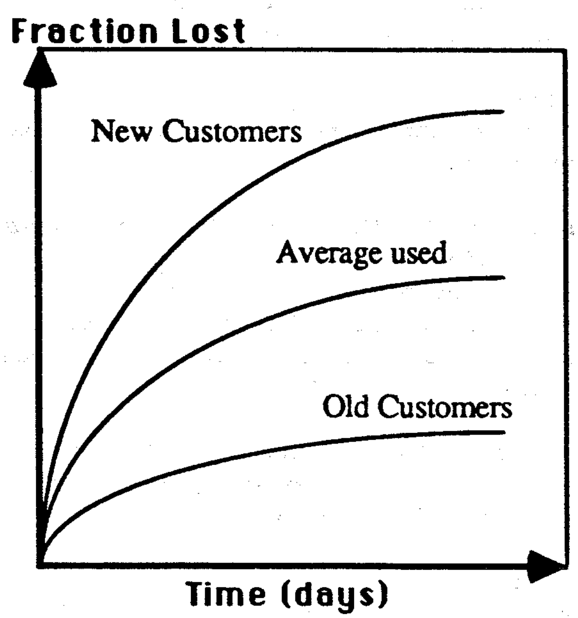

Figure 3: The graph shows how the fraction of customers lost varies with delivery delay. The team defined two groups of customers, new customers who need their set quickly and upgrading customers who, since they already have a set, are more likely to be patient (the numbers from the axis are removed for confidentiality)

When necessary the team saw the equations behind the model, as well as the STELLA maps. There is no reason why 'friendly' algebra should not be introduced to the team, as long as it is well documented. A sample is shown in Figure 4. Each equation uses terminology that is familiar to the team. Each equation has a note explaining the algebra in plain terms and indicating the dimensions (units of measure) of the lefthand variable. Presenting the algebra in this way encourages the team to be precise and explicit in their discussion.

Simulations of the model

The modelling process promoted a discussion on what could be done to improve control of the mail-campaigns. Campaigns normally involve mailing tens of thousands of letters throughout the whole area covered by the division. One solution, discussed by the team, was to phase the campaigns: send a small number of letters initially, wait until the response is known, mail the next section of the campaign, then wait and so on. This proposal was tested using the model, and evaluated by comparing customer loss with the basecase. The simulation clearly showed that phasing would be advantageous, and therefore reinforced the team's expectations.

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Bias = 1
{ if Bias > 1 then the promotion size (the number of letters mailed
out) is amid at generating demand that exceed the number of sets
currently in stock(dimensionless)}

ThresholdToStartPro = X
{Controls how large the inventory should be before a promotion is
started (Number of sets)}

PromotionDecision = If TotalInventory > ThresholdToStartPro Then
(TotalInventory * Bias) Else 0
{A campaign is launched when ever inventory is grater than the
threshold. The number of sets in the campaign is geared to available
total inventory, but can be increased or decreased according to the
assumed bias(numbers of sets)}

PromotionSize = PromotionDecision / ExpResponse
{The size of the direct mail campaign, based on inventory and expected
response rate(number of Letters)}

ExpResponse = 0.1
{Expected response rate from the direct-mail campaign (fraction of
mailed letters)}

Response = 0.1
{Actual Response from direct mail campaign(fraction of mailed letters)}
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Figure 4: Friendly algebra from a part of model which represents the decision to launch a direct mail campaign.

The model was also simulated to explore the effect on performance of error in response rate. Figure 5 shows two simulations. The top chart results from a response rate half a percent higher then expected and leads to 200 lost customers. The bottom chart results from a response rate half a percent lower than expected. There are virtually no lost customers. The simulation generated discussion on the process of estimating response rate and the importance of doing it right. No one had a proposal for improving the accuracy of the estimating process. But recognizing that error was inevitable, the team agreed that the campaign manager should be pessimistic when deciding how many letters to send out.

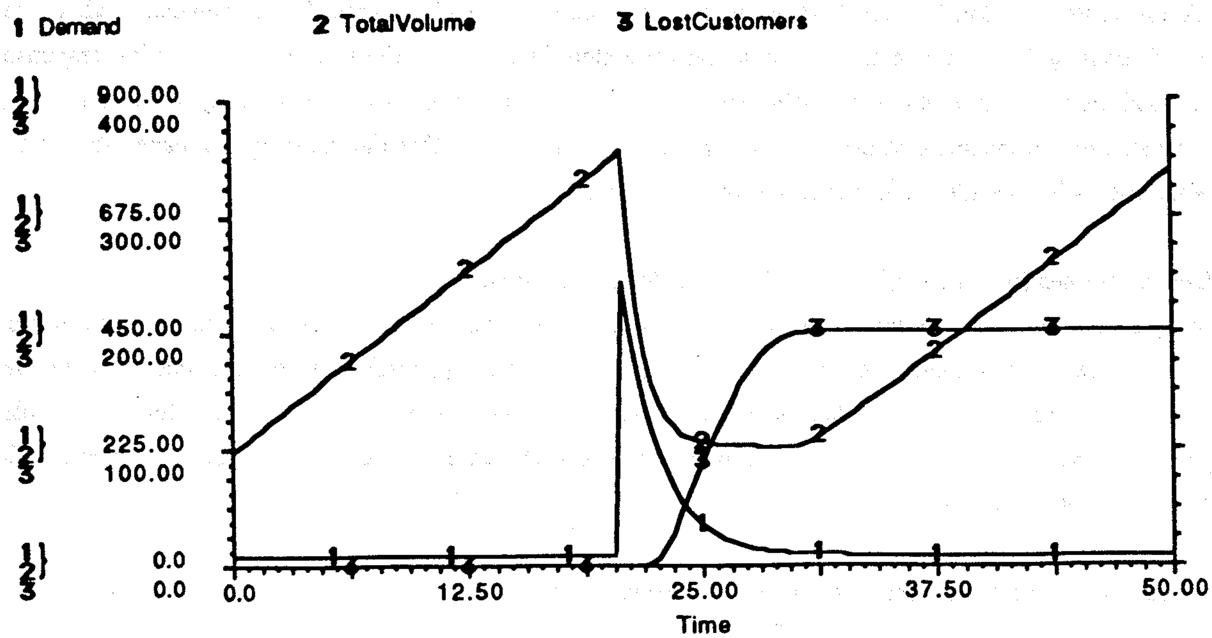
Lessons learned from the project about the model building process.

Many model builders have now recognized the importance of involving the client in the modelling process, if the model is to influence management thinking. A variety of approaches have been described in the literature, differing in the modelling activities opened to managers, the preparation of the teams, the role played by the facilitator and the size of model developed. Here we compare features of our process with others that have been reported.

In this project the factors that established involvement were:

- The financial manager attended a one-week strategic modelling course.
- The divisional management team allocated two days to an on-site training workshop.
- The training workshop involved a group conceptualization exercise on a problem of interest to the management team (sales force recruitment and training). The team's shared map was converted into a full-fledged, through crude, algebraic simulation model.
- The team members experimented, hands-on, with the modelling software.
- Problem focused workshops addressed current management problems such as inventory control, debt handling and promotion campaigns.
- All models were small and transparent.
- Models produced quick results.
- The time devoted to each model/issue was relatively short, typically 3 to 4 meetings spread-over 3-5 weeks.
- The team members controlled the modelling process - the facilitator did not impose a model.
- The team members all had operating responsibility. They were not in a staff function.

The two day workshop had some similarities with the strategic forum described in Richmond (1987). Participants got hands-on experience using Macintosh and STELLA. They took part in a 'live' conceptualization and model-building exercise on a subject of their own choice (the topic was not prepared in advance but arose during discussion). Although it of course was a crude, first-cut model the team was nevertheless able to recognize their own problem in the model. The main difference in comparison with the forum was that the principal purpose of the workshop was to provide training and a demonstration of the approach, rather than to examine a pre-specified strategic problem. The exercise convinced the management team to invest more time.



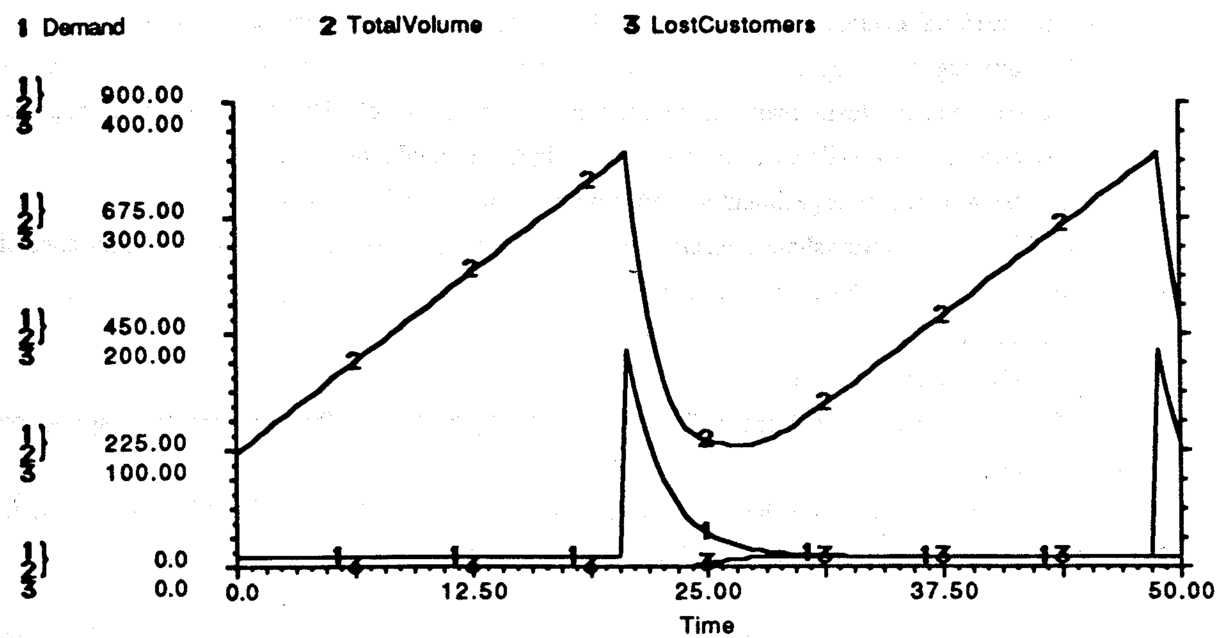


Figure 5: Simulation results from the model. The upper graph shows a simulation where the estimated response was half a percent lower than the actual, and the lower graph a simulation were the estimated response were half a percent higher than the actual. The "performance" parameter in this case is Lost Customers.

We decided to build very small models (like the direct mail campaign model) containing as few as 20 equations and never more than 50. This choice of model size can be seen as part of a continuing trend to explore how small a model can be and yet still be useful to a management team. Business modellers have often built models containing thousands of equations: many still do. More recently strategic models have been built containing between 50 and 200 equations, Morecroft et al. (1989), Verburgh et al (1990). Is there a lower limit to size? What are the advantages and disadvantages of a very small model? The advantages in this case seem to lie in areas such as communication and team composition. Because the models were small, and each new issue was started from scratch, it was quite easy to bring in new team members who had not participated in the original two day workshop. Typically for each issue modelled one or two new members were introduced; normally people with special expertise or responsibilities in the area of discussion. For example people from the accounting department joined when the modelling issue was debt handling. These new members contributed to the process in much the same way as the core team (the members who had participated in the two day workshop) of which there always were 3 or 4 in the team.

Small size has the advantage of yielding fast 'results' and allowing a variety of issues to be covered. Quick results can help win management time and avoid the problem, noted in Morecroft et al. (1989), of team members who feel they are giving more information than they are receiving. Each topic took about 3-4 meetings over a period of 3-5 weeks close to Richmond (1987) who suggests a process covering 4-6 weeks but much shorter than Morecroft et al. (1989) whose project spanned 6 months. Richmond's (1987) project culminates in a one day strategic forum involving group modelling workshops and participants' presentations. The workshop material is prepared in advance by the model builder. Here we involved the team in the whole modelling process covering conceptualization, formulation, testing and evaluation. As the team participated in everything - the resulting model could be smaller, yet still credible, than a model built by an expert based on the team's conceptualization.

There are of course disadvantages to using very small models. The major disadvantage is the difficulty of credibly representing a strategic problem with a small number of concepts. Morecroft et al's (1989) model of growth strategy interrelated marketing, customers, production and capacity expansion. Verburgh et al's health care model connected patient flow, cost and detailed factors influencing patients' and doctors' decision making. In our case each model covered a limited portion of the business. We could have chosen to develop one integrated model of ordering, inventory control, installation and customers' reaction. Such a model would have given a more complete view of the company and its business problems, but at the expense of less involvement by members of the organization. The modeller has to manage the model's credibility which stems from both team involvement and the team's perception of the adequacy of the model. There is a trade-off between size, adequacy and involvement. In this case very small models paid off.

The project was carried out with a management team that had operating responsibility (the management of the division). This is similar to Morecroft et al. (1989) where the project involved the managing director and senior functional managers throughout, but different from Verburgh et al.(1990) where the model building was carried out by professional model builders based on a conceptual model developed with the users. Without the involvement of key decisionmakers it is doubtful that such small models could have been influential.

The facilitator managed team expectations. He made clear to team members from the outset that models in this project were not intended to provide THE answer or THE forecast. Much of the insight from the project came from conceptualization, mapping and from discussions provoked during this process. The team accepted this view of model purpose and did not become preoccupied with precise numerical accuracy of parameters or simulations.

The project had one unanticipated benefit. Participants talked of improved communication among the management team in their daily work. The process developed a common language and shared understanding of business problems that extended beyond the confines of the modelling project into everyday management discussion and conventional management team meetings..

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