南華大學九十九學年度 博士班 招生考試試題卷

系所別：企業管理系管理科學博士班

科　目：管理論文評析（二）

<u>請用中文作答否則不予計分</u>

1. 請說明何謂 HQ strategy 與 client strategy? 並提出你(妳)對圖 9.a 中為何 HQ strategy 為何較差的看法? (20%)
2. 請詳細說明圖 3 所表達的意義為何? (20%)
3. 系統動態模式的信賴驗證主要可分那兩大類?說明這兩大類主要在驗證什麼? (20%)
4. 說明建立系統動態模式的步驟為何? (20%)
5. 說明本研究的主要目標與研究問題分別為何? (20%)

A system dynamics model as a decision aid in evaluating and communicating complex market entry strategies

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Abstract

Developing a market entry strategy is a critical activity for any firm but all the more so for those firms that wish to successfully compete in today's challenging global economy. Unfortunately, developing a market entry strategy is an ill-structured and complex activity for which structured approaches have proven inadequate. In less structured situations, data driven and model based decision-support systems (DSS) have been shown to be of significant help to decision-makers faced with such tasks. Getting managers to use such systems, however, is a major challenge that has been the subject of considerable research in the field of DSS. As far back as the 1970's scholars identified reasons why managers are reluctant to use such systems. Among the most often cited reasons why managers are reluctant to use these systems are: they do not understand the model inherent in the DSS; they do not know when to use them; they are unable to extend the use of the DSS; or they are unable to explain the model or its output to others. This paper describes the process of building a system dynamics model that can be employed by marketing managers to help them test the effectiveness of different market entry strategies, and equally important to help them to explain the system's logic and output. The model was built in a bottom-up fashion with the help of a team of marketing managers. In this way the team that helped build the model not only felt a sense of ownership concerning the model, but were also be able to better explain and defend their proposed strategy.

Keywords: System dynamics; Market entrance strategy; Ill-structured; Cognitive support; Heuristics

The concept of using computer-based information systems to support decision-making has existed for well over 20 years and many systems have been developed to aid corporate managers. The literature in marketing is replete with models derived from marketing and economics such as time-series data models to extrapolate exogenous variables or state space models to integrate econometric analyses with normative decision-making to address many problems faced by managers (cf. Naik and Raman, 2003). In marketing, many activities often exert a catalytic influence on other activities. For example product samples or collateral materials may not directly increase sales of prescription drugs but may enhance the effectiveness of detailing efforts (Parson and Vanden Abeele, 1981).

While existing modeling approaches can be linked to normative decision-making, in ill-structured and dynamic problem situations managers tend to follow their intuition rather than rely on computer-based information systems (Crockett, 1992). Intuition may lead to decision rules which are locally rational but often disregard the feedback structure embedded in complex systems. Sterman (1989) states that "misconceptions of feedback" reflect a failure on the part of the decision-maker to access correctly the nature and significance of the causal structure of the system particularly between the decision and the environment. In a decision environment where a group of business managers need to find an answer to a complex problem, traditional equation driven models are not easy to understand. This means that in most instances they cannot be used to easily and satisfactorily communicate complex ideas. Drucker (1974) noted that while formulae are the tools of management scientists they are of little interest to the manager. A cognitive map, on the other hand, makes the decision environment more explicit and captures the cause and effect of the decision-makers' values (Axelrod and Myril, 1976). They make mental models more explicit and therefore easier to articulate and communicate. McKenney and Keen (1974) argued that the central factor determining whether a manager will use a model or other cognitive aid is the extent to which it fits his style of thinking.

More recently, DeLone and McLean (1992, 2003) propose that in order for any information/decision system to be accepted and used, it must be compatible with the manager's approach to problem solving, it must be perceived as being useful, and it must be easy to use. The objective of this paper is to illustrate how a system dynamics approach can be used to help a team of managers to communicate complex ideas to senior management and to support their recommendations, in this case, a recommendation against a global market entrance strategy. Thus, the problem dimension for this study was twofold. First, the main challenge for this project was to provide scientific evidence to senior management as to why a global market entrance strategy would not achieve its expected results in a local market. Second, it became necessary to find a way to communicate the essence of a model being used to arrive at a strategy decision to those whose mental models do not correspond with those of managers presenting the argument. To address the former the author employed a modeling-simulation package. This was done so as to make the mental model of the decision-maker explicit and to help conceptualize a dynamic description of the market system. The flow diagrams in system dynamics are an excellent tool for helping improve communication with managers (Stenberg, 1980). They also can help elicit the perception of managers concerning how the system works (Hall and Roger, 1976) as well as help to instill confidence in the model structure and behavior.

System dynamics is a well established methodology that can be employed to provide managers with insights about market behavior when launching new products (cf. Homer, 1996; Lyneis, 2000; Sterman, 1989; Urban et al., 1990). The roots of system dynamics go back to engineering control systems and the theory of information feedback systems (Morecroft, 1987). In 1956, Jay Forrester reshaped a rather mathematical, engineering control systems approach into an analysis method for the visualization and simulation of feedback dynamics. Richardson (1996) defines system dynamics as "a computer-aided approach to policy analysis and design. With origins in servomechanisms, engineering and management, the approach uses a perspective based on information feedback and circular causality to understand the dynamics of complex social systems".

Determining how much to invest in product quality or product attractiveness, when to introduce a new product, how much to spend on marketing, and how to price the product are all critical management decisions that can dramatically affect a market entry strategy. Using system dynamics can help managers to test different strategies in a risk-free environment and then chose the strategy with the highest likelihood for success.

Even though system dynamics is an established management tool in many firms, it has not received the same level of acceptance as other management tools.

The simulation model presented in this paper was used as a decision-support tool to help a team of managers (the client) with the creation of a viable strategy for launching an innovative pharmaceutical, and to provide evidence as to why the global strategy might or might not achieve the desired objectives. For confidentiality, company or product name are omitted in this paper. Furthermore, some of the specific details in the model have been altered, but the overall structure and framework described in this paper are accurate. Given the professional interest in the methodology of system dynamics, surprisingly little consideration has been given to how different models can be used in marketing. This paper proposes such a methodology to test management policies and to communicate the cause and effect of different market entrance strategies for a new pharmaceutical product.

1. Market conditions

Launching a new product in a competitive market is a complex and challenging task for a decision-maker, where time pressure, incomplete information, organizational context and selfish motivation can strongly influence a decision (Sterman, 2000). As a result, many decisions turn out to be incorrect. Due to the complex and highly unstructured nature of a market launch decision the implications of a proposed launch strategy cannot be known with any degree of certainty at the time a decision is made.

Not so long ago pharmaceutical companies invested hundreds of millions of dollars in developing a new medicine and allocated virtually unlimited funds to marketing. Most new drugs were improvements on their predecessors, so selling the product was relatively simple — have your sales force tell doctors about the new product, refer to the merits of its predecessor, and the doctors will prescribe it. In fact, almost proportionally, the more sales reps contacted doctors, the more they would prescribe. Via frequent visits to virtually every doctor in the country, the sales force became, not surprisingly, the main communication tool for the industry. Recently, however, this marketing approach has changed due to an increasing pressure from government to lower healthcare costs. Accordingly, market forces have changed the way doctors prescribe drugs. Like any other service provider, doctors must find ways to improve the services they offer to their patients or risk losing them (and the income) to some competitor. At the same time, pharmaceutical companies have become an easy target for politics in a bid to cut overall healthcare costs.

The increasing cost pressure, the increase in better informed patients demanding quality service, and the rising competition among doctors has changed the way pharmaceutical companies approach the market with a new drug. Some pharmaceutical companies have begun to approach patients directly via marketing campaigns similar to those of fast moving consumer goods companies. The assumption underlying a direct-to-consumer approach (within the legal boundaries as they apply to advertising of prescription drugs) is to establish brand preference. Patients with a brand preference then could presumably persuade the doctor to write the brand name of choice on their prescription.

Other companies have positioned themselves to market across borders in order to take advantage of economies of scale. Rather than employing localized strategies to launch a new drug, companies go for global or at least pan-European strategies, which local markets have to adopt. The market launch strategy proposed by the client's head office was basically a direct-to-consumer approach, although it did not provide sufficient enough money to support targeting of and medical marketing to the doctors. Thus the local client was faced with the challenge of convincing the company's head office that, for the particular market, the proposed global strategy would not yield the desired results and should be replaced by a localized strategy before attempting a global one.

2. Methodology

The main objective of this study was to assist corporate management with a market entry decision-making by formulating a decision-support tool that would enable the testing of a wide range of policy options and help them better understand interactions among various factors which influence market success for management. While many more things happen in the real world than we have models for (Little 1984) it is the process to make the decision environment explicit, which helps management to gain confidence in the model.

As Zuboff (1988) concludes, "behind every method is a belief." The author's belief is that system dynamics is well suited not only to theory development but also to understanding complex behavior associated with strategy setting. This belief is based upon the following assumptions: (1) time is an important element in constructing a conceptual framework for capturing the interactions and interventions during market entrance; (2) while longitudinal process models employed in research often provide a limited (linear) perspective on time (Abbot 1995), a non-linear method such as system dynamics consists of multiple measurements of both independent and dependent variables and graphs the resulting data over time; (3) predictions made using a non-linear modeling approach are more qualitative than the predictions made using traditional approaches (Svyantek and Brown 2000); (4) an actor's interpretation of an action and its effect is part of a larger dynamic context (Sterman, 1989); (5) system dynamics models have long been associated with the notion that complex systems are counterintuitive — that the behavior of a complex system is often different from what one expects (Forrester 1961).

2.1. Creating ownership

Lane (1994) concludes that "clients' ideas must not just be in a model, they must be seen to be in a model", which means that involving the client throughout all stages of the model building process creates ownership. Building system dynamics models with client groups has a long tradition and is well documented (cf. Morecroft and Sterman, 1994; Richardson and Andersen, 1995; Vennix, 1996; Andersen et al., 1997). In the literature, several approaches to group model building are discussed (cf. Richardson and Pugh, 1981; Roberts et al., 1983; Vennix, 1994). These approaches varying in terms of numbers and arrangements of stages and the activities involved in the development process.

Richardson and Pugh (1981) define seven stages in building a system dynamics model: problem identification and definition, system conceptualization, model formulation, analysis of model behavior, model evaluation, policy analysis, and model use or implementation. Roberts et al. (1983) suggest a similar approach to constructing a simulation model. The modeling intervention for the local client team followed an approach similar to that of Richardson and Pugh. Unfortunately, the team was not able to encourage people from the client's head office to participate in the process. Their involvement would have helped foster ownership of the model at an early stage of the modeling intervention.

Often it is the senior management who call in consultants to help solve a particular problem. However, in this case, a line-manager took the initiative to call for external help. Thus, in this bottom-up approach, the first task was to convince the country manager that system dynamics is the right tool to solve his problem. A workshop with the project team and country manager was organized to introduce system dynamics in broad terms and illustrate the method using some practical examples. In discussions with the management team the author stressed the fact that his role in the project team was not that of a "teacher" but facilitator and that the simulation model would not be built behind closed doors but together with the team. The author also emphasized that this project would not only help the core client team involved in building the model to know better what they know already, but in all likelihood would also help reveal the underlying dynamics of what they do not know. Furthermore, it was important to have the county manager approve the project in order develop a tool that would not only enable him to understand the tool so that he could use the results to support his arguments against the global strategy but also so that the consultants would but integrated into the project.

3. Model conceptualization

As noted above, in following the established framework to build a model with a client team the first part of the intervention was to discuss problem definition and boundary issues for the

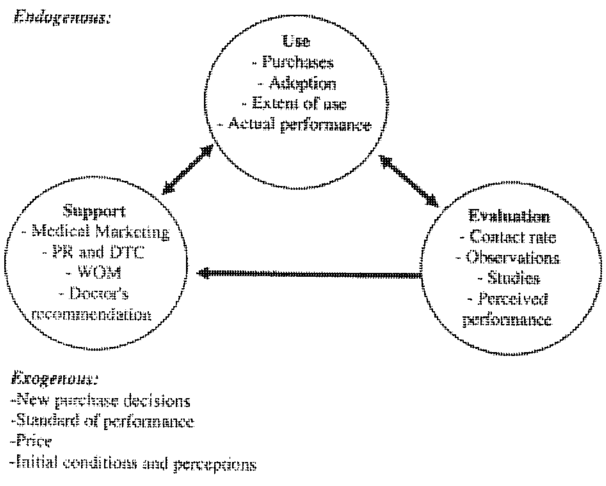

Fig. 1. Key variables and boundary of model. Adopted from Homer, J. B. (1987). "A Diffusion Model with Application to Evolving Medical Technologies." Technological Forecasting and Social Change 31(3): 197–218.

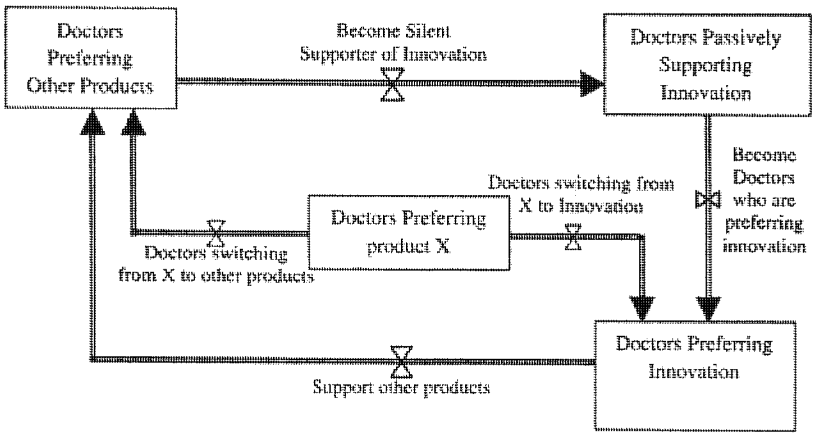

Fig. 2. Stock-and-flow structure of doctors influencing diffusion of new product.

model. In an effort to study market dynamics under different strategies the following questions had to be addressed:

i. What is the likely percentage of customers that will switch to the new product?
ii. How does the sales force affect prescription behavior of doctors and ordering cycle times?
iii. How do pre-marketing activities enhance word-of-mouth with opinion leaders?
iv. How do marketing activities influence diffusion of the new product among the target audience?
v. What is the market value of the new product over time?

The sector map shown in Fig. 1 provides a high-level view of the modeling project with key endogenous and exogenous variables that influence the diffusion of the new product. While the sector map only shows high-level variables, the simulation model consists of a more detailed view of the attributes that determine diffusion rate. However, as previously stated, some details of the model are omitted in order to focus on issues such as creating ownership and instilling confidence at the stakeholder level.

During the first meeting the team listed variables and parameters, which are *purported* to influence the diffusion of the new product. Next, key variables were identified so they could be visualized in order to assess the extent to which these variables depend on each other. The high-level map, shown in Fig. 2, determined also the boundary and part of the basic structure of the model and follows typical system dynamics-diagramming practices (Lane 2000):

- Rectangles represent state variables, called stocks, where things (e.g. people, widgets, dollars, etc.) accumulate.
- Stocks increase due to inflows and decrease due to outflows. Flows are shown as "pipes" connected to the rectangle.
- Flows are controlled by valves, which look like small inverted bow ties.
- Arrows between variables show causality.

After the management team agreed on the structural view of the market environment and system boundaries, the author conceptualized the simulation model in collaboration with the client.

The model structure shown in Fig. 2 depicts the flow and accumulation of doctors, who would evaluate, prescribe, and recommend the new product and thus influence the adoption rate. The population of doctors is disaggregated into sub-segments to measure the rate at which the different segments adopt the new

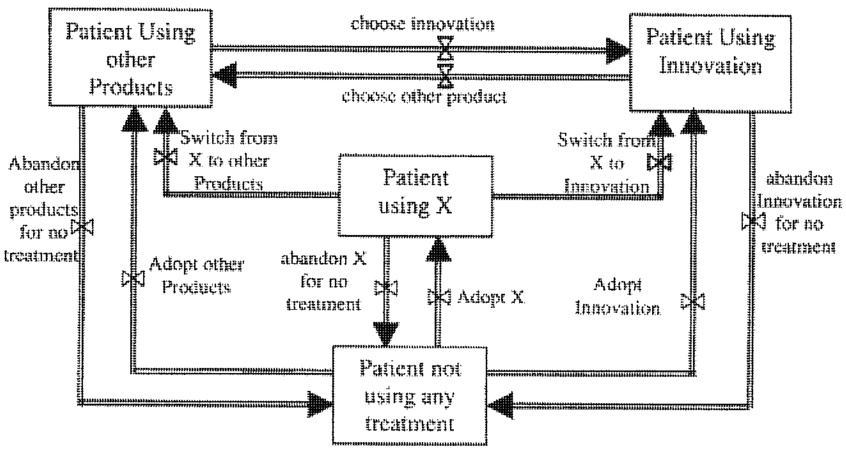

Fig. 3. Stock-and-flow structure of patients using different treatments.

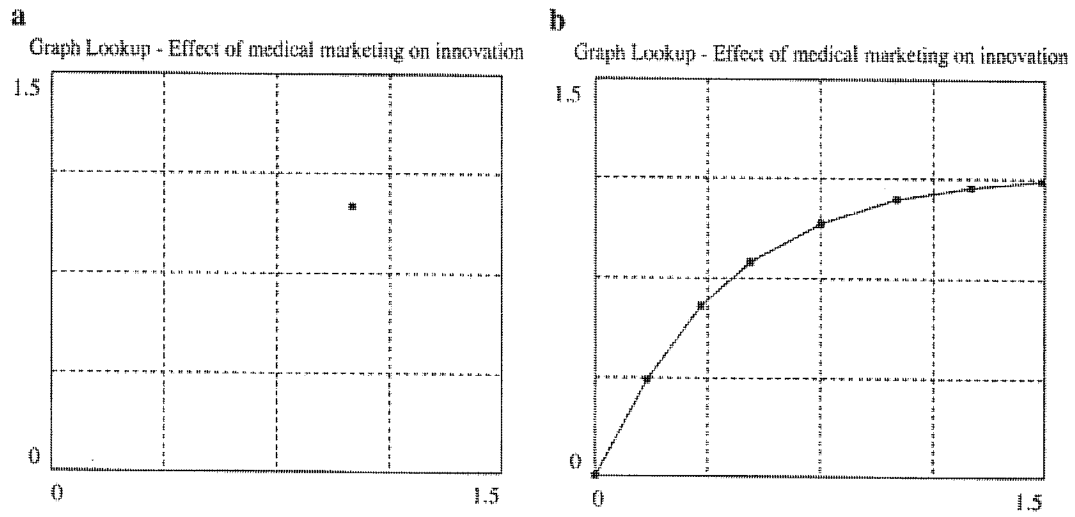

Fig. 4. a and b. Non-linear functions, elicited from client.

product. This part of the model structure was shown to the client to get agreement on the level of the detail needed to capture the relevant sub-segments in this therapeutic area.

While the model's representation of the doctors appears highly aggregated it nevertheless closely reflects an important insight into the local market, that is, that it is exclusively the doctors who prescribe, or control access to the medicine. Therefore, the rate at which the new product will be adopted must be formulated on the basis of a stock of doctors preferring the client's innovative product over others.

In order to model the adoption rate among patients, a stock-and-flow structure was added, shown in Fig. 3, to keep track of the number of people who are using the different treatments available in the market segment. The simulation model discussed in this paper consists of 235 equations but due to space limitations not every single link or all the different variables controlling the stock and flows are shown in the Figs. 2 and 3. However, upon request complete computer code and model documentation are available from the author.

The structure in this part of the model, as shown in Fig. 3, focuses on the flow of patients between stocks of users of a product in an effort to capture the shifting market share when launching the new product. The structure is near-symmetric with respect to users of the more comparable products "Innovation" and "other Products", whereas users of "X" had to be dealt with differently as X's brand recognition, available body of knowledge, customer retention strategies and other factors differ substantially from those of "Innovation" and "other Products". The rate equations for the patient flows use a standard fractional rate formulation with modifying factors "Product Attractiveness" and "Doctors' Recommendation", as well as product availability.

A symmetric structure was used for attractiveness of competitors' vs. attractiveness of the client's product. In discussion with the client, the author identified variables which constitute product attractiveness, such as convenience, reliability, safety, and novelty of product. Price was not considered a factor that influenced product attractiveness because of inelasticity in this segment of the pharmaceutical market. For some of these variables, data from existing market research and clinical trials was available to set initial parameter values.

Surveys and other sources of quantitative data were also available to set initial values and guide model development. Other attributes and underlying choice preferences influencing the adoption rate of the innovation were identified through secondary research and in discussion with the management team. However, there is considerable uncertainty about the effect of marketing on either patients or doctors, and the author therefore assumed a normal effect with mean and standard deviation derived from interview data with product managers from pharmaceutical companies. Furthermore, the author assumed that operating conditions for stochastic variables are bounded by acceptable attribute levels, i.e. a threshold was determined for soft variables where an increase in an attribute level would take the model outside of its operating boundaries so that the resulting model behavior would not be feasible.

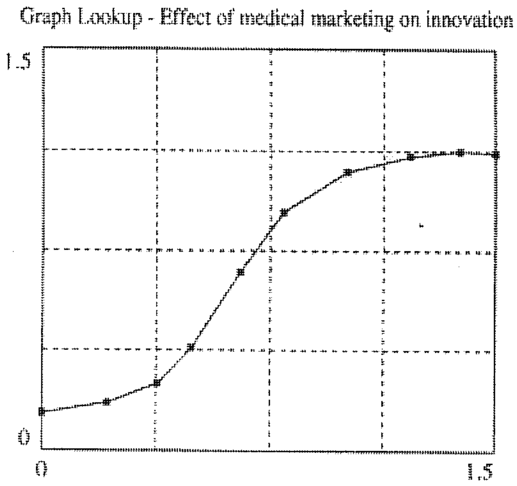

Fig. 5. Table function for effect of medical marketing.

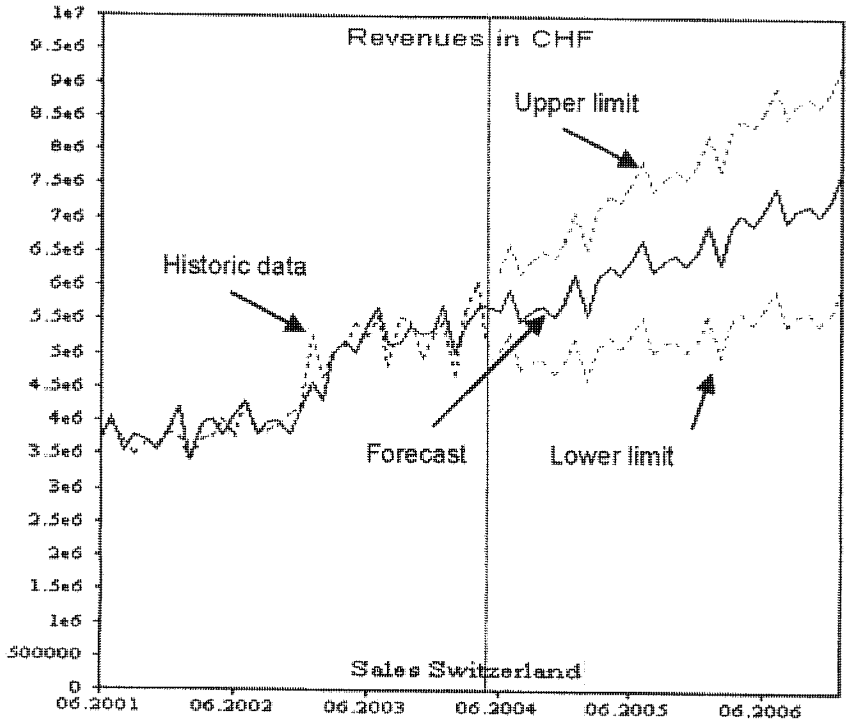

Fig. 6. Market forecast from SPSS Decision Time.

An important part of the conceptualization phase was to elicit information from the client in an effort to learn and also to achieve agreement on the shape and the boundary values of the table functions representing non-linear effects used in the simulation model. This helped account for influences by medical marketing or direct-to-consumer marketing on the diffusion of the new product. In a workshop with the client team, the author first explained how a graphical function models a non-linear influence on a flow rate. Then the team was introduced to the familiar multiplicative formulation of "standard rate times effect of ..." and asked for reasonable assumptions on the upper and lower boundary values of the effects. Next, every member of the team was asked to individually sketch their best estimate of the shape and limits of the graphical function around a designated neutral operating point in a prepared lookup table diagram as shown in Fig. 4a.

The team convened again, this time for a moderated discussion where the members would present their individual sketches to each other along with reasoning before they would settle on a common shape as shown in Fig. 4b. Eventually, the author presented them with his mental model of the lookup table to provide them ample opportunity to sharpen their reasoning skills and deepen their understanding of the effect under conideration.

This exercise helped establish a firm understanding of the non-linear interrelationships represented in the model and also clarified some of the uncertainties about the effect of marketing on the diffusion rate. Furthermore, involving the client in some technical conceptualization helped to create ownership in the model at an early stage (Fig. 5).

3.1. Model validation

At the beginning of the project, the management team was somewhat skeptical that this methodology would provide valuable insights. Therefore, a transparent and explicit validation process was needed to help build confidence in the model. The objective was to achieve a deeper understanding of the model, widen the view of the client team, and discuss more thoroughly potential applications. To do this, it was also important to explain how the model was calibrated using historic market data. As a result the client bought into the structural and behavioral consistency of the model.

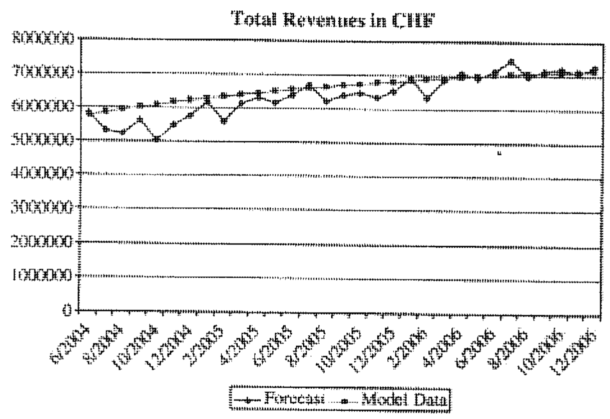

Fig. 7. Model calibration against analytical forecast from SPSS Decision Time (CHF=Swiss Francs).

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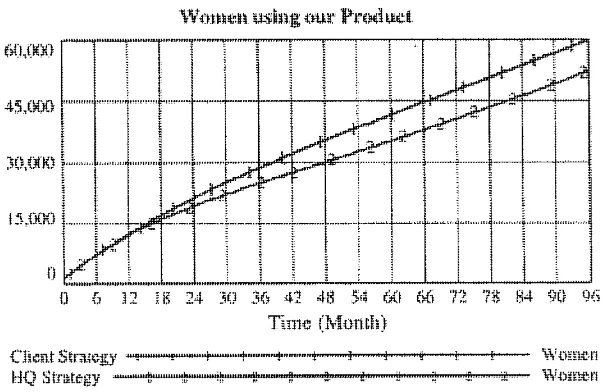

Fig. 8. Expected number of patients using the new product.

Forrester and Senge (1980) describe 17 tests for building confidence in a system dynamics model, while Sterman (2000) lists 12. Sterman's twelve tests examine models on both structural and behavioral grounds. Richardson and Pugh (1981) focus on collaborative model building projects that include modelers and model users, and categorize their tests for building confidence in a system dynamics model according to those that test for suitability and those that test for consistency.

Suitability tests determine whether the model is appropriate for the problem it addresses, while consistency tests examine whether the model is consistent with the slice of reality it attempts to capture (Richardson and Pugh, 1981). Besides testing the sensitivity of the model, using Monte Carlo analysis for constant variables, the model was calibrated against market data.

While these tests established confidence within the core team of the client, it was also critical to success that the country manager be convinced of the value of the modeling process and the model developed with the client team. Furthermore, it was essential to provide the local management team with a set of measures to support communication with stakeholders. To cope with the problem that most of the stakeholders and the country manager were unfamiliar with non-traditional analytical tools such as non-linear methods, a mixture of two approaches was used to build confidence in the model.

The first approach as noted above was to calibrate the model against historic market data. Because the purpose of building the model is to test management policy for the launch of a new product, the team needed a crystal ball to look into the future. So the assumption of the team was that if the model behaves the same way as a traditional analytical forecast tool, it will help to improve confidence in the model. Thus, the second approach was to calibrate the model against an analytical forecast tool the client was familiar with. SPSS Decision Time was used to forecast the therapeutic market in which the new product is launched. Fig. 6 shows the graph from SPSS Decision Time, which depicts the data range of historic and forecast revenues for the total market.

A system dynamics model is not a forecast tool and it was neither the client's nor the author's intention to use the model as a crystal ball. However, using a traditional analytical forecast tool, such as SPSS Decision Time, in tandem with the calibration efforts proved to be valuable in helping the client gain confidence in the model behavior.

Fig. 7 shows a fairly good fit between the historic and SPSS Decision Time data and the simulated time series. While causal maps and stock-and-flow diagrams were useful in revealing the interdependencies of key variables and thus helped us to communicate with the client, the calibration part was important to help "sell" the insights gained from the model within the client's organization. Building the model in close cooperation with the client helps to validate the underlying assumptions captured in the model; calibrating the model against data instilled confidence to support reasoning.

3.2. Exercising the model

This section shows a number of graphs comparing the proposed strategy from HQ against the strategy proposed by the local client team. Like a flight simulator is used to let pilots practice their skills in a risk-free environment, a graphical user interface was built for the management team in order to enable them change certain variables and then see how the market would respond.

Due to limitation of space in this article, only a few selected graphs to show the behavior of some key indicators in the system are presented. However, the model is able to dynamically present

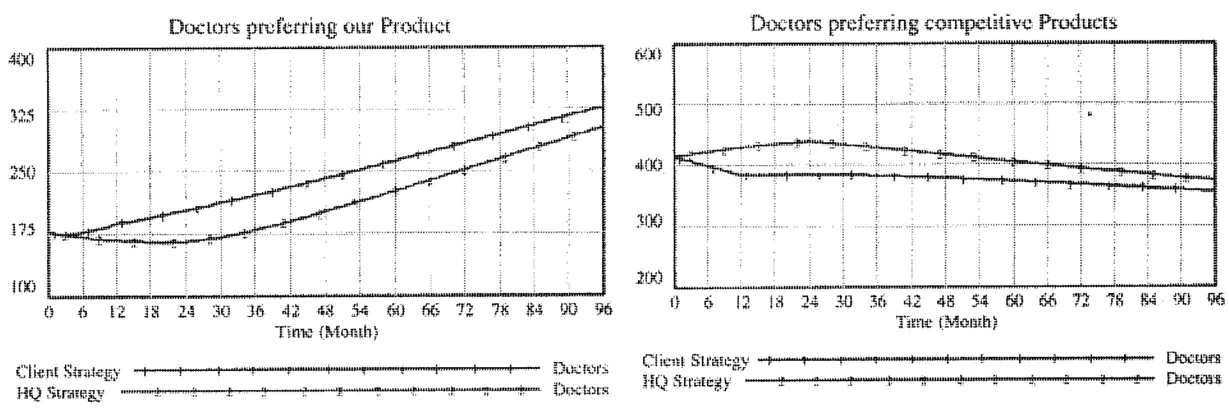

Fig. 9. a and b. Doctors preferring the new product viz. competitive products.

all the key variables as shown in Fig. 1. The clients were also able to use the model to test a number of resource based policies intended to optimize sales-rep frequency and medical marketing activities. The tests of these policies are not discussed here because the main task of the model was to support argumentation against the proposed launch strategy from HQ.

The graph in Fig. 8 compares the expected number of women who will use the client's product under two different launch strategies; HQ's strategy, which emphasizes a targeted approach towards patients, and the client's strategy which focuses on medical marketing and targeting. The two strategies are based on the same assumptions in terms of spending levels per year but allocate the budget differently.

The model was conceptualized so that effects from investment in medical marketing, direct-to-consumer marketing, and targeting (efforts towards changing preference attitude of doctors for the new product) can be changed to reflect the focal points of the two different strategies.

The model does not start at zero on the *Y*-axis because at the time of market launch there were already a number of patients who used the product as part of a clinical trial. As can be seen, the client strategy leads to a higher expected number of women who will use the product. While the marketing budget remains the same for launching the new product, the client's strategy seems to yield higher returns.

The graphs in Fig. 9a and b reinforce the previous observation that the proposed launch strategy from HQ does not achieve the same impact as the client's strategy.

The client strategy, which is focused on medical marketing and targeting yields better results than HQ's strategy in terms of doctors who prefer the new product. The results from using the simulation model confirmed the client's assumptions about the need for a localized market approach. Motivated by the results of the model and supported with calibration data, the client was able to successfully argue why he thought the proposed launch strategy from HQ might not achieve the desired objectives.

4. Conclusion

The above discussion clearly illustrates how a simulation model can be linked to normative decision-making as well as serve as a tool to gain insights into policy levers for a market entrance strategies. Furthermore, as this case illustrates, conceptualizing and developing a decision-support tool with the client can substantially improve the client's stature because it enables the client to demonstrate his/her in-depth knowledge of such a valuable decision aid. It also helps develop a sense of ownership in the model and fosters systematic experimentation in a risk-free environment. The client also gained an enhanced understanding of the dynamic nature of market feedback relationships and the leverage points for different strategies. Thus, the model not only helped substantiate the client's ideas about why he felt the global strategy may not achieve the desired results but also instilled in him the confidence needed to successfully argue against HQ's proposed global strategy.

Arguing against a proposed global strategy in a highly centralized organizational structure is a rather daunting task for a country manager. First of all, he or she needs to overcome the "not-invented here syndrome" whereby managers tend to neglect an outsider's propositions. As there are no irrefutable data yet, discussion about the pros and cons of global strategies tends to be very subjective. While verbal reasoning alone could eventually lead to similarly strong confidence in the local manager's strategy, seeing is believing. Using model-supported evidence accelerated and elevated the discussion to a different level and helped support the client's proposed strategy.

The model conceptualization process in the team-based environment created ownership within the boundaries of the local client, but the model nevertheless remained a "black box" for the stakeholders. Because the stakeholders were not prepared to devote the time needed to make the "black box" more transparent to them through a series of workshops, the team used scripts they were familiar with to test the efficacy of the model. In communication with the stakeholders, the country manager used Excel spreadsheets with graphs showing the results of the model calibration against historic market data and the market forecast data from SPSS Decision Time. This built confidence in the model's ability to correctly capture market behavior. Next, graphs were used, as displayed in Figs. 8 and 9 to compare the expected dynamics of the global strategy against the local strategy. These graphs supported the country manager's argument of why a local strategy can be trusted to yield better results. Using the insights gained from the modeling intervention, the country manager was able to convince the head office to allow for local adjustments of the strategy and launch the new product.

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