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**NEW PRODUCT DEVELOPMENT (NPD) SIMULATIONS:
SOME CHALLENGING QUESTIONS AND TOUGH MODELING
ISSUES**

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ABSTRACT

The purpose of this paper is to raise some very challenging questions about how to model new product development (NPD) issues in a computerized business simulation. Initially, we briefly review some of the key issues found in the NPD literature, framing each one as a question that challenges new product managers. The paper then addresses how a designer might model these questions in a strategy-oriented game that will include NPD elements. The overall purpose is to start an open forum whereby modelers could discuss and brainstorm contemporary business issues that warrant modeling into competitive business games.

INTRODUCTION

Computerized business simulations have been used as a pedagogical tool in academe and industry for more than 30 years. Unfortunately, most businesses don't focus enough on one of today's key challenges—maintaining a continuous stream of new products. The days of a single product or a few products with long life cycles are rapidly disappearing and therefore firms have to be committed to enhancing the new product development (NPD) process.

To help managers struggling with this issue, there is a need for more business simulations that model some of the key challenges of new product development. Students playing a new product game should have to consider questions such as: What, if any, new product should we develop? Should we look for a product that would be considered a major technological breakthrough or put the resources toward developing an incrementally improved product? What resources will be needed by Product and Process R&D to support the efforts? When do we expect to launch it? What are the technology risks associated with development? How will customers perceive this new product? What will our new product-marketing plan be? Should we crash the development cycle to be first to market or be a fast follower? What is the competition doing? What

role will the voice of the customer play in the new development process? The purpose of this paper is to start a dialogue on how to effectively model the challenges that companies face in the new product development arena. This we hope will encourage designers of new simulations to offer strategy-oriented games that embody some of the key elements of new product development.

**WHAT, IF ANY, NEW PRODUCT SHOULD
WE DEVELOP?**

Of course, the first question relevant to new product development (NPD) is whether to begin at all. Simulation designers may well want to enable the teams to choose not to begin a new product process, but rather to allocate their resources to existing products. When a business does decide to pursue NPD, it must choose from a great number of potential projects. One way to narrow this in a simulation is to offer a limited portfolio of new product types. We propose having the teams choose one from four new product possibilities. Two of these products could be viewed as “incremental” and thus be extensions of their current product mix. The other two products might be viewed as more technologically challenging, and be considered as major “breakthrough” products.

**BREAKTHROUGH OR INCREMENTAL
PRODUCTS?**

For incremental products, only a minor change or improvement is made over an existing product offering. Existing raw materials and processes are thus likely to be usable. Breakthrough products, on the other hand, represent a radical departure from a company's current product offerings. New materials and manufacturing techniques may be required to produce a breakthrough product. Therefore, modeling a breakthrough product will require a change in both the demand and the production functions. A second

Developments in Business Simulation and Experiential Learning, Volume 29, 2002

difference between these two types of products is the size of the marketplace. It is relatively safe to assume that the same number of consumers that purchase an existing product will purchase an incrementally improved version of this existing product. More challenging, however, is the breakthrough product. In one sense, firms that successfully launch a breakthrough product may be in a new marketplace, where they are not in direct competition with other firms. This new marketplace could be smaller or larger than the one for an existing product. Consumers may buy this radical breakthrough instead of or in addition to a firm's existing product offerings.

WHAT R&D RESOURCES WILL BE NEEDED TO SUPPORT THE EFFORTS?

We envision two R&D variables – one for process R&D and the other for product R&D. The process R&D variable would be modeled as a continuous variable that aids in differentiating a firm's existing product and lowering operating costs. The process R&D variable(s) would be directed at improving the cost structure of an existing product and/or the new product. The designer could model it so that teams introduce a new product and fail to have adequate market penetration because of operating or reliability problems due to an inadequate commitment to process R&D after product introduction. The product R&D decision involves specifying dollar allocations in conjunction with desired introduction dates. Both incremental and breakthrough types of products would be addressed via the product R&D variable.

IS THERE A STRUCTURED APPROACH FOR NPD?

Because the development of new products has many steps and potential pitfalls, successful organizations often adopt a formal process of phases and gates. At each "phase" of the development process, there are specific assessments ("gates") that must be passed before the development continues. Cooper (1993) describes a model with 13 phases and gates.

The incorporation of a phases and gates process into a business simulation raises many challenging issues. For example, one key issue is how **time** is represented in a simulation. If each phase described above takes one decision round in the game, then 13 decision rounds are required before any new products are even launched! Even worse, several subsequent rounds would be required to see how the product actually sells in the marketplace. One way to deal with this issue is to combine some of the phases, so firms can make the necessary decisions in fewer decision rounds. Even if multiple phases can be accomplished in one round, the designer would still have to decide whether these combined phases then become a single "hurdle" or whether each must be passed independently. Figure 1 shows an example of how the 13 phases above could be simplified and combined into 4 to 5 phases.

0 Beginning	1 Information	2 Make Decision	3 Development/ Testing	4 Go to Market
1. Initial Screening 2. Preliminary Market Assessment 3. Preliminary Technical Assessment	4. Detailed Market Study 5. Preliminary Business Analysis	6. Product Development	7. Alpha 8. Beta Test 9. Market Test 10. Trial Production	11. Final Business Plan 12. Production ramp up 13. Market launch

Figure 1 Five Phases That Could Be Used To Simulate The Existing 13 Phases

WHAT ARE THE TECHNOLOGY RISKS ASSOCIATED WITH THE PRODUCT?

In the simulation, firms would need to assess the development risk of any new technology. Incremental products may be modeled with low risks whereas major breakthrough products may come with high risk levels in terms of solving the technology issues associated with the new product. In our model, teams would face a series of

choices dealing with the level of financial commitment and a time schedule. The set of choices might also be influenced by random elements. The way the technology risk would work is as follows: the firm would first select the type of new product they want to develop, and then make two decisions. The firm would specify (1) the total product R&D dollar commitment to the project and (2) when they would expect to launch the product. A discrete joint probability function along with a random number generator

Developments in Business Simulation and Experiential Learning, Volume 29, 2002

would be used to model the technology risk. Figure 2 illustrates a simple risk function, which shows how the percentage chance for success increases with time and dollar commitment. Teams could be informed about the nature of the risk function either at game start or by purchasing technology risk data. Once a firm commits to a new product venture, the computer supplies a random number (between 0 and 1) and it would be compared to the probability associated with the risk function. If the random number was less than the joint probability the firm would receive information that they are on schedule, or if appropriate, that the new product was ready for launch. If, on the other hand, the random number was greater than the joint probability, then the firm would be informed that there had been a delay

in the development process. Such a delay might be for a fixed number of turns, or it might be indefinite, with the team facing another (slightly better) joint probability on the next turn.

Many different scenarios can be established and controlled with such a function. High-risk breakthrough products would require large dollar commitments, take many periods to develop, and have a small probability of success. Firms that take this strategy would be playing a high-risk scenario. Other scenarios might include lowering the joint probabilities for firms that fail to fulfill their product R&D commitments. Low risk incremental products would have higher probabilities of success and shorter time horizons for development.

R&D Spending	Time Periods Until Launch			
	T2	T3	T4	T5
\$ 1M	.20	.30	.40	.5
\$2M	.35	.45	.55	.65
\$3M	.40	.50	.65	.70
\$4M	.50	.60	.75	.90

Figure 2: An Example Technology Risk Function

WHAT ABOUT BEING “FIRST-TO-MARKET” VERSUS A “FAST FOLLOWER”?

How can a modeler enable different product development strategies like “first to market” or “fast follower”? For a first-to-market strategy to work, the players should somehow be able to progress more quickly than usual through the phases and gates. A fast-follower, on the other hand, will have to wait for a market leader to do most of the product development and then somehow reach market relatively quickly after the leader has launched. The key to each of these strategies is *to give the players the choice of how quickly to progress through the development process*. One possible implementation of this, described above, is the idea of a technology risk function associated with a given strategy. Using this function, a probability is assigned to the product development process based on the amount spent and the time invested. Teams that spend a lot of money and plan for a long development process will have a very high probability of a successful launch. Unfortunately, such a team may lose market share to another team that adopts a riskier approach and manages to launch somewhat earlier. This idea of a probability can also be used to determine when a team is ready to pass through the gate from one phase to the next.

A user/designer who wanted to permit “reverse engineering” would alter the technology risk function once a competitive firm introduced the new product. Larger probabilities combined with smaller R&D commitments would make it less risky and costly to be a “fast second.” But, the designer must balance the advantage of the “fast follower” with that of the “first mover.” One way to “lock-

in” some of the advantages of early firms would be through the use of exponential smoothing of the demand function. Another way would be to require the second firm to invest in Process R&D to actually produce a “reverse engineered” product. In this way, a fast firm might achieve some **patent protection** or **brand loyalty** that inhibit its customers from jumping to the lowest priced offering.

HOW WILL CUSTOMERS PERCEIVE THIS NEW PRODUCT?

Although the new product development process itself can be quite arduous, there are possibilities for disaster even after product launch. Some of these disasters are attributable to situations in which there was a “mismatch” between consumers’ and a company’s perception of a new product. A “shadow” product is one in which the manufacturer believes is an incremental development, but consumers see more as a breakthrough. A classic example of this is 3M’s Post-it Notes. While customers quickly found an array of uses for the Post-it Note, 3M slowly began to realize this product’s potential. Shadow products are often under-marketed, or under-produced.

The opposite mismatch is when a company sees its new product as a breakthrough, but customers do not. In this situation, sales can fall well below expectations, unless the seller educates consumers to explain the importance of the new product. Modelers will have to consider these potential mismatches not only from a market information perspective but also from the firm-level demand equation used.

Developments in Business Simulation and Experiential Learning, Volume 29, 2002

HOW IS THE BUSINESS CASE FOR A NEW PRODUCT EVALUATED?

For incremental products, firms could purchase market data in the form of Quality Function Deployment or customer surveys that would provide data on whether to proceed. The “voice of the customer” (VOC) could be modeled to play a large role with incremental products. Technology data would be available that would relate risk and cost of development. The accuracy and reliability of both market and technology data would be a function of cost of research and time required to obtain it. The authors/designers could then supply the teams with Excel Financial templates. These templates would serve as the basis of a business case and would generate new product pro forma income statements, cash flows, net present value and economic profit (EVA) calculations based on the data they obtained from market research. This fact-based approach would provide framework and the methodology for assessing whether to pursue and incremental new product. Teams would be encouraged to do sensitivity analysis. Fascinating issues such as: what if we only meet 50% of sales goals? Or what if we are six months late to market? or what if our unit manufacturing cost is 30% higher than planned can be addressed in a economic and logical manner. Marginal and robust business cases should become apparent with the Excel tool.

WHAT WILL OUR NEW PRODUCT MARKETING STRATEGY BE?

The literature suggests that very different approaches to marketing new products occur because of the fundamental differences in the nature of the products. If the new product is an incremental product or extension of an existing product, marketing tasks that involve listening to the existing market and effectively addressing that existing market are important. Customers may want lower price, more reliability, and better service rather than a massive new product educational advertising campaign.

The breakthrough new product may require the management team to envision and then build a new market for this product. The team must identify what might be the nature of this new product and then educate them as to benefits and reasons for buying the product. Sometimes the new product may transform the entire company! New manufacturing methods, coupled with new sales and distribution systems linked with new people may be required to be successful with the new breakthrough product.

A modeling suggestion would be to set a tableau where firms are to check off various elements of possible marketing plans. The mix would involve a marketing action associated with dollar cost. The combination of marketing activities based on the nature of the product would then be tied directly to the demand function. The demand function

might be the Gold and Pray Demand System as illustrated in Equation 1. Based upon the mix of choices made by the firm, the parameters (i.e. g_i and H and d) could be modified.

As an example, if a firm fails to seriously address “creating demand” for a breakthrough product, then g_1 and H and d could be modified to reduce demand for the new product. Firms, however, that effectively come up with creative demand generation methods would have different parameters that would allow less price elasticity and allow demand for the new product to grow.

The demand system could also be used to diminish market demand through the decay function H for those firms left in the market where their existing products are no longer technologically up-to-date with the new products in the market.

$$D = ng_1P^{-(g_2+g_3P)}M^{+(g_4-g_5M)}R^{+(g_6-g_7R)}H^d \quad [1]$$

Where

P = Price for the product

M = Marketing expenditure for the product

R = Product R&D for the product

g_i = Constants or parameters based on a priori specified elasticities

H = Decay or expansion parameter for new product introduction

d = Decay or expansion rate

n = Number of firms

The marketing portfolio also could be set so that if firms try to do all activities it would cause confusion in the market place and dampen demand and/or hurt their profitability by increasing their SGA expenses.

WHAT IS THE COMPETITION DOING?

A final issue relevant to the phases and gates process in general, and to the “first-to-market” or “fast-follower” strategies in particular is how quickly competitors are developing new products. To develop a successful strategy, teams should have access to information about how close their competitors are to launching their new products. If the other firms are still several turns away from launch, then it is probably not the time to “crash” the development process. If, on the other hand, my competitor has just launched a breakthrough product, it may be profitable to abandon my own product development, and try to adopt the fast-follower strategy. How firms discover this information could be another issue. One simple approach is to give teams the option to purchase this information as “competitive intelligence”.

CONCLUSIONS

New product development is an issue that is important to nearly every company in the world. Unfortunately, a high failure rate shows that execution of a new product development plan can be very difficult. Much of the difficulty can be attributed to the complex and interrelated nature of the process. Creating simulations can help prepare leaders for making these new product decisions, without the high stress and serious repercussions typical in the workplace.

The present paper is intended to begin a discussion about the modeling of the new product development process. Although the existing new product development research helps to identify some important issues, it does not talk about how these issues might be addressed in a simulation. The designer of a simulation faces unique challenges like: fairness, usability and time of play. Through an open discussion, modelers may gain new perspectives and concrete ideas that save time and make the inclusion of new features like NPD a possibility.

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