Reinventing a Business Simulation to Incorporate Risks Assessment in an Interconnected World

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This paper examines new modeling approaches for a business simulation in which established firms that have successfully competed in relatively stable markets now have an opportunity to enter into a new foreign market with an innovative product and a short time horizon.
The paper discusses:

- *Business simulations as a pedagogical tool and points out the need for change;*
- *How simulation participants will forecast demand and market acceptance of a firm's innovative product in the new market;*
- *How some of the foreign exchange operational risks can be modeled;*
- *How the complexities of capital budgeting for cross-border projects can be modeled;*

How a full-enterprise simulation is being "reinvented" to incorporate some of the challenges associated with rapid globalization, technology advances, and the risks associated with participating in less predictable markets.

Business Simulations – A Review

Full-enterprise business simulations have been used for nearly 50 years in classrooms and management development programs to improve the business acumen of participants. Simulation developers have worked to improve the validity of their models by expanding decision variables and making the games more realistic. In recent years developers have added IT enhancements, including easy-to-use decision support packages, enhanced graphics, Internet functionality, and social networking platforms. Today the use of computer simulations is common in business schools. The expansion in the use of games has, of course, been aided by increased microprocessor performance, sharper displays, and improvements in gaming software. Continued advances in technology allow business simulations to incorporate more decision variables while giving participants the support they need to formulate more complex strategies. As a result, games increasingly focus on strategy formulation and on providing immediate feedback on the quality of participants' decision-making skills. (Faria et. al. 2009) There is substantial evidence that students like participating in simulations more than traditional lectures and case studies. (Anderson & Lawton (2009) Since improving student satisfaction is receiving increased emphasis in many colleges and is becoming a factor in the evaluation of faculty performance, and, given that students enjoy simulations, there is low risk for instructors who use simulations in their classes.

The Market Leader in the U.S. - CAPSIM

One of the most popular global simulations is CAPSIM founded in 1985. In the late 1990s the developers utilized the Internet for market expansion and now they report on their website (http://www.capsim.com) that more than 85,000 university and business school students participate yearly in CAPSIM business simulations, with more than 2,000 professors running them in their classes. Their portfolio of simulations appears to be the industry leader in business simulation usage. In their promotional material, they present the following business challenges and tradeoffs that the participants have to address:

> "How A/R period impacts sales? How TQM decisions impact productivity? Who should decide on R&D effort: R&D or Finance or Marketing or…Production…or…? How automation level impacts HR and Finance decisions? Whether a particular product should be promoted through print media or email or direct mail or…. Several such imponderables are addressed by our managers on daily basis…successfully…and unsuccessfully…."

While these questions are good, they focus primarily on internal decisions made by managers competing in relatively stable markets. The simulation environment has students manage a poor-performing company with average products and gives the teams eight years to improve the company.

> "Entering the Capstone/CAPSIM Business Simulation experience, the challenge… is to turn around a poor-performing, $100 million company, with five average products, in very different market segments, while satisfying customer demands for better, faster and cheaper products. With five to eight years to build success… develop a strategy and implement it thoroughly with every decision."

The Next Generation: Rapid Globalization and Technology Advances

The next generation of simulations must embody the challenges that today's businesses are facing. These new challenges are driven by rapid globalization, technology advances, and the risks associated with participating in less predictable markets. In this paper, we describe how we reinvented a simulation, with similar shortcomings to those of CAPSIM, to include an "international opportunity add on." This "add on" enriches the learning process and addresses some of the challenges mentioned above. In our simulation, participants have a new high tech product and the possibility of entering into a new international market. Their planning horizon is only two years. Participants must address these questions: How will we forecast the adoption of this new product? Will it be rapidly accepted? How robust does our forecast have to be? Where should we manufacture the product – in the US or overseas in the country of interest? How will a short horizon of only two years impact our decisions? What if the currency exchange hurts the value of the dollar? What about the political unrest and its impact on the cost of capital.

In the following sections we will describe: (i) a method for forecasting sales, (ii) modeling domestic and international risks analysis, and (iii) our reinvented simulation model.

Forecasting Sales – The Bass Diffusion Model

In 1969 an analytical model for forecasting the first purchase of a new product category was published by Frank Bass in the journal *Management Science.* (Bass, 1969) Bass' model is a diffusion model because its hypothesis posits that the growth in demand for a new product or service is a function of how information about that product is diffused in a social system. Bass' work is now referred to as "The Bass Model" (Ofek, 2005).

The significant contribution of Bass is his assumption that the probability of additional first-time adoptions of a new product in a future time is the function of the number of consumers who have already adopted the product. Thus Bass considers new product diffusion to be viral, essentially stating that diffusion occurs in a way similar to the spread of a viral disease in society (Boehner & Gold 2012).

The model has been widely accepted. Over 200 academic articles have been published about the application of the model. Over the past 20 years businesses have employed the model to forecast adoption of a wide variety of products, including satellite TV, satellite radio, refrigerators, calculators, CD players, home PCs, and cell telephones (Mahajan et.al., 1990).

Application of the Bass Model creates a curve that specifies the period and cumulative first-time adoptions of a new product or service in a defined market. The model itself is relatively simple. Bass identifies two types of new product adopters:

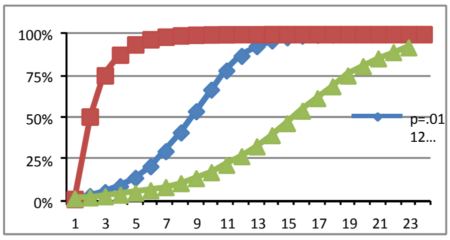
- Innovators: Adopt new products independent of the actions of others within a social system. In the model their adoption rate is represented by the letter *p*. The value of *p* is referred to as "the coefficient of innovation."
- Imitators: Their purchase of a new product is influenced by the adoption rate of others in a social system. They respond to input from others, specifically the communications of those who have already adopted the product. In the model their adoption rate is represented by the letter *q*. The value of *q* is referred to as "the coefficient of imitation." Bass states that the likelihood of additional first-time adoptions of a new product by imitators in a future time is a linear function of the number of previous adopters, with the actual number of adopters limited by the total market size, represented by *m* in the model.

The output of the Bass Model is a curve like the one in Figure 1 that represents period and cumulative adoptions of new products by both innovators and imitators.

The Bass Model has accurately forecast the rate of diffusion for a large number of product categories over multiple decades. In 1992 Bass was hired as consultant by DirecTV and asked to use his model to forecast the diffusion of the satellite TV product category. The forecast of satellite TV adoptions developed by Bass was stunningly accurate. Bass estimated a first year penetration of satellite TV of 1.37% of US households; actual adoptions were 1.21%. Bass' 1992 forecast of cumulative demand from 1994 through 1999 was also accurate. Bass forecast 9.4 million cumulative adoptions by 1999; actual adoptions were 10 million.

The simplicity and apparent accuracy of the Bass Model makes it a sound analytical tool for use in estimating demand in a computer-based simulation. The model quickly produces a demand curve and detailed period demand for any set of assumptions about the market size, the purchasing behavior of innovators, and the purchasing behaviors of imitators. Game participants can easily observe the demand impact of changing *m, p,* or *q* in the model. Changes in demand then naturally impact financial results.

Figure 1 *Bass adoption model*



Market Penetration - Various Values innovators (p) and Imitators (q)

Integrating the Bass Model into a simulation allows the participants to understand immediately the financial impact of relatively minor changes in demand assumptions. For example if the values for both *p* and *q* are reduced modestly the shape of the demand curve will change, significantly impacting break-even time. Different demand and financial profiles will impact decisions related to the attractiveness of entering a new market, required capital investment levels, and spending on marketing-related activities. The implications of the above curves on financial results are obvious. If management realized that demand would follow the p=.001 and q= .3 curve and that break-even might take more than a decade, management may choose not to enter the foreign market.

Capital Budgeting Complexities of Initiating Cross-Border Projects

In today's world, the names given to business courses, like "International Finance" or "International Management" seem like tautologies – needlessly redundant. Whereas internationalization (or globalization) was a major step for firms of the past, today's firms, large and small, operate in an interconnected marketplace that requires a global strategy from the earliest stages.

As an example we need to look no further than our own industry of higher education. Financial managers at even the smallest institutions now face challenges and complexities associated with: employing a multi-national workforce; handling payables and receivables in a wide variety of currencies; and financial oversight of overseas partnerships and branch campuses.

From an academic perspective, the theories revolving around the complex activities associated with multi-national enterprises (MNEs) have been developing since the 1950s (Dunning, 2001), but really began to blossom in the 1970s (Guisinger, 2001). Yet, even after 50 years of research and publications, evidence was found to suggest that corporations were still not applying "best practices" in the area of capital budgeting for international projects, especially in the case of small firms (Block, 2000). Large corporations have tended to adopt sophisticated techniques of capital budgeting at an increasing rate, but these techniques tend not to include the use of simulations for analyzing risks (McGowan, 2008).

Managing payables and receivables in a single currency is often enough of a challenge for small- to mid-size organizations, but introducing one or two or even 10 different currencies into day-to-day operations can put a strain on treasury operations. Furthermore, obtaining the benefits of lower costs of production and increased revenue do not come without substantial risks (Block, 2000). But, management's desire to exploit their firm's competitive advantages in a foreign market often clouds the complexities involved with undertaking a cross-border project. Building the capital budget for such projects requires many decisions from management, including:

- What is an appropriate discount rate that properly captures non-quantifiable risks?
- Should capital come from an internal parent-to-subsidiary loan, from a domestic capital market, or from a foreign source?
- How do the country tax rates impact the discounted cash flow?
- Is the local currency freely convertible and if profits are allowed to be repatriated will they be taxed?

However, often it isn't the number of decisions that is challenging for managers, but rather the level of uncertainty associated with each decision. International capital budgets are typically constructed systematically and with deterministic numbers. Capital budgeting models that account for probabilistic uncertainties would certainly be more robust, and hence, more valuable to managers (Zhang, et. al, 2011).

Reinventing a Full-Enterprise Business Simulation – a Work in Progress

A full-enterprise business simulation named Web-DECIDE, used both in classes and management development, serves as the basis for this new opportunity. Although used internationally, the simulation is primarily focused on US business challenges, business planning, and cross-functional analysis.

After playing Web-DECIDE to simulate six to eight quarters of total-enterprise management, participants review a business case describing the opportunity for entering Indonesia, a potential international market for their product – new, high tech, "Smart" LED Light Bulbs. The opportunity, however, has a short life cycle with demand lasting no more than two years.

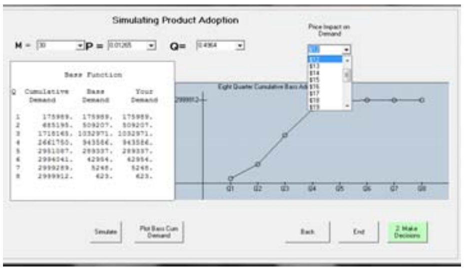
A Business Case, Excel Spreadsheets, and Simulation Software

The written case (i) describes the nature of the demand for the smart bulbs, (ii) reviews the key decision variables, (iii) discusses the risks of entering into this new market and (iv) summarizes the costs and benefits. The students also receive Excel spreadsheets that present basic financial models for the challenge. The team's task is to decide whether to enter into the new market and, if they do enter it, whether they should manufacture overseas or make their product in the US. They are put on notice that time is of the essence. We supply each team with a software package, which will assist them in the analysis and in making sound business decisions.

The Initial Challenge: Will the Product Be Rapidly Adopted?

The students need to understand the Bass Model and Parameters and learn how they might obtain estimates for *m, p* and *q* for their product. We supply them with the classic Bass Adoption article. (Bass, 1969) From the article they see there are two different approaches through which they can obtain the estimates. They can obtain them by using (i) Bass approach estimation for analogous products or (ii) multiple regression analysis on a data set in the case (estimating the parameters using OLS (Ordinary Least Squares) is difficult because of multicollinearity and instability of coefficients; the data was self-generated by the authors in such a way to avoid these real world pitfalls. OLS on their data sets will give reliable estimates). Once they have arrived at their estimates, they can use the software package to simulate demand situations with their estimates.

Figure 2



They can perform sensitivity analysis, find best and worst case demand scenarios, and determine the price elasticity of demand. From this screen, Figure 2, they can start to develop a plan for pricing and capital investment and a manufacturing strategy. They will be required to answer the following questions based on the case and the software:

1. Explain the roles that *p, q* and *m* play in the Bass Adoption model? Comment on their sensitivity.
2. Assume the true values for the three estimates are *m* = 30 (market size), *p* =.01265, and *q* = .4964. If your estimates were for parameters where: *p* =.01 and *q* =.3, which estimation error is the more serious – the error that results when p is off or *q* is off?
3. Calculate the value for price elasticity of demand? How might this elasticity impact your pricing decisions? Be specific!

After Simulating Product Adoption, the teams move to the Decision Screen, Figure 3, where they address the key decisions for this opportunity. These decision variables are: (i) manufacturing location – either domestic or overseas in Indonesia; (ii) price of the Smart Bulbs; (iii) capital expansion required; (They can distribute their CapEx dollars over two periods.); (iv) accounts receivables and payable terms; (v) hourly wage, and (vi) SGA (the case will inform the particpants that the S part of SGA is the majority component; they should think of SGA as primarily the marketing and selling components) and R&D allocations as a percent of revenue for the project.

For a number of the decision variables, we supply them with a brief description of benefits and risks associated with that decision variable. There is a check box for making the simulation "deterministic," which allows teams to change one decision variable at a time and see the impact on NPV.

Figure 3 *Decision Screen*

We encourage them to first focus on the domestic manufacturing option and see if it is a good business decision to enter into this rapidly developing market.

They are required to answer questions based on the case and the Excel spreadsheet:

1. Why might a firm opt for a second capital expendiure later in the two-year horizon?

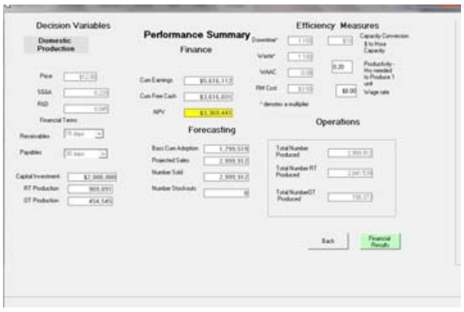
2. Describe two different strategies for SGA and R&D allocations? When would each be appropriate?

3. If the team changes their receivable terms from 45 to 15 days, what happens to the cash flow and how will it impact NPV?

Sensitivity Analysis: Understanding the Risks

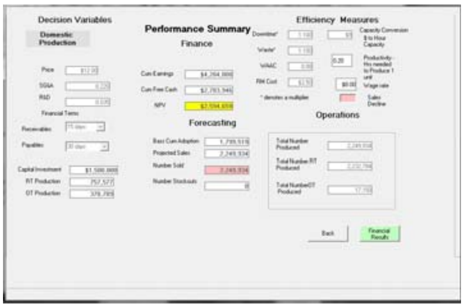
As an example, this team priced their Smart Bulbs at $12, invested $2 million in plant and equipment, changed their payables and receivables to 30 days and 15 days respectively, and increased both SGA as a percent of revenue for periods 6-8 and R&D over the full 8 periods. They checked "deterministic" so sensitivity could be easily performed. In this run the NPV is $3,369,441 and the cumulative earnings are over $5 million.

Figure 4 *The Performance Summary*



Decreasing capital by $500,00, as illustrated in Figure 5, shows that the NPV decreased by about $800,000. There is however an indication that their sales did not meet expectations.

Figure 5 *Impact of Decreasing CapEx*



After performing sensitivity analysis, participants should be able to answer the following:

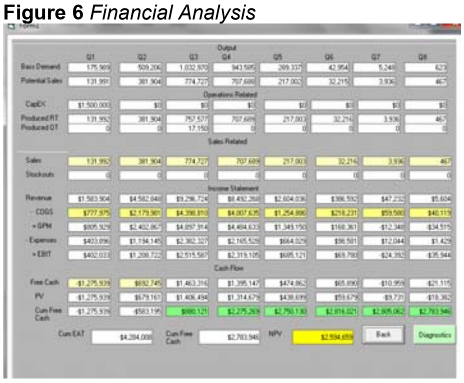
1. Holding the price constant and all other variables, what would be your capital investment strategy assuming your business objective is to maximize NPV?

2. Is it possible to increase cumulative earnings but not NPV? Explain why or why not.

3. Which has a larger impact on NPV, changing your receivables to 30 days or moving your payables to 60 days? Why?

To pursue the analysis further the participants can click on "Financial Results." Here they see more detail about the decisions and results. For example, they can see the firm had only a few units produced on overtime and encountered no stock outs! It appears the adoption rate was viral in the first year but fell off rapidly in the second. Figure 6 also shows the firm reached the break-even point from a simple cash flow perspective in Period 3.

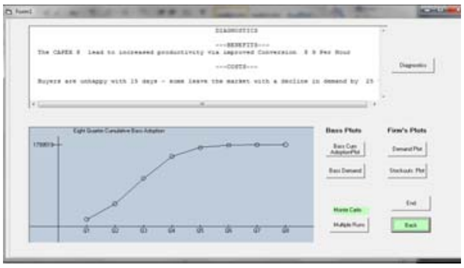
Figure 6 *Financial Analysis*



The Financial Analysis screen lends itself to questions like:

1. For Period 3 (i.e. Q3), explain in detail how the Free Cash number was arrived at. Be specific. Refer back to the case and the Excel spreadsheet for the specific costs and relevant numbers.

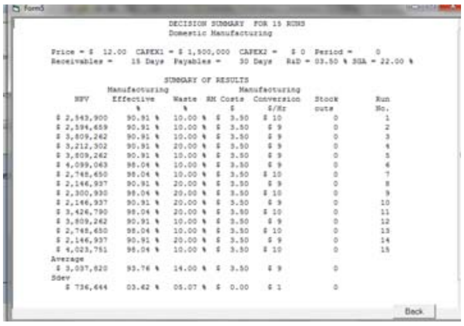
Figure 7 *Cost and Benefits*



The Diagnostics Screen shown in Figure 7 supplies even more detail on the costs and benefits, as well as the risks, associated with the decisions. Plots are available that show the demand pattern for each team, the Bass Model projections, and stock outs. To aid in the analysis, we provide a Monte Carlo simulation of 15 different runs with the same decisions but under conditions of uncertainty. In the example in Figure 8, the team's decisions are summarized along with the key results from simulating 15 different two-year cycles.

The results indicate the firm would obtain positive NPV for each cycle and the NPV average would average about $3.0 million in NPV. The challenge is to identify drivers for increasing NPV and reducing the risks (i.e. the Standard deviation).

Figure 8 *Monte Carlo Results of 15 Runs*


DECISION SUMMARY FOR 15 RUNS
Domestic Manufacturing

Price = $ 12.00 CAPEX1 = $ 1,500,000 CAPEX2 = $ 0 Period = 0
Receivables = 15 Days Payables = 30 Days R&D = 03.50 % SGA = 22.00 %

SUMMARY OF RESULTS

NPV	Manufacturing Effective %	Waste %	RM Costs $	Manufacturing Conversion $/Hr	Stock outs	Run No.
$ 2,543,900	90.91 %	10.00 %	$ 3.50	$ 10	0	1
$ 2,594,459	90.91 %	10.00 %	$ 3.50	$ 9	0	2
$ 3,809,262	90.91 %	10.00 %	$ 3.50	$ 9	0	3
$ 3,212,302	90.91 %	20.00 %	$ 3.50	$ 9	0	4
$ 3,809,262	90.91 %	10.00 %	$ 3.50	$ 9	0	5
$ 4,099,063	98.04 %	10.00 %	$ 3.50	$ 9	0	6
$ 2,748,650	98.04 %	10.00 %	$ 3.50	$ 10	0	7
$ 2,146,937	90.91 %	20.00 %	$ 3.50	$ 9	0	8
$ 2,300,930	98.04 %	20.00 %	$ 3.50	$ 10	0	9
$ 2,146,937	90.91 %	20.00 %	$ 3.50	$ 9	0	10
$ 3,426,790	98.04 %	20.00 %	$ 3.50	$ 10	0	11
$ 3,809,262	90.91 %	10.00 %	$ 3.50	$ 9	0	12
$ 2,748,650	98.04 %	10.00 %	$ 3.50	$ 10	0	13
$ 2,146,937	90.91 %	20.00 %	$ 3.50	$ 9	0	14
$ 4,023,751	98.04 %	10.00 %	$ 3.50	$ 10	0	15
Average						
$ 3,037,620	93.76 %	14.00 %	$ 3.50	$ 9	0	
Sdev						
$ 736,644	03.42 %	05.07 %	$ 0.00	$ 1	0	

Back

Manufacturing Overseas Another Option

The firm is also given the opportunity to build a manufacturing facilitiy in Indonesia and employ local Indonesians in the manufacturing process. The labor cost in Indonesia is about 12000 IDR which is slightly over $1 per hour—a major savings over the USA domestic rate of $8.00 perhour. But there are significant risks with the manufacturing decision. There is concern that productivity will be far lower that in the domestic operations and poor quality could hurt adoptions. Uncertainty in the political arena may impact the real cost of capital (i.e WACC), and the possibility that the exchange rate from LDR to US dollars could have a negative impact on cash flow and profits. These are simulated in the model.

Figure 9 *Overseas Manufacturing Decisions*

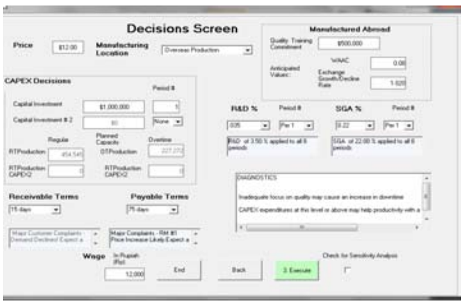
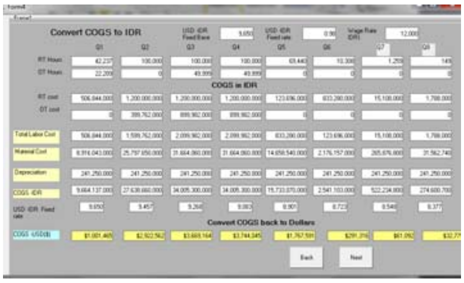


Figure 9 shows a set of decisions with Overseas Manufaturing. CapEx was set at $2 million and product price at $12. The team committed $500,000 to the quality development program in Indonesia.

As in the previous domestic manufacturing example, reviewing the Performance summary and the Diagnostics screen we would see both positive and negative outcomes. The firm had positive NPV of $2.7 million but the firm ran extensive overtime and had about 725,000 stock outs. Their suppliers raised their raw material cost because of the long terms for payment. The exchange rate dropped for an expected rate of growth of 1.01 to .98. Insufficient quality and R&D support overseas led to increased downtime and waste.

Figure 10 illustrates how the COGS should be calculated in IDR and then converted back to US dollars for the cash flow analysis. With the overseas manufacturing scenario, sensitivity analysis can be applied to WAAC and the Exchange rate.

Figure 10 *Understanding the COGS*



Summary

We hope this paper will start a discussion not only about the need for academic research in this rapidly changing interconnected world, but also about the need for new simulation models or "simulation add ons" in which simulation participants who have been competing in relatively stable markets now have an opportunity to enter into a new foreign market with innovative products and a short time horizon.

This "add on" or mini simulation that we developed raises some of the challenges brought about by a rapidly changing interconnected world. Dealing with shorter time horizons, new innovative products, market acceptance challenges and risks should make the simulation experience richer.

Students should be able to draw on tools and concepts that they learned in their business courses. These include topics from: accounting, economics, finance, marketing, strategy, business ethics and new product development. In fact the generation of the Monte Carlo simulations quantifies some of the risks in the simulation and can draw out some statistically-based questions such as: For the Domestic Manufacturing model, would your reject the hypothesis that the mean NPV is greater than $3 million? What is your *p*-value? Comparing the results of the two manufacturing operations, does there appear to be a statistically significant difference in the mean NPVs. What is your *p*-value? Or, from the Overseas manufacturing option, would you reject the hypothesis that true mean WACC with the political sensitivity is greater than 8.5%? What is your *p*-value?

In the short term "add ons" like we have presented here can be modeled easily to supplement the existing simulation that professors or trainers are using. In the longer run, we hope that new, comprehensive games will embody the elements that we discuss in this paper.

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