University of Bath

Alternative formats
If you require this document in an alternative format, please contact:
openaccess@bath.ac.uk

Opus: University of Bath Online Publication Store

http://opus.bath.ac.uk/

From Class to Boardroom: Developing the 'Innovation Game' for Strategic Management Learning

Yalabik, B.[*,1], Howard, M.[2] and Roden, S.[1]

[1]Information, Decisions & Operations (IDO)
School of Management, University of Bath
Bath, BA2 7TJ, United Kingdom

[2] University of Exeter Business School
University of Exeter
Exeter, EX4 4ST, United Kingdom

[*]Corresponding author, by212@bath.ac.uk

The Innovation Game: Lessons in Strategy and Managing Operations

Abstract

Purpose – We present a teaching tool (the Innovation Game) which aims to demonstrate the challenges of developing an effective innovation strategy in the context of new product development. The goal of the game is to enable participants to experience how strategic and operational choices made in relation to innovation strategy are interrelated and how these choices can impact on new product development success. Specifically we explore the impact of choices made in relation to capability accumulation, capacity management and product-portfolio management.

Design/methodology/approach – After presenting the learning objectives for the game with the support of relevant literature, we describe the design of the game and the context in which it was played. We review feedback (learning outcomes) from formal reflective post-game sessions with participants. This feedback indicates that our learning objectives have been satisfied.

Findings – Through experiential learning and reflective practice participants learn, for example, that: capabilities need to match the intended strategy; that investing in production capacity can be leveraged to aid negotiations with competitors, or it can be used as a bully tactic; and, that it sometimes is better to be an R&D 'follower' rather than a 'leader'. The participants also learn that the alignment of operational and strategic choices is necessary in order to leverage success in developing new products but that the actions and strategies of competitors has a direct impact also and need to be considered carefully.

Research limitations/implications – The teaching tool adopts a participative game playing and reflective learning approach to introduce into class some of the real-life competitive dynamics of managing new product development and decision making normally confined to the boardroom. While we argue the game demonstrates the challenges of developing successful strategy, the game is set in a static context in which certain external contingencies are not accounted for.

Originality/value - Demonstration of the importance of strategy to new product development is particularly difficult because of the longitudinal nature of product development and the tacit nature of the decision making process which often transpires long after projects are completed. We posit that the value of the Innovation Game is in reflecting on it as a practical, interactive tool which helps participants appreciate the challenges inherent in strategic and operational decision making related to innovation strategy and new product development success.

Keywords: Innovation, Experiential Learning, Games, Decision Making,

The Innovation Game: Lessons in Strategy and Managing Operations

1 Introduction

Innovation is a compelling theme in management with strong associations with growth, prosperity and the survival of the firm (Porter, 1985; Scherer, 1986; Kanter, 1990; Hamel, 2006). Understanding the key dimensions of innovation strategy is increasingly important for managers. Yet introducing the concept of managing innovation into boardroom discussions involving corporate strategy is fraught with difficulties (Burgelman and Sayles, 1986; Tushman and Anderson, 2004). In this paper we present a teaching tool, namely the 'Innovation Game', which highlights the interrelated nature of the decisions which surround a firm's innovation strategy. In the game, teams of participants (firms) make strategic and operational decisions as part of their innovation strategy. The primary learning objectives of the 'Innovation Game', are for participants to:

1. understand the challenges associated with making operational and strategic decisions regarding innovation strategy in a competitive environment,

2. understand that there needs to be some alignment between operational and strategic decisions, and that these decisions may be affected by external environmental (competitor and market-based) factors,

3. apply the understanding from learning objectives 1 and 2 to analyse competitor strategies and opportunities/threats in the market, making appropriate decisions to respond accordingly

In acknowledgment of the breadth of innovation as a topic area, the game focuses on the context of *new product development*. In accordance with this context, the game focuses on strategic and operational decisions related to capability accumulation, capacity management and product-portfolio management (Helfat, 1997; Morecroft, 1983; Cooper et al., 2001). The aim of the game is to enable participants to experience the complex interrelationship between these decisions relating to a firm's innovation strategy, operations and the marketplace, and the resultant impact on firm performance (new product development success) (Skinner, 1978; Hayes et al., 1996).

By using the game in a classroom setting, we achieve the learning objectives stated above by:

- Incorporating components that operationalise strategic and operational decisions

- Incorporating repeated play, which enables the revision of firm strategy between periods of play depending on product performance and the actions of competitors

- Allowing for reflections and reporting back to the group of participants at the end of the game.

Participants make strategic decisions related to the accumulation of capabilities and capacity. The operational decisions that must be made in the game are related to allocating production capacity and product-portfolios.

Our contribution in this paper is describing the design and use of this teaching tool, whilst presenting preliminary evidence of its effectiveness in aiding participants learning around innovation strategy. At time of writing, we have run the game a total of 11 times with more than 350 participants on Masters level innovation and operations management modules with participants from different backgrounds (e.g. Managers, MSc/MBA and PhD students), and different contexts (UK and India).

The use of a simulation or 'game' to enrich teaching environments is acknowledged to be a powerful learning aid (Zantow et al., 2005). This approach moves beyond the passive accumulation of knowledge presented through more conventional means such as a lecture, and can be described as an enabler of experiential learning (Kolb, 1984). Experiential learning focuses on the creation of an environment in which the participants learn through engagement in and reflection on what is taking place happening at a current point in time. The gaming environment created is artificial in nature, but incorporates relevant realistic elements associated with the organisational and market environment, so that the learning outcomes can be attained by participants under the guidance of the facilitator (Wolfe, 1975). There are an increasing number of cases today where games have been adopted across fields such as operations & supply, economics, finance and environmental management to demonstrate the

subtleties of strategic decision making that might otherwise be lost (e.g. Morecroft and Sterman, 1992; Zantow et al., 2005).

This paper is structured as follows: In Section 2 we review the literature relevant to innovation strategy, the new product development context and game playing in management settings. Section 3 outlines the structure of the Innovation Game and demonstrates further how the learning objectives are satisfied through playing the game. Section 4 provides participant and facilitator reflections on the game and its learning outcomes. The paper concludes with the game's contribution, limitations and potential for further research in Section 5.

2 Bringing theory on innovation to life

In this section, we review the relevant operations management literature linked to the components of the game. We also review the relevant teaching and learning literature, which discusses the adoption and effective application of games as teaching tools in the classroom.

2.1 Innovation, strategy and operations

Innovation is taught today as a collaborative process driven by vision and goals that reconciles or aligns business strategy and operational capability with external markets (e.g. Goffin and Mitchell, 2005; Tidd and Bessant, 2009). Alignment is where strategic priorities at the functional level match with and support business level strategies, and is generally presumed to contribute to enhanced firm performance (Joshi et al., 2003). Alignment is also applied to the market environment where adapting internal operations to 'fit' the marketplace is considered one of the most powerful forces that 'pulls' market needs through the organization (Slack et al., 2006). In the Innovation Game, participants are challenged to create alignment starting with operational capabilities, continuing with operational decisions, and ending with considerations of market dynamics and the strategies of competitors. Since participants in the game have limited resources to create this alignment, they need to take the process-based view of innovation as a 'funnel' (Rothwell, 1994) representing the flow of ideas being selectively pruned against a set of objectives, until only

relevant concepts make it to the end of the pipeline. This generic model of innovation asserts that ideas should be selected based on external factors affecting the market and prevailing technologies, but also on the firm's skills in the accumulation of capabilities, capacity management and product-portfolio management.

Capability accumulation enables firms to create new products and processes and become more dynamic by responding to changing market conditions (Helfat, 1997). Technological capacity-accumulation, either by acquisition or internal development, accelerates the rate of operational performance improvement (Figueiredo, 2002), where larger amounts of complementary technological knowledge and physical assets mean firms are able to undertake larger amounts of R&D (Helfat, 1997). The Innovation Game simulates these dynamics by allowing participants to invest in greater technical capabilities (in the form of improved R&D lead times and costs). Participants can also decide to be R&D 'leaders', or 'followers' who wait to see what products and/or markets will emerge as the attractive ones (Abernathy and Utterback, 1978; Scherer, 1986; Christensen, 1997).

The accumulation of these capabilities has significant implications for *capacity management*, where managers seeking to maximise the use of limited resources such as research staff, product lines, facilities and related infrastructure must make decisions over a system for product prioritization such as sharing a common capacity base (Morecroft, 1983). Capacity planning techniques force managers to consider not only upfront R&D, but the manufacturing systems, information requirements and operational features required of products as they enter service (Berry et al., 1982). The innovation game incorporates two dimensions of capacity management: First, participants are able to the purchase additional capacity. Second, over time the participants must select how to distribute this capacity amongst their portfolio of products. The decision to form alliances with key suppliers or competitor firms is often made to expand the firm's product knowledge and delivery capacity in cases of rising market demand (Slack et al., 2006). Participants in the Innovation Game are encouraged to negotiate to form such alliances in order to access and share markets and capabilities.

Product portfolio management provides the link between innovation strategy and operational capability by classifying products in the context of market growth whilst considering the impact on in-house skills and capacity requirements (Goffin and Mitchell, 2005). Product portfolios are used to make strategic choices e.g. markets, product selection, investment in technology, and to understand the implications for the allocation of scarce resources e.g. engineering, R&D, and marketing (Cooper et al., 2001; Mikkola, 2001). Product-portfolio management, therefore, not only measures the value of products in strategic terms, it also deals with balance: *'..having the right balance between the number of projects you do and the resources or capabilities you have available' (p361)* (Cooper et al., 2001). Participants in the Innovation Game must strike this balance as well – given the limited amount of resources available and the expected lead time and cost of R&D for different products, which markets should a firm pursue? This makes the initial choice of capability and capacity investments crucial.

2.2 Game playing in the management classroom

Strategic decision-making games are recognised in the literature as an effective pedagogical tool to explore the strategic operations of a company (Faria, 2001; Zantow et al, 2005; Walters and Coalter, 1997) in the classroom context. We define gaming as "*a situation where participants, operating as a group in responding to a competitive situation, have resources they dispose of according to rules, deal with losses/gains, and make moves on a simultaneous or sequential basis.*" The participants develop strategies for winning and make and implement decisions. [The gaming environment] "*..need not, but often does, possess some attributes of 'real' situation*" (Bowen, 1978: 3). Through the iterative nature of playing the game, the intrinsic properties of the problems and issues at hand will be better understood (Milling and Lehmann, 1994). Business games are designed to allow participants to carry out tasks in a low-risk environment with more focused competitive analysis and increased creativity (Scherpereel, 2005). One famous example is MIT's now ubiquitous beer game, simulating a real-life business situation; the amplification effect caused by delay in a supply chain setting played in lecture halls and boardrooms since the early 1960s (Sterman, 1989; Morecroft and Sterman, 1992). The Innovation Game is similar to the Beer Game in that participants play through repeated periods of
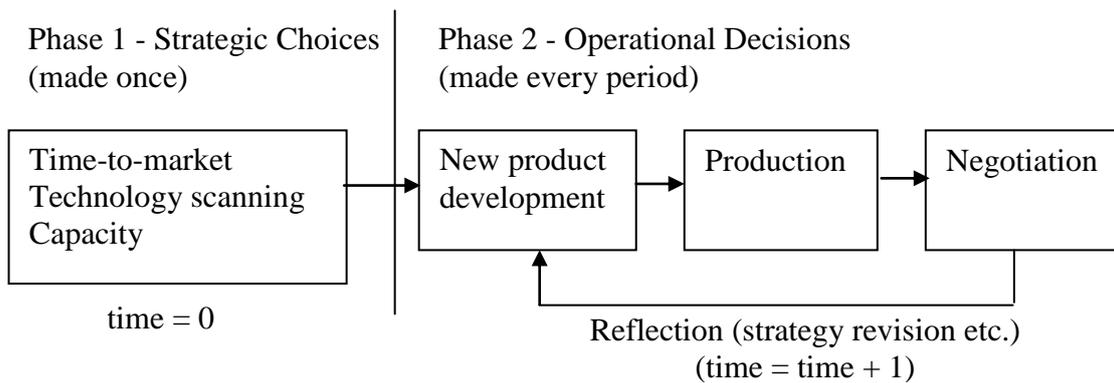
activity; make decisions based on restricted choices and information; work in teams (as firms or supply chains) towards a goal (product development success or lowest inventory cost); and, reflect, at the end, on the outcomes of their decisions and behaviour.

It is well acknowledged that in order to facilitate deep as opposed to surface learning, student participation at different levels should be encouraged to ensure engagement with the material (Marriott, 2004; Milling and Lehmann, 1994; Kohn, 1997). In a review of business games, Keys and Biggs (1990) differentiate between a functional (marketing, operations, finance) and industry simulated focus, and find that most games facilitate learning through the provision of three phases: (1) Experience; (2) Content; and, (3) Feedback. In the first stage learning takes place through game play, decision making and team interaction, while the content phase refers to the dissemination of ideas, principles and concepts regarding business practices. The final stage – Feedback, is crucial and focuses on individual reflection on the different aspects of the game. Keys and Biggs (1990) attribute much of the learning that takes place to this stage as students compare conceptual understandings of business practice (innovation strategy in this case), to the results of their actual gaming experience. The engagement between participants that the game encourages helps to further support this experiential learning process.

Referring to the Keys and Biggs' (1990) framework, the Innovation Game is developed as a functional game, targeted at managerial decision makers, but with an emphasis on operations managers. In order to facilitate learning effectively, the game was designed to ensure that each phase (experience, content and feedback) was incorporated. The perspective of Keys and Biggs (1990) is aligned with Kolb's (1984) framework describing a four-stage cycle of learning as (1) Concrete experiences; (2) Observation and reflection; (3) Formulation of abstract concepts and generalisations; (4) Testing implications of concepts in new situations. Thus, games conducted in a business setting combat some of the challenges faced by educators by providing an opportunity for concrete experience in an educational setting.

3 Method & description of the Innovation Game

The design of the game incorporates the constructs of interest outlined in the introduction and literature review. In this section we describe the design and running of the game whilst referring to the underlying constructs as necessary. Figure 1 represents the timing of events and the decisions that need to be made.

Phase 1 - Strategic Choices (made once)	Phase 2 - Operational Decisions (made every period)

```
┌─────────────────────┐      ┌──────────────┐     ┌──────────────┐     ┌──────────────┐
│ Time-to-market      │ ───► │ New product  │ ──► │ Production   │ ──► │ Negotiation  │
│ Technology scanning │      │ development  │     │              │     │              │
│ Capacity            │      └──────────────┘     └──────────────┘     └──────────────┘
└─────────────────────┘              ▲                                        │
        time = 0                     └────────────────────────────────────────┘
                              Reflection (strategy revision etc.)
                                   (time = time + 1)
```

Figure 1. Components of the Innovation Game

The Innovation Game is comprised of two main phases: In the first phase, teams (firms) make strategic decisions that determine some of their capabilities in the second phase. These capabilities are related to R&D (technology scanning and time-to-market) and capacity. The time-to-market and technology scanning capabilities can be purchased for general improvements in development lead times and development costs, respectively (we will refer to the effects of these improvements in later sections as they become relevant). Firms are also able to purchase additional production capacity at this point; each firm starts the game with a given capacity to be allocated across all markets. Once strategic decisions are made, they remain in effect for the entire game and can not be changed.

In the second phase, firms make new product development and capacity allocation (production) decisions over a number of periods (these decisions are described in more detail below). During this phase, firms are also able to negotiate with other firms to create strategic alliances to gain access to markets and capabilities. The different negotiation styles and social interaction that occurs between the participants as firms creates an interesting competitive dynamic.

At the start of the game each firm has the same product portfolio and the same budget, and so needs to prioritise the purchases of its capabilities and new product development efforts based on its adopted strategy. The firms are given an infinite horizon to work with and the objective of the game is stated as "to be the firm with the most money at the end of the game". The number of periods in the game is not announced at the start, although participants are aware of time limitations on the class session.

3.1 New product development

Each firm has a portfolio of products it can sell, and it can add products to its portfolio by investing in the development of new products. Table 1 presents the information provided to firms at the start of the game. All firms have Products 1 and 2 in their portfolios at the start of the game and are able to produce these products immediately, with no development time. At the start of each period, firms report the product(s) they would like to develop to the game facilitator (this information is not communicated to the other firms). This decision should be based on information provided in Table 1 relating to the market size for each product and the associated cost of development. The market for any product is shared according to how many units each firm brings to market (more on this in the next section). The development cost for each product is the amount deducted from a firm's "account" once the firm has decided to develop a product. A firm may purchase the "technology scanning" capability at the start of the game for a given percentage decrease in these costs.

Each firm has to wait a certain number of periods as defined in Table 1 (lead time) until they learn whether the development effort was successful. A firm may purchase the "time-to-market" option at the start of the game for improvements of 1 period for all lead times (the minimum lead time allowed is 1 period). Finally, each product has a given probability of being developed successfully (the outcome of any development effort is determined by using a random number generator). At the end of the lead-time, if the product was not developed successfully, all time and money spent towards development is lost.

10

Table 1. Sample product information

Product	Market Size (millions of £/period)	R&D Costs (millions of £)	Lead Time for development (periods)	Chances of Successful development (%)
Product 1	10	n/a	n/a	n/a
Product 2	20	n/a	n/a	n/a
Product 3	15	20	2	80
Product 4	25	40	3	60
Product 5	10	30	1	75
Product 6	30	50	2	55
Product 7	5	10	1	90

3.2 Production and market share

In order to simulate competition between firms, a market structure with quantity competition is imposed. That is, the per-unit revenue earned in the market depends upon the number of units that are on sale in any given period. To be specific, each "Market Size" figure in Table 1 assumes 1000 units of sales in that market. Prior to the commencement of the game, numerical scenarios are used to describe to participants how the market is shared (for the sake of this example, assume Firm A and Firm B are the only firms in the game):

> Scenario 1: Firm A brings 500 units of Product 1 to the market, while Firm B brings nothing → Firm A earns £5 million, as Firm A has fulfilled half of the market (which has size £10 million from Table 1). Firm B earns nothing.

> Scenario 2: Firm A brings 400 units and Firm B brings 300 units of Product 1 to the market → Firm A earns £4 million and Firm B earns £3 million, which are proportional to the amount of the market "covered" by each firm.

> Scenario 3: Firm A brings 900 units and Firm B brings 300 units of Product 1 to the market → Since the total quantity in the market is now 1200 units (which is more than the 1000 allowed), the firms split the market according to the quantities they brought in: A earns (£10 million)(900/1200) = £7.5 million and B earns (£10 million)(300/1200) = £2.5 million.

One more constraint that is imposed on firms is the following: Once a product is successfully introduced into a market by one or more firms, no other firm can enter that market for 2 periods. The objective is to provide an advantage to first-movers that replicates such advantages enjoyed by firms in practice for reasons such as access and familiarity to customers.

3.4 Development and testing of the game

We developed the game in several stages through two test runs and a pilot run. The starting point of development was the set of learning objectives as defined in the Introduction. The components of the game were designed to fit these objectives, although some components had to be taken out and others added after the test and pilot runs. The test runs were performed by having 3 members of faculty play the game and make suggestions for improvement. The pilot run was performed with a Master of Science class of 11 students, who suggested further improvements to the game while the authors made observations and took notes that allowed the game content and proceedings to be finalised. The major changes made after each the test and pilot runs as well as some of the improvements suggested after the real runs are summarised in Table 2.

Table 2. Changes in game after feedback

Run	Major changes made post-run
1st test	Marketing (pricing) decisions taken out
2nd test	Data entry for facilitator streamlined, reflection questions finalised
Pilot	Timer added, pre-game brief improved, product structure changed
Real	Changes in r&d, addition of random events, etc. proposed (more detail is provided in Section 4)

Certain aspects of real-life competition, such as pricing decisions independent from quantity decisions, were left outside the game's domain. The primary reason for doing so was to isolate the effects of the decisions made by the participants. It was felt that too many decisions may overcomplicate the game by preventing the observation of how decisions impact new product development success and therefore, profit. In turn, this may have created situations in which a firm could not identify the reasons behind its success or failure, and thus the game would not deliver its intended learning outcomes. Other changes made during the development phase were related to the specific questions to be asked to the participants during the reflection phase, the

introduction of the game in the pre-game brief, and improvements in the product information (Table 1) to add more complexity.

In the next section, we discuss the learning outcomes from the game, as identified through post-game reflections by participants. More details on the running of the game (spreadsheets and communication methods used, etc.) can be found in the Appendix.

4. Post-game participant reflections

As mentioned in the introduction, we ran the Game a total of 11 times, with classes ranging in size from 10 to around 70, and with team sizes of 5-7 participants. Apart from one session (managers), the participants were MSc, MBA, and PhD students. The game was mostly run around the middle of a course in innovation management or technology strategy, with some concepts introduced before and some after the game was played. At the end of each game, participants are provided with complete records of the game (R&D decisions, production allocation quantities, revenues, etc.) and given one hour to reflect on the following questions:

1. What was your strategy?
2. What did you learn from the game?
3. What would you do differently if you played the game again?
4. How would you improve the game?

Each team was then asked to present their responses to the questions above to the other teams. The participants were asked to document their responses on transparencies for presentations. All documentation was later collected by the facilitators. The results presented here are a summary of the responses on these transparencies as well as notes taken by facilitators during the presentations and related discussions. This part of the game constitutes the third 'crucial' phase in Keys and Biggs (1990) framework. The questions are designed to enable individual reflection on the different aspects of the game. Through reflection on the game play, participants are encouraged to compare their conceptual understandings of innovation strategy (with the aim of improving NPD success) to the results of their actual gaming experience. We will now discuss participant responses to each of these questions in

13

turn and discuss the implications of our findings in relation to the intended learning outcomes of the game.

Question 1: What was your strategy?

We can identify two dimensions that the participants chose to focus on in the responses to this question: (1) Capability accumulation at the start of the game and (2) product portfolio selection strategies. Looking at capability accumulation we can identify two main approaches. First, a number of firms believed that they should make moderate investments in capabilities to start the game while still keeping enough finance on hand to commence R&D immediately. This was in contrast to the second approach, where teams spent all (or most) of their starting budget on strategic choices (by spending large amounts on capacity in particular), believing that they would be able to overtake other firms after several periods were played and some revenue was earned from Products 1 and 2, which were readily available. After the game, firms who had adopted the first approach seemed to have felt "bullied" by the other firms .

The second dimension, portfolio management strategies, revealed the effect of bounded rationality and different attitudes towards risk. First, a large number of firms targeted Product 3 at the outset of the game (this was their stated strategy after the game), since Product 3 provided access to a good market at low R&D costs and had low uncertainty in development. At this point we would have expected more firms to recognise before the game that the market for Product 3 was not big enough to accommodate very many firms. Firms that did realize this chose to find their own niches, with some selecting other, less attractive, products and others taking chances on high-risk high-reward products (such as Products 4 or 6). Naturally, these strategies needed to be updated (or at least fine-tuned) over the first few periods, as firms observed what their opponents strategy and their relative performance.

Question 2: What did you learn from the game?

Figure 2 presents the learning outcomes related to Question 2 above.

Figure 2. Learning outcomes from the Innovation Game

As Figure 2 suggests, there were a number of key 'take-aways' for the game participants, which correspond with the learning objectives outlined in the introduction. For instance: participants through successive game playing, participants realised the importance of aligning capabilities (strategic decisions) with their intended capacity and portfolio management strategies (operational decisions). Participants also appreciated the different ways in which capacity can be used, for instance as a capability that can be marketed to others in return for access to markets or as an intimidation (bullying) mechanism. Finally, participants reported learning about the dangers of over-diversifying a product portfolio, and that the creation of a profitable product portfolio is still possible if a firm forgoes first mover advantages in return for the ability to monitor markets and respond to competitors with the benefit of hindsight. The participants also made observations relating to strategy more generally, such as the notion that the quality of a certain strategy should be measured against what other firms are doing and that flexibility and responsiveness are important characteristics of firm strategy. We believe that it is particularly important that students gained these types of insights through experiential 'learning by doing' rather than through a one-way communication of information from the lecturer to the student.

In terms of accumulation of capabilities, post-game feedback indicated that participants realised at an early stage (in some cases, before the game began) the need to consider the overall strategy of the firm when selecting capabilities. For example, firms that wanted to have diverse product portfolios invested in shortening their R&D lead times and reducing their R&D costs, expecting to use these capabilities to a great extent during the game. These expensive investments did mean that these firms needed to be more careful than other firms in making other expenditures such as those in capacity and selection of products (since they had less 'wiggle-room').. Other firms decided to minimise their investments in capabilities and have a more standardised portfolio of products. Whilst these firms may have compared less favourably to others in terms of capabilities they held, their strategic choices afforded them the financial flexibility to invest in new products in any given period or to tactically negotiate by paying other firms to stay out of their markets.

Feedback suggests that firms also found negotiation to be a powerful capability-accumulation tool. However, they also realized that collusion (whether implicit or explicit) could result in unwanted situations if not managed correctly. For instance, long-term 'market-sharing' deals between firms created situations in which firms were unable to respond to new opportunities in the market due to commitments made with another firm. In the mature stages of the game, opportunistic behaviour was observed in some of the alliances.

In terms of capacity management, participants found that increasing capacity, as one might expect, gave the firms more opportunities to diversify their product portfolio without taking on too much risk. However, it was also reported that capacity can be used in two other important ways. One common use of capacity throughout the game was to 'bully' other firms – those with greater capacities were able to move into markets where other firms were making profit and push them out. The common response to this was either negotiation or, more commonly, a move to other markets by the incumbent. Second, capacity was utilised as a bargaining tool – firms with greater capacities were able to market this capability to firms with smaller capacities and run production for them. This was a great way for firms to move into other markets without stretching themselves too thin.

In terms of portfolio management, participants found out the importance of having a deliberate strategy for moving from one product to other over a certain timeline, and to consider competitors' trajectories while making decisions. For instance, as described above, several firms invested in Product 3 as it was the 'best' product available, causing that market to be crowded. Once firms realised they were in a market with too many firms, those that had the flexibility to diversify into other markets had the advantage. Even then, the decision of which market to move into from there was not an easy one to make – does a firm move into a relatively unattractive, but empty niche, or does it attempt to get a smaller piece from a bigger pie? Firms also realised the danger of over-diversifying by under-estimating the time that it might take to get R&D investments back: some firms ended up with many products, all of which performed at mediocre levels due to the firm committing its capacity to too many markets at the same time.

It should also be noted that participants referred to concepts such as the product-process cycle (Abernathy and Utterback 1978) and the diffusion of innovation (e.g. Rogers 2003), which were touched upon in previous sessions. This was an opportunity to apply these models to strategic thinking while at the same time evaluating the effectiveness of these models.

Question 3: What would you do differently if you played the game again?

In responding to this question, the participants proposed alternative ways to play the game. Most of the suggestions that were made followed directly from their key take-aways and coalesced around the need to balance investments in capabilities and products with having the resources necessary for flexibility, and an increased need for negotiation and signalling by firms earlier in the game.

In addition to these points, participants stated the need to appreciate the difficulty of designing a 'good' strategy in an environment where every party has the same capabilities and can access the same information. As alternate strategies were being developed, the participants also came to the realisation that their new and improved strategies were going to be attractive to other firms as well. For instance, it was not uncommon to have a firm suggest they would attempt the development of a different

portfolio of products if they played the game again, while worrying that other firms were probably planning similar changes.

These suggestions lead to discussions on how mechanisms or tools can be integrated or used to aid strategic decision making. This was a good opportunity to introduce game-theoretic concepts such as signalling, reputation, and randomized strategies. This introduction was backed up by a more formal discussion of game theory in future lectures as appropriate.

Question 4: How would you improve the game?

Our observations of how the game was played and responses to question 4 allow us to reflect on what can be done for future versions of the game. As stated in Section 2, the current design of the game reflects some of the central components evidenced in the literature as important in the context of new product development. Focusing on these components, participants could gain an understanding as to why some firms were more successful than others. It seems that certain improvements are possible without overcomplicating the game. For instance, one improvement suggested by the participants was the addition of 'events', such as certain products becoming unavailable at random times during the game, or market sizes changing over time based on how much a market is served. One other improvement might be to make product introduction cheaper for late-comers to a market. Other possible improvements suggested by the participants include:

- product life cycles and new products becoming available over time
- R&D 'memory' – cheaper/more efficient R&D as investment accumulates over time
- Mergers / hostile takeovers
- Investment-sensitive product markets

5. Conclusion

At time of writing, we have received funding to create an online version of the Innovation Game. This will allow us to add functionality to the game and to improve accessibility via the World Wide Web for use by management educators and

professionals who can provide us with feedback on their experiences with the game as well as suggestions for improvements in design, structure and content. We are aware that this will alter some of the more social aspects of the game, as negotiations will no longer occur on a face-to-face basis. However, we also acknowledge that the game, in its current form, is not without its limitations. Despite having gone through several iterations as a result of feedback received from participants, these limitations relate to the scope of the learning outcomes and design of the game parameters. Given the nature of the topic and intended learning outcomes, it is inherently difficult to capture all the dimensions of innovation strategy in a gaming environment and therefore certain elements of the environment are not accounted for. Therefore, as a teaching tool, we expect that the game will develop over time and with increasing iterations of game play, will be updated and improved. We propose that a second phase of development should include an international study involving the further participation of business schools from around Europe, US and Asia to validate the game's applicability for cross-continent relevance in innovation education. Further, although we have resisted the temptation to create a sector-specific game design which identifies particular industries (e.g. pharmaceutical, ICT, aerospace), we believe this would be a valuable contribution for future versions of the game to target.

In terms of the research that we present in this paper, we feel that a more representative sample of participants would allow us to be more confident of the applicability of results. In particular, we feel that the participants in the sample, who were postgraduate students or experienced managers, might have benefited from previous experiences while playing the game and reporting on what they learned from the game. Thus, it would be interesting to see how undergraduate students might act under similar circumstances.

In addition, we feel that more accurate measurement of learning outcomes can be achieved through improved data collection during the running of the game. Quantitative data that can be collected more efficiently with the help of the online version can be used to (1) judge whether decision making has improved over time during the game, and to (2) gain insights into decision making which might then be used to potentially create an experimental set-up to be used for further research.

The Innovation Game presented in this paper offers an opportunity to re-examine how innovation strategy is taught in the classroom and understood by participants through experiential learning. Demonstrating the importance of strategy and innovation is particularly difficult for management scholars because of the longitudinal nature of the product development process. Showing how strategic and operational decisions impact of on this process is hard to capture in lecture material and is thus a suitable topic to 'learn by experience'.. While other operations and supply chain games are widely adopted by the management community, we felt none captured the essence of innovation as we wanted to teach it, or 'filled the gap' in our knowledge of how to effectively demonstrate the components of innovation strategy and dynamics of inter-firm collaboration/competition during new product development. Our contribution, therefore, is to introduce the concept of the Innovation Game, which applies experiential learning techniques to demonstrate the strategic and complex nature of innovation within and between firms. We believe we have devised a teaching tool that helps to inject into class some of the real-life competitive dynamics of new product development and strategic decision making normally encountered only in the boardroom.

References

Abernathy, W. and Utterback, J. (1978) Patterns of Industrial Innovation, in Burgelman, R. Christensen, C. and Wheelwright, S. (2004). *Strategic Management of Technology and Innovation*. McGraw Hill: NY.

Berry, W. L., Schmitt, T. G. and Vollman, T. E. (1982). Capacity Planning Techniques for Manufacturing Control Systems: Information Requirements and Operational Features. *Journal of Operations Management*. 3 (1), 13-25.

Bessant, J. and Tidd, J. (2007). *Innovation and Entrepreneurship*. J. Wiley & Sons: Chichester, UK.

Bowen, K. C. (1978). *Research Games: An Approach to the Study of Decision Processes*, ORASA text No. 3, Taylor and Francis, London

Burgelman, R. and Sayles, L. (1986). *Inside Corporate Innovation: Strategy, Structure & Managerial Skills*. Free Press.

Christensen, C. (1997). *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*. Harvard Business School Press.

Cooper, R.G., (1985). Industrial firm's new product strategies. *Journal of Business Research*, 13, 107-121.

Cooper, R.G. and Kleinschmidt, E.J. (2001). Benchmarking the firm's critical success factors in new product development. *Journal of Product Innovation Management,* 12, 374-391.

Cooper, R.G., Edgett, S.J. and Kleinschmidt, E.J. (2001). Portfolio Management for new Product Development: Results for an Industry Practices Study. *R&D Management.* 31 (4). 361-380.

Faria, A. J. (1990). Business simulation games after 30 years: Current usage levels. In: J.W. Gentry (Ed.), *Guide to business gaming and experiential learning*, p36-47. East Brunswick, NJ: Nichols/GP.

Figueiredo, P. N. (2002). Does technological learning pay off? Inter-firm differences in technological capability accumulation paths and operational performance improvement. *Research Policy.* 31 (1). 73-94.

Goffin, K. and Mitchell, R. (2005). *Innovation Management: Strategy & Implementation using the Pentathlon Framework*. Palgrave & Macmillan.

Griffin, A., and Page, A.L. (1997). PDMA success measurement project: recommended measures for product development success and failure. *The Journal of Product Innovation Management*, 13 (6), 478-496.

Hamel, G. (2006). The Why, What and How of Management Innovation. *Harvard Business Review*. 84 (2), 72-84.

Hayes, R., Pisano, G. and Upton, D. (1996). *Strategic Operations: Competing Through Capabilities.* Free Press: NY.

Helfat, C. E. (1997). Know-how and asset complementarity and dynamic capability accumulation: the case of R&D. *Strategic Management Journal.* 18 (5). 339-360.

Joshi, M. P., Kathuria, R. and Porth, S. J. (2003). Alignment of strategic priorities and performance: an integration of operations and strategic management perspectives. *Journal of Operations Management*. 21 (3). 353-369.

Kanter, R. M. (1990). *When Giants Learn to Dance*. Simon & Schuster, NY.

Keys, J.B. and Biggs, W.D. (1990) A Review of Business Games, pgs. 48-73. In: *Guide to Business Gaming and Experiential Learning*

Kohn, A. (1997) Students don't 'work' – They learn. *Education Week*, Sept 3.

Kolb, D. (1984). *Experiential Learning: Experience as the Source of Learning and Development.* Prentice Hall: NJ.

Marriott, N. (2004) Using computerized business simulations and spreadsheet models in accounting education: A case study. *Accounting Education*, Vol. 13, Supplement 1, 55-70.

Mikkola, J. H. (2001). Portfolio Management of R&D Projects: Implications for Innovation Management. *Technovation*. 21 (7). 423-435.

Milling, P.M. and Lehmann, F., (1994) Management games for group decision making in a dynamic environment. International System Dynamics Conference. 83-92

Morecroft, J. D. (1983). Managing Product Lines that Share a Common Capacity Base. *Journal of Operations Management*. 3 (2). 57-66.

Morecroft, J. and Sterman, J. (1992). Modelling for Learning. *European Journal of Operational Research.* 59 (1). Special Issue, May.

Porter, M. E. (1985). *Competitive Advantage: Creating and Sustaining Superior Performance.* The Free Press: New York.

Rogers, E. (2003). '*Diffusion of Innovations*'. 5th Edition. Free Press: New York,

Rothwell, R. (1994) Towards the Fifth Generation Innovation Process. *International Marketing Review*. 1 (1). 7-31.

Scherpereel, C.M. (2005) Changing mental models: Business simulation exercises. *Simulation Gaming*. 36 (5), 388-403.

Scherer, F. M. (1986). *Innovation and Growth: Schumpeterian Perspectives*. MIT Press Books: MA.

Skinner, W. (1978). *Manufacturing in the corporate strategy.* Wiley: NY

Slack, N., Chambers, S., Johnston, R. and Betts, A. (2006). *Operations and Process Management: Principles and practice for strategic impact*. FT Prentice Hall: Harlow UK.

Sterman, J. D. (1989). Modelling Managerial Behaviour: Misperceptions of Feedback in a Dynamic Decision Making Experiment. *Management Science.* 35 (3). 321-339.

Tushman, M. and Anderson, P. (2004). *Managing Strategic Innovation & Change: A Collection of Readings.* Oxford University Press: USA.

Walters, B.A. and Coalter, T.M (1997). Simulation games in business policy courses: Is there value for students? *Journal of Education for Business,* 72 (3), 170-175.

Wolfe, J., (1975). A comparative evaluation of the experiential approach as a business policy learning environment. *Academy of Management Journal,* 18 (3), 442-452.

Wolfe, J. and Roberts, C.R. (1986). The external validity of a business management game: A five year longitudinal study. *Simulation and Gaming,* 17, 45-59

Zantow, K., Knowlton, D. S. and Sharp, D. C. (2005). More than Fun and Games: Reconsidering the Virtues of Strategic Management Simulations. *Academy of Management Learning and Education*. 4 (4). 451-458.

APPENDIX: Running the Game

Here we describe the running of the game and highlight some of the learning outcomes as reported by the participants who played the game. At the time of writing, the game had been run 11 times: three times with a group of executive MBA students in the United Kingdom, eight times with a group of MSc students in the United Kingdom, and once with a group of executives in India. Both groups of participants were provided with instructions in advance and were asked to come to the session having read the instructions. There were additional introductions to the sessions to

make sure that all components of the game were clearly understood by participants, and trial runs of several periods each were played to demonstrate the progression of time and the decision making mechanisms. The trial runs also helped participants become familiar with the systems being utilised for record-keeping (a group of Microsoft Excel spreadsheets) and for communication of decisions (Production and R&D 'cards'). The main two spreadsheets utilised for record-keeping were the Summary Sheet (Figure A1) and the Revenue sheet for each period (Figure A2). Participants were allowed to observe these spreadsheets during the game to aid in decision-making.
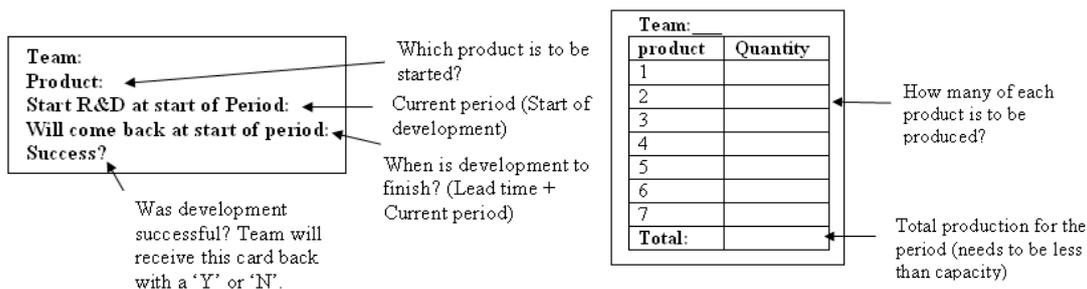
	A	B	C	D	E	F
1						
2						
3		1	2	3	4	5
4	Products av.	1,2	1,2	1,2	1,2	1,2
5	Period 1	5780378.233	6541796.488	9373113.059	8304712.219	
6	Period 2	8632075.472	9778664.731	14462989.84	12126269.96	
7	Period 3	10900068.06	12274274.05	16365131.58	35460526.32	
8	Period 4	21607142.86	13620300.75	19812030.08	36210526.32	
9	Period 5	27045454.55	19090909.09	27303030.3	23060606.06	
10	Period 6	26764705.88	23732026.14	21209150.33	27294117.65	
11	Period 7	26500000	23555555.56	23237547.89	28206896.55	
12	Period 8	19000000	23250000	27666666.67	36333333.33	
13	Period 9	19527027.03	21486486.49	20554054.05	33432432.43	
14	Period 10	20466751.92	24249011.86	21004417.58	34279818.65	
15	Period 11	20086206.9	23172413.79	21637931.03	34103448.28	
16	Period 12	20500000	23436363.64	21845454.55	34218181.82	
17	Period 13	0	0	0	0	
18	Period 14	0	0	0	0	
28						
29	TTM?	1	1			
30	TS?	1	1		1	
31	Cap?	1.5	3	9	6	
32	Marketing	0	0	0	0	
33	R&D					
34						
35	Profit	254,809,811	198,187,803	244,471,517	299,030,870	20000
36						
37	Init Cash	200000000				
38	TTM	50000000				
39	TS	20000000				
40	Cap	20000000				

Figure A1. Summary sheet

Microsoft Excel - March17RealThing

File   Edit   View   Insert   Format   Tools   Data   Window   Help

Quantities

Product	1	2	3	4	5	6	7	8	Total
	1,2	1,2	1,2	1,2	1,2	1,2	1,2	1,2	Total
1		300	500	200					1000
2			1000	450					1450
3		500	400	450					1350
4	1000								1000
5	150								150
6		500		500					1000
7									0
Total	1150	1300	1900	1600	0	0	0	0	

Revenues

	1	2	3	4	5	6	7	8
1	0	3000000	5000000	2000000	0	0	0	0
2	0	0	13793103	6206897	0	0	0	0
3	0	5555556	4444444	5000000	0	0	0	0
4	25000000	0	0	0	0	0	0	0
5	1500000	0	0	0	0	0	0	0
6	0	15000000	0	15000000	0	0	0	0
7	0	0	0	0	0	0	0	0
Total Revenue	26500000	23555556	23237548	28206897	0	0	0	0

Figure A2. Sample profit calculation sheet

In addition to these record-keeping tools, Production and R&D cards were utilised to allow the passing of information from the decision makers in the firms to the record keeper (Figure A3). The use of these cards was necessary in order to (i) allow the smooth running of the game and (ii) prevent firms from learning each others' decisions.

Team:
Product:
Start R&D at start of Period:
Will come back at start of period:
Success?

Which product is to be started?

Current period (Start of development)

When is development to finish? (Lead time + Current period)

Was development successful? Team will receive this card back with a 'Y' or 'N'.

Team:___

product	Quantity
1	
2	
3	
4	
5	
6	
7	
Total:	

How many of each product is to be produced?

Total production for the period (needs to be less than capacity)

Figure A3. R&D and Production cards

In each period, initially firms had 5 minutes to make R&D decisions and 5 minutes to make production decisions. These were reduced to 2 minutes after a few periods once participants started operating more efficiently. At the end of each period, firms were

allowed to negotiate for 5 minutes and the results of negotiations were communicated to the record keeper, who recorded any 'contracts' made.