Teaching Strategic Management with the
Industry Evolution Management Flight Simulator

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Abstract

The case method is the traditional way of teaching strategic management at business schools. While it aims to provide a simulated environment for strategy formation, the case method has several limitations. Many can be overcome through the use of Management Flight Simulators (MFS) by combining computer simulation models with conventional case studies. While many existing MFS focus on specific industries, we developed an Industry Evolution Management Flight Simulator that captures generic industry and firm structure with endogenous firm entry and exit. For effective teaching purposes, we then introduced staged game design, and tested both the MFS and supporting materials and pedagogy in strategic management classes at the MIT Sloan School of Management. We started with a version for a relatively simple competitive situation, represented by the salt industry, with pricing as the only decision variable. Later in the course we introduce a version for a more complex strategic setting, represented by the video game industry, where players make multiple decisions and where additional feedbacks are relevant, including network effects, complementary assets, and pricing in both the console and cartridge markets. Preliminary results are discussed.

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1. INTRODUCTION

Teaching strategic management (SM) effectively remains a challenge in business schools. Traditionally, SM is taught using the case method. Students prepare the case prior to class, and engage in class discussion on the strategic issues a typical general manager might face. Case teachers should not provide answers; instead they facilitate and guide the discussion using some frameworks and may summary the main teaching points at the end. The case method has its benefits and limitations. For many years various critics have argued that the traditional case discussion could be significantly enhanced through the use of computer simulations and management flight simulators (e.g., Richmond 1993, Morecroft and Sterman 1994, Warren 2001). Here we describe the Industry Evolution Management Flight Simulator, a flexible simulation environment designed to enhance the case method in teaching strategy.

1.1 Benefits of the Case Method

What are the benefits of the case method? First, it *simulates* strategy formation. Students learn strategy-making by role-playing and acting like a manager in a boardroom. Advocates argue that the case method allows students to learn by doing. "The case method creates a classroom in which students succeed not by simply absorbing facts and theories, but also by *exercising* the skills of leadership and teamwork in the face of real problems"[2]. Case studies allow the students "to think, talk, and act as the actual general manager would." (Christensen, et al. 1991). Second, a case *integrates* multiple aspects of strategy-making by presenting various factors managers face. It allows students to see the big picture by taking different functional disciplines, such as operations, marketing and finance, into consideration. "[T]he view that Harvard Business School wants its students to be able to grasp" is "the big picture" (Ewing 1990). Third, it is *participative*, *interactive* and *fun*. Students feel involved in discussion, they learn to interact and respond to other's arguments. Fourth, the case teaches students generic *strategic thinking skills,* known as strategy frameworks. The use of frameworks to dissect a case is actively

[2] See Harvard Business School website at http://www.hbs.edu/case/

facilitated and encouraged by instructors. Once learned, students can apply the frameworks to different cases in the real world where they seem appropriate.

1.2 Limitations of the Case Method

As much as a case can generate a simulated strategy formation, it has several limitations (Graham et al. 1992, Mintzberg 2004). Mintzberg (2004) argues that the case method "reduc[es] managing to decision making and analysis" and ignores the strategic process and implementation—getting it done. Even on the decision making and analysis front, however, the case method has limitations. First, hypotheses offered in a case discussion are *not testable*.. Since a case does not provide different possible scenarios beyond what had actually happened, there is no way of finding out what might happen if the company took a different route. Participants necessarily use mental simulation to judge what might happen if a particular course of action were pursued. As a result, students do not and can not take responsibility for their recommendations in the case discussion.

Second, the case discussion is *static* in nature in that it tends to focus on a strategy issue at a particular point in time. One may trace back the history of a company's development and make sense of the strategic choices it had made. However, this is subject to hindsight bias that the formulation of strategy in the presence of uncertainty as circumstances evolve over time (Plous 1993).

Third, mental simulation and the rhetorical setting of a case method are vulnerable to many well documented *judgmental biases*. Extensive research in behavioral decision theory and other fields documents the bounds on human rationality that create persistent judgmental biases and systematic errors in complex settings (Simon 1979, Kahneman, Slovic and Tversky 1982, Plous 1993). Some of the biases the case method is particularly prone to are hindsight bias—the tendency to believe I-knew-it-all-along when case results are presented prior to discussion, and confirmation bias–the tendency to seek evidence to confirm one's previous beliefs. Other biases relevant to case discussion include groupthink (Janis 1972) where premature consensus is reached and dissenting views are suppressed, and overconfidence, where confidence in judgment increases far faster than expertise or information acquisition warrants. These biases might give the wrong impression that there is *a* best strategy one should look for when there are clearly multiple scenarios (Plous 1993).

Fourth, even though case discussion integrates multiple factors affecting a business system, it is short on identifying the complex *feedback structure* among these factors. A case discussion is only as good as our mental models permit it to be. Each student offers arguments based on her mental simulations of what would happen under the given circumstances and decisions. However, it is well documented that our mental models have limited capability to simulate complex settings with multiple feedback processes, side effects, time delays and nonlinearities. Experiments show students and managers alike suffer from persistent "misperceptions of feedback" which result in extremely poor performance and slow or no learning (Sterman 1989a, 1989b, Senge and Sterman 1992, Diehl 1989, Kleinmuntz 1985, Brehmer 1990).

Fifth, the case method is *not replicable* by the student herself. To recap the lessons after the class is over; the student would have to resort to her notes and memory of the discussion. It is difficult to carry out the strategy-making process on her own without other students and a facilitator present. This dependency on the classroom-setting prevents students from replicating the case method alone.

Sixth, the case method is at best *partially participatory*. Given the time constraint and large classes typical of business schools (60-100 people in 80 minute sessions), a student typically speaks once or twice in the entire class. As a result, students may not fully participate throughout the whole strategy making process.

1.3 Management Flight Simulators

Many educators have argued that management flight simulators (MFS) can help overcome some of the drawbacks of a case method (e.g., Graham et al. 1994). A MFS is a computer simulation game that allows students to play the role of a manager and make strategic decisions with simulated corporate performance period-by-period. Much like flight simulators for pilot training, a MFS aims to train managers before they take on the real responsibility of running a company. It exposes students to possible strategic choices and consequences in a safe learning environment (Sterman 1992, Morecroft and Sterman 1994).

The use of a MFS together with conventional paper cases has long been practiced. Examples include the Beer Game (Sterman 1992) on supply chains; PeopleExpress (Sterman 1988) on the rise and fall of an airline company; Intecom (Morecroft 1984) on PBX switching technology in the telecom industry; and Beefeater Restaurant Microworld on running a restaurant in a service industry. Other MFS include the Professional Service Microworld, Oil Producer Microworld[3], Boom and Bust Enterprises, Food and Brands Enterprises, Commercial Real Estate, International Oil Tanker[4], etc.

The growing popularity of MFS in classrooms is due, in a large part, to their ability to address some of the shortcomings of the traditional debate and discussion case method. First, hypotheses about the consequences of a strategic move are *testable* in a MFS. The MFS creates a virtual world that can, in principle, overcome many of the impediments to learning in the real world (Sterman 2000, ch. 1). One can test in a controlled environment by varying one decision variable at a time, and receive immediate results. Since there are no other interventions besides the chosen strategy, the students take full responsibility for the success and failure of their decisions. Testability allows students to form hypotheses, test them, analyze the results, and reformulate hypotheses in an iterative process. A well-designed MFS provides feedback on the results of one's actions, allowing learning.

Second, strategy formation is not a one-shot game; rather it is a continuous process. The *dynamic* nature of a MFS allows students to make strategic decisions with feedback information period by period. It enables one to see how the impact of a strategy plays out overtime and when to adjust it when new circumstance arises.

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[3] See http://www.strategydynamics.com/info/microworld.asp
[4] See http://web.mit.edu/jsterman/www/

Third, it provides feedback that may help overcome the *judgmental biases* derived from our limited mental models. Since a MFS is a computer-based simulation, the results accurately follow from the assumptions embedded in the underlying model and are not affected by the limitations on mental simulations. Of course, the assumptions of the underlying model may be incorrect, foolish, or biased by the model designers. But given the assumptions, the simulator faithfully reveals their implications, while humans are extremely poor at such inference. Hindsight bias and groupthink may be reduced because results of the simulation are not known in advance. Confirmation bias may be reduced since the MFS allows repeated trials with multiple strategies, including testing counterfactuals and hypotheticals (though, as discussed below and in Isaacs and Senge 1992 and Sterman 2000), the mere existence of a simulator is not proof against bias and error).

Fourth, a MFS explicitly models the underlying *feedback structures* relevant to the case. It is difficult to derive those feedbacks purely from class discussion. By playing a MFS repeatedly, students may learn to identify the feedback loops that are responsible for the success or failure of a strategy. They might also discover unintended and counterintuitive consequences of their actions. One should keep in mind that a MFS is only as good as its underlying model, which is not comprehensive, and only incorporates the relevant factors designed for certain teaching purposes as judged by the designer. The goal of a MFS is not to replicate reality, but to teach students the ability to identify the feedback structure of an industry, and find high leverage points for strategic interventions.

Fifth, learning is *replicable alone*. One can play the MFS many times at one's leisure at virtually no cost. After a case discussion, a MFS can be assigned for students to explore and reflect on their own various strategies without the need for other participants' presence (though working in teams offers many advantages).

Sixth, a MFS allows students to be *fully participatory*. During the entire game, students make strategic decisions throughout the whole process. In addition, it is fun. Who would refuse playing a video game in a classroom? Students get excited and involved as they take the pilot's seat in real time. However, there are caveats regarding treating a MFS purely as a video game, which will be addressed below.

This paper focuses on a specific MFS – The Industry Evolution Management Flight Simulator (IEMFS). The IEMFS is designed specifically for teaching strategic management in business schools. In section 2, we describe the model structure underlying the IEMFS. Section 3 details the game interface design. We present two versions, representing the salt and video game industries, designed for a staged learning process. Section 4 discusses the student evaluations of the two versions, and lessons from the use of the generic version in classrooms. Finally, we conclude with future development of the IEMFS.

2. THE INDUSTRY EVOLUTION MANAGEMENT FLIGHT SIMULATOR

The IEMFS is designed specifically for teaching strategic management (SM) at business schools. There are two main goals of teaching SM. The first is to develop *strategic thinking skills* in the form of strategy frameworks so students can apply them in different settings. Some of the popular frameworks are Porter's five forces, value chain analysis, internal organizational design, demand-side increasing returns, etc. (Saloner et al. 2001). The idea is to train students to think analytically when dissecting a strategy challenge by learning which frameworks are appropriate under certain conditions.

The second goal is to disseminate *industry-specific knowledge* about distinct characteristics a particular industry possesses. A high tech firm faces different strategic challenges than a commodity producer or financial services firm. By learning which factors are relevant to which industries, students are able to identify high leverage points in a given industry.

To achieve these two goals, the IEMFS is designed with the following characteristics. First, its model boundary is at the industry level. Corporate strategy is enacted in, and performance constrained and enabled by, the context, internal and external, in which the firm operates. Instead of merely focusing at the firm-level, one needs to take factors within an industry into account when crafting strategy, including intra-firm organizational factors, inter-firm competition and cooperation, and firm-to-industry interactions. Warren (2001) demonstrates how business-level strategy (i.e. strategic issues facing a single-activity firm or division) can be formulated effectively with the aid of system dynamics. He calls for the modeling of corporate-level strategy (i.e. issues facing a multi-business firm). The IEMFS attempts to address some of those issues by modeling the generic industrial structure and endogenous firm entry and exit.

Second, the IEMFS captures their interlinkages through various feedback loops in the model. The model has a broad boundary, with few exogenous variables, to capture a wide range of feedback effects managers often fail to consider. The strength of each feedback loop depends on the particular industry. To make it industry-specific, the IEMFS can be calibrated according to the unique characteristics of an industry. Two versions, for the salt and video game industries (see section 3), illustrate different industry-specific strategic issues and calibration.

The IEMFS also introduces a third learning objective that is often missed in traditional SM classes, systems thinking skills, which will be elaborated in section 4.

2.1 Model Structure

Table 1 summarizes the scope of the model by listing the key endogenous, exogenous and excluded variables.

Table 1: Model boundary

Selected Endogenous Variables	**Exogenous Variables**	**Selected Excluded Variables**
Industry demand Product adoption Firm demand Demand forecasting Production Shipments Production capacity Investment in capacity Orders Installed base Price Market share Net income R&D investment Product functionality Marketing expenditure Brand equity Complementary assets Product Availability Compatibility Unit costs (fixed and variable) Unit direct cost Process Investment Learning curve Technology and cost spillovers G&A expenditure Firm entry and exit	Population growth rate Material costs Capital costs Technological changes (other than product development and process improvement)	Balance sheet Upstream supply chains Distribution channels Inventory Mergers and acquisition Capital markets Labor markets Corporate social investments Environmental constraints Macroeconomic conditions (business cycles, interest rates, inflation) Government policy

A notable excluded concept is the firm balance sheet. Many system dynamics models and flight simulators include the balance sheet, including endogenous issuance of stock, borrowing, stock price, and so on (e.g., the Oliva, Sterman and Giese 2003 model of the dot.com bubble and the Sterman 1988 People Express Management Flight Simulator). While it would be easy to include the balance sheet in the IEMFS, we have found that doing so often leads participants to blame failure on an alleged poor model of the capital markets. A common comment in such situations is “my strategy would have worked but your model of the capital markets didn’t appropriately value my company—and that’s why we went bankrupt.” By excluding the balance sheet and capital markets we create an environment in which the failure of a participant’s strategy cannot be blamed on outsiders who failed to see the value of the player’s vision and business plan.

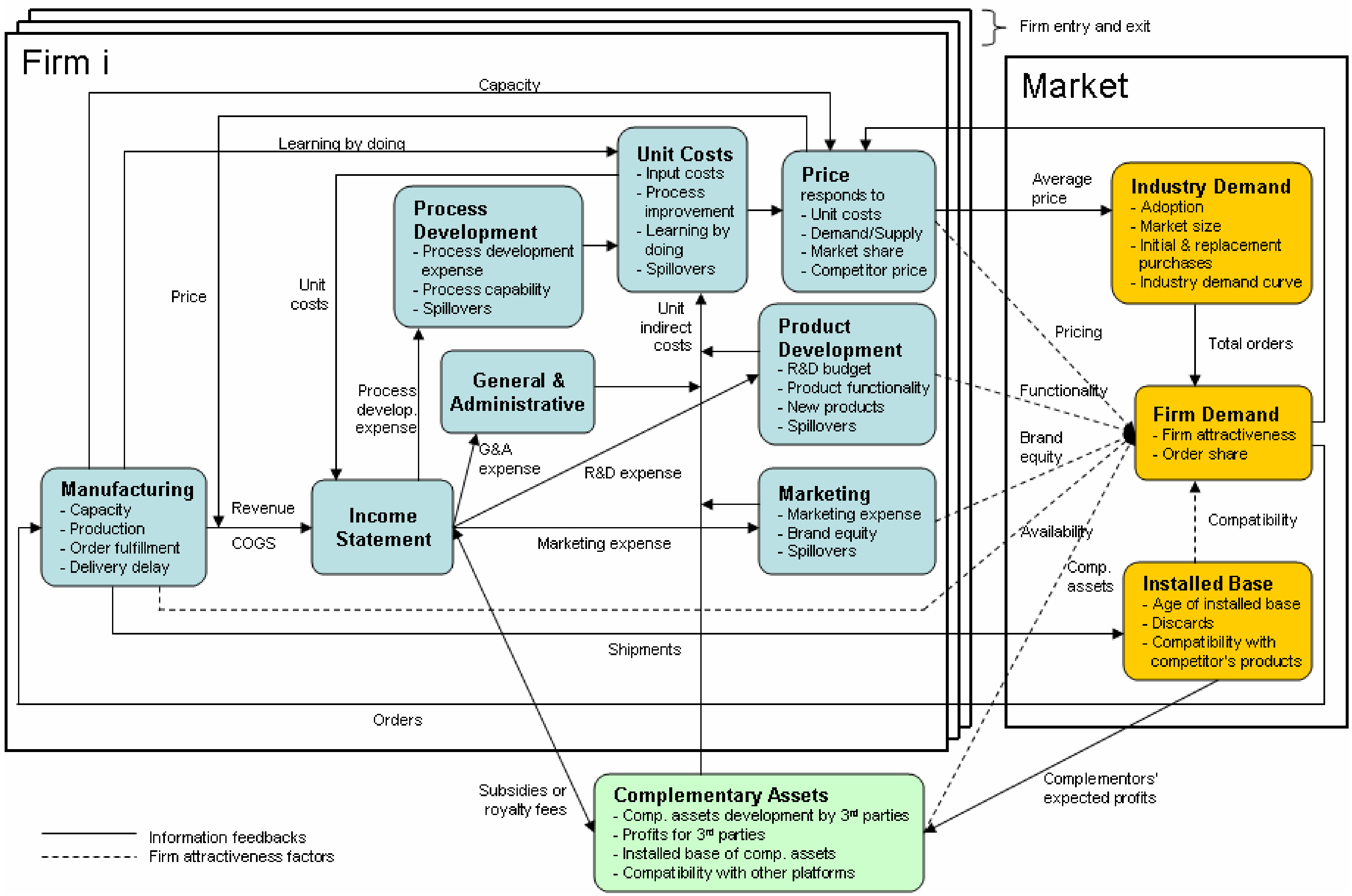
Figure 1 presents a high-level subsystem diagram of the Industry Evolution Model. There are three main sectors: the firm(s), the product market and the complementary asset market. The model can be configured to represent an arbitrary number of firms. The number of firms can be fixed or there can be entry and exit, which in turn can be exogenous or endogenous. Each firm receives orders from customers, then manufactures and ships the products, which add to the installed base in the market.

The income statement is calculated according to standard accounting conventions. Depending on the budgeting rules, revenue is allocated among process development, general and administrative expense, product development, marketing, and potentially, to subsidies paid to producers of complementary assets.

Demand for the firms’ product depends on overall industry demand and the firm’s share of that demand. Share depends on product attractiveness, which in turn depends on six factors. To increase firm attractiveness, one can either lower the price, improve product functionality through R&D investment, build up brand equity through marketing, increase product availability, provide more complementary assets for your product, and, lastly, increase the installed base of products compatible with yours. Not all these factors are active in all markets. For example, in the video game market, complementary goods (game cartridges) and compatibility are important, while in the salt industry, only price and availability are important.

The price of the product is often a decision in the MFS, but can be endogenously simulated by the model for firms against which the player of the game competes. The endogenous price formulation responds to four factors. *1. Unit costs*; *2. Demand/supply*

Figure 1: Subsystem Diagram of the Industry Evolution Model



balance: price rises when demand exceeds production capacity and falls when it is lower. *3. Competitor price*: prices tend to drop when competitors have lower prices. *4. Market share*: when the firm seeks a target market share higher than its actual share, price will be reduced to win share, and vice versa. The relative importance of these factors and asymmetries in the response to low and high values (e.g., low market share vs. high market share) can be set by the designer and, if appropriate, by game players.

Unit costs are made up of unit indirect and direct costs. Unit indirect costs include product development, marketing, process development, G&A expenses, and subsidies to complementary asset producers. Unit direct costs are composed of unit fixed and variable costs. Unit direct costs can be reduced through two means: learning by doing as manufacturing experience accumulates, and investment in process development.

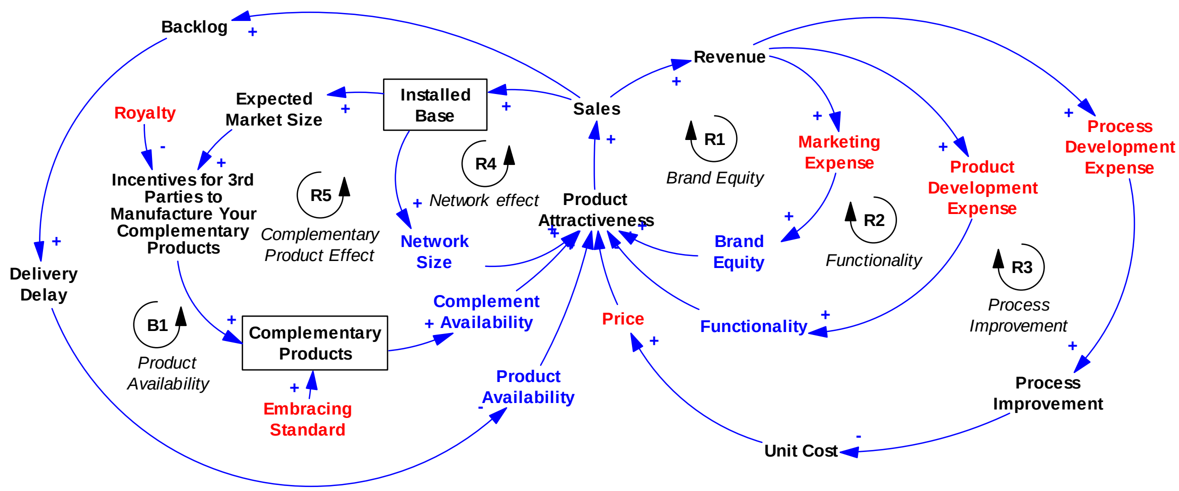
Complementary assets are modeled explicitly. Complementary goods include, for example, software and content for computers and electronic devices such as DVD and MP3 players, or blades for razors. In the model, complements are produced by independent third parties, who choose whether and which platform to produce for according to the expected profit of each platform. The player can, however, induce the complementors to produce more complementary goods for her product by providing subsidies or charging lower royalty fees (as shown in the video game industry version, section 3.2).

2.2 Feedback structure

Understanding the feedback structure of an industry is crucial for effective SM. Reinforcing feedbacks are important because they are the driving engines of corporate growth. Balancing feedbacks are the homeostatic processes that rebalance resource allocation as the relative payoffs to different activities change, and are the constraints that limit growth. Each loop may have different strengths in different industry. Effective strategies will strengthen or create feedbacks that drive growth, weaken competition, allocate resources effectively, and undermine the limits on market expansion.

While the IEMFS contains dozens of feedbacks, for teaching purposes, six main feedbacks are critical (Figure 2). These are six main determinants of product attractiveness (in blue), which can be controlled by a corresponding decision variable (in red). They are a small subset of the entire feedback structure, chosen because managers have more or less direct control over them. The idea is to have students use the feedback loop concept to consider tradeoffs among and the timing of various strategic interventions.

Figure 2: Main feedback loops



The six main feedback loops that determine product attractiveness are:

Brand Equity (R1): more revenue allows more spending on marketing, which increases brand equity and drives up product attractiveness. Greater attractiveness increases sales and thus revenue to be spent on marketing.

Functionality (R2): more revenue enables more investment in product development, which increases functionality and makes the product more attractive, leading to more sales and revenue to be invested in R&D.

Process Improvement (R3): more investment in process development leads to better process improvement, lowering unit costs. With lower costs the firm can lower its price while maintaining profit margins, which increases product attractiveness and provides more resources for process improvement. Though not shown, the model also includes the classic learning curve through which greater sales and production experience lead to learning that lowers unit costs.

Network Effect (R4): Sales add to the installed base, which increases the customer and user network size. When there is a positive direct network externality, as for example with fax machines, the expanded network size in turn drives up firm attractiveness and increases sales.

Complementary Product Effect (R5): in addition to the direct network externality, there is also the indirect network externality through which a greater installed base increases the expected market size for complementary products, which drives up the incentives for the third parties to manufacture complementary goods, increasing attractiveness, sales, and the installed base. One can also increase the incentive for complementors to produce for your standard by lowering the royalty fee charged to the third party, or simply embracing the competitor's standard. The availability of complementary products then causes the product to be more attractive and leads to higher sales.

Product Availability (B1): If orders rise faster than capacity (a typical situation, due to capacity acquisition and adjustment lags), the delivery delay for the product will rise, lowering attractiveness. The effect of availability on attractiveness forms a balancing feedback that can limit sales and market share during periods of growth when capacity lags orders.

In addition, some other main balancing loops are:.

Market Saturation: more marketing drives up the adoption rate, which gradually exhausts the pool of potential adaptors. Also, more adopters cause more word of mouth, which drives up the adoption rate and leads to eventual market saturation.

Pricing: higher pricing leads to more profit per unit, but it also drives down product attractiveness and causes lower market share, which may lead to lower overall profitability.

Entry and Exit: high expected profit margin is good for the incumbent, but it also induces new entrants and slows exit of existing competitors, which intensifies competition and drives down profitability.

Competitor Response: for each strategic move we take, the competitor can respond by either matching or even undercutting us. For example, when we spend more on R&D to improve product functionality, this may induce the competitor to invest more in R&D and make our product relatively less attractive.

Spillovers/imitation: as we accumulate experience and knowledge that lowers our unit costs or improves product functionality, spillovers allow our competitor to imitate our experience at low cost, and thus reduce our competitive advantage.

3. GAME INTERFACE DESIGN

To make the model user-friendly for teaching, we created gaming interfaces using Venapp (see vensim.com). Instead of showing all model variables (there are several hundred for each firm), the interfaces are designed to reveal information and decision variables relevant to the specific case and teaching purpose. In the spring semester of 2005, we built a generic interface that incorporates a range of decision variables (Table 2). It enables students to set many key parameters that determine the characteristics of the market, the technology, cost structure for each player, and competitive strategies. For example, student can set the size and underlying growth rate of the market, customer preferences (the relative importance of the different factors affecting product attractiveness), the initial level of market maturity, the potential for cost reduction and product improvement through learning and R&D, the presence and strength of spillovers, and the strategies of their competitors. This “generic” version was first used in Professor Rebecca Henderson’s Technology Strategy class at the MIT Sloan School of Management, a 2nd year elective for MBA students. The model was used in conjunction with original cases on the salt, radial tire and high-performance golf club industries.

The screen shot below illustrates the contextual parameters players can set prior to the game. Table 2 provides a list of decision variables players make in the game.

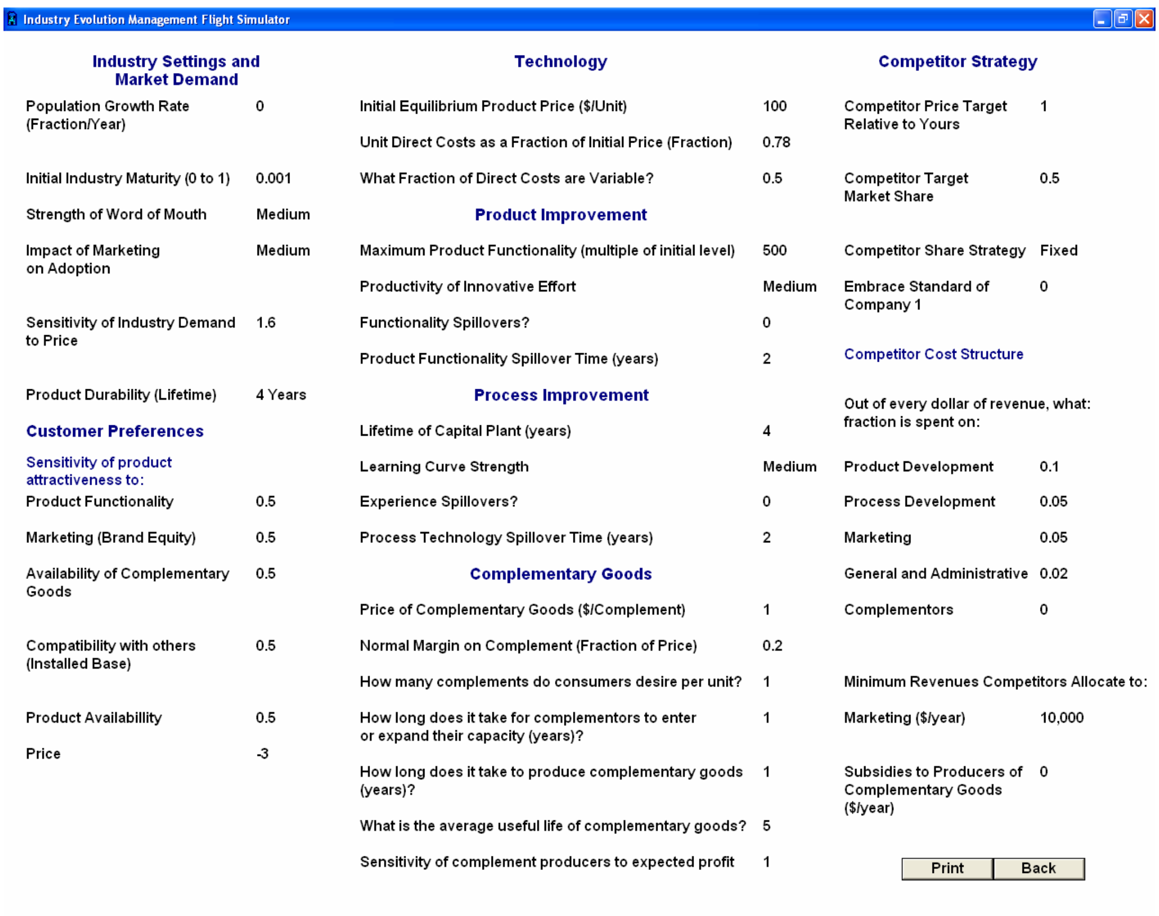


Table 2: Decision Variables in the Generic Interface

Decision variables

Pricing policy relative to competition
Target market share
Market share strategy
Expenditure on
   Product development
   Process development
   Marketing
   Subsidy to complementor
Minimum subsidies to complementor
Minimum marketing expenditure
Embrace competitor's standard

Though the list in Table 2 captures only a fraction of the strategic decisions a manager would face, a common reaction from the students was that it was too complex for effective learning. When one made multiple decisions at once, the interactions among them complicated the outcome further and made it hard for people to untangle individual effects. Participants often perceived the resulting outcome to be random or too complex to understand. It became less effective to teach and learn as a result. We discuss student feedback on this beta test further in section 4.

To avoid overwhelming students with too many contextual settings and decisions at once, we introduced *staged game design*, where we start with a simple version with one decision variable and then gradually introduce new variables in the later versions. Through staged design, students can focus on the dynamics of each feedback loop one at a time.

We designed two versions of the IEMFS taught in the first-year Strategic Management course at MIT Sloan in the spring of 2006. The first simulates the salt industry, with pricing as the only variable in a two-player setting. The second represents the video game industry with additional decision variables such as firm entry time, target market share, royalty fee charged to complementors, and the decision to offer cross-platform compatibility.

3.1 Salt industry version

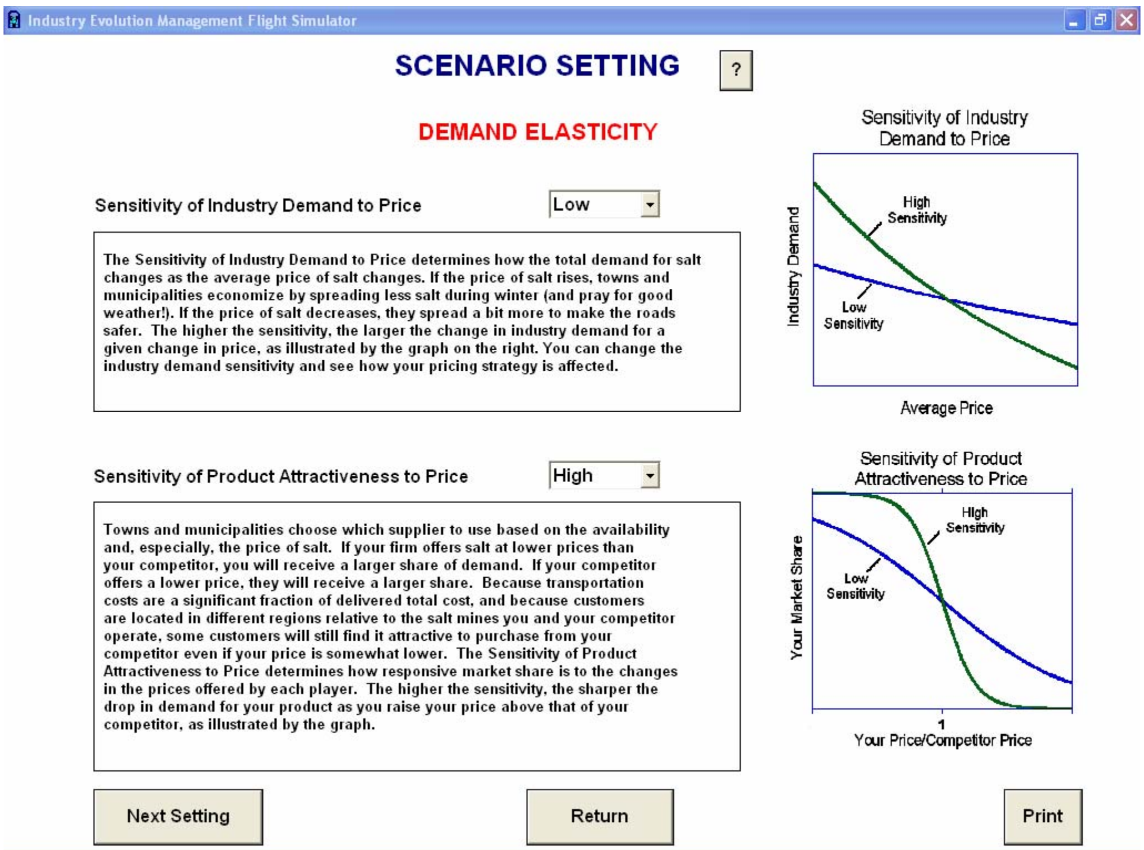
3.1.1 Salt case

The first version represents the salt industry as described in the original case study on the salt industry we developed to accompany the simulator (Henderson and Sterman 2005). It is a two-player price competition game. The student plays the role of the President and CEO of Compass Minerals International, a large salt producer, whose main clients are cities that buy rock salt for deicing roads. To keep things simple, there is only one decision variable, price, and there are only two firms with identical structure (including cost structure and production capacity). The playing field is level: any differences in performance are due to differences in the pricing strategies of the firms alone. Students form two teams and compete against each other. Their goal is to maximize cumulative profit over a period of ten years. Both sides simultaneously set prices each year and receive feedback in the form of realistic reports on market shares, revenue, profit, costs, etc. No direct communication is allowed between the teams (as this would violate US antitrust law). Players need to select pricing strategy based on their best judgment about how the competitor and customers may respond.

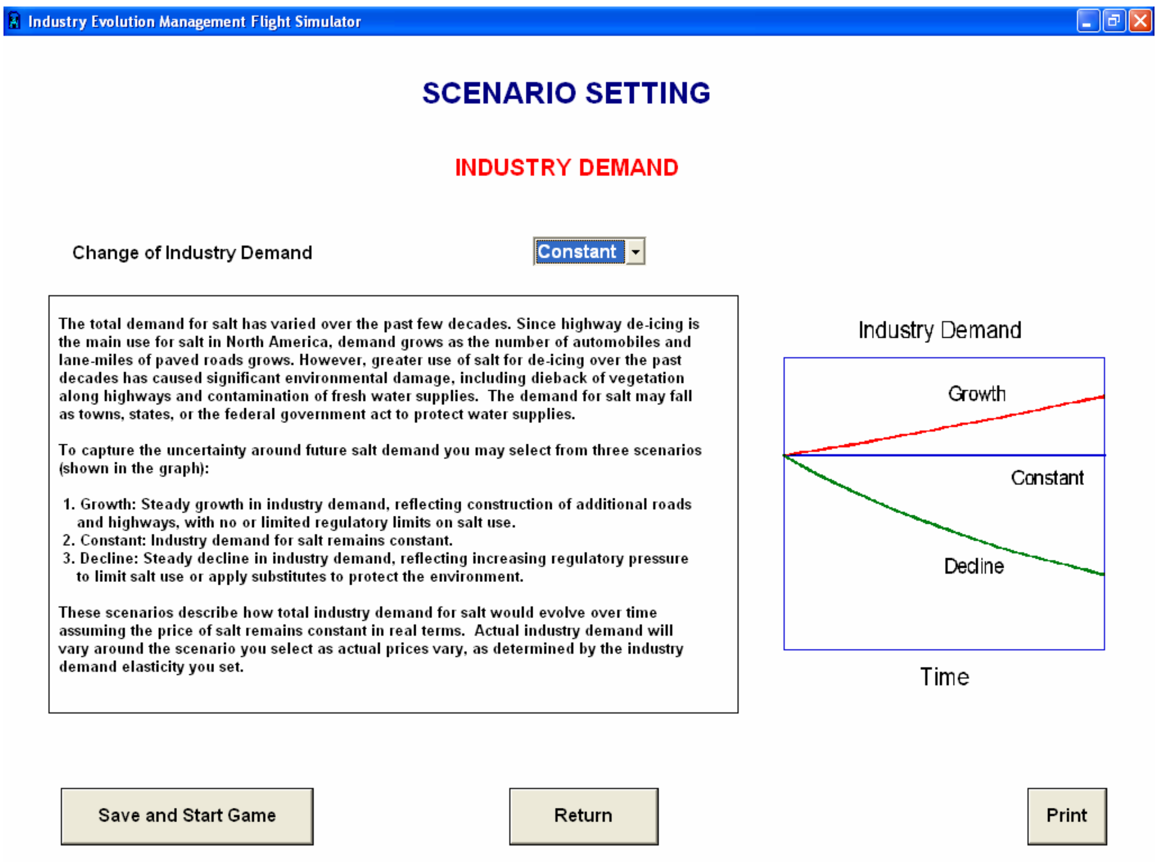
3.1.2 Scenario settings

Prior to the start of the game, players set three main industry characteristics. The first two are shown in the screen below. First, they choose the *Sensitivity of Industry Demand to Price* determines how the total demand for salt changes as the average price of salt changes (the industry demand elasticity). If the price of salt rises, towns and municipalities economize by spreading less salt during winter. If the price of salt decreases, they spread a bit more to make the roads safer.

Second, players set the *Sensitivity of Product Attractiveness to Price*: towns and municipalities choose which suppliers to use based on the availability and, especially, the price of salt. If one firm offers salt at lower prices than the competitor, it will receive a larger share of demand. Because transportation costs are a significant fraction of delivered total cost, and because customers are located in different regions relative to the salt mines both firms operate, some customers will still find it attractive to purchase from the competitor even if one firm's price is somewhat lower. The Sensitivity of Product Attractiveness to Price determines how responsive market share is to the changes in the prices offered by each player. The higher the sensitivity, the sharper the drop in demand for the firm's product as it raises its price above that of its competitor.

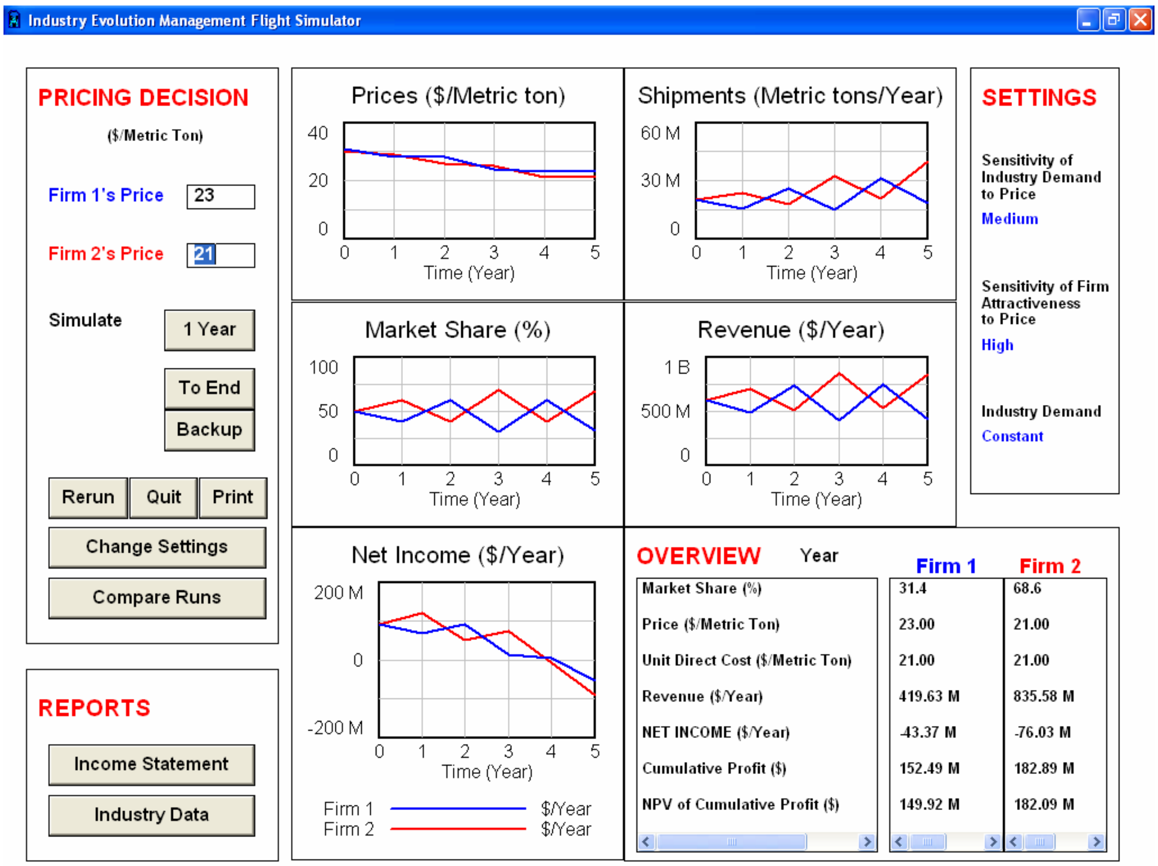


The third setting is Industry Demand (shown below). The *Industry Demand* for salt varies with population growth, particularly, with growth in highway lane miles, since highway deicing is the main use of salt. There are three possible scenarios: *1. Growth*: a steady growth in industry demand. This is the case when there are more highways built over time. *2. Constant*: no growth or decline. *3. Decline*: a steady decline in industry demand. The decline scenario captures a plausible future in which growing environmental damage from road salt leads to government regulation limiting its use.



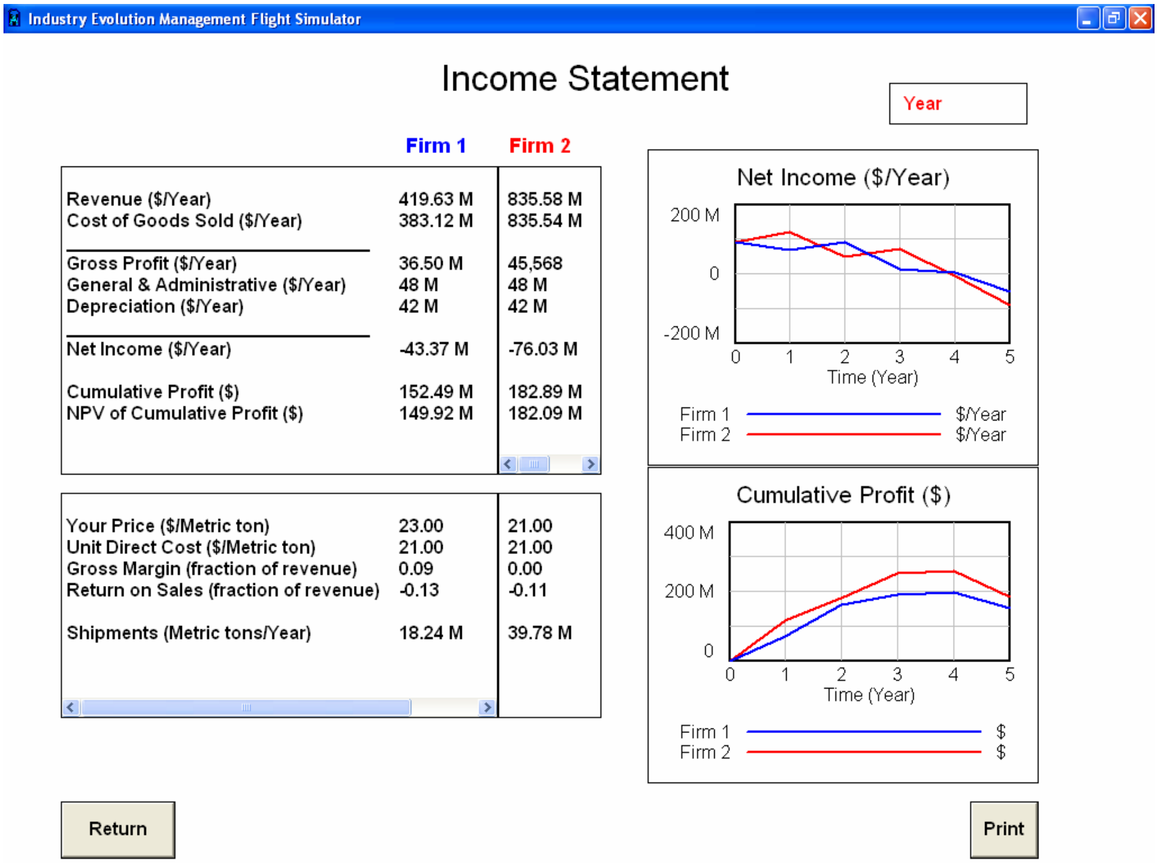
3.1.3 Decisions

The following shows the decision-making screen. Each firm sets prices simultaneously. One can simulate year-by-year or all the way to the end. There are five charts shown on the screen: prices, market shares, net incomes, shipments, and revenues for both firms, with an overview of their numerical values at the corner.



3.1.4 Reports

Besides the five charts on the decision-making screen, there are two additional detailed reports. The following screen shows the income statements for both firms.



The next screen shows industry sales and revenues. There reports are designed to mimic the information a typical manager may have when setting strategy.

3.1.5 Teaching points

The salt version of the simulator is quite simple. Most of the feedbacks captured in the model are deliberately turned off; the dynamics arise solely from the pricing decisions of the two firms. Salt is a mature commodity industry, and the dominant considerations in product attractiveness are availability and price. Since capacity is ample, pricing is the main instrument for a firm to gain competitive advantage. Other feedbacks relating to, e.g., product development, process development and marketing are less important. As a result, pricing is the only decision variable in the game.

Traditionally, one uses game theory and concepts such as the prisoner's dilemma to explain price competition. Two firms can either engage in a self-destructive price war or they can learn to collude implicitly and share the monopoly rent. Knowing game theory is one thing, playing it out in reality is another. Game theory assumes perfect rationality, whereas in real life, people may respond according to recent memory and short-term future expectation of competitor's actions. The salt game gives students real time simulation of strategy making in response to and anticipation of competitor's actions.

3.2 Video game industry version

3.2.1 Nintendo case

The video game industry version of the simulator has been customized to portray the early days of the video game industry as described in the Harvard Business School Case: Power Play (A): Nintendo in 8-bit Video Game (Brandenburger 1995). The student plays the role of either Nintendo management or their chief rival, Sega. In 1986, Nintendo introduced its 8-bit console into the U.S. market. Nintendo's revenue is generated by the sale of consoles and the royalty fee paid by game developers. For the purpose of the simulation, we assume Nintendo builds and sells the consoles and licenses outside developers to create the games. These developers then pay Nintendo a royalty on each cartridge sold.

3.2.2 Scenario settings

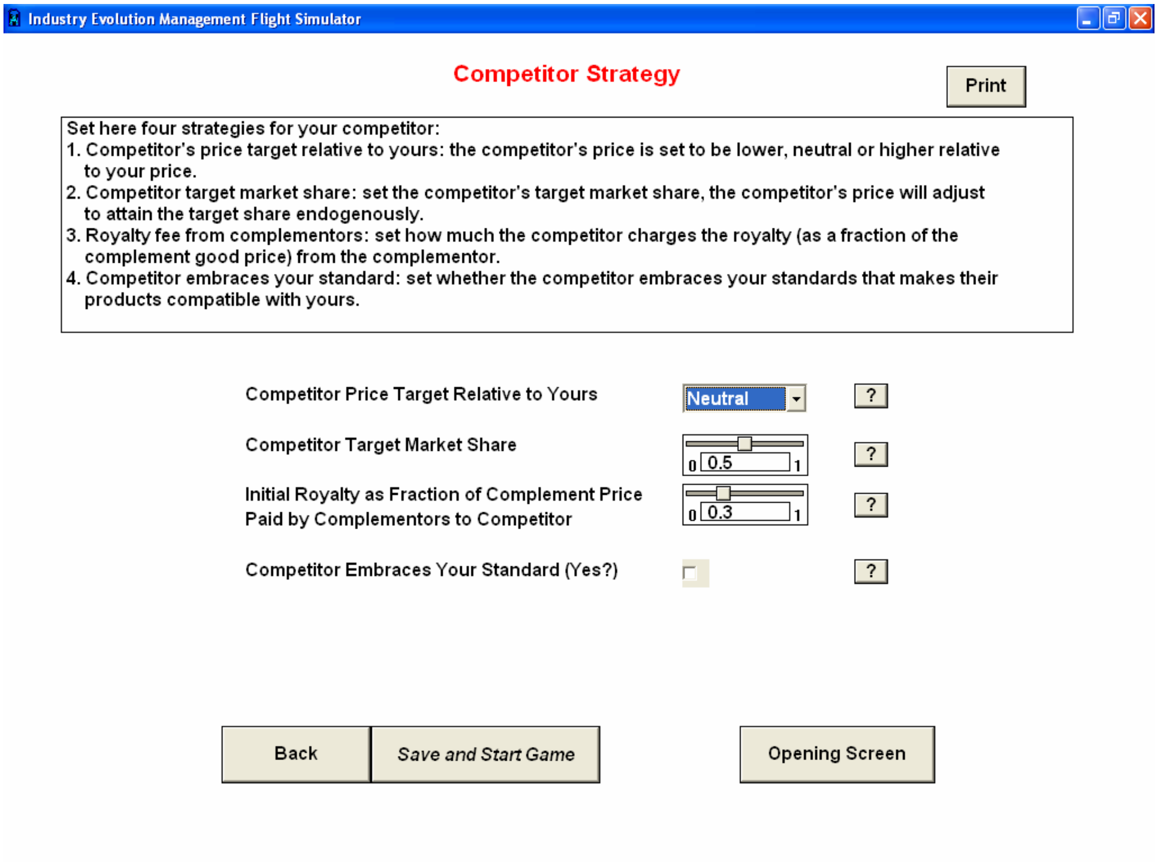
There are two scenario settings prior to the game: firm entry and competitor strategy.

Firm Entry:

Three firm entry scenarios can be set prior to the game (see screen below). In the first, both firms enter the game at the beginning. In the second scenario, the competitor is the only firm in the game to start with and the player enters later in the game. The decision to enter is one of the choices players must make. In the third scenario the player is the only firm to start with and the competitor enters later. Here one can further specify whether the competitor will enter endogenously, based on expected profit, or exogenously, at a certain year. The threat of competitor entry creates more uncertainty, much like the real world.

Competitor Strategy:

There is only one competitor, simulated by the computer. Before playing, the participant sets key elements of the competitor's strategy: *1. Competitor's price target relative to yours*: the competitor's price is set to be lower, neutral or higher relative to your price, all else equal. *2. Competitor target market share*: the competitor's price will adjust to attain its target share endogenously; here the player sets the competitor's target for market share. For example, 50% would indicate willingness to split the market evenly with the player, while 80% would indicate a desire to gain a dominant share, causing the simulated competitor to lower its price relative to other factors when share is less than 80%. *3. Royalty fee from complementors*: set the royalty the competitor charges third party game designers (as a fraction of the game cartridge price). *4. Competitor embraces your standard*: set whether the competitor embraces your standard and makes their products compatible with yours.



3.2.3 Decisions

There are five decision variables: entry time, pricing policy relative to competition, target market share, royalties charged to complementors and whether to embrace the competitor's standard and offer a compatible product.

Entry time:

The game can be configured so that both firms enter at the same time or so that the player chooses when to enter and compete against Nintendo. In the latter case, the player has the choice to decide when to enter. The later it is, the harder it might be to compete. One can test out different strategies in face of various entry times.

Pricing policy:

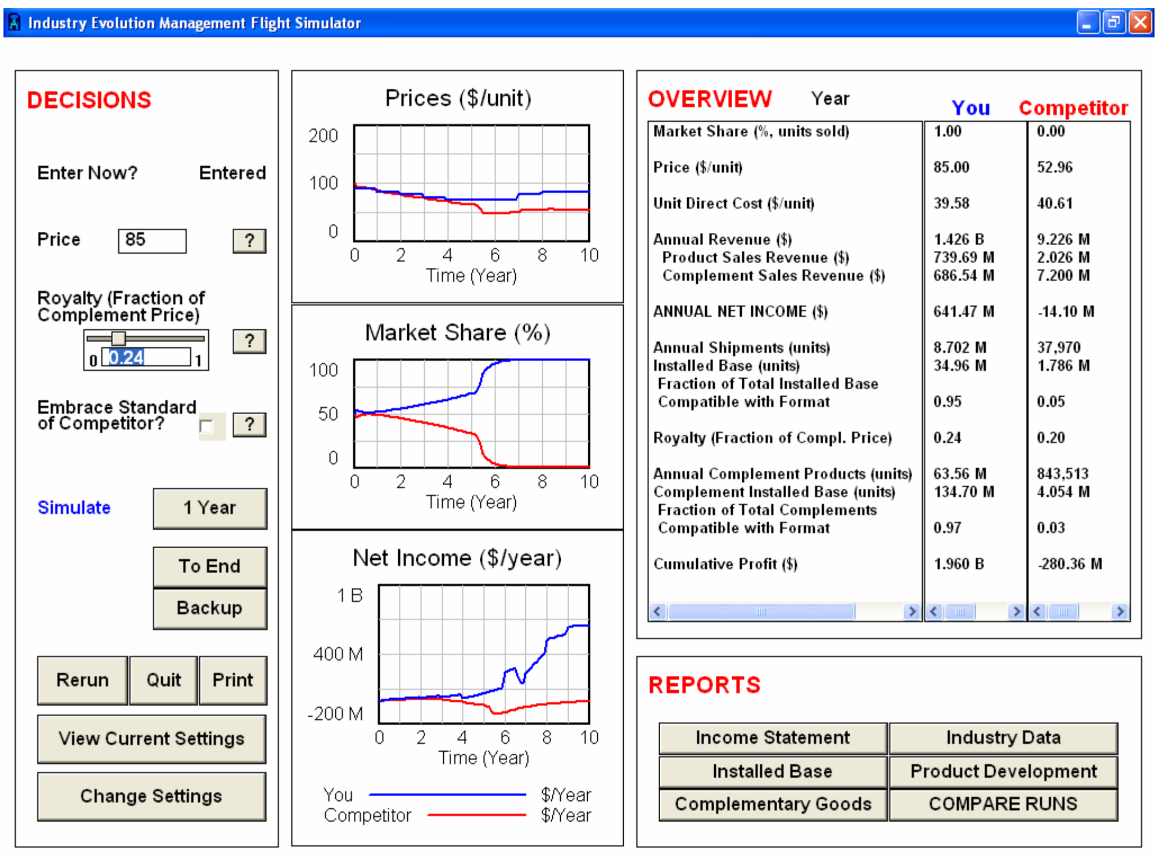
Players set the price charged for their consoles.

Fraction of Complement Price as Royalties:

A game console is useless without games to run, and much of the revenue generated in the industry comes from sales of game cartridges. What royalty will you charge to third parties developing game cartridges for you? The larger the royalty, the more you make from each cartridge sold. However, the larger the royalty, the lower the profit to the third party developers, so fewer will choose to develop games for you (they may instead form a partnership with your competitor or simply not enter the market).

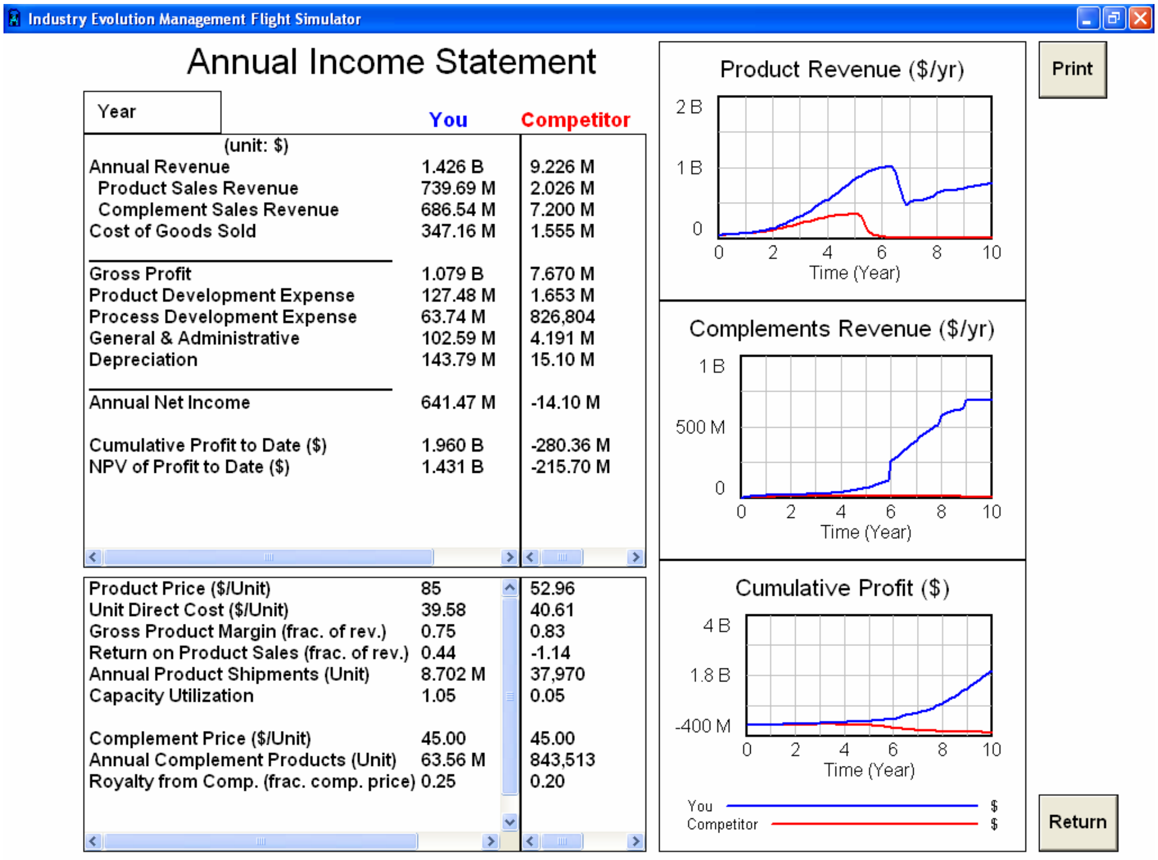
Embrace the competitor's standard:

You have the option of designing your console so that it will not only play cartridges designed for your system but can also play cartridges developed for your competitor's system. Similarly, if your competitor embraces your standard, their consoles will be compatible with cartridges developed for your system.

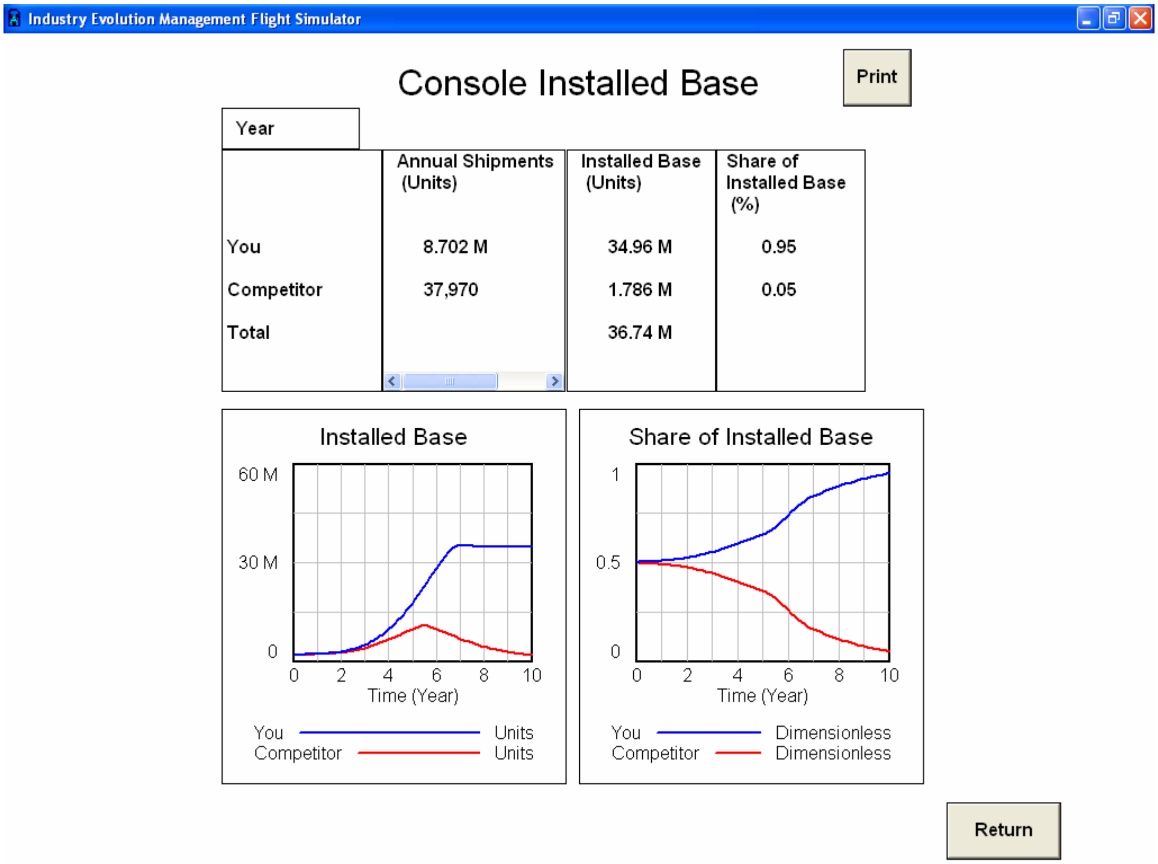


3.2.4 Reports

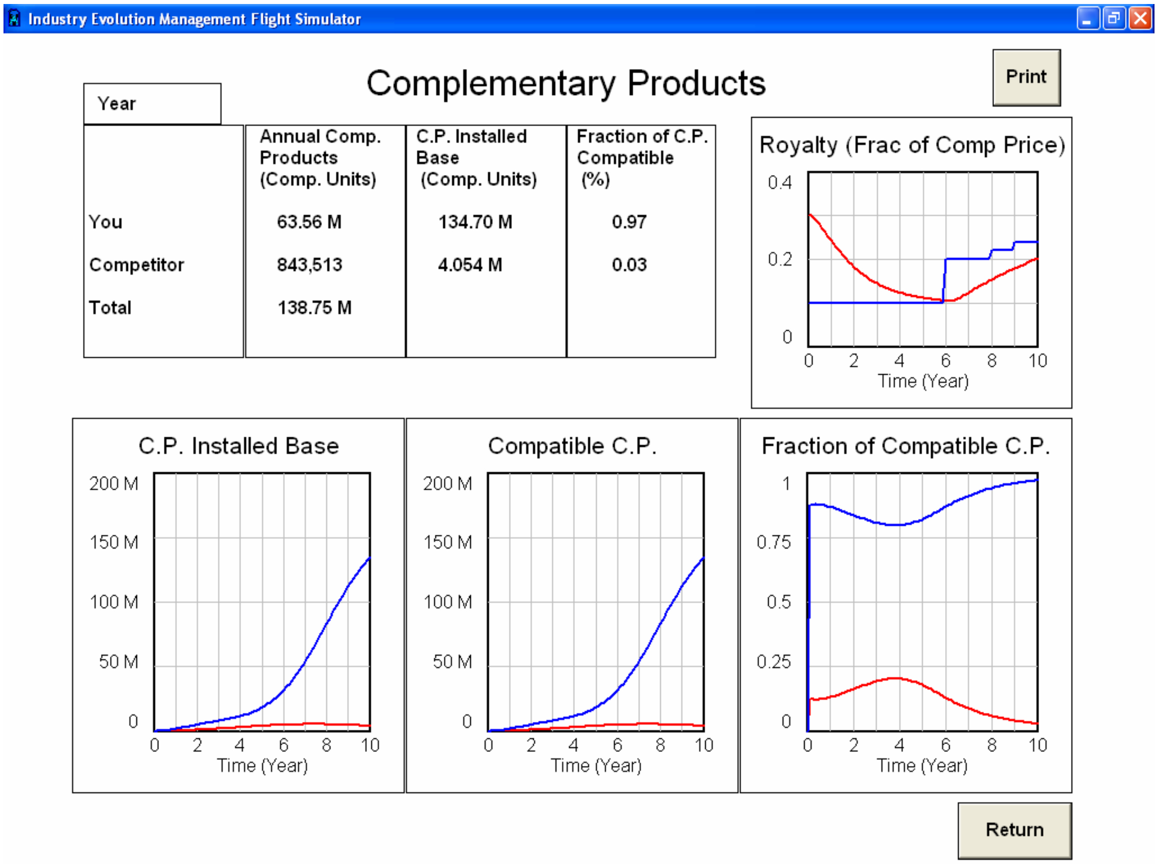
Players receive reports including the income statement, industry data, the installed base of consoles and game titles, and console functionality. The screen below shows a typical income statement report.



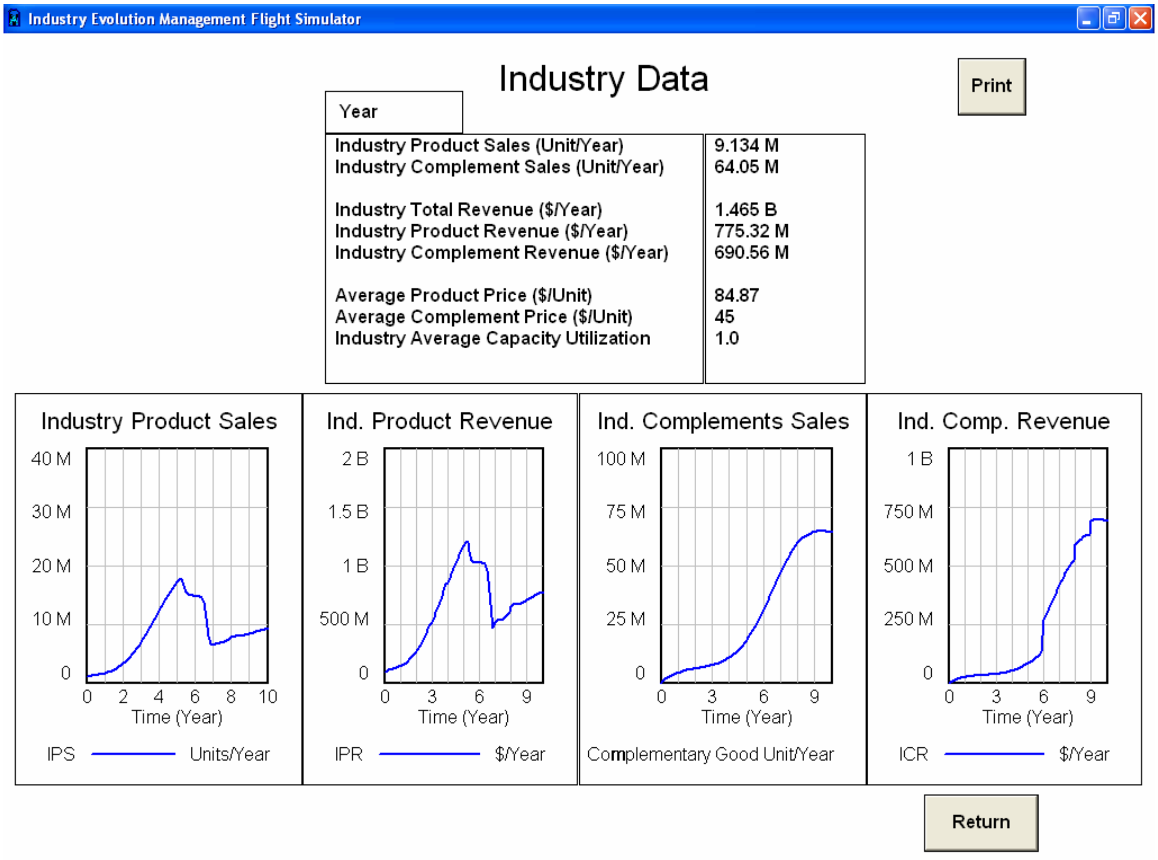
The installed base report shows the annual shipments, the actual numbers and the fractions of installed base compatible with one's format for both firms.



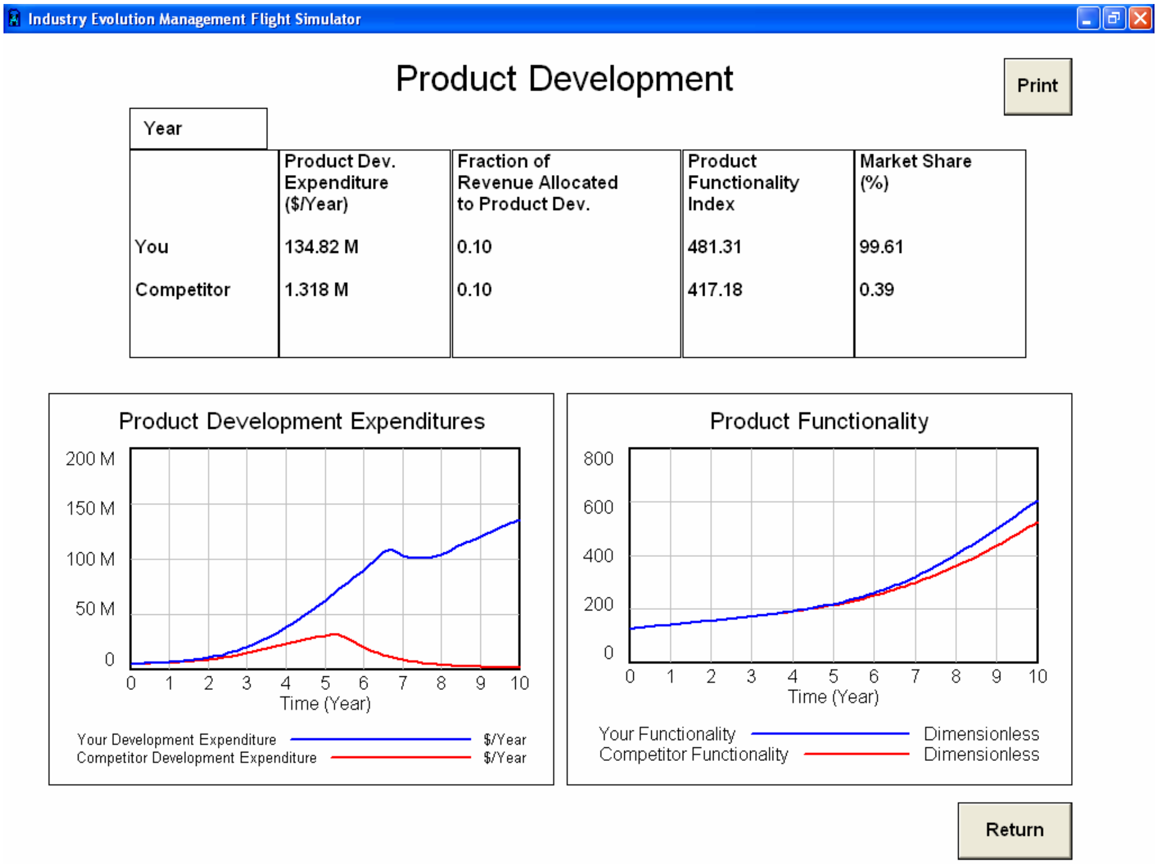
The complementary assets report shows royalty fees and the actual numbers and the fractions of complementary assets compatible with one's format for both firms.



The Industry data report shows industry sales and revenue for both the product (consoles) and the complementary assets (game titles).



Lastly, the product development report shows product development expenditures and the resulting functionality improvement.



3.2.5 Teaching points

The main teaching point of the video game industry version is how to create and capture value in an industry dominated by increasing returns or positive feedbacks (Arthur 1996, Shapiro and Varian 1999, Sterman 2000, Sterman et al. 2006).

In the video game industry, one strong positive feedback is the *network effect*. The more game consoles Nintendo sells, the larger its installed base in the market, which makes its console even more attractive because people are likely to perceive it as the dominant standard and because their games will work on their friends' machines. In addition, a larger installed base induces more game developers to produce game titles for its console because they perceive a larger market for its standard. This fuels the second powerful positive feedback, the *complementary asset* loop, or indirect network effect, in Nintendo's favor.

Another teaching point relates to *standards and compatibility*. By embracing the competitor's standard, you make the competitor's game titles compatible to run on your consoles, which make your console more attractive. However, this does not create full interoperability: your game titles cannot run on the competitor's console unless it also embraces your standard. These decisions introduce interesting dynamics for students to learn how standards may evolve over time, and the advantages and disadvantages of open versus closed proprietary standards.

4. LESSONS AND EVALUATIONS

We beta tested the generic simulator in Prof. Rebecca Henderson's Technology Strategy course in the spring term of 2005. "Tech Strat" is an advanced MBA elective focusing on strategy development and implementation for technology-based industries. The generic model and game described above were used in conjunction with original cases developed for the salt industry, high-tech golf equipment and radial tires. The model was used live in class, with students suggesting strategies and translating these into specific decisions, which were then entered by the professor. Students were also given the game for their individual use over spring break in conjunction with their term paper, in which they select a real firm and industry and recommend a strategy for success using the various frameworks they learned during the course. Students were invited to (1) provide us with comments on the model and interface; and (2) configure the game to (roughly) match the industry they selected for their term paper and use the model to develop strategies for success.

Student response was generally favorable, though there were several valuable lessons. First, using the model in class takes substantial time. Students (rightfully) ask many questions about the underlying assumptions and structure of the model. Rather than take scarce class time to go into details, we prepared (nontechnical) documentation that described the model purpose, architecture, and main assumptions, at the level of a good technical report or competitive assessment managers might prepare in a real setting. The documentation also included instructions for running the game so they could use it on their own. Nevertheless, considerable time was spent describing the model rather than using it.

Second, there was significant heterogeneity in the class (of about 130 students) in terms of prior exposure to system dynamics and MFS. Roughly half had taken the introductory course in system dynamics; these people had worked with various MFS such as People Express and had learned the basic concepts of system dynamics, including causal loop diagramming, stock and flow mapping, and simulation using Vensim. Those who lacked such experience had many more questions about the mechanics of the game and how to learn from a MFS.

Third, students found the model quite complex. Even though we limited the number of parameters students could set to configure the characteristics of the industry and competitive environment, it took quite a long time to go through these and set up a scenario. To use such a simulator in a class of 80 minutes requires focus on a particular small set of scenarios and considerable discipline on the part of the facilitator/faculty member. Since not all questions and possibilities can be addressed in class, it is useful for students to be able to try sensitivity analysis and other strategies on their own as homework or follow up after an in-class MFS session.

Fourth, students found it difficult to provide specific decisions and make the tradeoffs required by the MFS. It is easy in a case discussion to suggest that a particular firm should, say, aggressively price the product, build innovative products and brand equity so they can gain market share and drive their costs down the learning curve faster than their rivals can. It's quite something else to make hard decisions such as how much to cut price, and whether to fund the increased R&D and marketing budget by cutting something else or by taking a hit to earnings. The obvious discomfort students felt in having to be so specific and operational—and then getting immediate feedback on the consequences of these decisions—is a valuable benefit of the MFS: they will have to make such difficult decisions in the real world, where vague generalities about "being aggressive" won't cut it. The MFS helped them learn how to translate general strategic objectives into specific decisions, and how to interpret the feedback they received from the market—how long should they stick with their strategy before revising it in the face of market outcomes different from their expectations? Does the system exhibit worse-before-better behavior? Did the competitors and customers react to their decisions in ways they did not expect? Confronting these situations is of course one of the main benefits of the MFS. However, as discussed by Isaacs and Senge (1992) and Sterman (2000), having to do on in public, before one's peers, can be threatening and trigger defensive behavior. Generally, our students are highly competitive and threw themselves into the situation with enthusiasm, but some were reticent, and the public nature of the testing process may affect their willingness to try risky or innovative strategies and probably focused people on finding successful strategies that improved performance from run to run while suppressing experimentation designed to learn about the system dynamics, particularly if such experimentation might have yielded a poor outcome.

In response to the lessons from the generic simulator discussed above, we developed the industry-specific salt and video game versions. Because they focus on a particular case and are customized to it, there are fewer parameters to set and decisions to make, speeding explanation and play. Both versions were beta tested in the first-year Strategic Management course at MIT Sloan in the spring of 2006. Below are student evaluations of the effectiveness of the salt industry and Nintendo simulators. We surveyed all students taking the class, receiving roughly 300 responses,. We asked them to rate their degree of agreement or disagreement with various statements such as "the simulators were effective" using a standard 7-point Likert scale, with 1 indicating strong disagreement and 7 indicating strong agreement. The survey is shown below:

Industry Evolution Management Flight Simulator Feedback

Thank you for your participation in using the Industry Evolution Management Flight Simulator (Salt and Video Game versions) in 15.900. As part of Sloan's mission to lead innovation in management education, our goal is to develop interactive simulation-based learning environments to complement the traditional case method. Your feedback will help us improve the simulators and develop new ones. Many thanks!

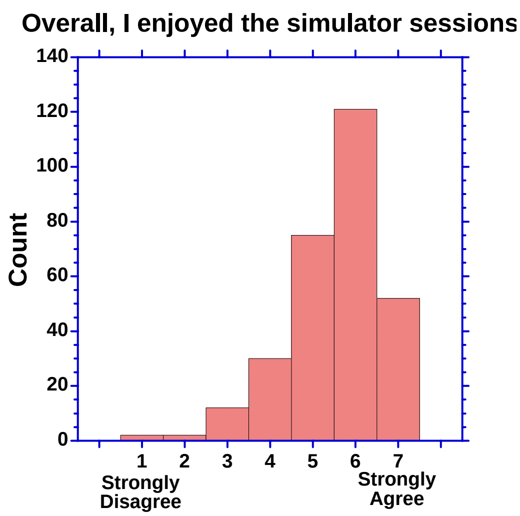
	Strongly Disagree			Neutral			Strongly Agree
Overall, I enjoyed the simulator sessions	1	2	3	4	5	6	7
	Strongly Disagree			Neutral			Strongly Agree
The Salt industry simulator was effective and useful	1	2	3	4	5	6	7
	Strongly Disagree			Neutral			Strongly Agree
The Nintendo industry simulator was effective and useful	1	2	3	4	5	6	7
	Strongly Disagree			Neutral			Strongly Agree
We should continue to use simulations like these in 15.900	1	2	3	4	5	6	7
	Strongly Disagree			Neutral			Strongly Agree
I would like to be able to work with the simulators on my own as well as in class	1	2	3	4	5	6	7
	Strongly Disagree			Neutral			Strongly Agree
I would like to be able to learn using simulators in other classes	1	2	3	4	5	6	7
	Too Much			About Right			Too Little
The time spent on the simulators was	1	2	3	4	5	6	7
	Strongly Disagree			Neutral			Strongly Agree
I prefer lecture and case discussion over the use of simulators	1	2	3	4	5	6	7

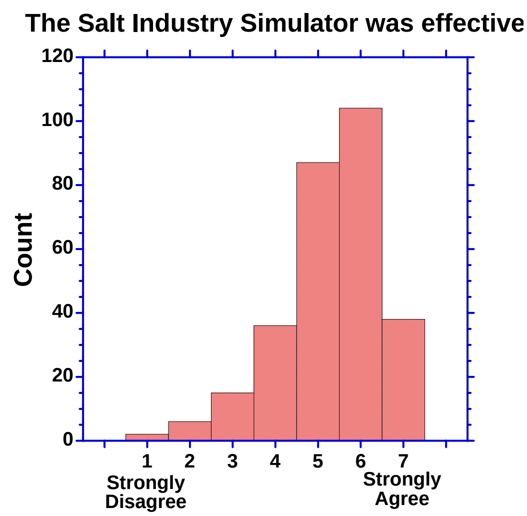
A good way to use simulators is to	Strongly Disagree			Neutral			Strongly Agree
Select a few teams to play in front of the class (as done this term).	1	2	3	4	5	6	7
Break the class into teams and let all teams play simultaneously, so everyone gets to play at least once.	1	2	3	4	5	6	7
Assign the simulator as homework and discuss results in class, so everyone gets to play as much as they want.	1	2	3	4	5	6	7

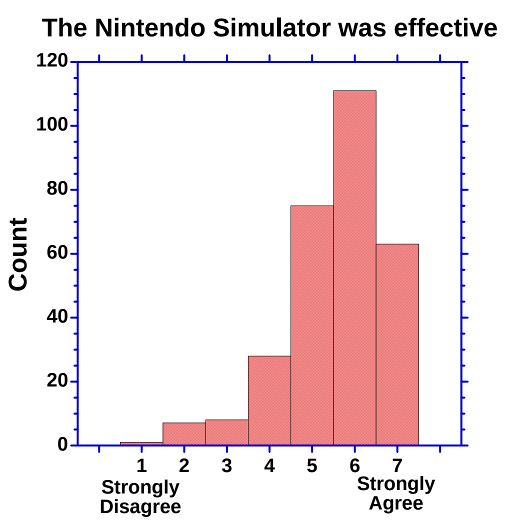
Other (please specify)

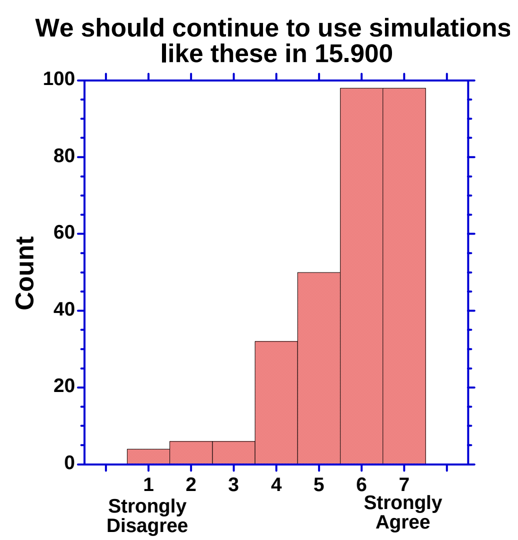
The survey results are shown below:

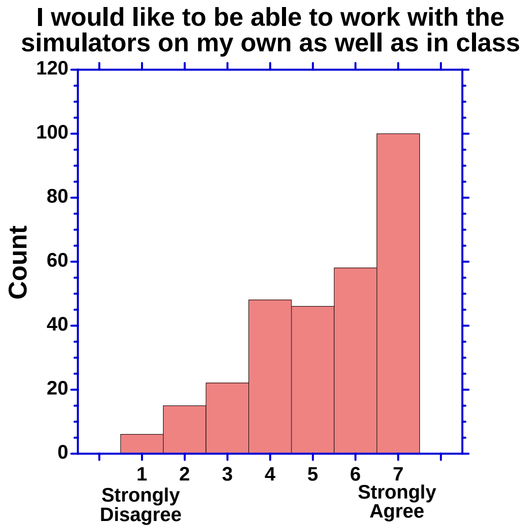
	Average	Std Dev	N
Overall, I enjoyed the simulator sessions	5.53	1.13	294
The Salt industry simulator was effective and useful	5.31	1.20	288
The Nintendo industry simulator was effective and useful	5.57	1.18	293
We should continue to use simulations like these in 15.900	5.73	1.31	294
I would like to be able to work with the simulators on my own as well as in class	5.33	1.64	295
I would like to be able to learn using simulators in other classes	5.36	1.39	292
The time spent on the simulators was	4.12	1.13	294
I prefer lecture and case discussion over the use of simulators	4.25	1.43	290
Select a few teams to play in front of the class (as done this term)	4.75	1.43	288
Break the class into teams and let all teams play simultaneously, so everyone gets to play at least once.	4.96	1.62	292
Assign the simulator as homework and discuss results in class, so everyone gets to play as much as they want.	4.37	2.01	293

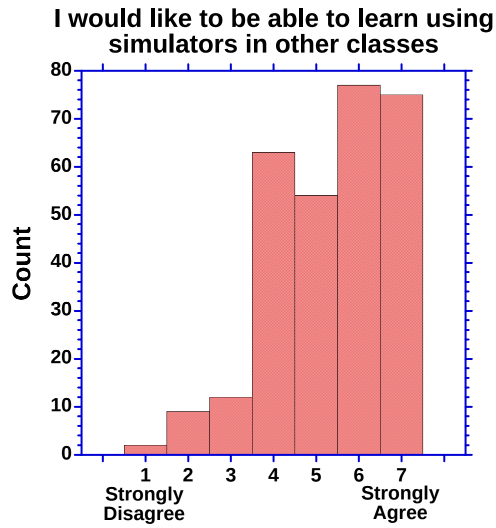


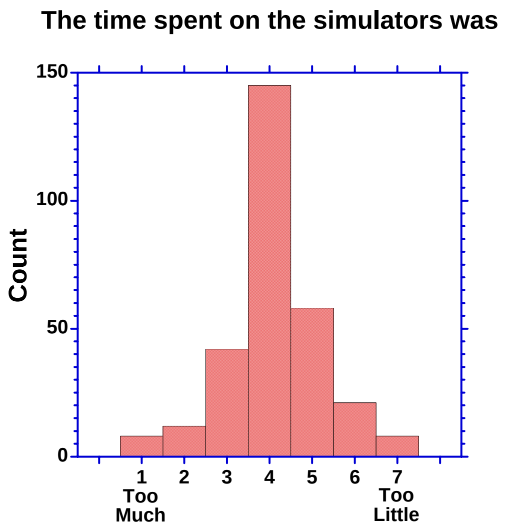


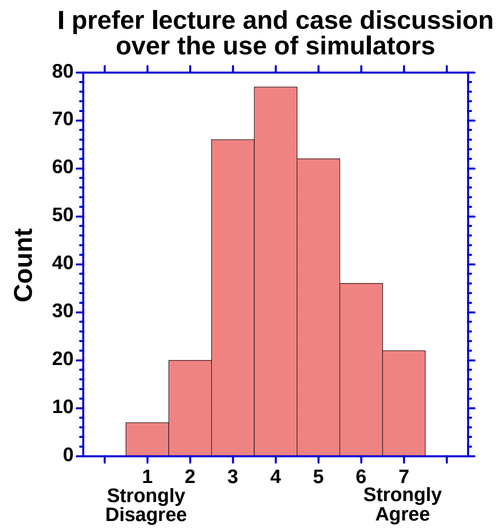




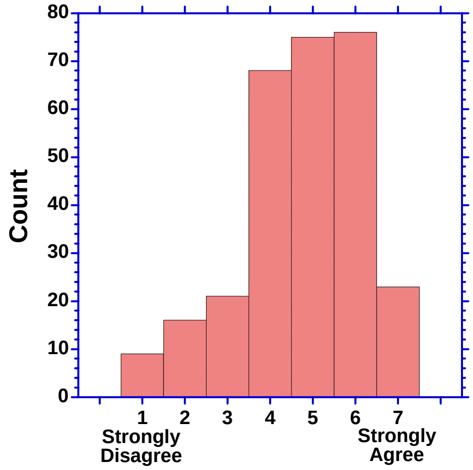

I would like to be able to work with the simulators on my own as well as in class
Count
120
100
80
60
40
20
0
1 2 3 4 5 6 7
Strongly Disagree
Strongly Agree


I would like to be able to learn using simulators in other classes
Count
80
70
60
50
40
30
20
10
0
1 2 3 4 5 6 7
Strongly Disagree
Strongly Agree

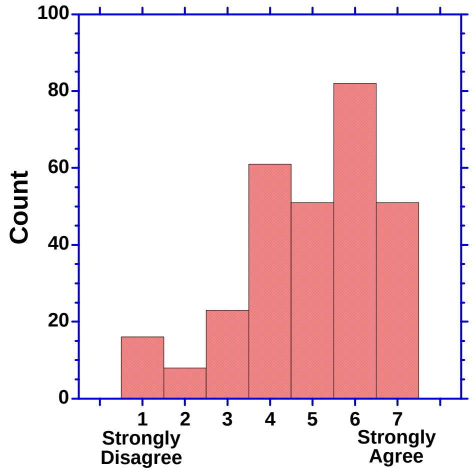

The time spent on the simulators was
Count
150
100
50
0
1 2 3 4 5 6 7
Too Much
Too Little


I prefer lecture and case discussion over the use of simulators
Count
80
70
60
50
40
30
20
10
0
1 2 3 4 5 6 7
Strongly Disagree
Strongly Agree

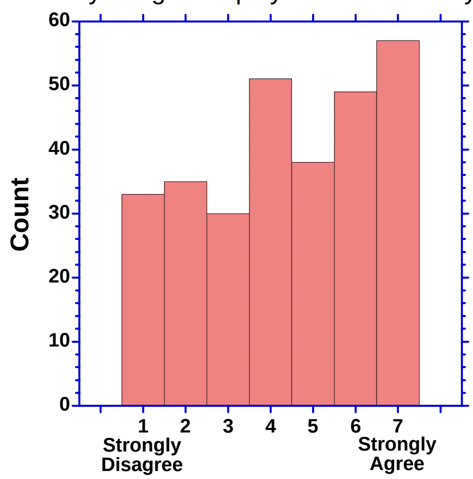
A good way to use simulators is to
Select a few teams to play in front of the class
(as done this term)



A good way to use simulators is to
Break the class into teams and let all teams play
simultaneously, so everyone gets to play at least once



A good way to use simulators is to
Assign the simulator as homework and discuss results in class,
so everyone gets to play as much as they want



On average, students rated both simulators as quite effective and useful. They wish to continue to use such simulators in the strategy class and in other courses. They would like to have the ability to play the simulators on their own, outside of class, but, unsurprisingly, do not want to have them assigned as mandatory homework. There is considerable heterogeneity regarding how to best use the simulators; further experimentation will be needed since the students only experienced one of the options and so have difficulty comparing the one they experienced to hypothetical alternatives. Of course, these survey responses, while encouraging, are not definitive. Whether the simulators actually led to durable, actionable insight into strategic situations, and whether they do so better or worse than the traditional case method requires further investigation.

5. FUTURE DEVELOPMENT

There are two general directions for future development. One is to calibrate the current Industry Evolution Model to additional case studies from different industries, and design interfaces that allow students to take on more decisions at once, such as expenditure in marketing, product development, process development and G&A. The idea is to produce versions of the IEMFS to accompany the key traditional paper cases in a strategic management course.

The second future development is the refinement and elaboration of the current model. Some of the excluded model variables (see Table 1) can and should be made endogenous depending on the teaching purposes. For strategic issues concerning supply chain management and logistics, one could incorporate the upstream supply chains, inventory and downstream distribution channels in the model. For issues related to corporate finance, we could add the balance sheet and capital markets to explore interactions between the real and financial sides of business operation. In terms of the evolution of industry structure, the current model captures firm entry and exit, but does not address merger and acquisition, diversification, specialization, alliances and business webs. The more complex a strategic issue is, the more beneficial the use of a MFS might be. The feedbacks arise from firm to firm interactions will complicate strategic management significantly, a MFS focusing on industry evolution dynamics might prove to be a more effective way of teaching strategic management overtime.

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