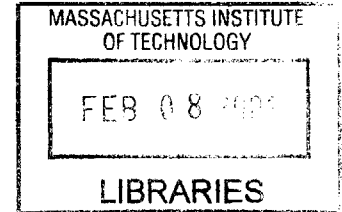


**An Investigation of a Web-based Tool for Concept Testing and  
Development: A Study of the Securities Trading of Concepts  
(STOC) Research Method**

**BARKER**

by

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**Submitted to the System Design and Management Program  
in Partial Fulfillment of Requirements for the Degree of  
Master of Science in Engineering and Management**

at the

**Massachusetts Institute of Technology**

**February 2001**

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# An Investigation of a Web-based Tool for Concept Testing and Development: A Study of the Securities Trading of Concepts (STOC) Research Method

by

Laurie Taylor Hart

Submitted to the System Design and Management Program  
on January 5, 2001 in Partial Fulfillment of  
the Requirements for the Degree of Master of Science  
in Engineering and Management

## ABSTRACT

The Securities Trading of Concepts (STOC) methodology was experimentally and theoretically analyzed. In addition, participant patterns and behaviors during the experimental study were evaluated in great detail. Finally, a comprehensive concept development framework was developed in order to thoroughly assess the effectiveness and integration of this new research methodology.

Briefly, the STOC methodology is an electronic market exchange game where participants trade securities of new product concepts. The securities represent shares of the company that owns each product concept, rather than the concept itself. Each participant begins the game with a lump sum of faux money as well as shares of each of the securities available for trading. The participant's goal in the trading competition is to maximize the value of their personal portfolio. The securities price information, collected throughout the trading simulation, indicates both the individual and group preferences.

The prediction capability of the STOC method is supported by early experimentation and analysis included in this study. The STOC method provides incentives for customers to provide honest feedback. In addition, it more closely replicates real customers' purchase-decision behavior, which is heavily influenced by perceived images developed through the opinions of others and the competitive environment. And, unlike most research methods, STOC evokes excitement and enthusiasm during the experiment; thus, motivating the participant to personalize his or her responses.

The experimental data suggests that the STOC method is extremely effective at choosing the top few concept winners and losers.

Understanding a product's architectural constraints, as well as key customer attributes, is critical to a successful implementation of STOC. A capital-intensive firm, such as an automotive company, would clearly benefit from STOC concept research, assuming thoughtful implementation.

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An Investigation of a Web-based Tool for Concept Testing and  
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**Table of Contents**

CHAPTER	PAGE
00. Abstract.....	2
0. Tables of Contents.....	3
1. Introduction.....	5
1.1 Motivation.....	5
1.2 The Challenge.....	7
1.3 Hypotheses.....	10
1.4 Approach of the Study.....	10
2. Concept Development and Testing Process.....	12
2.1 Strategy.....	13
2.2 Idea Generation.....	16
2.3 The Voice of the Customer is Important.....	19
2.4 Concept Refinements and Selection.....	21
2.5 Choosing Winning Concepts is Hard, yet Critical to Success.....	23
2.6 Concept Prototyping and Testing.....	25
3. Virtual Consumer Research.....	29
3.1 Virtual Benefits.....	29
3.2 Virtual Challenges.....	31
3.3 Virtual Methods.....	33
4. The Experimental Study.....	37
4.1 Market Background.....	37
4.2 Crossover Vehicle Case Study .....	39
4.3 Laptop Bag Case Study.....	44
4.4 Respondents.....	48
4.5 Results and Analysis.....	48
4.6 STOC Participant Trading Behavior.....	52

An Investigation of a Web-based Tool for Concept Testing and  
Development: A Study of the Securities Trading of Concepts  
(STOC) Research Method

**Table of Contents (continued)**

CHAPTER	PAGE
4.7 STOC Market Dynamics .....	57
5. STOC Implementation.....	60
5.1 Respondent Enthusiasm in Web Markets.....	60
5.2 Implementation Ideas.....	61
5.3 STOC Integration into The Product Development Process.....	62
5.4 An Automotive Example.....	64
6. Conclusions.....	68
6.1 Conclusions.....	68
6.2 Suggested Areas for Future Research.....	70
7. Bibliography.....	72
8. Appendix A.....	75

## Chapter 1. Introduction

### 1.1 Motivation

Mature product development firms are often faced with intense competition; therefore, their primary success determinants often become: 1) producing the lowest cost product; 2) getting new products to the market quickly; and 3) meeting the customer's needs best. Consumers, in general, are demanding more refined products, while industry processes continue to be optimized in order to maintain profit margins. These three elements are the most accurate indicators to the sustaining power of a mature product development firm.

The automotive Industry is an excellent example of a mature industry with cost and time-to-market as key success determinants. This is when the process phase of Foster's S-Curve<sup>1</sup> becomes important. During the 1980s and 1990s, lean manufacturing enabled companies such as Toyota to gain significant market share, while outsourcing enabled companies like Chrysler to increase their presence. Meanwhile, the once-automotive-powerhouse, General Motors, continued to lose market share, perhaps due to its outdated processes and overhead-intensive cost structure. Today, recent trends such as modularity and mass customization are further impacting the market.

Improvement in product cost and process are very interesting and important elements to the success of a firm and are therefore heavily studied by academia. This thesis,

however, primarily examines tools and enablers that can assist a firm in its quest for delivering winning concepts: those that best meet the customer's needs.

Like most customers in mature industries, current automobile customers are extremely demanding. They want to be surprised, delighted, and impressed by the features and craftsmanship of the vehicles they purchase. They have the right to be extremely picky due to multiple product offerings. Features such as safety and comfort can explain the ever-increasing number of mini-van and sport utility vehicles in the U.S., while new features, such as on-board navigation and Internet-capable systems are introducing new design paradigms. To further complicate matters, manufacturing firms, like automotive, may have conflicting goals in that they are not heavily incentivized to embrace radical innovations to please their customers. This is due primarily to their tightly held complementary assets (i.e., capital-intensive machinery and equipment, manufacturing processes, systems knowledge, and distribution infrastructure). The price to enter a totally new market might be substantial and the risk is significant. Despite these internal pressures, the intense levels of competition are driving fear into many mature industries like automotive and the race to be the first to develop a new dominant design is often heavily subscribed.

Since the introduction of the Internet, new paradigms in just about every industry have evolved. Most firms acknowledge that they will be affected by this new technology, but they are often faced with high levels of anxiety and confusion. They rapidly develop strategies in an attempt to secure their position in this new marketplace.

With these increasing pressures, determining the winning concept is always difficult. Competitive information, consumer market surveys, and historical trend data all assist in developing concept ideas; however, selecting an idea to pursue is always the most difficult challenge. This is especially the case in mature industries such as an automotive. Customer research data is not consistently reliable and concepts cannot always be test marketed due largely to the time and expense of physical prototyping.

Virtual concept testing offers firms the ability to test market multiple concepts in the earliest stages of design without incurring the large expense. In addition, new concept testing methods, coupled with improvements in media richness of the Internet, will enhance the respondent's experience; therefore, allowing a firm to get high quality customer research information virtually. Tools such as virtual concept testing, if implemented effectively, could drastically change a firm's ability to design and develop large-scale products for the consumer.

The purpose of this thesis is two-fold. First, this thesis attempts to understand and outline a good concept-development process for mature product firms. Second, this thesis investigates an innovative, non-traditional Internet-based research method termed STOC (Securities Trading of Concepts) and then suggests a method of implementation for an automotive firm.

## 1.2 The Challenge

There are several elements of challenge facing new marketing research tools including the STOC method:

## Real-world Prediction Capability

Understanding customers is difficult. Traditional marketing research methods such as surveys and focus groups assume that the customer is in tune with what they need and they strongly rely on honest participants. The KJ and Shoji Shiba Language Process Methodologies offer a more scientific framework for deducing latent customer needs from statements made by the customer, but these methods rely on specialized facilitators and can be subjective. Conjoint research methods attempt to out-smart the respondent by looking for patterns in their answers and discriminating between good and bad data, but they still rely on honest and knowledgeable participants. The common link between all of these methods is that their success lies with getting reliable customer input. Therefore, much time and preparation is often spent ensuring that the customer has a clear understanding when responding to questions. Physical prototypes and/or clear representations of products are often necessary to acquire good customer responses.

Being wise to the strategic framework surrounding the products that are being researched is important and presents a further complication in obtaining good customer information. As new technology develops, customers' needs evolve and change considerably. The researcher must always be cautious of emerging technologies that may surprise and delight customers tomorrow.



Like the other methods, the STOC technique faces challenges in acquiring reliable customer input. There are, however, unique opportunities for the STOC method, which are discussed in the following chapters.

### The Limitations of Virtual Technology

Internet technology provides the capability to quickly obtain massive quantities of data from customers all over the world. Computer technology allows for high-quality virtual product representations often at a significantly lower cost than physical prototypes. These technologies provide an enormous opportunity in the field of marketing research. The challenge is determining how to get good information from the virtual world. Pre-screening may not be as reliable since there is no means for ensuring the selected respondent is the one who is actually responding. The second challenge is in developing electronic products that are engaging and that provide the customer with a real sense for the physical product.

### Integration into Product Development Process

The usefulness of any consumer research technique is dependent on the firm's ability to integrate it into its product development process. All of the techniques that are discussed in this paper are useful at different phases of development. Determining how to integrate the STOC research tool into a firm's established process can be particularly challenging.

### 1.3 Hypotheses

There are two hypotheses for this study. Early experimental data as well as the theory of efficient markets supports the first, while the second is supported by the author's background and experience in the automotive industry.

- 1) Consumer preferences can be predicted by their trading behavior in a securities market simulation.
- 2) The automotive industry could utilize a STOC tool for predicting customer preferences in the early stages of design.

### 1.4 Approach of the Study

The approach of this study entails four base elements: 1) research on concept-development literature, 2) research on Internet methods, 3) understanding the new STOC method, including a few experiments, and 4) analysis on effectiveness and integration into a product development organization.

#### Research Concept-Development Literature

Research included key marketing literature published by Hauser, Urban, Dahan and Srinivasan. It also included various elements of Robert Cooper's Stage Gate and Ulrich & Eppinger's Product Development process publications. Shoji Shiba's TQM and Burchill's Concept Engineering publications were also extremely relevant and useful.

### Research Internet Methods

Research included key publications by Dahan, Srinivasan, Hauser, Urban and Vriens, Loosschilder, Rosbergen, Wittnik.

### Understand The New STOC Method

STOC is a cutting-edge research tool that was developed at the Massachusetts Institute of Technology<sup>2</sup>. Understanding this method included research into fundamental financial market publications by Sanford Grossman and also more recent literature from Nicholas Chan, Andrew Lo, and Tomas Poggio.

### Experiments

Several experiments, using potential customer respondents, were conducted to assess the prediction capability of the STOC research method. Evaluation of the method and the participant behavior elements were thoroughly analyzed.

### Implementation of the STOC Method

The author's experiences and background in the automotive industry provided a good framework for this portion of the study. Literature from Hauser, Dahan were most useful. And again, product development literature from Ulrich & Eppinger and Cooper were extremely relevant.

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<sup>1</sup> Foster, R., Innovation, *The Attacker's Advantage* (New York, NY: Summit Books, Simon and Schuster, 1986)

<sup>2</sup> Chan, Dahan, Lo, and Poggio (2000)

## Chapter 2: Concept Development and Testing Process

Most would agree that the success of a product development company is strongly dependent on their ability to introduce innovative concepts that startle and excite consumers. According to a study conducted by Robert Cooper, the single strongest predictor of investment value is “degree of innovativeness of the company.”<sup>1</sup> Product innovation not only attracts customers, but also heavily influences the financial markets in determining the worth of a company for long-term investment purposes. In addition, product innovation is speeding up in most industries due to technological advances, increased competition, shorter product lifecycles, and more demanding customers,<sup>2</sup> therefore, making concept choices even more relevant.

Because the introduction of exciting products is crucial to the success of a company, the concept development and testing stages of the product development process is probably the most important. Furthermore, a study conducted by the NRC states that over 50% of product life-cycle costs are determined in the concept-formulation phase, and about 75% of life-cycle costs are committed by the end of concept validation.<sup>3</sup> Despite the importance of this stage, many companies spend little time and effort in this area and most do not have effective methods for developing product concepts that they are confident will satisfy customer needs.

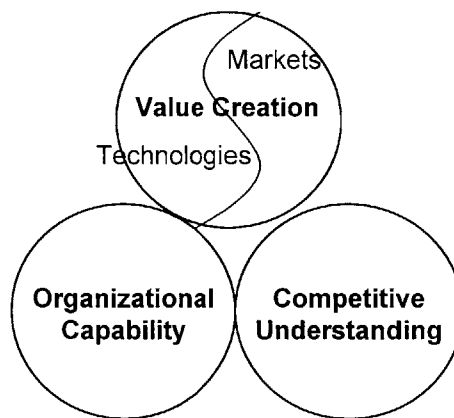
The remaining sections of this chapter outline the necessary steps in the concept development and testing stage of the product development process. It is important to

note that there are two strategic groupings for concept development: technology push and market pull. This chapter focuses mainly on a market pull perspective; however, many of the techniques discussed could be modified slightly to apply to a technology push scenario as well. Each of these categories relies on customer input for refining, testing, and selecting winning concepts.

Also note that this chapter outlines a traditional product development framework in order to enable a better understanding of integration of the STOC research method discussed in the later chapters.

## 2.1 Strategy

The first step in developing a successful concept design is identifying the opportunities available to the firm. This includes examining a firm's internal capability as well as market trends. A thorough analysis in this area is required before anything else. MIT Professor Rebecca Henderson describes effective strategies as resting on three foundations (or three "bubbles").<sup>4</sup>



Three Foundations for Effective Strategy

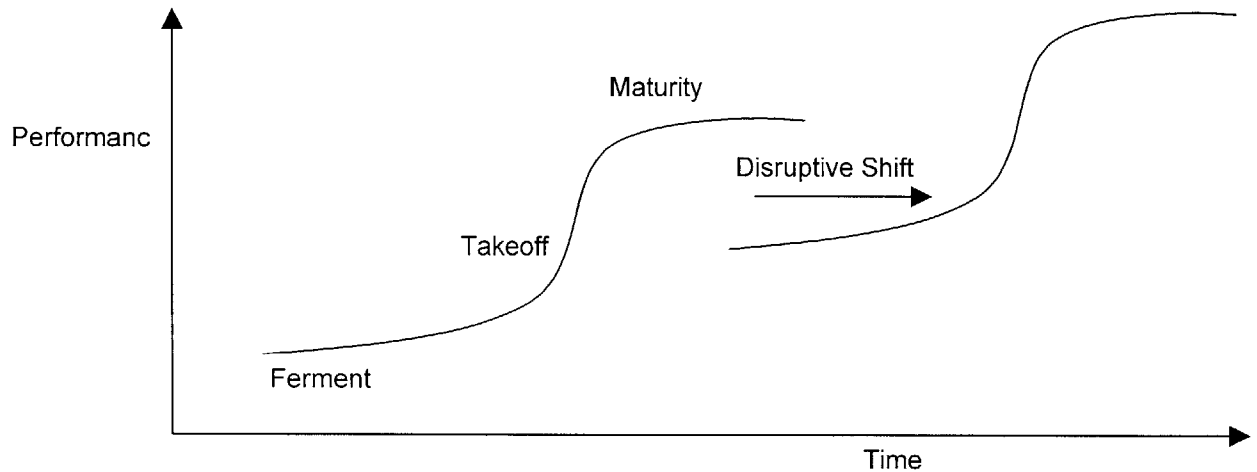
A firm may begin this process by developing an understanding of how it will create value in the market place. It needs to determine what technology to use and what markets it will penetrate or create. The second step is to determine what the organization is capable of producing or perhaps outsourcing. Can it pull this off with its capabilities? The third step is to understand the competition and its capabilities. Can the firm succeed in this competitive environment? How will it capture value?

Foster's S-Curve, along with Christianson's theory on disruptive technology,<sup>5</sup> are excellent frameworks to start with in developing a technology strategy. Understanding where a firm's industry lies on the S-Curve, and analyzing what disruptive technologies are about, are key to identifying new product opportunities.

In order to understand this analysis, there are two definitions of importance:

- Disruptive Technology – a technology that is newly evolved and attracts users of another technology, even though it may be inferior in the early stages. An example is the personal digital assistant (PDA). The Palm Pilot PDA was inferior in the beginning and most Franklin Day-Planner consumers did not immediately switch to this new technology. But eventually, the majority starts to use the new technology and the old becomes obsolete. The industry then shifts to a new S-Curve. Firms must always be aware of potential disruptive technologies and use this framework in identifying opportunities for new product ideas.
- Sustaining Technology – a technology that rejuvenates interest in the current technology. It is often a refinement of existing technology. It is new, but not

necessarily on a different S-Curve. An example might be a sport utility vehicle. Although this vehicle is different from a traditional car or truck, it uses the same fundamental technology.



Foster's S-Curve

The above graph demonstrates the framework and phenomena of shifting to a new industry S-Curve. The period of ferment indicates the incubation stage of a new concept and its first introductions into the marketplace. The take-off period is one in which affordable and viable products are now offered to most. The maturity stage is when the product is well established and small improvements can be made to radically change the product and/or market. This is when intense competition exists and new disruptive technologies emerge.

Using the Automotive industry as an example: most would agree that this industry is at or very close to, the maturity level of the S-Curve, with some limited opportunities for

growth in undeveloped world markets. The automotive steady state market has evolved over the past century, introducing several sustaining technologies along the way. Although the first automobile was introduced in the late 1800s, many years would pass before what we today call the automotive industry would develop. In the early ferment period, an automobile was an expensive “toy” few could afford. Wealthy enthusiasts or venturesome customers would purchase these vehicles while the masses continued to use traditional methods of transportation. The take-off period of this industry, however, was incredibly steep due to Henry Ford’s introduction of the affordable automobile. This led to the mass production and distribution of the automobiles of today.

Once a strategic framework is developed and thoroughly analyzed, the firm then understands its competitive and organizational opportunities. It can then move to the creative phase of idea generation.

## 2.2 Idea Generation

The exploration of an extraordinary idea is usually the most exciting phase of the concept-development process. The KJ method, or more recently referred to as the Shoji Shiba’s Language Processing (LP) method, is a useful tool for idea generation. The LP method, originally developed as a total quality management tool with a weakness orientation, has evolved over time, and is useful in many areas beyond its original structured problem-solving activities. The LP method assists in understanding customer needs along with identifying market opportunities, and can be an extremely



useful tool in the exploration stage of concept development. It emphasizes suspension of judgment during exploration and, instead, exposes the practitioner to multiple vantage points, and then, using the power of “semantics,” clarifies his or her understanding<sup>6</sup>.

Another useful tool is Burchill’s Concept Engineering, a customer-centered process of data collection and reflection designed to develop product concepts that will meet or exceed customer expectations. There are five stages to this process, with the first four focusing on concept generation. The process begins with “Understanding the Customer’s Environment,” which includes the development of an exploration plan based on the project scope, followed by a series of customer visits with emphasis on collecting verbatim statements and field observations. The team then is able to formulate a mental model of the customer’s environment. Next is Stage II, “Converting Understanding into Customer Requirements,” which includes analyzing and transforming customer visit notes from the language of the customer to the language of the company and finally into requirements. Stage III, “Operationalizing What You Have Learned,” is when vital requirements are investigated with customers and quantitative metrics are developed. In Stage IV, “Generating Concepts,” an exhaustive listing of solutions to customer needs is created, which are then carried up the ladder of abstraction to formulate an overall concept<sup>7</sup>.

Burchill’s Concept Engineering and Shoji’s LP Methodology both rely heavily on listening-to-the-customer skills. These processes are focused on good customer

interviews, asking the right questions, hearing the right answers, and then, being able to decipher these thoughts into useful and implementable information. The success of these processes is primarily the result of the practitioner's capability, which is directly correlated to the amount of experience he or she has had with these tools.

Customer information is often influenced by many factors, and is therefore extremely sensitive. Reliable insight is often difficult to attain. Surveys and interviews are a very subjective and difficult method for obtaining reliable customer information. In addition, customers may not be able to communicate what they would purchase until a product is actually presented to them.

Some argue that the generation of ideas by technically savvy individuals within the firm should also be encouraged. One technique is for engineers to observe users in their natural environment. This method encourages creative ideas and solutions to customer problems that might normally be overlooked. Engineers are also encouraged to review customer satisfaction data and categorize customer needs according to the Kano Model for delighting customers (i.e., "Must Have", "More the Better" and "Delighter").

Computer technology as well as the Internet have provided additional opportunities to assist in idea generation. Techniques that attempt to improve the quality and reliability of information obtained from customers are rapidly evolving. One such method is the Information Pump, developed by MIT professor Drazen Prelec (2000). More on virtual methods is included in the next chapter.

### 2.3 The Voice of the Customer is Important

This section was included at this point to provide some background on the usefulness of customer information. Once the idea generation phase ends, an intensified emphasis is placed on the true predictor of customer preference. The intense pursuit of the concept that customers will like best is now heavily subscribed.

Some argue that customers don't know what they want and that asking them can often be misleading. Robert Lutz, former President and Vice Chairman of Chrysler Corporation, details in his book how successful companies "are often run by enthusiasts who, in the normal course of gratifying their own tastes and curiosities, come up with products so compelling, so startling, and so exciting that customers practically rip their trouser pockets reaching for their wallets." He goes on to say that that consumers are dishonest and throw away passion when responding to customer surveys. He explains how a marketing research respondent ceases to be a real person by virtue of having been selected to answer questions.

*[Respondents] cast away childish things, whims, emotions, [and their] own eccentric tastes – and instead uphold the honor of [their] class by giving serious, mature, and eminently left brained answers. – Robert Lutz*

Lutz also explains how consumers most often make purchase decisions with their right brain, yet most customer research obtains left-brained information, at best<sup>8</sup>.

Most probably agree with Lutz in that customer passion is a key element in determining the success of products and ultimately a company; however, deciding to commit a large amount of capital to a specific concept is difficult. The individuals responsible for this

decision are likely willing to accept the assistance of the customer. In addition, studies demonstrate that most successful companies have a clear strategy that includes some level of concept testing prior to product development in order to ensure customer acceptance to the market place. According to studies conducted by Robert Cooper, teams that drive winning new products that feature high-quality marketing actions such as: preliminary and detailed market studies, customer tests, field trials, and test markets are blessed with more than double the success rate and 70% higher market share than those projects with poor marketing actions<sup>9</sup>. Furthermore, strong market orientation increases company success rate by 38.6% and is strongly correlated with new product performance<sup>10</sup>. In fact, the most relevant problem that exists in companies is that they tend to ignore or misuse research. Many companies avoid it altogether due to high costs or because they have developed the mentality that consumers do not know what they want. Others perform concept testing too late in the process and ignore the results because it is too costly to change at that point in the project. This mistake strips these companies of the opportunity to shape the final product in a manner that the customer wants and/or gauge acceptance before the new design begins.

Perhaps the question is not whether or not customer information should be obtained, but rather, how can research studies bring enthusiasm and passion to the customers when they are responding? Firms should probably spend more time on refining methods to acquire reliable customer information rather than ignoring it altogether.

## 2.4 Concept Refinements and Selection

After the idea-generation stage, refinements and trade-offs are necessary to formulate viable product concepts. Winnowing down the number of concepts to a manageable few is also a significant output of this phase.

Attribute-based conjoint can be used to determine how to bundle attributes into preferable customer products. This method presents the customer with a pre-specified number of product bundles, and attempts to understand the trade-offs the customer would be willing to make. The result of this method is the customer's utility of each attribute and a few concept bundles to pursue.

Selection matrices are another attractive method for the refinement of concepts and eventual selection. They offer the ability to objectively evaluate concepts against criteria that the firm feels is important to achieve a successful product. Ulrich and Eppinger offer a two-stage selection methodology that includes "concept screening" and "concept scoring." Each stage uses a decision matrix to rate, rank and select the best concepts<sup>11</sup>. The "concept screening" stage is based on the method developed by Stuart Pugh, deemed the Pugh concept selection process.

The following is an example of one that might be used for an automotive application:

Selection Criteria	Concept 1	Concept 2	Concept 3	Concept 4	Concept 5	Concept 6
Appearance/ Styling	0	+	+	0	-	0
Craftsmanship	0	+	+	0	0	-
Comfort	+	-	-	0	+	+
Safety	+	0	-	0	+	0
Durability	0	0	0	0	0	+
Performance	-	+	+	0	-	0
Fuel Economy	+	0	0	0	0	0
People Capacity	+	+	0	0	+	0
Cargo Space	+	-	-	0	+	+
Variable Cost	+	-	0	0	+	+
Manufacturing Cost	0	0	-	0	0	0
Sum +'s	6	4	3	0	5	4
Sum 0's	4	4	4	11	4	6
Sum -'s	1	3	4	0	2	1
Net Score	5	1	-1	0	3	3
Rank	1	5	6	4	2	2
Continue?	Yes	No	No	Combine	Combine	Yes

### Concept Screening Matrix for an Automotive Application

Developing the selection criteria on the left side of the matrix is important and should be based on attributes deemed important by the customer. These can be obtained through customer interviews, conjoint analysis and market surveys. In addition, corporate goals, as well as manufacturing and operational alignment, can be evaluated with these matrices. A reference concept is chosen as the benchmark for the remaining concepts. Each product concept is then evaluated against each attribute with respect to the reference concept and given a "+" if it is better, a "-" if it is worse, and a "0" if it is the same. The concepts are then ranked. The team then evaluates the results and determines which concepts to pursue, revise, and/or combine.

The concepts are then refined and subjected to a second matrix evaluation deemed by Ulrich and Eppinger<sup>12</sup> as “concept scoring.” The screened concepts are now evaluated against a more detailed list of attributes with a heavier weighting placed on the more important criteria. A scale of 1-5 or 1-10 is used instead of the “+ 0 – “ scale. The final concepts are then selected based on these results.

Decision matrices are a good method for winnowing down the number of concepts. They allow the team to include the elements that are most important to the customer as well as the firm’s strategic goals. They also provide an excellent concept refinement mechanism by identifying the strengths and weaknesses of each concept.

## 2.5 Choosing Winning Concepts is Hard, yet Critical to Success

Making the final decision on the one concept to pursue is the final part of the concept development and testing process. Research concludes that the success rate for choosing winning concepts is extremely low. Abbie Griffin’s research suggests that for about every four projects selected for development, only one becomes a commercial success<sup>13</sup>. Stevens and Burley conclude that only 1 out of 3000 ideas generated becomes a commercial success<sup>14</sup>. Therefore, we might conclude that current practices are not working as well as most would like. Cooper’s research<sup>15</sup> concludes that a lack of “homework” is a major reason for failure, primarily poor market analysis and lack of market research. Many companies tend to move directly from the idea stage into full-fledged product development.

The automotive industry, like many capital-intensive industries, has minimal tolerance for mistakes in selecting concepts. Poor concept choices can be extremely costly from a vehicle-line perspective, but may also detrimentally impact a company's brand image. One example is the 1995 introduction of the radically styled Ford Taurus, which was a huge disappointment resulting in a loss of market share, heavy rebates, poor consumer image, and loss of the previously held #1 sales position to the Honda Accord. Ford has since updated and improved the Taurus with the successful 2000 model introduction, but overcoming the negative image established by the 1995 model was difficult. There are many such examples across industries that demonstrate the damaging effects of poor concept choices that go beyond profit and loss.

A more recent trend in product development is to delay the final concept selection as long as possible – freeze the concept at the last possible moment. Marco Iansiti articulates this strategy by outlining two product development models: Traditional and Flexible. The traditional model is one that has clear stage gates with final concept decisions being frozen early in the product development process; while a flexible model encourages concept evolution during the development phase of the project. The product architecture protects for, and even embraces, change. This model requires a development process characterized by flexibility and responsiveness along with an inherent ability to gather and synthesize technical and market information as the concept evolves.<sup>16</sup> Srinivasan, et al, go even further in recommending that multiple concepts be pursued in parallel<sup>17</sup>. The real question, however, is two-fold. It is not just how you choose the winning concept, but when to make the choice in the product



development process. The latter is extremely dependent on the organizational DNA and the product architecture, while the former is the toughest decision of all; however, there is no question that this choice is easier if made later in the process.

## 2.6 Concept Prototyping and Testing

Concept prototyping and testing are tools that are used to support the decision on the final concept. These tools provide a more realistic opportunity to gauge customer interest and purchase intent. They also allow for better estimates for sales and price sensitivity, which are needed for formulating the business case and strategy needed to kick-off the product development stage. Concept testing also helps spot product deficiencies early on in the project, when they can still be reasonably corrected. Determining which projects to dedicate limited resources and large capital expenditures toward is one of the most difficult decisions facing companies. Concept testing is a valuable input into this decision process and should be included in an affordable and practical manner.

There are various methods used to prototype and test concepts. These methods may include one or several of the four dimensions listed below:

1. 3-D Physical Prototypes
2. Verbal Descriptions
3. 2-D Visual Depictions
4. 3-D Virtual Depictions

Although there is no question that physical prototype testing is the most reliable and desirable method, it is often extremely expensive and time consuming. It often requires significant time to create physical properties for testing, thus making them difficult to utilize in a competitive market. Because of this, many companies avoid extensive upfront concept testing and may wait until the development stage begins to spend their prototype funds. Larger companies often get caught in this paradigm since the concept development activities are often inadequately funded and are not part of the core product development division. Prototypes cannot be developed until the concept has been selected and budgeted as an official program. But to their detriment, companies using this technique often find themselves frustrated due to their inability to take action on the research results they receive. They have chosen a concept and are already tied to a design. Although refinement and incremental insights are useful, revolutionary information cannot be applied during this stage. Perhaps the suggested approach is to develop a versatile architecture such that continuous research can be applied throughout the development stage. This however, is extremely challenging in products as complex as an automobile.

In the absence of physical prototypes, firms may conduct their research using verbal descriptions. This is clearly not as reliable as physical testing, however, depending upon the product, some valuable insight may be obtained at a substantially lower cost. It is important, however, that the participants have had experience with similar products or they are likely to develop their own mental model of what the product entails, which may differ greatly from reality. Some level of visual depiction is often necessary for

clarity. Verbal concept testing is particularly difficult to conduct on products where image and perceptions are important customer decision criteria.

Visual prototypes cost significantly less than physical prototypes and require little time to build. These benefits provide an opportunity for firms to test multiple concepts with the consumer. Research suggests the use of 2-D visual prototypes closely approximate results obtained from the use of physical prototypes<sup>18</sup>. In addition, computer technology provides exciting opportunities for enhanced visual depictions with 3-D capability and animation. And the Internet provides more flexibility in reaching consumers for concept testing and representation on the web. As this technology continues to mature, these methods will become more viable for mainstream industries.

Complete elimination of physical prototypes for many applications is highly unlikely, at least in the near term. This explains the continued advancements in rapid prototyping technology. There are certain product characteristics that are extremely difficult to replicate without physical properties, even with the animation features of new computer technology. For example, an important customer attribute of an automobile is “roominess.” Visually representing this attribute is difficult even with sophisticated animation technology. Research continues to determine how to represent such spatially oriented elements in the virtual world.

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<sup>1</sup> Cooper, Robert G., *Product Leadership; Creating and Launching Superior New Products*, (Cambridge, MA: Perseus Books, 1998)

<sup>2</sup> See Note 1

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- <sup>3</sup> National Research Council, *Improving Engineering Design: Designing for Competitive Advantage* (Washington DC: National Academy Press, 1991).
- <sup>4</sup> Henderson, Rebecca, *15.984 Technology Strategy Class Notes* (MA: Massachusetts Institute of Technology, Spring 2000)
- <sup>5</sup> Christensen, Clayton M., *The Innovators Dilemma* (MA: Harvard Business School Press, 1997); Foster, R., *Innovation, The Attacker's Advantage* (New York, NY: Summit Books, Simon and Schuster, 1986)
- <sup>6</sup> Center for Quality Management, *The Language Processing Method* (Cambridge, MA: CQM, 1995).
- <sup>7</sup> Center for Quality Management, *Concept Engineering* (Cambridge, MA: CQM, 1998).
- <sup>8</sup> Lutz, Robert A., *Gutz: The Seven Laws of Business That Made Chrysler the World's Hottest Car Company* (New York, NY: John Wiley & Sons, 1998)
- <sup>9</sup> See Note 1
- <sup>10</sup> See Note 1
- <sup>11</sup> See Note 16
- <sup>12</sup> See Note 16
- <sup>13</sup> Griffin, Abbie, *Drivers of NPD Success: The 1997 PDMA Report* (Chicago, IL: Product Development & Management Association, 1997)
- <sup>14</sup> Stevens, Greg A. and Burley, James, "3000 Raw Ideas = 1 Commercial Success!," *Research Technology Management*, May-June 1997, pp. 16-27
- <sup>15</sup> See Note 1
- <sup>16</sup> Iansiti, Marco, "Shooting the Rapids: Managing Product Development in Turbulent Environments," *California Management Review* 38, Fall 1995, pp.37-57.
- <sup>17</sup> Srinivasan, V., Lovejoy, William S., and Beach, David, "Integrated Product Design for Marketability and Manufacturing," *Journal of Marketing Research* 34:154-163 (1997).
- <sup>18</sup> Dahan, Ely, and Srinivasan, V., "The Predictive Power of Internet-Based Product Concept Testing Using Visual Depiction and Animation," *Journal of Product Innovation Management* 17: 99-109 (2000)

## Chapter 3: Virtual Consumer Research

The Internet provides incredible opportunities for obtaining information from customers all over the world. Firms are vigorously designing web sites that include virtual chat rooms and smart agents to obtain information from customers. With recent advances in personal desktop computers, along with exciting new graphics software, virtual concept evaluation methods have become real possibilities for firms. Many new consumer research methods are evolving around these technologies.

### 3.1 Virtual Benefits

Virtual concept methods provide a multitude of benefits:

#### Reaching People

The Internet provides exciting opportunities for reaching consumers. As people embrace computer technology, the network of reachable consumers continues to grow. Virtual methods allow a firm to extract information from households all over the world. Unlike the telephone, which also provided consumer accessibility, the Internet provides visual and engaging interfaces. Concepts and ideas can be well represented using virtual tools. This is an incredible new possibility that firms must utilize. A firm can now test market concepts in the homes of the “busy” people who are always difficult to capture for market research studies. They can also visit children who can easily get online at home or even at school to respond. These participants are less inconvenienced by virtual methods. They are able to respond on their own terms.

There is no long drive to a particular location for a research study. The key here is to design entertaining and exciting virtual methods that will provide an incentive for the customer to participate.

### Getting Good Information

The interconnected virtual communities on the web provide exciting new possibilities for consumer research as well. Firms can develop methods that interact with users or possibly just observe the group. Graphics capability and interactive software allow for engaging and exciting interfaces that enhance the user's experience providing for higher quality research. Honesty and less intimidation are expected from the virtual world. The participant is not uncomfortable stating his or her real opinion. The facilitator might be virtually unknown. Virtual communities also offer the exchanging of information between respondents, which might enhance the quality of research data on products where customer purchase decisions may be influenced by the opinions of other's.

### Enhanced Capability

The Internet has enhanced the capabilities of the market research field. Firms can now obtain research information at an incredible speed. Concepts can be tested in days rather than the months required for traditional testing methods. Virtual methods also offer enhanced representation of concepts. Products concepts can be elaborate graphical depictions, including animation. Interactive representation and instructions provide for a higher quality of respondent understanding and amusement of survey

tasks. In addition, the Internet allows for enhanced computational capability providing the opportunity for more sophisticated adaptive research methods.

### Ability to Test Multiple Concepts

One of the most interesting benefits of the Internet is that it allows a firm to test multiple concepts at the earliest stages of design and at a relatively low cost. Virtual concept representation software continues to evolve with costs that are substantially lower than physical prototyping for most product concepts. Low-cost virtual product concepts could also offer increased flexibility and adaptability for continuous concept testing, allowing for a stream of customer insight into the product design and engineering trade-off process. The key is to determine how to integrate virtual concept representation with product engineering tools in order to streamline the concept evaluation process.

### 3.2 Virtual Challenges

Although the benefits are substantial, virtual methods also have a few challenges to overcome:

#### Virtual Respondent

It is difficult to really know who is responding from the virtual world. Many people take on secret identities and may not feel obliged to provide their personal information. Furthermore, they can terminate their session any time they desire. These respondents are in control. They can provide whatever information they want, when they want. This presents firms with the challenge of introducing methods that offer the respondent an

incentive to provide good information or that smartly extract good information from the respondent without their even being aware that they have given it.

Another complication is the lack of a human facilitator during the virtual consumer research. Although tools exist that provide for high quality instructions, questions may still arise and respondents might become frustrated and unable to participate. Thoughtful instructions and interactive help-tools are important for effective implementation.

### Computer Response

Virtual methods that include elaborate graphics and computational requirements might be unacceptably slow for some users who have less advanced technology. However, Moore's Law, articulated by Dr. Gordon Moore in the 1960s, states that computing speeds and densities double every eighteen months; thus, major technological transformations occur in just a few year's time. Computer memory, for example, is about sixteen thousand times more powerful today for the same unit cost than it was in about 1976, and is one-hundred and fifty million times more powerful for the same unit cost than it was in 1948.

### Confidentiality and Security

Virtual methods may raise confidentiality and security concerns. Consumer research in the earliest stages of concept design is most often extremely confidential. Internet



implementation may compromise the secrecy of these new concept ideas if these methods are not implemented carefully.

### 3.3 Virtual Methods

With the incredible opportunities provided by the Internet, it is no surprise that new virtual consumer research methods continue to emerge. Dahan and Hauser articulated some exciting new methods, under study at MIT, in their research on the virtual customer. Below is a brief description of a few of these methods:

#### “Listening In” to the Customer

The Internet provides the capability for firms to observe consumer behavior on a web site or chat room. This method attempts to identify areas of customer dissatisfaction by observing their search patterns or with the assistance of a virtual sales representative<sup>1</sup>. For example, a customer may search for a violet colored interior for her Ford Focus automobile on the [www.Ford.com](http://www.Ford.com) web site. She may be disappointed that this color currently does not exist. If the number of people searching for this attribute becomes substantial, perhaps it is one that the firm should consider implementing.

#### Information Pump

The Information Pump (Prelec 2000) is a method of evaluating customer opinion of new and existing product concepts. The concept is revealed to a group of respondents virtually connected by the Web. Respondents are individually provided with statements about the product concept that has been revealed to them. They are then requested to

guess whether others will find each statement to be true or false. Respondents are rewarded on their ability to accurately predict the opinions of other respondents. In addition, respondents are required to develop statements of their own to be evaluated against the true/false criteria. This provides added benefit, in that respondents are putting their own ideas and thoughts creatively into this process<sup>\*</sup>.

### User Design

User design is a virtual method that allows participants to create their ideal product by dragging and dropping their favorite elements onto their design palette. Let us consider an automobile design, for demonstration purposes. First, the user might drag and drop the favorite exterior style vehicle onto their design space. The user then begins to add all of the preferred content into this automobile; however, there is a price associated with each feature. As features are added or removed from the user's design space, the price, exterior styling, and performance characteristics of the automobile reflect each change. The user then makes compromises and trade-offs until his or her ideal automobile design is complete. Web software tools allow this method to be an exciting and conceptually engaging experience.

### Virtual Concept Testing

The virtual concept test method presents customers with several visual concepts with detailed attribute information for each. All concepts are initially priced the same. Respondents are requested to pick their favorite concept at this initial price. Once the

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<sup>\*</sup> For more information see "The Virtual Customer," Dahan, Ely, and Hauser, John, Massachusetts Institute of Technology, November 2000.

concept is chosen, the price increases for that concept, while the others remain at the initial price. The respondent then continues to choose his or her favorite concepts until all of the selections are chosen. The respondent's choices are then converted into preferences for each concept based on conjoint-like analysis methods. The effectiveness of this method has been demonstrated by early research conducted by Dahan and Srinivasan 2000<sup>2</sup>.

### Securities Trading of Concepts (STOC)

STOC is a cutting-edge research methodology developed at MIT by Chan, Dahan, Lo and Poggio<sup>3</sup>. Participants compete in an electronically simulated market game where securities for new product concepts are traded. The securities represent shares of the company that owns each product concept, rather than the concept itself. Each participant begins the game with a lump sum of faux money as well as shares of each of the securities available for trading. The participant's goal in the trading competition is to maximize the value of his or her personal portfolio. The securities price information, collected throughout the trading simulation, indicates both individual and group preferences.

The STOC market research method is one of the most exciting new tools. The STOC method takes advantage of most of the benefits offered by the Internet, while mitigating many of the drawbacks of virtual methods. By providing the incentive to win, this game-like research method encourages honest participant responses while accounting for real customer behavior, which is heavily influenced by the opinions of others and the

competitive environment. Additionally, the STOC method evokes excitement and enthusiasm during the experiment; therefore, the participant is likely to personalize his or her responses.

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<sup>1</sup> Glen Urban (2000)

<sup>2</sup> Dahan, Ely, and Srinivasan, V., "The Predictive Power of Internet-Based Product Concept Testing Using Visual Depiction and Animation," *Journal of Product Innovation* 17:99-109 (2000).

<sup>3</sup> Chan, Dahan, Lo, and Poggio (2000)

## Chapter 4. The Experimental Study

The primary purpose of this chapter and the experiments conducted in this study is to understand the market prediction capability of the STOC research tool. A second, very interesting purpose, is to analyze the individual STOC participant's trading behavior. Although some research has been conducted in the Bike-Pump case (Chan 2000) this study attempts to use two new cases that expand the capability and performance demonstration of the tool. These are: Crossover Vehicles and Laptop Bags.

### 4.1 Market Background

Before discussing the detailed experiments, this section provides a few brief paragraphs describing the mechanics of financial trading markets, including the MIT WebMarket. This may be interesting to those who want to understand the market structure used for the STOC Market Research experiments. Below are descriptions of three major types of market structures, with some slight variations within each <sup>1</sup>:

1. Auction Market – These markets attempt to meet supply and demand to complete a trade transaction. A Call Auction allows orders to accumulate for simultaneous execution at a single price. These orders are made periodically or at a specified time. A Continuous Auction market allows transactions to occur when buy and sell orders cross (i.e., when the bid price exceeds the selling price, or when market buy (sell) orders match limit buy (sell) orders). Most real-world security markets are Continuous Auction markets.

2. Agency Auction Market (with Market Makers) – The Agency Auction market is similar to a continuous auction market; however, it includes market makers. A market maker is a specialist that provides liquidity for a particular stock. They continuously provide bids and offers, essentially determining the intrinsic value of the stock. One of the most valuable functions of the market maker is to maintain an efficient market by 1) keeping the bid-ask spread to a competitive level and 2) stabilizing prices and preventing the impact of large deviations from one transaction to the next. Market makers are subject to strict rules and regulations set forth by the Securities Exchange Commission. The NYSE is one example of an Agency Auction Market.
  
3. Multiple Dealer Market – The Multiple Dealer Market includes multiple specialists for each stock versus the single specialist used in the Agency Auction Market. A dealer bids and offers on behalf of his/her own portfolio rather than the supply and demand of the trading participants. The dealer is engaged in competition versus other dealers. Although the competition element provides for high efficiency in the market and lower transaction costs, dealers are not heavily regulated and a higher risk for collusion exists. The NASDAQ is one example of a Multiple Dealer Market.

The MIT WebMarket is a software tool used for the STOC trading experiments. The WebMarket provides a platform for many types of electronic securities trading on the web and features automated brokerage service, order execution, clearing and

settlement operations\*. This financial market simulation tool was configured to accommodate each of the STOC market research studies and operates as a Continuous Auction with user trading options to 'limit sell' or 'limit buy'. There are no market makers or dealers in the STOC configuration.

#### 4.2 Crossover Vehicle Case Study Description

A Crossover vehicle is a new breed of vehicle rapidly entering the US automobile market. These vehicles have the image, utility, and safety features of an SUV, but the performance characteristics of a passenger car. These vehicles also offer unprecedented levels of interior comfort and flexibility to their owners. The customer is often termed upper-middle class Mom or Dad who wants a fun vehicle to accommodate his or her family's transportation and recreational needs as well as trips to the Home-Depot. These customers are looking for a more upscale vehicle and tend to be put-off by the image associated with mini-vans, even though those vehicles offer many of the features they desire. Key crossover vehicle design elements include exterior styling, seating capacity, seating flexibility, cargo capacity, fuel economy, performance, towing capacity and price. Although there are other important attributes, such as comfort, safety, and roominess, this study was limited to eight elements so as not to overwhelm the participants. Eight vehicles were also chosen to represent the crossover class. Again, there are many other vehicles that could have been included, but this study was again limited for simplicity.

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\* For more comprehensive information see the WebMarket project, conducted by Nicolas Chan, Andrew Lo, and Tomaso Poggio within the Center for Biological and Computational Learning in the Department of Brain and Cognitive Sciences at the Massachusetts Institute of Technology.

Below is the web site information provided to the participants of this study, which offers a more detailed description of the crossover vehicle case:

### Product Information

The only information that is available is product information for the crossover vehicles. Each vehicle is rated in terms of the seating flexibility, cargo volume, fuel economy, horsepower, acceleration from 0-60mph, and towing capacity. Based on the overall desirability of the crossover vehicles, you must evaluate the worth of the corresponding companies. Our rating system is as follows.



**Seating Flexibility** How easy is it to reconfigure seating and storage?

*Difficult / Fixed* ←→ *Easy / Very Flexible*

**Cargo Volume** How much storage capacity in cubic feet (min/max)?

*15 / 50* ←→ *50 / 100*

**Fuel Economy** What is the EPA gas mileage (city / highway)?

*13 City / 17 Hwy* ←→ *20 City / 25 Hwy*

**Horsepower** What is the engine's horsepower rating ?

*150 hp* ←→ *300 hp*

**0-60 Seconds** How long to accelerate from 0 to 60 mph?





























*10 sec.* ←→ *6 sec.*





























**Towing Capacity**

*barely adequate* ←→ *indestructible*



And the following table presents the quality of the crossover vehicles. Click on the images to view in more detail.

	Pontiac Aztec	Mercedes-Benz ML320	Acura MD-X	Buick Rendezvous
				
Seats	5	5 (7 opt.)	7	7
Seating Flexibility				
Cargo Volume				
Fuel Economy				
Horsepower				
0-60 acceleration				
Towing Capacity				
Price	\$24,000	\$39,000	\$37,000	\$30,000

	Lexus RX-300	BMW X-5	Audi All-Road	Toyota Highlander
				
Seats	5	5	5 (7 opt.)	7
Seating Flexibility				
Cargo Volume				
Fuel Economy				
Horsepower				
0-60 acceleration				
Towing Capacity				
Price	\$36,000	\$49,000	\$42,000	\$29,000

The following experimental methods were used to assess customer preferences for the crossover vehicle class:

- 1) Crossover Vehicle Survey – Each respondent was given the above vehicle matrix and was requested to pick and order his or her top three purchase preferences.

2) Crossover Vehicle STOC – The same respondents from the above survey also engaged in a 15-minute trading experiment using the MIT WebMarket software. Although this method could be administered virtually, in order to isolate the question of predication capability of the STOC method, this experiment was conducted in a controlled computer laboratory environment. Each user was given detailed instructions. Once all of the participants felt comfortable with the trading software, each user logged into the system using their e-mail address to represent their identity. The users began the game with 100 shares of each crossover vehicle stock and \$10,000 in “cash” to be used for trading. Trades of each user, along with the group results, were tracked and recorded for the purpose of analysis.

The following user instructions from the web site further detail the crossover STOC experiment:

### ***Overview***

In this trading game, there are 8 companies that manufacture and sell crossover vehicles. These companies are trying to spin-off the operation that manufactures these vehicles. These spin-offs will go public and their initial public offering (IPO) prices are to be determined in the MIT WebMarket. You are given some cash and an equal number of shares of each of the stocks. The objective of the game is simple -- maximize your profits by trading the stocks of the 8 companies using your own personal valuation of the companies, as well as any information you are able to glean from market dynamics for the 8 stocks.

### ***Financial Information***

In this case, we focus on the profitability of manufacturing and selling the crossover vehicles, which determines the prospects of the companies and, consequently, how much their stocks are worth. The retail prices and manufacturing costs may differ across the 8 crossover vehicles, but you should ignore this issue for the moment--for simplicity, assume that all 8 companies have identical cost structures, manufacturing capabilities, distribution channels, financial structure, management expertise and other factors that may affect their profitability. All companies will offer the same number of shares of common stock to the public.



## Market Environment

The 8 crossover vehicle companies are Pontiac, Mercedes-Benz, Acura, Buick, Lexus, BMW, Audi, and Toyota. The stocks of the 8 companies may be priced at any level, and is determined solely by market dynamics, e.g., *your* trades. Prices of the stocks should reflect the earning power of the corresponding companies and therefore their crossover vehicles. Note that it is the stocks of the company but *not* the crossover vehicles that are traded in the market.

You are given an allocation of 100 shares of each of the 8 stocks and initial endowment of \$10000 in cash. No borrowing or short-selling is allowed. At the end of the trading session, your portfolio will be valued at the closing prices of the market. The objective of the game is to maximize the value of your final portfolio.

The MIT WebMarket Trading Interface used for the crossover vehicle STOC experiment is shown below:

The screenshot displays the MIT WebMarket Trading Interface. At the top, it shows the browser address bar with 'MIT WebMarket: pwkim@mit.edu'. Below the browser window, there is a 'Market News' section with the message '09:51:31: Market is Open'. To the right of the news, there is a trading interface with a 'Symbol' dropdown menu set to 'Type\_A', a 'Size' input field, and a 'Price' input field. Below these fields are buttons for 'Buy' and 'Limit Sell'. An orange arrow points from the 'Market News' section to the 'Symbol' dropdown menu.

In the center, there is a price chart for 'Type\_A'. The y-axis ranges from -0.25 to 0.25, and the x-axis shows time from 09:54:52 to 09:54:53. The chart shows a single horizontal line at a price of 0.00. Below the chart, there is a 'Quote / Portfolio' table.

	Last	Low	High	Bid (size)	Ask (size)	Volume	Quantity	Market Value
Type A	-	-	-	(0)	(0)	0	100	0.00
Type B	-	-	-	(0)	(0)	0	100	0.00
Cash								10000.00
Total								10000.00

An orange arrow points from the 'Market Value' column of the 'Type A' row to the value '0.00'. At the bottom of the interface, there is a 'Warning: Applet Window' message.

The user's portfolio includes information on each stock available to trade in the game. Type A and Type B represent the stocks available for trading. For the crossover case, each vehicle brand (i.e., Toyota, Pontiac, etc.) was listed in this column. The rows indicate the Last, Low, and High price traded for each type of stock. They also indicate the highest Bid price and corresponding order size and the lowest Ask price and corresponding order size for each type of stock. The Volume row indicates the amount of trading occurring, while the Quantity row indicates the number of shares the user owns and the Market Value row is the dollar value of these shares. The graph in the left corner can be used to evaluate the historical performance of each type of stock. Limit Buy and Limit Sell are the mechanisms the trader uses to perform transactions. See Appendix A for more detailed user instructions.

#### 4.3 Laptop Bag Case Study

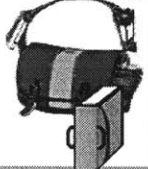



A company by the name of Timbuk2 is planning to introduce new laptop bag designs to the market. They are interested in MIT's research in order to determine the features they should offer on their real laptop bag product. This case provides a unique opportunity since these bags will eventually be sold to Sloan MBA students; thus providing real customer data and future validation of the STOC method. Key laptop bag design elements include price, size, color/appearance, logo, handle design, PDA holder, cell phone holder, pocket design, closure design, and reinforcement boot. Timbuk2 identified eight laptop bag design concepts for consideration (Type A through H).

The following is the web site information provided to the participants of the study, which offers a more detailed description of the laptop bag case:

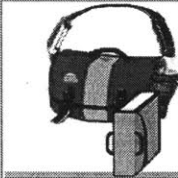
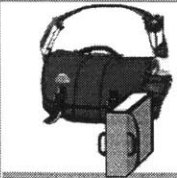
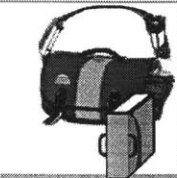

## Product Information

The only information that is available is product information for the laptop bags. Each bag has set of attributes in terms of price, size, appearance, logo, handle, PDA holder, cell phone holder, mesh pocket, closure for sleeve, and boot. Based on the overall desirability of the laptop bags, you must evaluate the worth of the corresponding companies.

And the following table presents the attributes of laptop bags. Click on the attribute values to learn more about the attributes in detail.

	Type A	Type B	Type C	Type D
				
<b>Price</b>	<u>\$87</u>	<u>\$84</u>	<u>\$69</u>	<u>\$87</u>
<b>Size</b>	<u>Medium</u>	<u>Medium</u>	<u>Medium</u>	<u>Large</u>
<b>Appearance</b>	<u>Red &amp; Black</u>	<u>Black</u>	<u>Red &amp; Black</u>	<u>Black</u>
<b>Logo</b>	<u>No</u>	<u>No</u>	<u>No</u>	<u>Yes</u>
<b>Handle</b>	<u>No</u>	<u>Yes</u>	<u>No</u>	<u>No</u>
<b>PDA Holder</b>	<u>Yes</u>	<u>No</u>	<u>No</u>	<u>Yes</u>
<b>Cell Phone Holder</b>	<u>Yes</u>	<u>Yes</u>	<u>No</u>	<u>Yes</u>
<b>Mesh Pocket</b>	<u>Yes</u>	<u>No</u>	<u>No</u>	<u>No</u>
<b>Closure for Sleeve</b>	<u>Full Flap</u>	<u>Full Flap</u>	<u>Velcro Tab</u>	<u>Velcro Tab</u>
<b>Boot</b>	<u>Yes</u>	<u>Yes</u>	<u>No</u>	<u>Yes</u>



	Type E	Type F	Type G	Type H
				
<b>Price</b>	\$92	\$99	\$99	\$69
<b>Size</b>	Large	Large	Large	Medium
<b>Appearance</b>	Red & Black	Black	Red & Black	Black
<b>Logo</b>	Yes	Yes	Yes	No
<b>Handle</b>	Yes	Yes	Yes	No
<b>PDA Holder</b>	No	Yes	Yes	No
<b>Cell Phone Holder</b>	Yes	Yes	Yes	No
<b>Mesh Pocket</b>	Yes	Yes	Yes	No
<b>Closure for Sleeve</b>	Full Flap	Full Flap	Full Flap	Velcro Tab
<b>Boot</b>	No	Yes	Yes	No

The following experimental methods were used to assess customer preferences for the laptop bag design:

- 1) Laptop Bag Survey – Like the crossover vehicle experiment, each respondent was given the above laptop design matrix and was requested to pick and order their top three purchase preferences.
- 2) Laptop Bag STOC – Once again, the same respondents from the above survey also engaged in a 15-minute trading experiment using the MIT WebMarket software. Like the crossover experiment, this study was conducted in a controlled computer laboratory environment. Each user was given detailed instructions. Once all of the

participants felt comfortable with the trading software, each user logged into the system using his or her e-mail address to represent their identity. The users began the game with 100 shares of stock for each laptop bag design and \$10,000 in “cash” to be used for trading. Trades of each user, along with the group results, were tracked and recorded for the purpose of analysis.

The following user instructions from the web site further detail the laptop bag STOC experiment:

### **Overview**

In this trading game, there are 8 companies that manufacture and sell laptop bags as their only product. These companies will go public and their public offering (IPO) prices are to be determined in the MIT WebMarket. You are given some cash and an equal number of shares of each of the stocks. The objective of the game is simple -- maximize your profits by trading the stocks of the 8 companies using your own personal valuation of the companies, as well as any information you are able to glean from market dynamics for the 8 stocks.

### **Financial Information**

In this case, we focus on the profitability of manufacturing and selling the laptop bags, which determines the prospects of the companies and, consequently, how much their stocks are worth. The retail prices and manufacturing costs may differ across the 8 laptop bags, but you should ignore this issue for the moment--for simplicity, assume that all 8 companies have identical cost structures, manufacturing capabilities, distribution channels, financial structure, management expertise and other factors that may affect their profitability. All companies will offer the same number of shares of common stock to the public.

### **Market Environment**

The 8 laptop bag companies are named Type A, Type B, Type C, Type D, Type E, Type F, Type G, and Type H. The stocks of the companies may be priced at any level, and is determined solely by market dynamics, e.g., *your* trades. Prices of the stocks should reflect the earning power of the corresponding companies and therefore their laptop bags. Note that it is the stocks of the company but *not* the laptop bags that are traded in the market.

You are given an allocation of 100 shares of each of the 8 stocks and initial endowment of \$10000 in cash. No borrowing or short-selling is allowed. At the end of the trading session, your portfolio will be valued at the closing prices of the market. The objective of the game is to maximize the value of your final portfolio.

The MIT WebMarket Trading Interface was identical to the one used for the crossover vehicle STOC experiment detailed in the previous section.

#### 4.4 Respondents

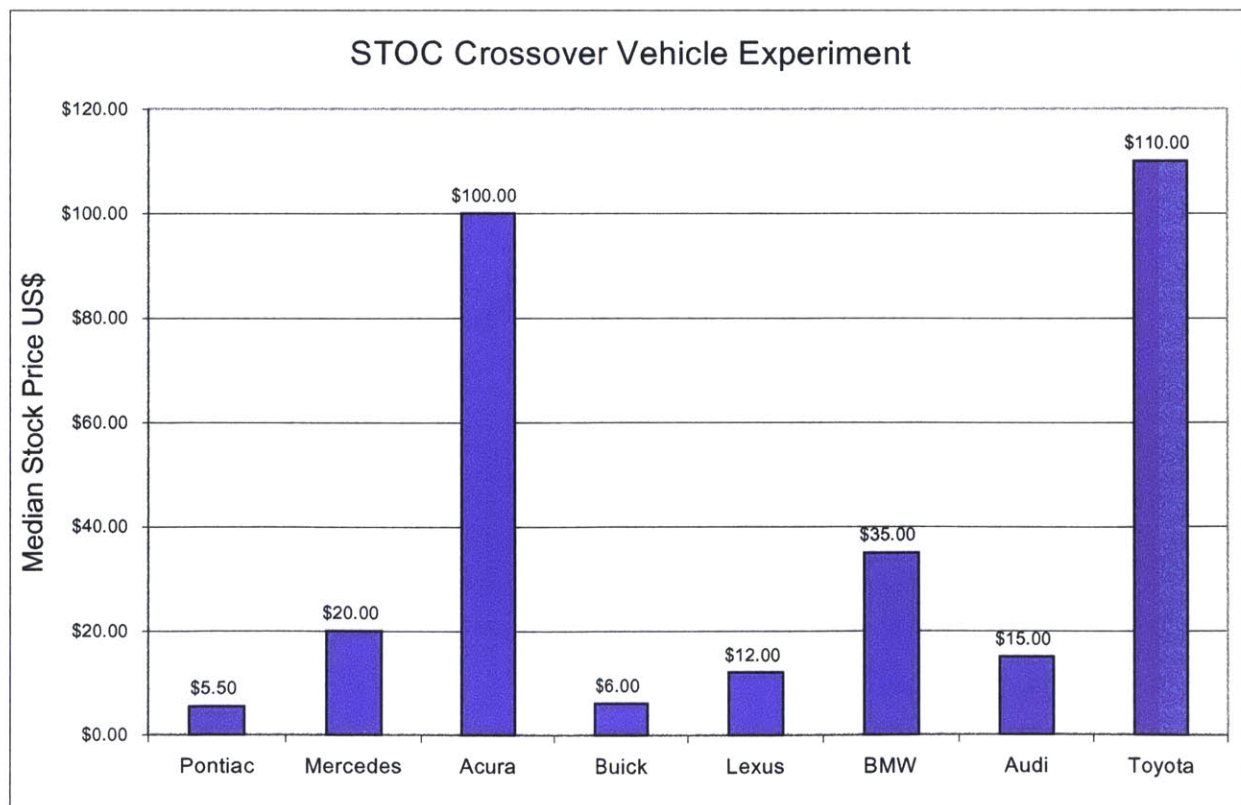
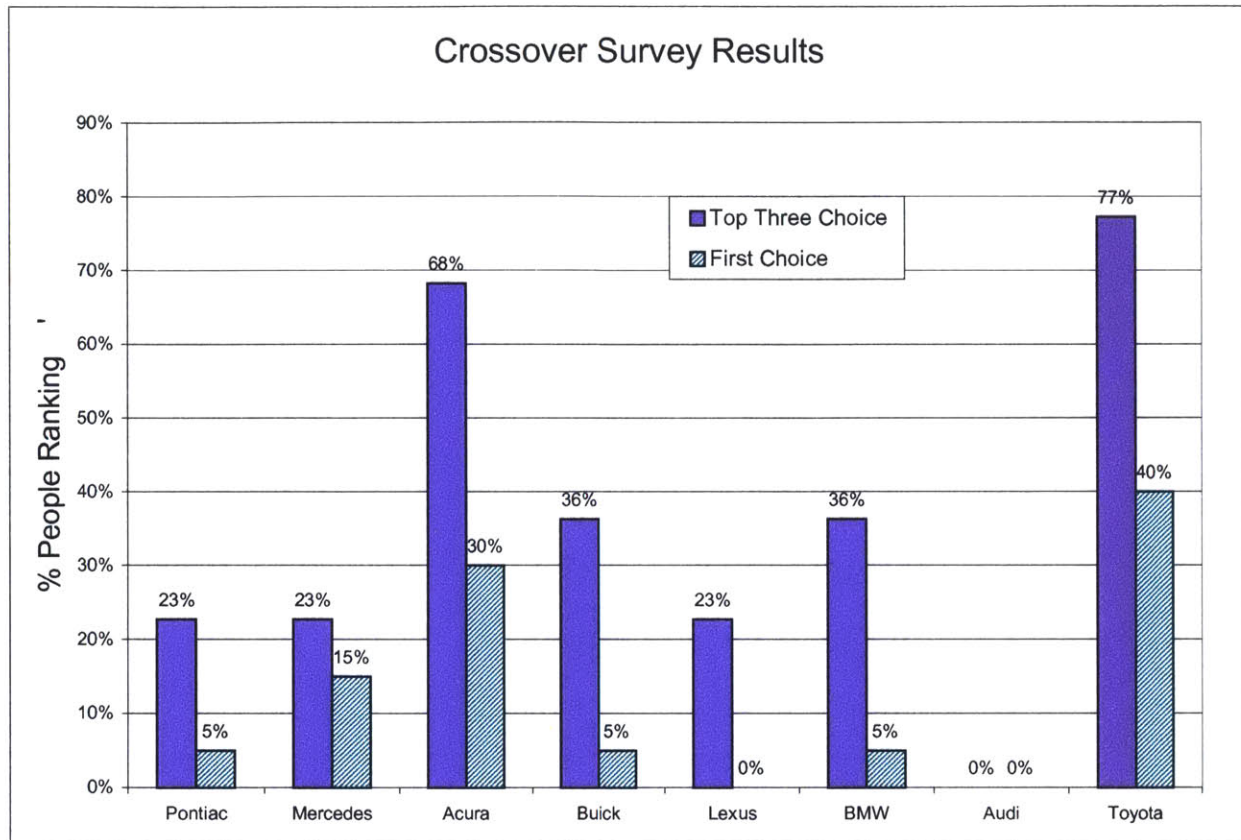
The 25 respondents used for the Crossover Vehicle and Laptop Bag experiments were students in the System Design and Management Program at MIT. The average age of these respondents is about 35 years. Most of the students are married and many of them have children. These respondents are well educated with a strong background in science and/or engineering. Most hold multiple degrees and are currently working in management positions with companies such as Ford, Xerox, Kodak, The U.S. Navy, NASA, and others. The students participated in this study as part of a seminar on virtual concept testing, conducted by Professor Ely Dahan. The same students participated in both the Survey and STOC experiment; therefore, providing a direct comparative data set.

#### 4.5 Results and Analysis

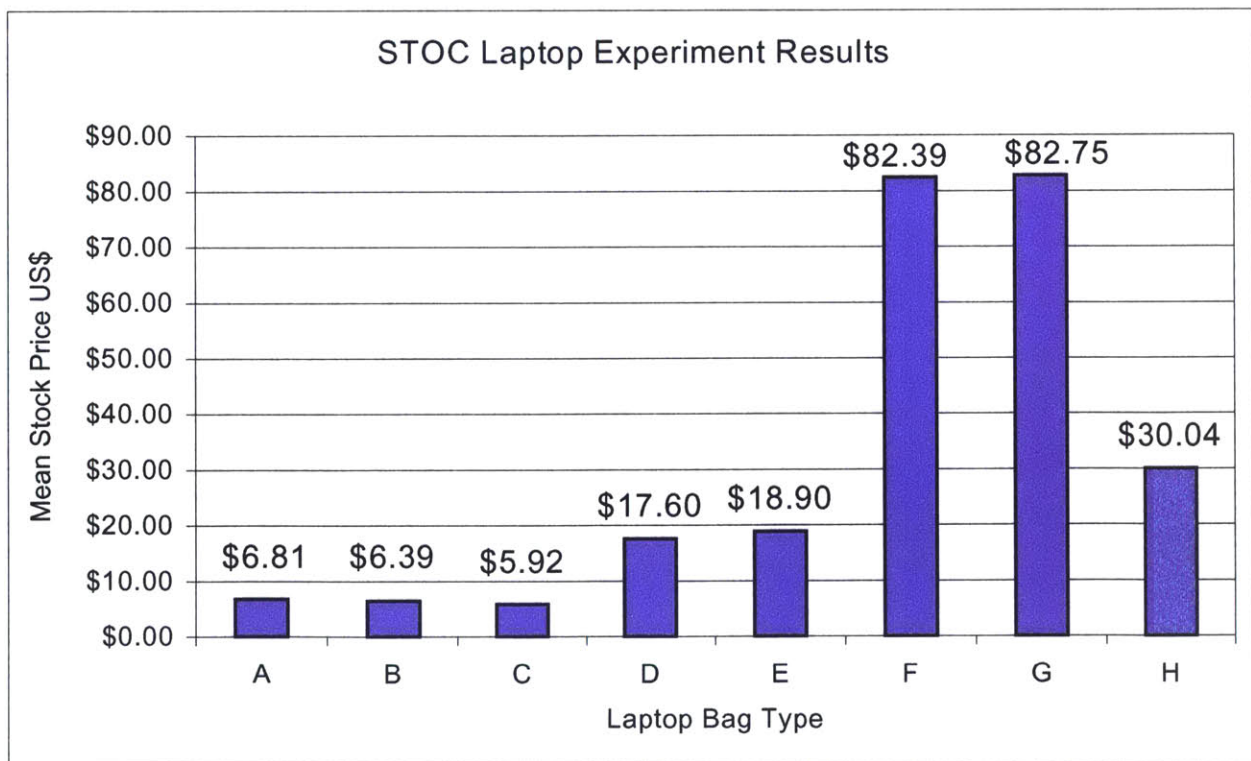
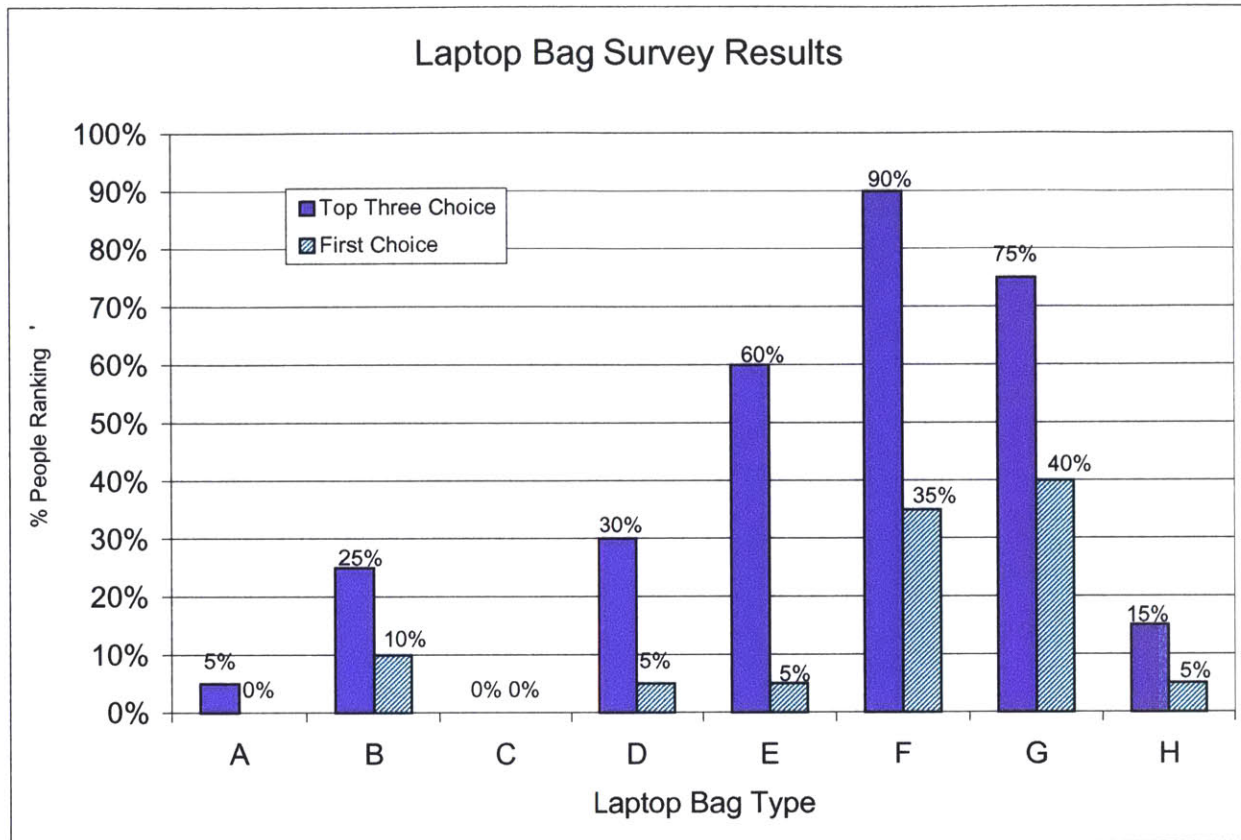
This section details the results from the data collected during the experiments described above. The author also provides a brief summary and analysis of these results. This section closes with the author's thoughts, ideas, and theories on the behaviors exhibited during the STOC experiments.



#### 4.5.1 Crossover Vehicle Case Results



### 4.5.2 Laptop Bag Case Results



The top graph in each case depicts the percentage of people who ranked each vehicle, or laptop bag, as one of their top three purchase choices and as their first purchase choice. The bottom graph represents the median stock price for each vehicle, or laptop bag, recorded during the STOC simulation. The median price is used rather than the closing price, in order to exclude the erratic behavior that is often exhibited by the traders at the end of the trading game.

#### 4.5.3 Data Analysis

Although these data are the result of only two tests, the STOC and Survey results seem to correlate remarkably well for the top two to three choices. This trend agrees with the earlier research conducted using bike-pumps (Chan 2000) <sup>2</sup>.

More testing and prove-out is necessary to fully assess the true prediction capability of the STOC method, but the experimental results from this preliminary testing indicate that the method has definite possibilities for predicting the top few winning concepts.

Other trading web sites are also demonstrating remarkable prediction capability. The Hollywood Stock Exchange (HSX.com) is an entertainment web site that operates a movie and celebrity stock-trading game. The values of movies and stars rise or fall based on how well the traders expect them to perform. HSX has proved to be an accurate predictor of such sleeper hits as "The Blair Witch Project"<sup>3</sup>.

For this STOC experimental study, the only data available to compare with the STOC results are the Survey data, which indicate only personal preferences of the individuals.

A better comparison would be between the STOC results and real market share. Trading behavior of the individuals is not necessarily based solely on their personal preferences. In fact, the trading behavior of each individual should be unique. Real customers exhibit this behavior as well. Some customers may purchase items that they prefer, and not request any additional feedback or information, while other customers purchase items only after thorough research and are heavily influenced by the opinions and preferences of their peers. These customers differ greatly in their purchase utility functions, yet they all seem to converge toward the preference of the group. This is what the author believes is happening in the STOC trading market.

#### 4.6 STOC Participant Trading Behavior

There appear to be three dimensions to the STOC participants trading behavior. The first dimension is based on whether the participants are individually or group motivated. In other words, do the participants use their personal utility to determine the value of a product or are they instead most interested in the utility of the group. The second dimension is based on whether the participants are updating their trading behavior after observing the STOC game or are they instead choosing to maintain their initial trading behavior. The third dimension is based on whether participants are valuing stocks based on customer preference or are they instead observing trading patterns and simply attempting to win a game.

These three dimensions lead to eight different participant trading behaviors (2X2X2) as indicated in the matrix below:

	Trading Behavior	Individually Motivated	Group Motivated	Update	No Update	Preference Trading	Just a game
1	Pure Individual Utility	X			X	X	
2	Individual Utility at First, Update Based on Group Behavior	X		X		X	
3	Individual Utility at First, Update Based on Just a Game	X		X			X
4	Pure Group Hypothesis		X	X		X	
5	Group Hypothesis at First, Update Based on Group Behavior		X	X		X	
6	Group Hypothesis at First, Update Based on Just a Game		X		X		X
7	Purely Just a Game	X			X		X
8	Purely Just a Game		X		X		X

The following is a more detailed description of these eight scenarios:

### (1) Pure Individual Utility

In this scenario, participants trade solely on the basis of their personal preferences. They are uninfluenced by the group and do not update their trading behavior.

Customers exhibit this behavior when purchasing products to meet inherent needs. Functional products such as a toothbrush or hair dryer are likely purchased in this manner.

### (2) Individual Utility at First, Update Based on Group Behavior

Market opens, participants begin trading based on their personal preferences. At this point, pure individual utility should be demonstrated. As the market responds, individuals then become influenced by the other participants' trading behavior. Participants are updating their trading motivations based on the apparent group preference.

Actual consumer purchases should closely imitate this type of trading behavior. When making a purchase decision, an individual may first decide that one alternative best meets his or her needs, and it very well might; however, as the individual becomes familiar with others' perceptions and opinions of the product, they may alter their purchase decision and will often decide with the group. The perception of a product is very important to its ultimate success. In the past decade, there has been a significant amount of emphasis placed on the importance of brand image and perception. The fashion and automobile industries attest to this importance.

### (3) Individual Utility at First, Update Based on Just a Game

Like the previous scenario, participants begin trading based on their personal preferences. As the market responds, participants begin to disregard their personal preferences and instead begin to merely play a game. This trading behavior is very similar to scenario (2); however, the participants are not updating their trading behavior based on the preference of the group, but are instead using historical performance data to assist in their effort to win the STOC game.

Customers do not usually behave in this manner unless, perhaps, they are purchasing investment products that will eventually be sold for a profit, such as diamonds or gold. However, these traders may help keep the market efficient.

#### (4) Pure Group Hypothesis

In this scenario, participants trade solely on the bases of their guess at the group's preference. They do not update their behavior. The idea that these participants are uninfluenced by the groups trading behavior during the STOC game, however, might seem somewhat unlikely.

Customers might exhibit this type of behavior when purchasing products that are perceived to have more value if preferred by the group. They attempt to hypothesize which products will be most popular with the masses. This would apply for image-savvy products like fashion or home interiors. This type of customer behavior could also occur when purchasing products where depreciation is important, such as a home or boat.

Regarding their unwillingness to update: perhaps these participants feel they are equipped to better predict what the group will eventually prefer and therefore, disregard short term group trends and go with their gut feel.

#### (5) Group Hypothesis at First, Update Based on Group Behavior

Market opens, participants once again begin trading based on their guess at group preference. At this point, pure group hypothesis trading is demonstrated. As the market responds, however, these participants become influenced by the trading

behavior of the group and then update their group hypothesis / trading behavior accordingly.

Again, customers might exhibit this type of behavior when purchasing products that have more perceived value if preferred by the group. This differs, however, from pure group hypothesis trading in that the customer changes his or her opinion of the group's preference based on the opinions of others. For example, in the fashion world, the customer might initially read a magazine or watch a fashion review indicating which styles are "in" or "out". The customer develops a prediction of the group's preference and makes purchases based on this information. The customer then sees what others are actually wearing and updates his or her opinion of group preference and makes new purchases based on observation.

#### (6) Group Hypothesis at First, Update Based on Just a Game

This scenario is identical to scenario (3), but the participant begins trading based on their group hypothesis rather than their individual preferences.

#### (7) & (8) Purely Just a Game

In scenarios (7) and (8), the participants are only interested in winning the STOC game. The Individual or Group dimension is irrelevant since these traders are purely motivated by the game itself. These participants never update their trading behavior, but instead continue to carefully examine the market as it moves up and down, making trades based on the performance characteristics of the stocks.



Although customers do not normally behave in this manner, this type of trading behavior might help to stabilize the market, provided other participants are trading based on personal and group preferences. These players look to historical highs and lows and can help to maintain an efficient market.

#### 4.7 STOC Market Dynamics

These eight trading behavior scenarios lead to some interesting questions such as: What participant behavior combination is required to get useful STOC results? This is a very interesting question that should be the focus of future research. The author, however, attempts to provide some preliminary thoughts on this question and the dynamics of the STOC market simulation in the following paragraphs. The author proposes three different market scenarios:

##### Preference Dominance

There are a few individuals with strong preferences throughout the game – they are either using their individual utility or hypothesizing for the group, but they do not update their trading behavior. The remaining participants (i.e., those who update their behavior) merely converge around these strong individuals. The convergers could either be group speculators (update trading behavior based on group dynamics) or gamers (update trading behavior based on just a game). The result is likely to be the average of the preferences of the few strong individuals.

Does a preference dominance scenario yield good information? A firm is trying to understand the preferences of a select group that they believe will buy the new product

they plan to introduce. Does the firm want to be guided by the strong individuals in this group? This is good customer information, representing the chosen participant pool. The STOC method is obtaining real customer preference. Those who converge to the preference dominators merely act as a filter for much of the game; however, their individual preferences might have been incorporated at the start, before they updated their behavior. The preference dominators and convergers may exist in the real consumer world as lead users and market followers, respectively. Perhaps this is the phenomenon exhibited in this example.

### Converger Market

In this market, all of the participants update their trading behavior during the simulation. In the beginning, however, each participant expresses some level of preference. They then update their behavior once trading commences.

Is a market made up of only convergers troublesome? Well, the participants do provide their individual preference in the beginning and should then be converging to their collective preferences as a group once the trading commences. This market dynamic should include less large fluctuations in the market and since preference was provided upfront, it should provide good customer information.

### No Preference

There are likely other trading scenarios or combinations that could be analyzed, with most providing some level of good customer information, however, the No Preference is one that may lead to poor results. None of the traders in this market express any

preference at all, right from the start. The STOC simulation is merely a game and the goal is to win. Preferences are never even considered; therefore, no useful information would be expected.

One possibility for ensuring that personal preference is expressed during the STOC simulation might be to offer the highest valued concept (or some affordable variant) to the participant as a prize. Now the participant has two goals: 1) to maximize the value of their personal portfolio, and 2) to have their favorite concept win. Other incentives could possibly be aligned to ensure an appropriate trading mix.

What if, however, the mitigating actions described above are ineffective? How can one determine if a STOC trading group is good or bad? Other than making interpretations of the STOC data results, the answer to this question is not incredibly obvious; however, it is, nonetheless, important and should be considered in future research.

The bottom line is that some number of individuals trading based on preference, either initially or throughout the trading simulation, is required in order to obtain useful information. Depending upon the reliability of these individuals, very few may be needed to obtain useful customer information.

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<sup>1</sup> Chan, Nicholas, Lo, Andrew, Poggio, Tomaso, "The MIT WebMarket Project," Massachusetts Institute of Technology (1998)

<sup>2</sup> Chan, Nicholas, Dahan, Ely, Lo, Andrew, and Poggio, Tomaso. "Securities Trading of Concepts (STOC)," Massachusetts Institute of Technology (2000)

<sup>3</sup> Bates, James, "Site Hopes to Put Profitable Spin on Hollywood Fame Game," Los Angeles Times (2000)

## Chapter 5. STOC Implementation

### 5.1 Respondent Enthusiasm in Web Markets

Much excitement and interest is expected from participants of the STOC game-like method. Electronic markets are rapidly appearing all over the world. People are trading using various web-based software tools. In addition, familiarity with trading and financial markets is ever-expanding. The average American is now involved in some level of trading, likely due to the infusion of excitement generated by early success of high-tech stocks. Many of these individuals have access to the Internet and are likely conducting their trading transactions through an online broker or trading service.

Market trading has previously been used for items other than to assess pricing in financial markets. In fact, entertainment-based web markets are becoming more and more popular. The Hollywood Stock Exchange attempts to predict box-office success by offering stock and bond trading of movies, stars, music, and more, while the Iowa Electronic Markets ([www.biz.uiowa.edu/iem](http://www.biz.uiowa.edu/iem)) attempts to predict the outcome of political elections, such as the presidential race. Both of these trading sites are extremely enjoyable and include a rather large group of subscribed users.

In addition to the public interest in markets and trading, a competitive game-like method is certainly more amusing than the more traditional consumer research methods. Furthermore, the STOC method provides the opportunity for better alignment of incentives to motivate participants to supply good information.

## 5.2 Implementation Ideas

A customized version of the STOC research tool might be incorporated into a firm's web site, providing access to subscribed members. Or, perhaps, a group of firms would sponsor this web site as a research consortium. The implementation of this virtual market research tool might seem fairly straightforward, but firms have confidentiality to consider, especially when considering new concepts. The following are a few different scenarios that a firm might consider during their implementation. All of these methods assume that the firm has acquired or developed web market type software and that virtual prototypes have been developed and used in the trading simulation.

### Controlled Focus Group

The first implementation mirrors traditional focus group methods in that a group of respondents are recruited in advance, to later participate in a controlled experiment. This method would require the participants to travel to a central site where they would log on to a computer and trade with other participants for a prescribed duration of time (much like the experiments in this study). The firm would still enjoy the benefits of the STOC method in retrieving good consumer information; however this implementation has many of the drawbacks associated with focus group methods such as the expense of facilities, travel, facilitators, incentives, etc., and the physical limitations on participants.

### Virtual Focus Group

This method is similar to the first, except that the respondents are virtual. Limited access is granted over the Internet for the recruited respondents. The respondents are then required to log-on at a prescribed time and begin trading with each other for a specified duration. This method eliminates the need for much of the cost associated with traditional focus groups; however, user identity may be in question and confidentiality is less protected.

### Continuous Virtual Site

A firm might also decide to create a continuous trading site like the Hollywood Stock Exchange. This could be implemented publicly over the Internet or perhaps internally to protect confidentiality. Participants would buy and sell stocks of differing concepts currently under consideration by the firm. Innovative software might even provide a feature for designers and engineers to quickly upload new concepts that they are considering. After a week or two of trading, the winning few concepts might be apparent. The challenges include value creation (if publicly implemented), confidentiality, and software innovation. All of these are interesting areas for further research.

## 5.3 STOC Integration into the Product Development Process

The STOC method seems to work well for products that include a number of attributes and where the differences between the competing concepts is easily identifiable by the participant. Participants seem to have the ability to sift through the various attributes

and develop a utility; however, if the number of attributes is too large or complicated, participants may become overwhelmed and confused. Therefore, the best implementation of the STOC method is likely to occur at the early stages of concept development, where the differences between the competing concepts are more apparent.

In addition, the research data to date suggests that the STOC tool is very effective at winnowing a group of concepts down to the top two or three. Therefore, this paper again suggests that the STOC method be implemented during the early concept development stage when multiple concepts are being considered. During this phase, the expense and time required for physical prototype testing is extremely cumbersome and often cannot adequately support project needs. Traditional market research methods may also require more time than the project can afford. STOC is an extremely effective decision tool for quickly limiting the number of concepts under consideration. It probably does not eliminate the need for eventual physical prototype testing; however, early implementation will cut the number of concepts, thus the number of physical prototypes, down to a manageable size for consideration and refinement.

Another possible use for the STOC method might be in refining the price of a new product just before it enters the market. Perhaps a firm is entering an existing market and wants to ensure appropriate pricing with respect to competition. The STOC method would allow the firm's new concept to compete with existing competitive products. The value of these concepts to the customer would be inferred by their

trading behavior. This effectiveness of this implementation, however, depends on participants' ability to differentiate between the competing products. The research thus far does not include analysis of this theory; however, it is a very interesting implementation and a suggested area for future research.

#### 5.4 Automotive Example

In order to better understand the STOC research tool implementation, this thesis considers an automotive example.

##### 5.4.1 Automobile Decomposition

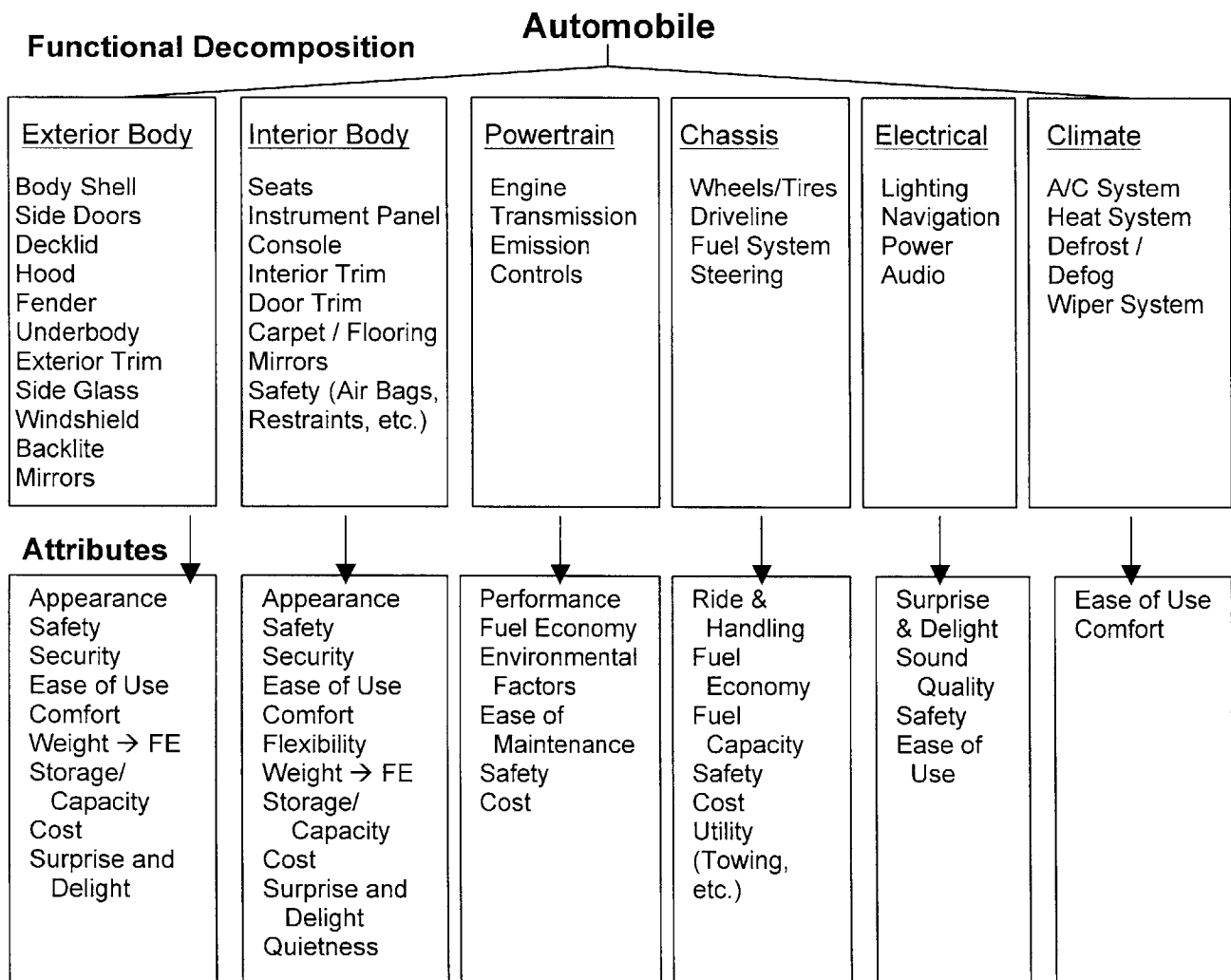
Proper execution of the STOC method relies on carefully thought out choices to set up each experimental study. Determining the design elements to include as well as the concepts to evaluate is a difficult task in itself. There are various marketing research techniques, described in the first few chapters, which will assist in understanding attributes such as conjoint analysis and listening to the customer. It is difficult, however, to design a useful concept selection study without a thorough understanding of the architectural and engineering restrictions and their linkage to customer attributes. This is especially important when considering a complex design like the automobile.

A functional decomposition framework attempts to identify the primary customer attributes associated with the concept and its parts. It indicates the linkage of these attributes to functional, engineering areas of importance. Functional decomposition provides a framework for ensuring that architectural limitations are factored into the



research studies prior to the selection of concepts. It also facilitates the involvement of engineering teams in the design of the STOC or other concept research experiments.

Below is a functional decomposition of the automobile and the corresponding mapping to the relevant customer attributes:



The functional decomposition framework can be used to transform the customer important attributes into STOC research elements. For example: flexibility and storage

were identified as critical customer attributes for the crossover vehicle study. In the crossover case, flexibility was linked to the adjustability of seats while storage was linked to passenger and cargo capacity. Many combinations can be evolved and aligned with market strategies and customer profiles using the decomposition framework. Once an understanding of the attributes that are important to the customer is accomplished, linking them to functional areas to include in the STOC research study should be straightforward using the decomposition framework.

#### 5.4.2 Where and How does STOC fit into the Automotive PD Process

A market and technology strategy is identified and a customer profile articulated. Then research is conducted on the functional elements that will eventually roll into a concept. Voice of the customer is helpful in developing these elements. Conjoint is useful in refining the concept. Shoji Shiba's Language methodology is used to identify new ideas for Surprise and Delight features. User design allows respondents to personalize these ideas into a desirable concept. Once all of this early idea generation work is complete, several full-vehicle concepts emerge. Now it is time to determine which of these concepts will be pursued and advanced further. This is when the STOC method is useful. Studio designers provide illustrations of the themes that are under consideration. Marketing provides the input for features and identifies the desired attributes based on the customer profile. Engineers provide the concept design and constraints of execution. Rather than building prototypes for market testing, these concepts are quickly uploaded to a web site for evaluation. The scenario might be "A New Vehicle for The Youth Market." The concept alternatives may differ as much as a

mini-coupe to a pick-up truck. The STOC methodology will quickly enable a firm to determine the best two concepts to further pursue and refine.

#### 5.4.3 Implementation Technique

The automotive industry is extremely competitive and is, therefore, very sensitive to confidentiality. Implementation of this method on the Internet might be somewhat precarious. A controlled focus group implementation is the most prudent execution. The benefits of virtual prototypes and more reliable customer information clearly exist with this type of implementation; however, the drawbacks include the high costs associated with facilitation, etc.

Another opportunity for an automotive firm is to include an ongoing internal STOC trading web site for employees. The demographics for a large organization may provide an excellent research pool, while confidentiality would be maintained. Incentives could certainly be aligned, not to mention the organizational excitement and enthusiasm that would be generated.

## Chapter 6. Conclusions

### 6.1 Conclusions

- Voice of the customer information is crucial to successful choices in winning concepts. A study of prior relevant research confirms that the selection of the concept to pursue is best made with consumer information and concept testing.
- Virtual concept evaluation methods have become real implementation-ready possibilities for firms. A study of new and innovative virtual research techniques confirms their value and importance to a capital intensive firm such as automotive. Virtual techniques include benefits such as increased ability to obtain good customer information, enhanced computing and technical capability, and a better ability to test multiple concepts at the earliest stage of design. Virtual challenges include the lack of a human facilitator for instructional purposes, the uncertainty of participants' identities, computer response time, and finally, maintenance of confidentiality and security.
- The STOC methodology testing on Crossover Vehicles and Laptop Bags correlates remarkably well with individual survey results on consumer preference. More testing and prove-out is necessary to fully assess the true prediction capability of the STOC method, but this preliminary testing indicates that the method has definite possibilities for predicting the top few winning concepts. Other trading web sites are also demonstrating

remarkable prediction capability such as the Hollywood Stock Exchange (HSX.com) entertainment web site.

- The STOC method seems to work well for products that include a number of attributes and where the differences between the competing concepts is easily identifiable by the participants.
- There appears to be three dimensions to the STOC participants trading behavior: 1) Group or individually motivated, 2) Update or maintain trading behavior during the session, 3) Trade based on preference or is it just a game. These three dimensions lead to eight different participant trading behaviors (2X2X2):
  - (1) Pure Individual Utility
  - (2) Individual Utility at First, Update Based on Group Behavior
  - (3) Individual Utility at First, Update Based on Just a Game
  - (4) Pure Group Hypothesis
  - (5) Group Hypothesis at First, Update Based on Group Behavior
  - (6) Group Hypothesis at First, Update Based on Just a Game
  - (7) & (8) Purely Just a Game
- Participants that trade based on preference, either initially or throughout the trading simulation, are required to obtain useful STOC results. Depending upon the reliability of these individuals, very few may be needed to obtain good customer information.
- The following STOC implementation scenarios are possible: Controlled Focus Group, Virtual Focus Group, and Continuous Virtual Web Site.

- This paper suggests that the STOC method be implemented during the early concept development stage when multiple concepts are being considered. During this phase, the expense and time required for physical prototype testing is high and often cannot adequately support the project needs.
- A decomposition framework can be used to identify the primary customer attributes associated with a concept such as an automobile and its components. It indicates the linkage of the attributes to functional, engineering areas of importance. This framework is then used to determine how to develop design element combinations that align with market strategies and customer profiles.
- One interesting implementation idea for a highly competitive firm, such as an automotive company, is to include an ongoing internal STOC trading web site for employees. The demographics for a large organization may provide an excellent research pool, while confidentiality would be maintained. Incentives could certainly be aligned, not to mention the organizational excitement and enthusiasm that would be generated.

## 6.2 Suggested Areas for Future Research

- Further examination of STOC participant trading behavior is needed. Perhaps a more comprehensive look at participant market dynamics in order to characterize a STOC group as good or bad.

- Further examination of incentive alignment is needed. The question of how to align incentives to achieve a useful group dynamic is one of great interest.
- The examination of the STOC method in refining the price of a new product just before it enters the market. Perhaps a firm is entering an existing market and wants to ensure appropriate pricing with respect to competition. The STOC method might have the firm's new concept compete with existing competitive products to determine appropriate pricing.

## Bibliography

Bates, James, "Site Hopes to Put Profitable Spin on Hollywood Fame Game," *Los Angeles Times* (2000)

Burchill, Gary W., Brodie, Christina Hepner, *Voices into Choices* (Cambridge, MA: CQM, 1997)

Center for Quality Management, *Concept Engineering* (Cambridge, MA: CQM, 1998).

Center for Quality Management, *The Language Processing Method* (Cambridge, MA: CQM, 1995).

Chan, Nicholas, Dahan, Ely, Lo, Andrew, Poggio, Tomaso, "Securities Trading of Concepts (STOC)," (MA: Massachusetts Institute of Technology, 2000)

Chan, Nicholas, Lo, Andrew, Poggio, Tomaso, "The MIT WebMarket Project," (MA: Massachusetts Institute of Technology, September 1998)

Christensen, Clayton M., *The Innovators Dilemma* (MA: Harvard Business School Press, 1997)

Cooper, Robert G., *Product Leadership; Creating and Launching Superior New Products*, (Cambridge, MA: Perseus Books, 1998)

Cooper, Robert G., "Stage-Gate Systems: A New Tool for Managing New Products," *Business Horizons* pp. 44-54 (May-June 1990).

Dahan, Ely, and Hauser, John, "The Virtual Customer: Communication, Conceptualization, and Computation," *Working Paper*, (MA: Massachusetts Institute of Technology 2000)

Dahan, Ely, and Hauser, John, "Managing a Dispersed Product Development Process," *Working Paper* (MA: Massachusetts Institute of Technology (2000)

Dahan, Ely, and Srinivasan, V., "The Predictive Power of Internet-Based Product Concept Testing Using Visual Depiction and Animation," *Journal of Product Innovation* 17:99-109 (2000).

Dolan, Robert J., "Conjoint Analysis: A Manager's Guide," *Harvard Business School* 9-590-059 (May 8, 1990).

Foster, R., Innovation, *The Attacker's Advantage* (New York, NY: Summit Books, Simon and Schuster, 1986)



Green, Paul E. and Srinivasan, V., "Conjoint Analysis in Consumer Research: Issues and Outlook," *Journal of Consumer Research* 5:103-122 (September 1978)

Green, Paul E. and Srinivasan, V., "Conjoint Analysis in Marketing: New Developments With Implications for Research and Practice," *Journal of Marketing* pp. 3-19 (1990)

Griffin, Abbie, *Drivers of NPD Success: The 1997 PDMA Report* (Chicago, IL: Product Development & Management Association, 1997)

Grossman, Sanford, "On the Efficiency of Competitive Stock Markets Where Traders Have Diverse Information," *The Journal of Finance* 31:573-585 (May 1976).

Grossman, Sanford J. and Stiglitz, Joseph E., "On the Impossibility of Informationally Efficient Markets," *The American Economic Review*, pp. 393-407 (June 1980).

Grove, Andrew, *Only the Paranoid Survive* (New York, NY: Random House, 1996).

Henderson, Rebecca, *15.984 Technology Strategy Class Notes* (MA: Massachusetts Institute of Technology, Spring 2000)

Huber, Joel, "What We Have Learned from 20 Years of Conjoint Research: When to use Self-Explicated, Graded Pairs, Full Profiles or Choice Experiments," (Duke University, 1997)

Huber, Joel, Wittink, Dick R., Fiedler, John A., and Miller, Richard, "The Effectiveness of Alternative Preference Elicitation Procedures in Predicting Choice," *Journal of Marketing Research* 30:105-114 (February 1993)

Iansiti, Marco, "Shooting the Rapids: Managing Product Development in Turbulent Environments," *California Management Review* 38, Fall 1995, pp.37-57.

Lo, Andrew W. and MacKinlay, A. Craig, *A Non-Random Walk Down Wall Street* (Princeton, NJ: Princeton University Press, 1999)

Lutz, Robert A., *Gutz : The Seven Laws of Business That Made Chrysler the World's Hottest Car Company* (New York, NY: John Wiley & Sons, 1998)

Moore, Geoffrey A., *Crossing the Chasm*, Rev. ed. (New York, NY: Harper Collins, 1999), pp. 9-62.

Pugh, Stuart, *Creating Innovative Products Using Total Design* (Reading, MA: Addison-Wesley Publishing Company Inc., 1996).

Reinertsen, Donald G., *Managing the Design Factory* (New York, NY: The Free Press, 1997).

Rodgers, Everett M., *Diffusion of Innovations* (New York, NY: The Free Press, 1983), 3<sup>rd</sup> ed., pp. 241-270.

Sage, Lee A., *Winning the Innovation Race; Lessons From The Automotive Industry's Best Companies*, (New York, NY: John Wiley & Sons, 2000).

Shiba, Shoji, Graham, Alan, and Walden, David, *A New American TQM* (Cambridge, MA: CQM, 1993).

Srinivasan, V., Lovejoy, William S., and Beach, David, "Integrated Product Design for Marketability and Manufacturing", *Journal of Marketing Research* 34:154-163 (1997).

Stevens, Greg A. and Burley, James, "3000 Raw Ideas = 1 Commercial Success!," *Research Technology Management*, May-June 1997, pp. 16-27.

Ulrich, Karl T. and Eppinger, Steven D., *Product Design and Development* (Boston, MA: McGraw-Hill Companies Inc., 2000).

Urban, Glen, Hauser, John R., Qualls, William J., Weinberg, Bruce D., Bohlmann, Jonathan D., and Chicos, Roberta A., "Information Acceleration: Validation and Lessons From the Field," *Journal of Marketing Research* 34:143-153 (February 1997)

Urban, Glen, Weinberg, Bruce D., and Hauser, John R., "Premarket Forecasting of Really-New Products," *Journal of Marketing* 60:47-60 (January 1996)

Vriens, Marco, Loosschilder, Gerard H., Rosbergen, Edward, and Wittnik, Dick R., "Verbal versus Realistic Pictorial Representations in Conjoint Analysis with Design Attributes," *Journal of Product Innovation Management* 15:455-467 (1998)

## Appendix A: Internet STOC Trading Instructions

### 1. Choosing a Stock

MIT WebMarket (wkim@mit.edu)

Market News  
09:51:31: Market is Open

Symbol: Type\_A Size: 100 Price: 0.00  
 Type\_A Buy Limit Sell  
 Type\_B

Open Orders Cancel Order

Transactions

Quote / Portfolio

	Last	Low	High	Bid (size)	Ask (size)	Volume	Quantity	Market Value
Type A	-	-	-	(0)	(0)	0	100	0.00
Type B	-	-	-	(0)	(0)	0	100	0.00
Cash								10000.00
Total								10000.00

Warning: Applet Window

### 2. Submit a Limit Order

buy/sell at a price better than or equal to the specified price (limit price).

MIT WebMarket (wkim@mit.edu)

Market News  
09:51:31: Market is Open

Symbol: Type\_A Size: 70 Price: 70 3/4  
 Limit Buy Limit Sell

Open Orders Cancel Order

Submit a "Limit Buy" order of 70 shares at \$70 3/4.

Transactions

Quote / Portfolio

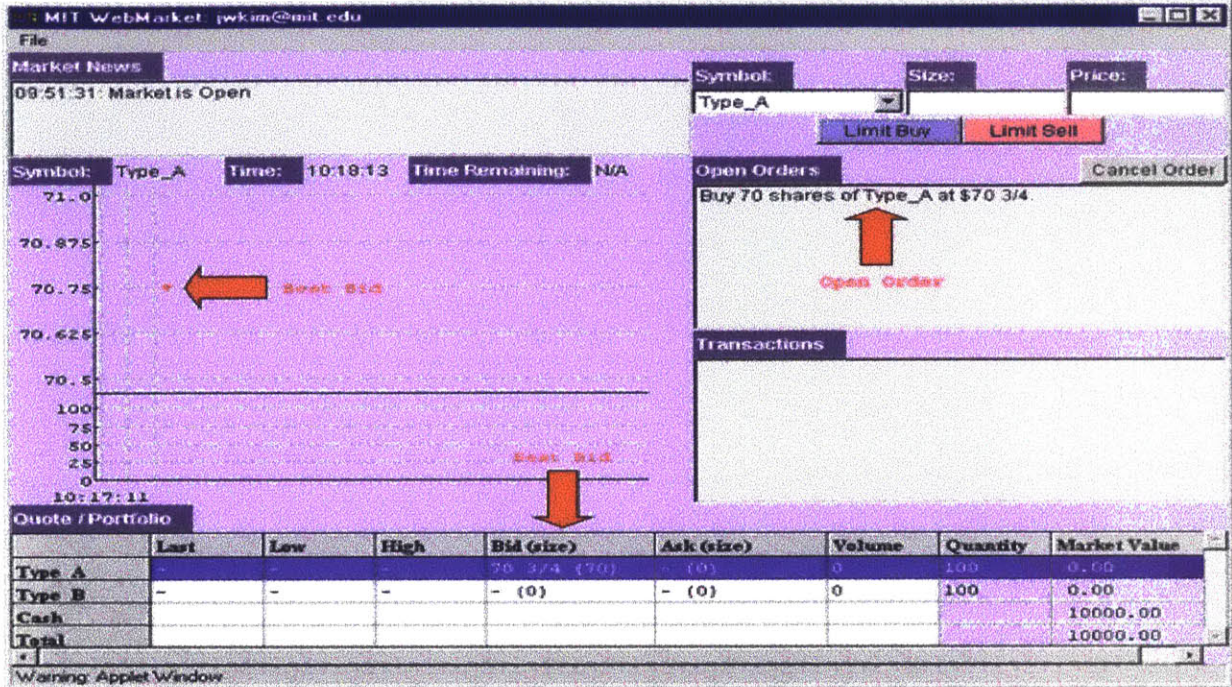
	Last	Low	High	Bid (size)	Ask (size)	Volume	Quantity	Market Value
Type A	-	-	-	(0)	(0)	0	100	0.00
Type B	-	-	-	(0)	(0)	0	100	0.00
Cash								10000.00
Total								10000.00

Warning: Applet Window



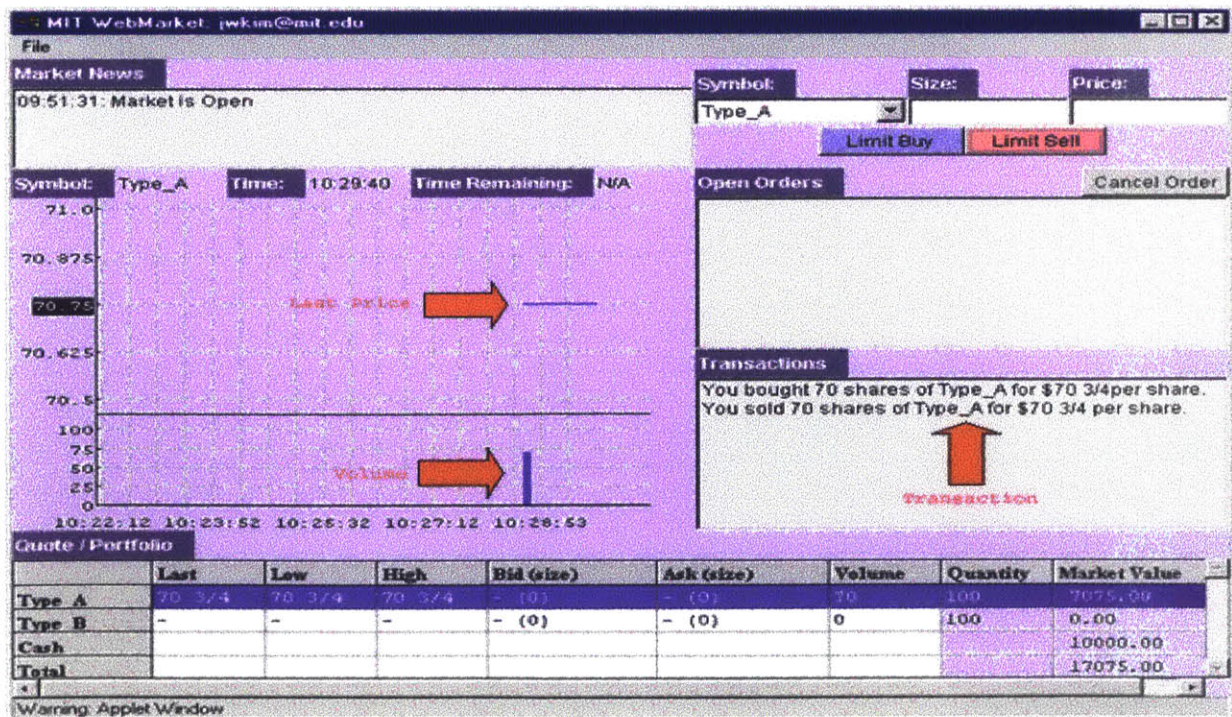
### 3. Submit a Limit Order

a limit buy order with the highest price becomes the best bid in the market.



### 4. A Transaction

a limit sell order matched with a limit buy order and resulted in a transaction.





## 5. Cancel an Order

MIT WebMarket: jwkim@mit.edu

File

Market News  
10:34:56: Market is Open

Symbol: Type\_A    Size:    Price:   

Limit Buy    Limit Sell

Open Orders    Cancel Order

Buy 10 shares of Type\_A at \$29

Select an open order and click button to cancel.

Transactions

Quote / Portfolio

	Last	Low	High	Bid (size)	Ask (size)	Volume	Quantity	Market Value
Type A	70 3/4	70 3/4	70 3/4	29 (10)	- (0)	70	100	7075.00
Type B	-	-	-	- (0)	- (0)	0	100	0.00
Cash								10000.00
Total								17075.00

Warning: Applet Window

## 6. Order Cancelled/User Portfolio

MIT WebMarket: jwkim@mit.edu

File

Market News  
10:34:56: Market is Open

Symbol: Type\_A    Size:    Price:   

Limit Buy    Limit Sell

Open Orders    Cancel Order

Order Cancelled.

Transactions

Quantity and Value of your stock holdings.

Quote / Portfolio

	Last	Low	High	Bid (size)	Ask (size)	Volume	Quantity	Market Value
Type A	70 3/4	70 3/4	70 3/4	- (0)	- (0)	70	100	7075.00
Type B	-	-	-	- (0)	- (0)	0	100	0.00
Cash								10000.00
Total								17075.00

Warning: Applet Window



## 7. User Logout

The screenshot shows the MIT WebMarket interface for user jwkim@mit.edu. The interface includes a 'Logout' button, a 'Market is Open' notification with a red arrow pointing to the time 10:57:48, and a red message 'Logout from the market.'. The main area displays a price chart for 'Type\_A' with a price of 70.75 and a time of 10:57:48. The chart shows a price of 70.75 at 10:51:25, 10:53:05, 10:54:46, and 10:56:26. The interface also features 'Limit Buy' and 'Limit Sell' buttons, an 'Open Orders' section with a 'Cancel Order' button, and a 'Transactions' section. At the bottom, there is a 'Quote / Portfolio' table.

	Last	Low	High	Bid (size)	Ask (size)	Volume	Quantity	Market Value
Type A	70 3/4	70 3/4	70 3/4	- (0)	- (0)	70	100	7075.00
Type B	-	-	-	- (0)	- (0)	0	100	0.00
Cash								10000.00
<b>Total</b>								<b>17075.00</b>

Warning: Applet Window