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A Model to Assist in the Growth of Technology-based Product Firms

By

James Bowen, M.M.S.

**A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment
of the requirements for the degree of Doctor of Philosophy, Management.**

**School of Business
Faculty of Public Affairs and Management
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Ottawa, Ontario**

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A Model to Assist in the Growth of Technology-based Product Firms

ABSTRACT

Considerable academic research has focused on providing strategies for managers of product-based firms, ranging from strategies that have proven their worth in empirical testing to those that are based on one individual's experience. In some cases these strategies are placed in a structure that has been designed to guide the manager in selecting among various possible strategies. Such structures might cover different aspects of the organization from marketing to research and development (R&D) and could consist of a number of issues or categories of issues to consider when developing or choosing the appropriate strategy. Such structures might be based on some underlying assumptions or theory concerning the area of concern, such as the product life cycle theory.

The product life cycle theory divides the life of a product into stages and provides a set of marketing-related strategies applicable to each stage. In this particular theory, the manager is left with the task of choosing strategies and tailoring them to the firm and product. This particular theory provides no suggestions related to the development of the technology inherent in the product.

This dissertation proposes that a model for technology-based product companies should take into account the following three issues:

First, marketing strategies should not be chosen in isolation from technology strategies;

Second, the structure should be derived from both empirically grounded literature and the practitioner experience; and,

Third, the structure should be usable by executives in technology based product companies.

This dissertation focuses on outlining a model (See Appendix A for definitions of theories, models and frameworks) that is designed to address the aforementioned issues for technology based product companies.

The dissertation proposes a model that provides simple mechanisms to understand the trends in the technology and market, and, to prepare the technology-based product company to induce a transition in the marketplace.

The model was developed by combining the literature with the results of interviews of individuals from technology-based product companies. The model proposes an approach to continuously anticipate, prepare and induce changes in the market place.

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This thesis marks the culmination of many years of work beginning in 1980 with the start of my Bachelours degree in Commerce. At the beginning of my fourth year I started working part time and continued my studies part time. I graduated in 1985 and in 1989 started my Masters degree part-time while working 3/4 time. I graduated with the second degree in 1992. Five years later I began my Ph.D. in 1997 while working full time.

Really what this course of activities demonstrates is the team effort involved and the purpose of this section is to acknowledge some of the team who assisted in completing my education.

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CHAPTER 1: INTRODUCTION

This chapter presents a general background on frameworks and a definition of technology-based products. As well, this chapter presents an overview of the thesis document.

A survey of founders of 100 companies on the 1989 Inc. magazine's "500" list of fastest growing companies in the US revealed that:

- 41% had no business plan;
- 26% had a rudimentary plan;
- 5% had some financial projections for investors; and,
- 28% had a complete business plan.

Entrepreneurs sometimes lack the time, motivation and money to interview potential customers, construct competitive cost structures or project technology, and, thus construct meaningful business plans trends [Bhide, 1991]. In addition, managing a product-based company is challenging due to the large number of marketing, organizational and other decisions required, even more so if a line of products is involved [Bridges, Coughlan and Kalish, 1991; Wind and Robertson, 1983]. Technology-based product futures are difficult to predict and yet such predictions are required to have an approach to prepare for the future [Stacey, 1992]. For example, growing a company in an internet-based environment to requires both planning and executing the plan [Yoffie and Cusumano, 1999].

Two examples of technology-based product companies that have experienced rapid growth and appear to have different market approaches from each other are Netscape and Microsoft.

Netscape's early approach was on being adaptable and capitalizing on its ability to take ideas and turn them into products to meet its continuously changing customer requirements. Although as one senior manager stated: "Two years into the company it probably would have been a good thing to have a formal planning process." [Yoffie and Cusumano, 1999].

On the other hand, Steve Ballmer, Microsoft's President, emphasizes Microsoft's strategic approach takes into account changes in the market when necessary. Microsoft has a structure in place to systematically examine the environment and develop plans to both react and shape it [Yoffie and Cusumano, 1999].

Frameworks to Aid in Decision Making

To aid in making decisions and deriving market approaches academic and practitioner research have provided a variety of strategies for managers and executives of product firms. These include strategies that have been empirically tested in large number of different settings and those that are based on one individual's experience [Mansfield, 1968; Rogers, 1983; Moore, 1995; Beard and Easingwood, 1996; Bridges, Yim and Briesch, 1995].

Rogers and Moore have used the adoption of innovations theory as a structure to guide the manager in selecting between various possible strategies [Rogers, 1983; Moore, 1995]. Such structures might cover various aspects of the organization from marketing to R&D and could consist of a number of issues or categories of issues to consider when developing or choosing the appropriate strategy. Such structures might be based on some underlying assumptions or theory concerning the area of interest.

For example, a well-established general theory exists to assist managers in choosing strategies for products [Onkvisit and Shaw, 1989]. This framework, referred to as "the Product Life Cycle", consists of a two-attribute space (time and sales) in which to position a product. Each of these stages can have a number of associated strategies. In this particular theory the manager is left with the task of choosing strategies and tailoring them to the firm and product.

Moore and Bass have developed approaches to guide managers in the development of corporate strategy for technology-based products [Moore, 1995; Bass, 1969]. Moore's approach applies his experience [Moore, 1995] to the adoption of technology/innovations theory [Rogers, 1983] while Bass' is an empirical approach [Bass, 1969].

The advantages of approaches based on an underlying theory are:

- 1) Evidence of the theory's validity and generalizability are available in previous research.
- 2) Such approaches also provide the capability to anticipate a future scenario and by doing so reduce uncertainty in decision making.

Technology Based Products

Definition

This dissertation focuses on technology-based products before developing an approach to assist executives in technology-based product firm. This section provides an understanding of technology-based products.

Technology-based products are composed of knowledge, skills and artifacts and have a high degree of uncertainty about their viability in the market place¹ [Moriarty and Kosnik, 1989]. The level of uncertainty of a product's viability is a function of such issues as the unproven engineering or technical features in the product and the level of marketing effort needed to accomplish an acceptable ROI [Bergwerk, 1989].

¹ See Appendix D for a definition of uncertainty and risk.

The technology-based products include products in computer hardware, software, telecommunications, advanced materials, pharmaceuticals, semiconductors, electronic equipment, and specialty chemicals industries [Ryans et. al., 2000].

Corporate Operating Environment

Technology based product companies operate in an environment that includes [Ryans et. al., 2000]:

1) Complex and dynamic market chains

Technology-based product companies typically have less vertical integration than less technology-intensive companies. As such technology-based product companies rely on a network of partners such as system integrators to deliver the product to the customer. This network of partners might be unstable due to the ever changing nature of technology and market opportunities.

2) Network effects

Network effects appear when the value of the product to one customer depends on the availability or usage of the product by another customer. For example, email, fax machines or the internet are more valuable when others have the same technology.

3) High speed of change

The market for technology-based product companies can undergo rapid and continuous change. This requires executives in the technology-based product companies to continually make decisions regarding the customers they will serve, and, the functions and usage of their product. For example, the change in the market from mainframe computers to minicomputers to personal computers saw leadership in the market change from IBM to DEC and Hewlett Packard to Compaq, Dell and Apple.

4) Blurred market boundaries

Market boundaries are defined as the dividing line between markets, for example, different markets exist for personal computers and computer workstations sold by SUN Microsystems. As technology continues to improve in functionality and reduce costs, the functionality thought exclusively available or required in one market can migrate to another. For example, desktop publishing capabilities found in products such as Aldus' Pagemaker have migrated into word processing packages such as WordPerfect and Word. As a result, the market between the desktop publishers and the office worker overlaps.

Value of Models for Decision Making in Technology-Based Product Companies

Models can assist in anticipating the possible scenarios of the future for the product in the market and its underlying technology [Stacey, 1992]. With the aid of appropriate models, planning for a corporation can then focus on [Stacey, 1992]:

- Generating new perspectives on what is going to occur;
- Structuring the planning issue in useful forms; and,
- Noticing potential and possibility.

The Proposed Model

A model suitable for a technology-based product company, for the purpose of this thesis, could consist of the following elements:

- 1) A multidimensional space that will position the technology based firm, its technology and its product(s) such that a possible strategy set linked to its position can be found. In the proposed framework the first step is to determine the technology and market position on frameworks that utilize a life cycle approach. In such life cycle approaches, under favourable conditions, it would be expected that the firm's technology/product would traverse the stages. Each stage has a set of implications for the present and for the future stages.

The next set of constraints is continuum based. Instead of a life cycle with a beginning and end, this set of constraints can be described as a point along a series of discrete points. Upon identifying the current position on a continuum or set of categories it may not occur or be prudent that other positions will be occupied at a later time. For example, the corporate culture, competitive environment and the firm's resources and capabilities could be accounted for with a continuum based approach.

- 2) A mechanism to select the appropriate strategy set for the firm and its product(s). This mechanism must be able to adequately account for the firm and its product's particular circumstances in order to chose or develop an appropriate strategy.
- 3) In this stage, the possibility that the firm may have multiple products based on a technology or products based on different states of a technology development may need to be factored in. This technique should be easy to utilize, and, able to allow all aspects of the organization to understand and implement it. This would seem to call for a visual representation.
- 4) Finally a population of strategies to fill this model. The population of strategies and tactics could be drawn from both the academic and practitioner's literature.

In the following diagram, a matching technique is used to find appropriate strategies given the firm's specifics and its positions in the technology and market.

Figure 1: The Proposed Model

Structure of the Thesis

In the Literature Review section, the technology and adoption of innovation life cycle theories are presented as mechanisms to anticipate future market and technology possibilities. Choosing appropriate strategies and tactics are the desired outcome when

utilizing frameworks such as Moore's [Moore, 1995]. Strategies and tactics are defined in the literature review section along with illustrative examples.

The next section presents the research hypotheses.

The Research Model section begins with an explanation of transitions in the market and presents the model constructed from both the practitioner and academic literature.

The Methodology section presents the grounded theory approach used in this thesis research.

The Interviewee section presents information concerning the interviewee selection process and interviewee profiles.

The Research Results section presents the results applicable to each hypothesis from the interviews with executives.

The Revised Model section revises the research model based on the interviews with executives from technology-based product companies.

The Further Analysis section presents a similarity measurement approach to examine the similarity of each respondent to each other and the revised model.

The model is then examined in light of the overall planning process for technology-based product companies.

The next three sections cover the implications, generalizability, conclusions and further research.

The appendixes contain further information concerning theories, models, the material used in the interviews and the interviewee results.

CHAPTER 2: LITERATURE REVIEW

In this section, the product, technology and adoption of innovations life cycle theories are presented which provide the capability to represent the technology and its market such that a perspective of possible future scenarios can be achieved. As well, an overview of the concepts of strategy and tactics is presented including illustrative examples drawn from well known technology-based product companies.

Representing the Technology and the Market

Moore (1995) utilizes the adoption of innovation life cycle theory to provide strategies for technology-based product firms. Technology-based product marketing differs from other products due to the necessity of moving the product through the technology life cycle [Popper and Buskirk, 1992]. In addition, as evidenced from the preceding description of technology-based products, such products require one or more life cycle-based theories to position the products in the market and the technology.

The following sections provide a review of each of three life cycle theories to position technology-based products in the market and the technology. These theories assist in deriving appropriate strategies for technology-based product company. Each of the theories describes a two attribute or two variable space. The section begins with a general discussion on life cycles.

Life Cycles

All biological organisms go through a life cycle of birth, growth, maturity and death. In addition, many human enterprises such as the Roman Empire have a birth, maturation, and decline stage [Lilien and Rangaswamy, 1998]. It has been suggested that such a life cycle is also appropriate for products [Lilien and Rangaswamy, 1998]. Of course the length of the life cycle varies for different products. Some such as salt, peanuts and wine have long life cycles where the product remains relatively unchanged for long periods of time. Others such as California wine coolers and presidential Hallowe'en masks have short life cycles [Lilien and Rangaswamy, 1998].

Software Life Cycle

Many life cycles exist. The software development process can be viewed as an example life cycle.

Typically software is developed as part of a project which is a temporary undertaking to create a unique product or outcome, for example developing an information system [PMI, 1996]. Temporary means that the project has a beginning and end. Unique means completing something that has never been done before, although in general, it may be similar to other projects or may have parts that are the same. Because it is unique the project must be progressively elaborated. This means it must be described in detail with allocations to stages and various levels of detail [PMI, 1996].

The software life cycle contains the necessity to deal with uncertainty since the exact sequence of necessary activities, duration, costs, etc. is unknown [PMI, 1996]. Thus the project is broken down into phases which correspond to the project life cycle of start to completion. Each phase is marked by deliverables, for example, code or documents or test results and so on [PMI, 1996]. An approach is a spiral model with four cycles [PMI, 1996]:

1) Proof of concept cycle

- obtain business requirements;
- define goals for proof of concept;
- produce conceptual system design;
- design and construct the proof of concept;
- produce acceptance plans;
- conduct risk analysis; and,
- make recommendations.

2) First build cycle

- derive system requirements;
- define goals for first build;
- produce logical system design,
- design and construct first build;
- produce system test plans;

- evaluate first build; and,
- make recommendations.

3) Second build cycle

- derive subsystem requirements;
- define goals for second build;
- produce physical design;
- construct second build;
- produce system test plan;
- evaluate the second build; and,
- make recommendations.

4) Final cycle

- complete unit requirements;
- final design;
- construct final build;
- perform unit/subsystem/system; and,
- acceptance tests.

Utilizing this cycle approach provides corresponding strategies for the management of the software development process [PMI, 1996]:

- 1) **Initiating processes** - recognizing that a project or phase should begin and committing to do so.
- 2) **Planning processes** – devising and maintaining a workable scheme to accomplish the business needs of the project.
- 3) **Executing processes** – coordinating people and resources to implement the plan.
- 4) **Controlling processes** – ensuring the objectives of the project are met by monitoring and measuring progress and taking corrective action when necessary.
- 5) **Closing process** – formalizing acceptance of the project or phase and bringing it to a close with the required outputs such as documentation. This output becomes the input of the management process for the next cycle.

Benefit of Using the Life Cycle Approach

The importance of the concept of products having a life cycle, is not whether a particular product or technology has a life cycle, but that by using a life cycle expected outcomes can be envisaged and strategies formulated [Lilien and Rangaswamy, 1998]. For example, resources can be directed to consumer awareness in the introduction stage of a product and to differentiating the product from other products in the mature stage.

Life cycles have been calculated for computer Random Access Memory (RAM) technology, 754 ethical drugs, the development of Boeing's airplanes, and automobiles [Lilien and Rangaswamy, 1998]. These empirically derived life cycles provide a mechanism to suggest strategies for similar products or future generations of a product based on a given location of the product within the life cycle. Thus intervals along the life cycle are of interest since they suggest situations that may occur and assist the company to define the appropriate approach for the market.

Events

The movement of a product along a life cycle is influenced by the combination of a company's actions/inactions and factors outside the company's control. External factors include market innovation, market concentration, economic cycles, supply constraints and replacement sales [Harrell and Taylor, 1981; Thorelli and Burnett, 1981].

The following sections discuss the:

- 1) Technology life cycle;
- 2) Product life cycle; and,
- 3) Adoption of innovations life cycle.

The Technology's Life Cycle

Technologies, in general, follow a life cycle similar to biological organisms. Beginning in an immature stage, and under the right circumstances, a technology could increase in functionality until it reaches its mature stage at which point increases in capability/performance become difficult [Foster, 1986].

The technology life cycle begins before a technology is introduced to the market as a product and is still in the R&D stage [Popper and Buskirk, 1992; Shanklin and Ryans, 1984].

The life cycle of a technology is typically represented graphically as an "S" shaped curve on a two dimensional graph with capability on the Y-axis and resources on the X-axis. As shown in the following figure, this curve captures the relationship between the amount of resources (personnel, effort or investment) required and improvements in technological performance [Foster, 1986].

Figure 2: The Technology Life Cycle

For example, in the early stages a large amount of resources may only obtain incremental advancements in performance. The Technology Life Cycle theory assumes that, in general, a new technology's performance improves as more R&D resources are spent. At a certain point, a technology's performance capabilities start to increase. In the mature stage of the life cycle, marginal performance differences are all that is possible even given large investments. This limit at the top of the "S" curve means that eventually the technology will only show marginal or no improvements to technological capability. For example, the ultimate density of a silicon chip limits the number of functions that can be performed and before the silicon chip there was an upper limit of connecting wires that could physically fit within a computer's case.

It has been observed that new product models are made available in rapid succession [Meldrum, 1995]. Since the efficiency of the technology can be expected to change in a predictable sequence such rapid successions in the early stage of a technology provide

support for the idea that performance can be incremented in larger amounts with a given R&D effort [Foster, 1986].

"S" shaped curves have been derived for several technologies including [Foster, 1986]:

- Artificial hearts (survival in weeks vs. cumulative laboratory years of work);
- Chemicals such as Orthoxylene and Napthalene (selectivity yield vs. cumulative R&D effort) used in paint thickeners and plastics; and,
- Rayon and cotton materials used in tires (Relative cord performance vs. millions of R&D spent).

Competing Technologies

Sometimes during a technology's life cycle a new competing technology is developed. Initially the second technology's performance may be less than the first but it then might overtake and replace the first, moving the whole performance capability for the resulting product or process to a higher level. An alternative scenario is the second innovation might start at lower cost/performance ratio and cause the established parameters that are used to evaluate similar products to change. The new product might introduce a metric not previously possible or not seriously considered and make it the top consideration in the user's mind [Bower and Christensen, 1995].

For example, 3.5 inch computer disks originally had a smaller storage capacity than 5.25 inch computer disks and as a result were not seriously considered by the manufacturers of the larger computer disks. Storage capacity was the prime attribute of the media valued by customers. However, the smaller drives that the smaller disks needed had lower power consumption requirements, took less space and were lighter in weight. These were attributes that some computer manufacturers desired such as those making notebook computers. As the computer manufacturer's attention began to focus on the smaller computer disks further research enabled the storage capability to increase, until the smaller computer disk innovation overtook the market of the larger computer disks.

Patterns of "S" curves might emerge when technological development is tracked over time. For example, a mature technology may be replaced with a new technology and produce a series of "S" curves [Foster, 1986].

Figure 3: A Series of Technologies

Finding the Technology's Position on the Technology Life Cycle

In this thesis the technology life curve is used to provide an indication of possible future capabilities for a technology. Thus where the technology currently resides on the technology life cycle curve must be approximately determined.

The first step is to determine where a technology resides on the curve is to utilize a measurement of the technology's capability. Then the second step is to determine the technology's position on the life cycle.

Step 1: Measurement of Capability

Technology capability would normally be measured by some underlying metric, for example, in personal computer technology this could be CPU technology such as 8 bit, 16 bit and 32 bit CPUs or z80, 8088, 286, 386 CPU chip [Bayus, 1998]. In the examples given earlier in this dissertation, the unit of measurement could be survival in weeks for artificial hearts or relative cord performance for tires [Foster, 1986].

Step 2: Finding the Position on the Life Cycle

There are two approaches that could be utilized to find the position of a technology on the life cycle curve:

- 1) **Estimate it** - Using mathematical models the life cycle curve can be approximately estimated with a small number of data points [Foster, 1986]. In this approach a technology such as the size of the computer's Random Access Memory (RAM) could be modeled by obtaining or estimating information concerning the amount of Research and Development (R&D) effort for each generation of RAM technology. Even if such information only resulted in a few data points, (for example, it is estimated that the 256K RAM took \$100M to develop [Rogers, 1995]) similar estimates could be obtained for later and earlier generations resulting in enough data points to estimate the life cycle curve.

A simpler approach is to use available historical data points along with an estimate by experts of the upper limit of the technology. This could provide the necessary data to estimate a basic "S" shaped curve. For example, expertise could have been utilized to predict the maximum number of wires that could fit inside a computer before the advent of silicon-based computer chips and thus give an estimate of the upper limit of the curve.

The historical data points along with the estimates can be used such that for any portion of the curve the mathematical derivative can then be calculated or estimated. A simple heuristic could be used to suggest that:

- If the mathematical derivative tends to infinity then the portion of the curve is a vertical straight line and the technology is in the middle portion of the curve;
- If the derivative tends to 1 then the portion of the curve is a 45 degree line and the technology is neither near the beginning or end of its life; and,
- If the derivative tends to zero (less than .1) then the portion of the curve is a horizontal line and the technology is either near the beginning or end of its life.

2) Use Rules-of-Thumb - Foster (1986) suggests that the technology is in the mature stage when:

- 1) There is increasing discomfort among top management about R&D output.
- 2) Development costs and delays have started increasing rather than falling
- 3) There is more process R&D than product R&D.
- 4) Creativity is waning as measured by: the patents applied for, new products developed, or new ideas suggested.
- 5) There is disharmony or discouragement in the labs.
- 6) Market segmentation is becoming key to increased sales.

- 7) There are wide differences in R&D spending amongst competitors with little apparent market effects.
- 8) There are frequent changes in R&D personnel with little effect.
- 9) Market leaders are losing market share to smaller competitors in niche markets.
- 10) Weaker competitors are succeeding with radical approaches that were dismissed by market leaders.

However, Foster does not provide an indication of how many heuristics must be present in order to clearly state that a technology is in the mature stage or if any of the heuristics are more significant than others [Foster, 1986]. As well Foster does not indicate heuristics for other stages of the life cycle or if these aforementioned heuristics could be inverted or modified in some way to indicate other stages in the life cycle.

Technology Life Cycle curve analysis recognizes that technological development often follows a pattern and as such some forecasting of development patterns is possible and of value [Goodman and Lawless, 1994].

The Product Life Cycle

Overview

The Product Life Cycle widely associated with the field of marketing generally contains four distinct stages: Introduction, Growth, Maturation, and Decline [Onkvisit and Shaw,

1989]. A product's profits and sales can be expected to change over its life cycle. One would expect that the firm's strategy would also be expected to change over time [Lilien and Rangaswamy, 1998]. As shown in the following figure, a curved line represents the relationship between time and sales can be drawn and divided into stages. In the following figure sales begin slowly and then increase at an increasing rate at some point the sales may level off or decline. After which replacement sales of the product may again start to increase the rate of sales at an increasing rate as in line A or lightly increase as in line B or decrease as in line C [Harrell and Taylor, 1981]

Figure 4: Project Life Cycle Curve

Using the four distinct stages, the firm can be expected to develop strategies appropriate for each stage. The cycle starts at market launch and with minimum adoption of the new product by the market. It then moves to the second stage where sales start to increase at an increasing rate, the third stage is characterized by a stable level of adoption while the final segment shows a declining rate.

Several factors influence the length and form of the life cycle, for example, changing needs and wants, changes in technology, and the rate of its adoption in the market [Lilien

and Rangaswamy, 1998]. In addition, innovation, market concentration, competitive structure, economic cycles, supply constraints, and replacement sales also have an effect [Chamberlin, 1965; Cooper, 1993].

Product life cycles are closely related to the diffusion and adoption of innovations. It can be considered as the supply view of the Adoption of Innovations life cycle [Wind, 1982].

In the first stage initial sales are low, few customers are knowledgeable about the new product or service. Marketing tends to focus on stimulating awareness, interest, trial and purchase. In the introductory stage only a few innovators will purchase. As recognition and acceptance grows early adopters provide the initial purchases for the growth stage. Competitors appear to drive the price down and actually have the beneficial effect of increasing the information flow to the market. The early majority form the bulk of the growth stage. As the number of new customers decreases so does the rate of growth. In maturity sales are derived from the late majority and laggards and replacements of earlier purchases.

Four Life Cycle Stages

The following section will summarize each stage in terms of several key points [Onkvisit and Shaw, 1989].

Introduction Stage

The introduction stage, sometimes called the “Pioneering” stage begins with the launch of a new product that satisfies either a new or existing need. Generally, such a product does not begin with direct competition. It may begin with sales to one type of market such as industrial markets followed by sales to consumer markets. Such a product typically has flaws and requires continued improvements, with services in great demand to overcome product shortcomings.

Lower production runs lead to high costs. Interestingly it has been suggested that the production process follows a similar life cycle to the product [Onkvisit and Shaw, 1989]. Marketing costs might be high due to the education of the buying public required and the lower sales volume.

One interesting management implication suggested is that introduction of the product during a recession can greatly diminish its chance for success [Onkvisit and Shaw, 1989].

Growth Stage

The growth stage marks the point of the product’s acceptance by the market. This stage can be divided into two parts [Onkvisit and Shaw, 1989]. The first part has increasing

sales at an increasing rate and the second characterized by increasing sales at a decreasing rate. For example, the 1983 sales of VCRs in the United States doubled over the 1982 sales showing sales at an increasing rate, however, the 1987 sales were a 2% growth over the 1986 sales. This could be due to the fact that 2/3 of US families had a VCR by that time.

During this stage, increased sales result in more specialized production equipment and thus economies of scale are realized. As mass production, mass distribution and mass marketing are realized they enable lower costs and increased profit. However, competitors enter and keep the profit margin from its growth potential. These newcomers continue to bring new modifications to the product and process technologies, typically resulting in product lines. This necessitates larger inventories to hold the new product line. As new capabilities in production and product occur, segmentation of the market is now more possible. Ultimately brand loyalty and brand marketing tend to be stronger and weaker firms start to disappear from the market. During this stage the product is less susceptible to poor economic conditions.

Maturation Stage

During the Maturation or “Saturation” stage the sales volume levels-off as the mass market reaches its desired adoption level for the product [Onkvisit and Shaw, 1989]. Economic conditions once again play a factor in determining the sales of the product as the market is starting to look at replacement units rather than original purchases. Brand loyalty and a small number of competitors leads to a more predictable sales level. By this

time competitors are entrenched by a number of entry barriers: large sales volumes, brand loyalty, established distribution network, and a full product offering to segmented target markets. The inventory and service systems become costly and complex.

Decline Stage

During this decline stage or product “Obsolescence” stage economic conditions play a strong role in influencing the product as customers are starting to move to a new product offering. The firms remaining in this product category begin to experience rising product costs as the need to support older technology with fewer customers grows. On the other hand marketing costs tend to fall since the market is well versed in the product [Onkvisit and Shaw, 1989].

Profit margins can be attractive as competitors drop out, the product line shrinks, and service charges rise.

Support for the Product Life Cycle Concepts

Generally it has been argued that there are two causes for change in the product through its life cycle, instability of supply and demand [Onkvisit and Shaw, 1989]. In general there are two contributing factors to these instabilities: the diffusion of innovations theory and the theory of monopolistic competition [Chamberlin, 1965]. The innovation theory focuses on the sales of products and services during the life cycle. The theory of monopolistic competition basically states that, in general, there are many firms selling similar products that are almost substitutes of each other. If market entry is relatively

easy new competitors enter and attract customers. Thus current firms tend to focus on product differentiation including both actual product differences and psychological ones. The complete theory focuses on the variation in the number of firms and their behaviour during the product life cycle.

Criticism for the Product Life Cycle

Some authors have criticized the product life cycle concept. For example, they have pointed out that some products never go through the life cycle [Onkvisit and Shaw, 1989]. In addition, One set of authors asserts that the concept doesn't seem to hold for products at the brand or even category levels [Dhalla and Yuspeh, 1976].

Management Implications

This section focuses on management implications suggested by the product life cycle, in particular, marketing implications.

Introduction Strategies

The general recommendation in the introduction stage is to provide only one or a few product models [Onkvisit and Shaw, 1989]. Since the idea is to pursue the whole market and not begin segmentation. As well, to educate the customer with the product concept and not confuse the issue with variations of the product. This generally suggests a limited distribution network focusing on an outlet where a greater interaction between

customers and sales/technical staff is possible. Due to the limited competition the sales staff focus on selling the concept rather than counteracting competitive products. The key focus of the company's marketing is to become the industry standard for the product class. It is generally recommended that a higher price is warranted in order to focus profits on obtaining economies of scale, etc.

Growth Strategies

In this stage segmentation is recommended to gain a lead on the competitors [Onkvisit and Shaw, 1989]. The product line is expanded in the effort to expand market share and maintain profits. Price reductions can be justified as less product modifications are necessary, economies of scale are obtained and sales volumes gained. Selective promotion strategies tend to be developed for each segment.

Maturation Strategies

Intense competition begins to reduce the field of competitors of those without a complete product line. Competitive advantages can be obtained with a highly trained distribution network. Price should not be the focus of competition but the firm should focus on differentiating attributes of the product.

Decline Strategies

It is suggested that product lines should be reduced to the most profitable and advertising selectively focused on the most profitable segments. Price has to be balanced between

the increasing costs of a lower rate of production and the cost necessary to keep a market that is declining.

The following table contains the characteristics of each stage of the product life cycle for product, place, promotion and price [Wind, 1982]:

Table 1: Product Life Cycle: Marketing Mix

[Wind, 1982]

Characteristics	Introduction (pioneering)	Growth (acceptance)	Maturation (saturation)	Decline (obsolescence)
Product	Shallow product line	Segmentation and modifications.	Highly Segmented	Shallow product line
Place (distribution)	Exclusive	Selective	Intensive	Selective
Promotion	Primary demand. Informative about existence, advantages and use.	Selective demand, Merits as opposed to competing products.	Selective demand. Product differentiation.	Primary demand

Price	Highest	Declining	Stable	Declining then stable and probably increasing later
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The Product Life Cycle

The Product Life Cycle theory can be regarded as a dependent variable which marketing departments can influence rather than an independent variable to which companies should adapt their marketing programs [Harrell and Taylor, 1981].

While various scholars disagree on the correctness of the concept or its ability to drive management implications, perhaps the marketing mix and the product life cycle have enough of a relation to suggest management implications [Onkvisit and Shaw, 1989].

Adoption of Innovations Life Cycle

The Adoption of Innovations Life Cycle Theory (Sometimes referred to as the Adoption of Technology Life Cycle) can be used to understand the technology's position in the market.

The introduction of something new in the market as *perceived by the customer* is an innovation [Rogers, 1983]. The manufacturer or supplier may or may not perceive the

technology as new. It's the customer's perception that is crucial since this perception will determine their buying behaviour. For example, a facsimile machine is no longer an innovation in much of the world, but in some parts it might be. As an innovation, potential customers might be concerned about its value to their organization or even of its soundness as a reliable machine.

Diffusion

One of the first steps of introducing a new product to a target market is to create widespread awareness of the new product in the target market [Scheuling, 1989]. This communication task is one aspect of diffusion. *Diffusion* is the process by which an innovation is communicated through certain media over time among the members of a social system [Rogers, 1995]. The process of diffusion describes the way information related to the new product is spread to and throughout the target market. In part, it represents the communications flow concerning an innovation that leads from the producer to the buyer and buyer to buyer and perhaps buyer to producer.

The Adoption Process

Typically this process takes place between people in a recognized sphere or group of people with common interests. The adoption process is the decision making process that an individual progresses through from the initial stage of hearing about an innovation to the actual adoption of the product.

The adoption of innovation process is the adoption over time of new products and services by adopting units within social systems in a given culture as stimulated by marketing activities [Rogers, 1983]. This is sometimes referred to as the diffusion of innovations.

Finding the Innovation's Position on the Adoption of Technology Life Cycle Curve

Everett Rogers popularized the idea that the adoption of innovations follows a life cycle of adoption or sales in the market based on earlier work done with farmers [Rogers, 1962, Bohlen and Beal, 1955]. The Rate of Adoption of a particular product vs. time curve is typically presented by Rogers as a curve similar to a bell shape [Rogers, 1983]:

Figure 5: The Rate of Adoption Over Time

The curve is divided into five stages. Each of the stages has a segment of the target market with distinctive characteristics [Moore, 1995; Rogers, 1995].

The following chart provides the indicators to determine the segment of the adoption life cycle curve a given product might currently reside in.

Table 2: Segments of the Adoption of Innovations Life Cycle

[Moore, 1995; Rogers, 1995].

Segment	Indicator	Characteristics of Target Market
Innovators	This category of people tend to be those that enjoy technology for its own sake. They tend to be the R&D people or the “techies” in an organization. They tend to purchase new technology-based products based on the intriguing nature of the innovation’s possible benefits.	<ul style="list-style-type: none"> - Users have a high level of technical knowledge. - A high degree of uncertainty exists concerning the product. - The user may not be part of operational units of an organization.

		<ul style="list-style-type: none"> - Innovators typically collect information, ideas and new concepts.
Early Adopters	Tend to be those people interested in the breakthrough potential of an innovation. They tend to want to change the nature of the business environment to their advantage.	<ul style="list-style-type: none"> - Such people could be opinion leaders. - Typically need detailed examples on solution possibilities for new technology.
Early Majority	Tend to be more interested in the incremental operational effectiveness the innovation brings.	<ul style="list-style-type: none"> - Users may have long corporate purchase cycles.
Late Majority	Tend to only be interested when the innovation is now well tested and only adopt that which is necessary to remain competitive.	<ul style="list-style-type: none"> - The technology's uncertainty is largely removed. - The support infrastructure is in place. - Users are under pressure from various sources to adopt.
Laggards	They tend to resist innovations and will	<ul style="list-style-type: none"> - Users may be isolated

	only purchase when there is no other option.	from sources of new ideas. - Users typically have limited resources. - Users might have a lengthy decision process.
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Typically, 2.5 % of the market are Innovators, 13.5% are early Adopters, 34% Early Majority, 34% Late Majority and 16% Laggards [Rogers, 1995].

The adoption life cycle curve can also be described as the percentage of the market that has adopted the innovation or technology vs. time as seen below [Rogers, 1995]:

Figure 6: Percentage of Adoption vs. Time

Attributes of Innovations

According to Rogers there are five attributes of innovations [Rogers, 1962]:

- 1) **Relative advantage** – is the degree to which the innovation is perceived as being better than the current approach. This advantage is generally an economic advantage either by doing something better than before or doing something that could not be done before. This advantage has to be something of value to the firm or the ultimate consumer. This value can be realized through the innovation's contribution to the adopter's profitability, through the innovation's cost savings in time and effort, as well as, the immediacy of the return on investment (ROI) e.g. how fast it takes to realize ROI. This return on investment can come from a variety of sources including the producer of the innovation or the adopter's organization. For example, the producer of the innovation can provide a direct reward to the individual adopter or the organization. The return on investment can be financial as in the case of an increase in profitability; it can be non-financial such as an increase in morale. It can also be negative such as a "punishment" for not adopting the innovation such as loss of market share.

Relative advantage has to take into account the cost of switching from the current methods to the new method including any infrastructure costs necessary to support the new innovation [Gatignon and Robertson, 1985]. The greater the relative advantage the greater the likelihood it will be adopted.

- 2) **Compatibility** – The degree to which the innovation is perceived to be consistent with existing values, past experiences and needs. In some cases the adopters may not be aware of the need for an innovation until they can clearly understand the consequences of a new idea. Obviously the more compatible with the existing infrastructure or approaches the more likely it will be adopted.
- 3) **Complexity** - The degree to which the innovation is perceived as being relatively difficult to understand and use. Obviously the more complex the innovation the less likely it will be adopted.
- 4) **Trialability** – The degree the innovation can be experimented with on a limited basis. If the innovation can be tried without making a purchase or having a negative effect on the organization such as an unacceptable cost or damage to corporate/individual reputation, it is more likely to be adopted. The impact of the trialability is also influenced by the stage of adoption. For example, an innovator tends to take longer to complete an adoption process due to the

higher learning curve, while a laggard has lots of examples to learn from and might complete their adoption process faster.

- 5) **Observability** – The degree to which the results of the innovation are visible to others. For example, an innovation could be an idea or concept and thus it is less easy to observe the innovation's effects. An innovation that is easily demonstrated and has an easily seen positive effect on the organization is more likely to be adopted.

Innovations could be placed along a continuum that can be divided into innovation types [Bower and Christensen, 1995]. At one end of the continuum, a continuous innovation is least likely to disrupt existing consumption patterns, for example, a variation in a food product. A discontinuous innovation develops new consumption patterns, for example, the impact of personal computers on the industrial work force [Bower and Christensen, 1995].

Critical Mass in Adoption

Certain technologies require a critical mass of adoption in order to realize optimal benefits, for example, in order for the telephone to be useful, desired destinations must also have a telephone. This creates an interdependence between members of the target market [Rogers, 1995], which means that the decision to adopt is dependent on whether others in the target market are adopting, have adopted or chosen not to adopt, similar to

network effects discussed earlier [Ryans et. al., 2000]. However, the adoption rate, once critical mass is reached, tends to be faster since each non-adopter comes under increasing pressure to become part of the system as seen below [Rogers, 1995].

In the following figure, the technology with the critical mass requirement is being adopted at a lower rate until the critical mass is reached and then is adopted at a faster rate than the normal/typical rate [Rogers, 1995].

As an illustrative example consider that the facsimile machine technology was originally invented in 1843 by Alexander Bain who called it a "recording telegraph" [Rogers, 1995]. It was over 100 years later that RCA made the first product called a "telecopier". In 1965, the product sold for \$8,000. It was not until the 1980s that it gained widespread use due in part to telephone infrastructure advances that provided the necessary low cost infrastructure along with technological advances such that a critical mass of users appeared and the technology quickly spread.

Figure 7: Critical Mass Adoption Rate

Choosing the Life Cycles for the Thesis

Three life cycles were presented in the preceding sections: product, technology and adoption of innovations. For the purpose of this thesis a life cycle theory or theories needs to be chosen that will assist in anticipating future possibilities in the market and the technology.

Following the lead from Moore and Rogers, this thesis uses the Adoption of Innovations (Technology) Life Cycle Theory to represent technology-based products in the market [Moore, 1995; Rogers, 1983] and the Technology Life Cycle Theory to represent the technology [Foster, 1986; Popper and Buskirk, 1992; Shanklin and Ryans, 1984].

Technology is represented in the market in the form of a product. A technology could be manifested in one or more products. As such, the product life cycle was not chosen for the purpose of this thesis because it represents only one manifestation of a product and thus doesn't capture all the technology's possibilities [Popper and Buskirk, 1992].

Strategy and Tactics

This section provides an overview of strategies and tactics that frameworks or models would be expected to provide for executives in technology based companies. This section also contains example strategies from well known technology-based companies.

Utilizing an appropriate theory might provide an understanding of a technology's position in its life cycle or the market such that suggested actions or inactions can be derived. These actions or inactions can be divided into strategies and tactics.

In the military, a strategy is defined as the *science and art of employing a nation's armed strength to accomplish the goals of the nation's leaders*. Tactics are *the operational art and science of deploying the armed forces against the enemy* [Andrews, 1971].

A tactic usually has more detail concerning the actual implementation of an approach or plan or concept. In addition tactics usually cover a shorter time frame than a strategy would. In other words, a strategy is a plan or method for achieving an end while tactics are the art or skill of using available means to reach an end [Rogers, 1995]. Tactics can be considered as more reactive while strategy is more pro-active. Corporations must consider both tactics and strategy in order to survive and succeed in their market.

Tactics are responsive to changes in the marketplace and pressures of other environmental forces. The strategy is concerned with the long term development of the corporation and its products [Andrews, 1971].

From Mission Statement to Tactics

Most firms have a corporate mission perhaps implicitly or explicitly stated. This is a statement of the firm's scope of activities [Lilien and Rangaswamy, 1998], for example, to provide automated office systems to a global client base. This mission statement should be translatable into directly measurable objectives to make that mission statement operational. These objectives typically cover all aspects of the organization, for example, objectives for sales growth applicable to marketing or production costs for manufacturing.

Given the objectives for every aspect of the organization, the corporation can then detail the actions it intends to undertake to produce a sustainable competitive advantage. In other words, the corporation's strategy is the link between market opportunities, the corporate mission statements and its resources [Scheuling, 1989].

In general, a winning strategy could involve performing different activities from or performing similar activities in different ways than rivals [Porter, 1996]. The choice of a strategy implies the corporation has also chosen what not to do. A company hopes to establish a difference it can maintain.

In the corporate environment [Rogers, 1995]:

A strategy is the creation of a defensible competitive advantage

*Tactics are defined as the detailed description of each activity
necessary to achieve the strategy.*

Corporation tactics, for example, could detail what features the corporation's product should have or what are the brand identities or what are the distribution entities to utilized?

As well, corporate tactics could include answers to such issues as what is [Wind and Robertson, 1983; Scheuling, 1989]:

- The product's price;
- The advertising budget;
- The advertising frequency;
- The segmentation of the market and positioning of the product;
- The necessary services and their implementation approach to complement the product; and,
- Choice of channels of distribution.

Why do we Need Strategy?

A criticism of the “strategy and tactics” approach is that it involves planning, and planning ahead in the technology field is difficult [Andrews, 1971]. The criticism is that accuracy in forecasting with point estimates is difficult if not impossible and long-range plans can not be trusted with any confidence, particularly so in the technology field with its rapid pace of innovation and changes.

The uncertainty involved in the technology-based products field may make it more difficult to set reasonable goals, know what market data to collect and how to account for unexpected effects [Rogers, 1995]. The corporate strategy for a technology company must have the flexibility to deal with unanticipated opportunities and the commitment to allocate resources to achieve objectives.

For example, a process to collect information on competitive actions and analyze the data would provide the possibility for managers in technology-based product firms to modify their strategies over time as appropriate, and, continuously match the environmental realities to their tactics.

It is equally important when devising a firm’s strategy that coordination between various organizational units be attempted [Wind and Robertson, 1983] such that strategies and tactics complement each other. This is sometimes referred to as a fit between tactics and strategy. A strategy involves a whole system of tactics, not a collection of parts.

When a strategy has been developed, the necessary tactics to implement it must also be devised [Porter, 1996]. A winning strategy will be less effective unless a winning set of tactics is also implemented. It usually follows that such tactics are related and interconnected. One measure of potential success of the strategy and tactical plan(s) is the connection between the tactics and strategy. For example, a strategic statement envisioning a highly customized product offering could be less effective without an appropriate inventory system. An advertising campaign for a new complex system could be less effective if the salesforce is not properly trained in the system's capabilities.

Communication of The Strategy and Tactics

The corporation should express a consistent and persistent concept of its focus so as to communicate its purpose to all stakeholders. A successful strategies/tactics set must achieve coordination between the corporate units. If the strategies/tactics set is not well understood or articulated, the likelihood of the "team" achieving an optimal result is less [Lehmann and Winer, 1998].

For example, the R&D strategy would outline the resources it intends to commit and the level of technology to achieve, and, the focus of its efforts. Or it might detail its desire to maintain the leading edge status for its technical products or be a stimulating place of work for its employees [Andrews, 1971].

Example Strategies of Technology-based Product Companies

The following examples illustrate strategies utilized by technology-based product or service companies that experienced rapid growth in the market.

Netscape's Strategy

Formed in 1994 as Mosaic Communications Corporation, and within 4 years transformed into a half a billion dollar company called Netscape Communications Corporation, it was the fastest growing software company of all time [Yoffie and Cusumano, 1999]. After becoming Netscape it generated \$80M in sales in one year and in just over 3 years reached annual sales of \$500M. Their vision was based on the power of the internet and its resulting need for a universal interface that was computer operating system independent and able to work on technologies such as kiosks and cell phones [Yoffie and Cusumano, 1999].

In 1995, Netscape focused on the consumer market and the potential of internet-based commerce. In 1996 Netscape targeted the intranets and corporate networks based on internet protocols. By 1997 Netscape held 80% of the market for web servers within corporations, and were looking to extend Netscape's range [Yoffie and Cusumano, 1999]. This came with a focus on extranets. Extranets consist of intranets that were connected to suppliers or other partners giving selected access between corporations [Yoffie and Cusumano, 1999], for example, Chrysler's Supply Partner Network connected 12,000

business partners. By 1998, the browser was expanded to become a portal and relabeled the Netcenter. The portal contains a wide range of services and content.

Netscape focuses on producing a small range of quality products. By 1997 Netscape's investment was in products covering the internet, extranet and intranet [Yoffie and Cusumano, 1999].

Netscape's strategy can be summarized with this quote from Marc Andreessen, cofounder of Netscape:

"...market share equals revenue later and if you do not have market share now you are not going to have revenue later. Another fundamental lesson is that whoever gets the volume does win in the end. Just plain wins." [Yoffie and Cusumano, 1999].

Cisco's Strategy

Cisco's strategy is to continually focus on [Bunnell and Brate, 2000]:

- 1) Emerging markets.
- 2) Providing a complete network solution to the customers.
- 3) Defining the industry wide networking software protocols.

- 4) Forming strategic alliances or making acquisitions to manage competitors and get access to new technology and markets.

Cisco believes that the time window of opportunity for emerging markets is small and therefore uses a first-to-market approach. Cisco's strategy is implemented by ensuring communication from the customer to the company is top priority, hiring technical sales people and using the internet to allow customers to help themselves and communicate to the company [Bunnell and Brate, 2000].

Cisco's internet web site for customers started in 1993 with the capability to review a bug-report data base, post problems, comment on postings, and email alerts to those interested in a posting. The online order center includes parts, price lists and online configuration tools to ensure that a customer's order is feasible before it is accepted [Bunnell and Brate, 2000]. In part, Cisco's previous success came from sticking to core values while switching tactics, products and people as necessary [Bunnell and Brate, 2000].

Amazon.com's Strategy

Amazon.com has a simple strategy of creating a community of users in which their experience with their product and the company is positive and induces customer loyalty [Spector, 2000]. This requires commitment to service and creating a positive customer experience. The internet plays a significant role in creating the context for the purchase

decision emphasizing selection, convenience and price. Amazon's strategy was similar to Netscape's and summarized as "get big fast" and later expressed during 1999-2000 as "get bigger faster" [Spector, 2000].

Summary of Example Strategies:

It appears that Cisco, Netscape and Amazon.com focused on achieving the largest market share possible as quickly as possible. In addition, each attempted to provide the complete product/service offering.

Literature Review Conclusions

This section outlines some of the gaps and weakness in the literature. The literature on the three life cycle curves and strategies and tactics left the following unanswered issues:

- How do external factors, such as alliances, shape and affect the length of the individual life cycle curves.
- How is the length of each life cycle curve affected by the technology and/or product type. For example, will the length and shape be different for salted peanuts vs. technology-based products.
- What are the indicators of the inflection points on each life cycle curve.
- For the technology life cycle curve, Foster does not specifically suggest strategies for each segment of the curve.

- Foster does not provide an indication of how many of his suggested heuristics must be present in order to clearly state that a technology is in the mature stage or if any of the heuristics are more significant than others [Foster, 1986]. As well, Foster does not indicate heuristics for other stages of the life cycle or if these aforementioned heuristics could be inverted or modified in some way to indicate other stages in the life cycle.
- There is no mention of how the strategies suggested by the product life cycle could be adapted to company specifics given financial and other limitations.
- In the strategy and tactics literature there needs to be a clear methodology for deriving, choosing and adapting strategies and tactics to the company specifics.
- In the strategies and tactics there is no clear method to measure the potential success of chosen strategies or how complete the chosen strategy and tactics approach are.
- In the practitioner literature the strategies and tactics chosen by a technology-based firm are given but there is no indication of how they were derived or whether they were evolutionary in nature. And if evolutionary what were the evolutionary factors of change.
- Another issue is whether the technology life cycle and the adoption of technology life cycle can be merged to provide a perspective of the technologies evolution and its potential market success.

In general while the literature suggests concepts, such as the life cycles, what is missing is an overall model that combines them. This combined model may be evolutionary in

nature and it may utilize management expertise to cover the gaps in concepts suggested in the literature. Research can focus on developing a model that describes the actual approach utilized by practitioners.

CHAPTER 3: RESEARCH QUESTIONS AND HYPOTHESIS

This chapter presents a brief discussion on theories and then the research hypothesis that was developed based on the literature review.

It has been suggested by Hartman (1998) that current management literature is, to some degree, deficient in adhering to the approach of theory, correspondence rules and observation. This has lead to research that is either empirical but atheoretical or theoretical in nature "with no discernible relation to reality" [Hartman et. al., 1998]. This approach has resulted in some literature that has a lack of linkage between management practice and theory, resulting in "a failure to weld the theoretical domain with the empirical" [Hartman et. al., 1998].

To be more meaningful it is suggested that theories should have a stronger linkage to observables. This is not always easily accomplished. For example, if the decision behaviour of actual managers deviates from a theory it may not be possible to prove whether the theory or the manager's approach is correct [Hartman et. al., 1998]. In some cases this is compounded with the empirical observation problem in finding a validated measurement of what is desired.

The research in this dissertation can essentially be divided into two stages: to develop a model based on and expanded from the literature, and to fine-tune or modify it based on empirical observations.

In the literature there does not appear to be any attempt to utilize both the Technology Life Cycle and the Adoption of Technology curves to produce an approach to facilitate decision-making for senior executives in technology-based firms. Perhaps there has been no attempt to utilize both curves because the lifecycles focus on different areas: One on marketing and the other on technology and researchers perhaps focus on either marketing or technology development and not both.

The research starts with the construction of a model focused on facilitating the growth of technology-based product firms that utilizes their product's position in the technology and adoption of innovation life cycles in order to derive a model-based positioning of the product. Utilizing the theories should lead to an anticipation capability that can be used to recommend appropriate strategies and tactics.

The hypotheses in the research are:

Question 1: One can reasonably assume that senior executives in technology based firms do not read all the recent literature in the academic and practitioner publications that would be relevant to them.

Do the interviewed senior executives use a procedure that includes the components of the proposed model?

Hypothesis 1: Interviewed senior executives will employ a strategic decision approach that includes components of the proposed model.

Question 2: Given that the model will reflect both the practitioner and academic literature it would seem reasonable that the model may not be in the logical order that senior executives in technology-based firms would agree with.

Do the senior executives that are interviewed, use the components in the proposed order?

Hypothesis 2: Interviewed senior executives do not use the components in the proposed order.

Question 3: Based on the volume of both the practitioner and academic literature it seems reasonable to suggest that executives are not aware of all such knowledge and conversely the literature does not contain all of the heuristics and approaches that senior executives utilize. Thus it seems reasonable to suggest that the model developed prior to interviews will not completely represent all of the approach utilized by senior executives.

Do the senior executives that are interviewed, use additional considerations beyond the ones currently being proposed in the model developed prior to the interviews?

Hypothesis 3: Interviewed senior executive will utilize additional considerations beyond the ones currently being proposed in the model developed prior to the interviews.

Hypothesis Summary

Beyond these hypotheses, the central goal of this research is to present an initial model, collect empirical data about the relevance of the model and use the resulting initial model-data combination to produce a revised model. The goal is to have a practical model as a result. But the measuring of whether this goal is achieved is essentially subjective.

CHAPTER 4: RESEARCH MODEL

This section presents the research model proposed for facilitating the growth of technology-based product firms. The research model is defined as the model developed based on the literature and developed prior to conducting interviews with executives in technology-base product companies. The section begins with a description of transitions and then continues with a description of the model's concepts.

Innovation is a force for disequilibrium or discontinuity in the market and the cause for revolutionary restructuring of the markets [Goodman and Lawless, 1994, Schumpeter, 1962]. If the market moves to the new and different state and the return to the preexisting marketing conditions is essentially impossible that is defined as a discontinuity in the market's operation [Goodman and Lawless, 1994]. Discontinuity is a major force behind many economic changes [Goodman and Lawless, 1994].

New technology can create whole new markets, it can affect the demand for products, the cost and price structure and barriers to entry. The strategic implications of the discontinuities brought by new technology products are different than predicting a shifting of market share [Goodman and Lawless, 1994].

This discontinuity represents a "transition" between one technology or set of market conditions which, if successfully anticipated, can be a significant opportunity [Goodman and Lawless, 1994].

Transitions

In this section, an understanding of and an appreciation for technology transitions is presented.

In the market there is typically a technology set that comprises the infrastructure or operating tools of the business or consumer environment. For example, Video Camera Recorders (VCRs) using videotapes or Personal Computers (PCs) using Windows 2000 or the 286 Computer Processing Unit (CPU). The introduction of new technology products might change the infrastructure of the environment by providing new functionality, requiring new user behaviours or allowing new possibilities. This replacement of a technology with another could create a discontinuity and could result in a dramatic change in the market place. An example was of this phenomenon when solid state electronics replaced vacuum tubes [Foster, 1986].

Merriam-Webster's Online Dictionary defines a transition as: A passage from one state, stage, subject, or place to another, and, a movement, development, or evolution from one form, stage, or style to another [Merriam-Webster, 2000]. A transition occurs when a new technology eclipses the old, and therefore creates a new ground in which to compete [Yoffie and Cusumano, 1999].

In the technology based product industry, a number of transitions have occurred over the last 20 years resulting in new product categories and companies that were unheard of before a given transition. For example, the network router and hub market were, to a

large extent, unknown by the general population in the 1970s and 1980s. These markets were dominated by relatively new companies such as Cisco systems and Bay Networks [Bunnell and Brate, 2000]. Bay Networks has since been acquired by another company. The relatively new market of the PC printer is dominated by the established Hewlett Packard (HP) company while the computer operating system market is dominated by the relatively new Microsoft company and its Windows operating system [Moore, 1995].

In the communications market over the last few decades several transitions have occurred: the market structure has changed to accommodate touch-tone phones, answering machines, fax machines, voice mail and email [Moore, 1995].

The Microprocessor Transitions

A transistor is a device that acts as an electrical switch and can be turned off and on, this on/off capability can then be used to store information in a binary format [Jorgenson, 2001]. The first transistor was made at the Bell Laboratory in 1947 from the semiconductor material Germanium [Jorgenson, 2001]. An integrated circuit consists of many transistors and is also known as a memory chip. A memory chip that is programmable by software became known as a logic chip or microprocessor. Over the last few decades the microprocessor has migrated through several generations of technology:

The first microprocessor (Intel 4004) was generally used in calculator applications and was incapable of computer-type functionality [Bayus, 1998]. The first generation of personal computers (PCs) utilized a variety of second generation microprocessors. These microprocessors were Intel's 8080 introduced in 1974 and 8085 in 1975, Zilog's Z80 in 1975, and Mostek's 6502 in 1975, all of which utilized an 8 bit processor [Bayus, 1998].

The second generation PC's utilized the third generation 16 bit microprocessor. CPUs utilizing this technology were introduced by Intel (8086 in 1978, 8088 in 1979 and 80286 in 1982), and, Motorola (6800 in 1978 and 68010 in 1979). Zilog and Mostek did not provide a third generation product line.

The third generation of computers used the fourth generation 32 bit microprocessor. CPU's using the 32 bit architecture came from Intel with its 80836DX in 1985, Intel's 80386SX in 1988, 80846DX in 1989 and 80486SX in 1991, along with Motorola's 68020 in 1986 and 68030 in 1989. As each generation of technology was introduced there was a transition period in which the new technology overtook the old.

This is illustrated in the following figures, that display an approximation of the sales curves of computers by microprocessor and CPU as can be seen there were several transition periods [Bayus, 1998]:

Figure 8: Transitions in the Microprocessor and CPU Technologies

Transition examples are numerous in the technology-based product industry. Some transitions take time before the effect is diffused through the market and some diffuse quickly. For example:

- In the 1990's the per megabyte cost of hard disk drives (HDD) magnetic storage halved approximately every 17 months [Curry and Kenney, 1999].
- From 1985 to 1996 the average annual rate of decline in the price of microprocessors per transistor was 35%, for memory chips the rate of decline was 20% [Curry and Kenney, 1999].
- In the PC market from 1980 to 1989, HDD realized an annual average price decline per megabyte of storage of 30%.

- When IBM introduced the system 360 in the 1960's the transition from the older IBM mainframe computers to the system 360 took more than 2 decades to complete [Yoffie and Cusumano, 1999].
- The Apple computer introduced in 1977 took a decade and a half to fundamentally change user behaviour, and the internet is probably 5-10 years before its impact completely diffuses to the mass market [Yoffie and Cusumano, 1999].
- At the end of 1996, Packard Bell and Compaq introduced the sub-\$1,000.00 PC. Within three years (by 1999) the sub-\$1,000.00 PC accounted for 68% of retail purchases [Curry and Kenney, 1999].
- In Europe, it took six years to achieve 72 million PC-based web users, current estimates predict achieving the same number of users for wireless device-based web users in 3 years [Keating, 2001].
- Dense Wavelength Division Multiplexing (DWDM) provides the capability to send multiple signals through optical fiber simultaneously. Installation of DWDM technology has doubled the transmission capability of fiber optic cables every 6-12 months [Jorgenson, 2001].

Such high rates of change indicate transitions have occurred between older and new technology. When Cisco Systems entered the market in 1986, organizations were in need of a method to connect disparate computer networks to communicate via a router. A router transmits and translates data to and from disparate computers. This technology quickly diffused into the market allowing Cisco to ride a transition and realize a market

capitalization of billions of dollars one year after it started [Bunnell and Brate, 2000]. Cisco became the fastest growing company ever by reaching a capitalization amount of \$200 billion US in 15 years.

Four Types of Transitions:

Based on the literature, there are four assumed transition types [Foster, 1986; Moore, 1995; Rogers, 1995]:

1) Along the Technology Life Cycle Curve and the Adoption of Technology curve

These two curves form a basis for establishing the technology's position in the technology life cycle and the market. Each of the curves has an initial inflection point at which the technology's capability or the products' market sales, as applicable, begins a sharp increase.

2) Crossing of Curves

In this situation two or more technologies are competing to provide the same functionality. While one may start out inferior to the other if it eclipses the other, a transition could occur. For example, IBM's mainframe computers created a demand within companies for more and more reports than could be generated by a company's Management Information System (MIS)

department. Along came the distributed computing approach of Digital Equipment Corporation's (DEC) VAX and computing could be done outside the traditional MIS department allowing company managers to generate their required reports by personnel within their department and therefore shifting the market to distributed computing [Moore, 1995].

3) Convergence

Convergence is when one or more technologies combine into one product offering. For example, telecommunications technologies converging with computers.

John Chambers, CEO of Cisco, foresaw that the convergence of the internet and long distance phone services will occur and create a market in which long distance calls being placed over the internet free-of-charge [Bunnell and Brate, 2000].

4) Infrastructure

In some cases, the technology-based product itself relies on other technologies in order for it to operate. A change in one of the support technologies can affect the available functionality of other technologies and spark a transition for a related technology. For example, email relies on the network and mail

server technology, a change in network technology could allow additional features to be incorporated into an email product. Microsoft's office suite relies on an operating system which relies on PCs which rely on CPU technology. As shown below, Microsoft's Office Suite relies on a number of underlying technologies:

Application: Microsoft Office.

Operating Systems: Microsoft Windows, MAC, and Unix.

PCs: Compaq, IBM, Packard Bell, Dell, NEC, and MAC.

CPUs: Intel, Motorola, and RISC.

A Technology-based Product Company can be Proactive and/or Reactive to Transitions

There are many methods for a technology-based product corporation to derive a strategic approach for transitions. One method is to be synchronized with the events of the market. A strategy tuned to events is basically one of reaction [Eisenhardt and Brown, 1998]. In this approach, companies respond to the events generated by competitors, changes in technology or new customer demands. For example, new products are generated when the R&D laboratory produces something deemed worthwhile or entry into new markets is done when demand is sufficient to justify it. [Eisenhardt and Brown, 1998]. This approach has the flaw that it could involve reacting after the competition has initiated a change in the market, a change that could take some time to effectively react to thus potentially losing market share.

Another approach is for a corporation to effectively lead the market with its own schedule of predetermined events.

Gordon Moore in 1965 made the observation while plotting data on memory chips that each new chip contained approximately twice as many transistors as the previous memory chip [Moore, 1965]. In addition, he noticed that each chip was being released approximately 18-24 months after the last, this computes to a growth rate of 34-45% per year [Jorgenson, 2001]. The first chip released by Intel in 1971 had 2,300 transistors and the Pentium 4 released November 2000 had 42 million transistors. Yet prices of the chip have decreased by 41% per year between 1974 and 1996 [Jorgenson, 2001].

Gordon Moore, cofounder of Intel Corporation, introduced the concept of "Moore's Law" which states that the capacity of the microprocessor computer would double every 18 months [Eisenhardt and Brown, 1998]. This means that not only is the computer infrastructure in the market continuously increasing in its capability but that the demand for increased capability or lower operating costs by customers is also increasing.

But this doubling in capability does not occur in a random manner. In order to make this prediction a reality, Intel's strategy is to lead the market according to their schedule [Eisenhardt and Brown, 1998]. Intel has built their strategy and processes around making their prediction a reality in which approximately every eighteen months a new generation

of chip technology is introduced. For example Intel builds silicon chip manufacturing factories two years in advance of demand. Intel's strategy is to have their competition follow Intel's lead, and, make customer demand and technology changes in the industry occur according to Intel's lead.

Cisco Systems, Emerson Electric, Gillette, Netscape, SAP, Sony, Starbucks and 3M utilize a similar strategy. For example, 30% of revenues from 3M come from new products every year and Netscape introduces a new product every six months [Eisenhardt and Brown, 1998]. Again this implies the capability to organize the corporation such as the release of these products is feasible given the imposed schedule.

Attempting to lead the market, implies a capability to anticipate the trends in the technology and market, and, that the corporation is prepared to manage and induce a transition. It also implies that there is a long term vision, e.g. to dominate the chip market. It is accomplished as an iterative process since transitions are repeatedly induced [Garvin, 1995]. The phases of a process to implement such an approach are also overlapping [Eisenhardt and Brown, 1998]. Phases such as anticipating and preparing could be concurrent. The effect on the prevailing market of a transition can be significant and the approach of any particular company to plan or react to such changes can vary [Moore, 1995].

Example Transitions for Technology-based Product Companies

Transition periods create instability in the market that make way for new products and/or companies [Stacey, 1992]. As seen in the following examples, the outcome of this period of instability is uncertain as to which products/technologies and/or companies will prevail in the market [Stacey, 1992].

Software - WordStar, WordPerfect and Word

In the 1980's MicroPro's WordStar was the main word processor package and in competition with WordPerfect, computerized word processor technology was a relatively new technology. As part of the drive to radically improve its technology by introducing WordStar 2000, MicroPro changed its underlying technology base. This move meant its newer and superior technology was incompatible with its previous version's file formats, essentially eliminating its installed base advantage. This opened the installed WordStar customer base to other choices, and, allowed WordPerfect to come out of the transition as the leader in the market [Moore, 1995].

Similar scenarios occurred again in the late 1980's when IBM introduced the OS/2 operating system thus inducing a potential transition. For customers the choice was between OS/2 and its direct competitor Microsoft's Windows. During this transition WordPerfect was in competition with Microsoft's Word. The decision of the management of the corporation of WordPerfect was to standardize on OS/2. However,

when the transition was over, Windows had prevailed over OS/2 and WordPerfect had lost market leadership to the Windows-based Word [Moore, 1995].

Hardware - 80286/386

In 1981, IBM introduced the Personal Computer using Intel's 8086-8088 microprocessor and Microsoft's MS-DOS [Jorgenson, 2001]. Later, IBM's decision to gradually switch from the 80286 Intel microprocessor to the 80386 allowed Compaq to introduce the more powerful processor during the Fall of 1986 and gain market share [Curry and Kenney, 1999].

Software - SAP

At SAP, the German Enterprise software company, transitions have occurred several times over its multi-decade life [Meissner, 1997]. During its start up years SAP gained a market lead over its competitor IBM due to SAP's radical data processing approach. In 1970's data processing was completed on large mainframes in batches. All the relevant data was entered and all processed at once. This approach had at least two problems: the results of transactions were unavailable until some time after the transaction took place and errors in data entry sometimes might go unnoticed until after the batch had been run thus requiring rerunning the batch. When SAP started they chose a real-time data processing approach which meant the operator could process data as it became available. This approach relied on the new terminal technology that allowed the operator to directly

interact with the computer as opposed to the old punch cards which were filled in or punched and the batch was processed.

In 1987 when UNIX was the preferred operating system of universities and research institutes, SAP undertook decisions to build a UNIX-based version when at the time it implied a high financial risk since the future of UNIX was uncertain [Meissner, 1997].

In 1992 SAP introduced SAP R/3 that utilized a client-server architecture that allowed data processing to be shared amongst processors allowing significant decreases in processing time. As well, R/3 utilized a graphical user interface when most of its competitors still utilized text-based screens for computer interaction. This represented a push towards more user-friendly software that then moved the software into a wider community of users.

The first large order for R/3 was placed by Chevron, an oil company in the US. The client-server architecture was initially met with skepticism and took some convincing before Chevron agreed to try the new approach. R/3 took \$920 million to build and required an anticipation of technology and market trends in order for the CEO to announce "With R/3 we had the right product at the right time" [Meissner, 1997]. SAP has stated that "We have been successful ... because we anticipated the future trends in data processing quite right" [Meissner, 1997].

Cisco

In Cisco's case their transition was partly induced by the US Congress [Bunnell and Brate, 2000]. In 1987, one year after Cisco had started, the US Congress opened the ARPnet (precursor of the internet) from a closed system of the military and university environment into a commercial entity. This immediately increased the number of online hosts to more than 28,000 and created the need for connecting networks.

Currently Cisco is anticipating future trends with Voice over the Internet (VoIP) based on its own internal usage and savings of \$30,000 a month in long distance charges. Cisco attempts to anticipate the technology requirements and the market acceptance of such technology [Bunnell and Brate, 2000].

Wang

The computer company Wang clung to proprietary mainframe and word processing systems after developments in the industry had changed the focus of the market into "open system" formats. This decision, in part, led to its decline [Bunnell and Brate, 2000].

Anticipating and Preparing for a Transition

A significant potential can be realized by both anticipating and preparing for a transition [Goodman and Lawless, 1994]. It also appears that forecasting accurately such transitions in advance is quite difficult.

Intel

Intel anticipated the importance of graphics and multimedia in relation to their product in the early 1990s [Brown and Eisenhardt, 1997]. Thus, they formed the required alliances with telecommunications, cable and movie companies including the creation of a media lab and development of an Internet server. In addition, Intel invested in media, Internet and graphics companies in order to help create the multimedia and three-dimensional graphics capabilities that they anticipated the market would demand.

Intel's approach has been to induce the transitions as much as it can [Brown and Eisenhardt, 1997]. Competing in the technology-based product market appears to be a matter of anticipating and inducing the transition and not waiting for the discontinuity to occur [Brown and Eisenhardt, 1997].

Microsoft

Microsoft's strategy does not appear to be based on picking a strategy position and executing it or building on core competencies but more of a creation of a relentless flow of competitive advantages that form together to become the strategy [Brown and Eisenhardt, 1997]. This provides Microsoft with the capability to take advantage of emerging markets and technologies.

AOL

As AOL grew during the 1990's, competitors such as AT&T reacted to their market approach by changing the internet usage pricing structure from an hourly fee to a flat fee. When AOL responded, the actual demand far exceeded expected demand and AOL customers experienced a capacity shortfall [Brown and Eisenhardt, 1997]. The transition in the market acceptance had not been accurately anticipated causing the need for fast reaction on the part of AOL.

Making a Model

Beginning with the desired framework presented earlier the following section presents the model derived from the literature review. According to Stacey (1992) a model should:

- 1) Generate new perspectives on what is going to occur.

In the proposed model the first step is to understand the technology and market position on frameworks that utilize a life cycle approach. In life cycle approaches such as the adoption of innovation and technology, under favourable conditions, it would be expected that the firm's technology/product would traverse the stages [Rogers, 1995; Foster, 1986]. Each stage has a set of implications for the present and for the future stages and thus would generate perspectives on what is going to occur.

- 2) Structuring the planning issue in useful forms.

The approach should be understandable and useful.

3) Noticing potential and possibility.

Some form of assistance in understanding what should be done for the company and its product(s) is required. This could entail presenting a technique for determining the most appropriate strategy and tactics or it could entail presenting a specific set that are most appropriate for a given environment. A population of strategies and tactics will be drawn from both the academic and practitioner's literature and provides the set of approaches for the model.

The Model's Concepts

Transitions result in conditions of high uncertainty during which well-developed and trusted methods of competing may no longer apply [Goodman and Lawless, 1994].

Traditional approaches to strategy have difficulty with rapid and unpredictably changing industries. Such approaches tend to overemphasize the degree that industries, competencies and strategic positions are viable and for how long [Brown and Eisenhardt, 1997]. Rapid and unpredictable change appears to create the necessity to anticipate the future. Anticipation means to foresee possible technologies, new customer segments, marketing channels, and products and services. By anticipating, a corporation can lead in the creation of new technologies and products, markets, industry standards and customer expectations [Brown and Eisenhardt, 1997].

Inducing can be described as the actions to create new markets and customer expectations and to change the current existing technology-based product market to another. Inducing can also include creating awareness of the new technology-based product or creating new markets or simply as demand creation. [Scheuling, 1989; Brown and Eisenhardt, 1997].

Given the preceding sections, the need to anticipate and prepare for transitions along with the significant potential for those that can also induce² the transition, have been identified and can be represented in the following figure.

Figure 9: The Model's Components: Anticipate, Prepare and Induce

In the preceding figure the components have not been linked. Although it could be viewed as a sequential set of steps, at this point there is no intended indication of ordering or even whether the components are sequential and not concurrent. However, Gavin, Eisenhardt and Brown indicate that the components would be *iterative* and *overlapping* as they are executed as a process [Garvin, 1995; Eisenhardt and Brown, 1998].

Model Representation: Objectives Hierarchy

Organizations have a fundamental goal(s) they are trying to accomplish, for example, maximizing shareholder return and maximizing employee satisfaction [Clemen, 1996]. Maximizing shareholder value is a general goal or "fundamental" objective for a corporation and accomplishing it is achieved by accomplishing other goals referred to as "means objectives" [Clemen, 1996]. The means objective provides the detail/tactics or the means to accomplish the fundamental goal. A means-ends model can be represented in a simple hierarchical tree or in other forms [Clemen, 1996]. In the following example Maximizing Safety is accomplished through means objectives which begin with activities [Clemen, 1996]:

Figure 10: Example Objectives Hierarchy

² Induce means to bring about; give rise to; persuade; prevail on; to cause some to happen. The Canadian Oxford Dictionary, edited by Katherine Barber, Oxford University Press Canada, Toronto, 1998.

Porter (1996) represented a company's strategy in a similar approach using bold circles to represent strategies and other circles to represent the necessary tactics using lines to represent interrelationships.

To illustrate, assume a corporation produces a small electronic add-on for cellular phones, such as a pocketsize printer for receiving faxes. The corporation has decided on providing a limited service low cost product. Perhaps this strategy is based on providing a “copycat” product. In order to provide this, the company has chosen to utilize the internet as its primary marketing channel. A narrow product allows the support staff to become knowledgeable and efficient in selling the product. This also allows manufacturing to devote resources to process related innovations since the product line is small and stable. R&D also focuses on devising a simple to assemble product reducing the need for after sales support.

Figure 11: Strategies and Tactics Example

The following sections will present the concepts in this thesis in a objectives hierarchy with each lower level displaying more detail than the higher level [Clemen, 1996]. The boxes represent the objectives and arrows connect the lower level objective with the higher level objective.

The Anticipation Concept

Life Cycle Curves

The two life cycle curves, described earlier, provide a well-established method to anticipate possible transition periods.

This thesis focuses on companies whose technology based product is near to the first inflection point on each curve [Goodman and Lawless, 1994].

The position of the technology on each of the two curves can more or less be established by utilizing relatively straightforward heuristics. Various sources of information or data gathering methods can be used to provide the necessary information for the heuristics to be utilized.

Information Sources or Data Gathering Approaches for Transitions

Available information can be reviewed or a plan to gather the relevant information could be put in place. There exist entire books that cover various approaches and techniques to gather competitive or business intelligence such as Vella (1988) or Dutka (1999) .

A few example approaches are: a continuous policy to examine new technologies perhaps through pilot projects or prototypes could be implemented in order to anticipate future directions of the market and technology [Brown and Eisenhardt, 1997]. These activities can be focused on the near future along with longer range potential. Such activities should also have a focus on the most likely future and lesser likely futures [Brown and Eisenhardt, 1997].

This policy could involve introducing the technology to the market in an unfinished form in a variety of markets. Feedback could provide the firm the ability to find appropriate markets and shape the product and its services [Lynn, Morone and Paulson, 1996].

Example: Information Gathering approaches of Technology-based Product Companies

Cisco

Cisco's approach to gathering information about trends includes investing in start-up companies with promising technology [Bunnell and Brate, 2000]. For example, Cisco

made an investment in a company called Cascade for its ATM technology as "an offensive and defensive move in a market segment that we were just beginning to understand" [Bunnell and Brate, 2000].

Microsoft

Microsoft in the late 1970's focused on the revolution that the microcomputer would bring although this ran contrary to the technical ideas of others who believed that microcomputers would never amount to anything given the power of mainframes [Tsang, 2000].

In some cases Microsoft designs and builds its products with technological requirements that are not currently available. In 1979, Microsoft started to move into database systems and licensed a technology called Microseed. However, the hardware speed needed to run Microseed was not available and such hardware speed did not come to the market fast enough [Tsang, 2000]. In 1982, Multiplan was developed for laser printers that were not even available yet, and utilized concepts such as proportional fonts.

In 1983, Word had support for the "computer mouse" before the "mouse" was considered a viable concept. At Microsoft, Bill Gates Microsoft CEO personally visits representatives from the semiconductor, CD-ROM, printers, display companies to understand the future trends of those technologies [Tsang, 2000].

SAP

Anticipating the market and technology future is an important component of a technology-based company's capabilities. At SAP, the German enterprise software company, the general principle was to not limit their product functionality to what existing computers were capable of but to always develop for the next generation of computers [Meissner, 1997]. For example, when SUN Microsystems introduced the work station running UNIX in the 1982, this provided a cheaper implementation computer for SAP software.

The Anticipate Concept added to the Model

The model can now be enlarged to include the information gathering approach, two life cycle theories used to place a technology in the context of its life cycle and the market, and, heuristics to find a technology's place on the life cycles. The following figure illustrates the process of gathering information from various activities or information sources with the objective to understand the current and future directions of the market and technology. This information is mapped against the heuristics of a framework such as the Technology Life Cycle or Adoption of Technology Life Cycle Theories to anticipate the current and future directions/trends of the market and technology.

Figure 12: The Process to Anticipate

The Preparation Concept

In this section, the tactics for preparing the company for the transition is presented.

It has been noted that the organization itself has to be structured to take advantage of conditions of high uncertainty during which well-developed and trusted methods of competing may no longer apply [Goodman and Lawless, 1994]. Preparing an organization for a transition involves the corporation's resources, partners, technical options, employee skills, etc. [Brown and Eisenhardt, 1997].

Preparation Tactics

Two possible tactics that could be the focus of an organization are: increasing the speed and responsiveness of the organization. These tactics are applicable in environments where the rate of change in the market and technology is high and the need to adjust quickly to market and technology is important for survival [Goodman and Lawless, 1994; Brown and Eisenhardt, 1997; Unisys, 2000].

Increasing the speed or tempo of operations

Speed of operations is defined as the quickness in operations that an organization is able to achieve. For example, companies can use a business process that utilizes the internet to test-market products and immediately fine tune offerings on the basis of customer input therefore reducing product development cycles [www.unisys.com, 2000; Alberts *et al.*, 1998]. Increased tempo can be realized by a globally dispersed organization that can now work 24 hours a day, minimizing unproductive hours and facilitating concurrent processing.

For example, in some situations IBM develops and tests software such that as one team finishes work for the day another team in a different time zone continues with work [Alberts *et. al.*, 1998].

In another example, calls to Sun Microsystem's customer support seamlessly switches to different locations as the work day ends in one location [Alberts *et. al.*, 1998].

Other examples exist in product design, software development, management consulting and health care [Grenier and Metes, 1995; Sweha, 1996; Dubinskas, 1993; Voegtli, 1996; Pomerantz *et. al.*, 1995].

Increasing the service or responsiveness of the organization

This is defined as the capability to provide service in a myriad of formats for a variety of needs. Electronic business allows organizations to provide service and support on a 24 x 7 basis. It can also enable self-service, where online clients access product information and maintain customer profiles in order to complete various functions such as sales, and after sales service.

Organizations can also improve service levels through electronic monitoring of a customer or potential customer's web visits by following navigation paths to evaluate a web site's effectiveness or tracking click-throughs for online ads to gather information about interests/preferences [Unisys, 2000; Alberts *et. al.*, 1998].

Preparation Activities

The following section is not meant to be a complete description of preparing an organization for a transition. Instead, it presents merely some example approaches or issues found in the literature [Hagel and Singer, 1999]. The following approaches are divided into three that are organizational-related and three that are technology related.

Organizational Related

1. Online Tools

Web enabled software applications/tools could be utilized to create the necessary online environment of data, productivity and decision support tools for individuals to work together. Online collaboration tools can result in improved product design processes such as demonstrated by Boeing's design of the 777 [Tapscott, 1996; Sabbagh, 1996].

2. Autonomous Decision Making

Autonomous decision making provides the potential for local planning to adapt to situation changes including modifying processes. A common operational picture of information provided to all relevant participants allows each to understand and make decisions with a limited need for interaction with others. For example, at Dell

Computers a common information set allows suppliers and partners to make decisions and take actions, in conjunction with predetermined guidelines, while minimizing the need for communication and coordination with others [Sengupta and Jones, 1999].

In the transportation sector some companies now have an in-transit information network that duplicates the physical network. At companies such as Union Pacific, United Parcel, Federal Express and CSX, in transit networked sensors generate near real-time situation awareness of a parcel transportation status, even with thousands of boxcars or millions of packages a day. Such information provides the potential for those companies to make real-time operational decisions and their customers to better plan for their parcel's arrival [Tapscott, 1996].

Providing such information increases the potential for innovation and the ability to recognize and recover from errors. Organizations can be viewed as systems with a large number of interacting players [Brown and Eisenhardt, 1997]. In this perspective, decisions by individual players interact to reconfigure the organization's structure and processes on a continuous basis to best fit the environment at a particular point in time.

For example, Wal Mart uses point of sale information on 90 million transactions a week on potentially 100,000 products to produce a near real-time information perspective for the company and their suppliers [Moore, 1995; Palmeri, 1997]. This allows suppliers to understand the store-level situation including trends and make decisions with a minimum need to coordinate with Wal-Mart. This capability has meant that Wal Mart

has eliminated its purchasing department. At the store level managers have access to all inventory and in transit data for all stores [Foley, 1996]. Coupled with analysis tools, decisions regarding re-pricing or transfers of inventory between stores can be undertaken to take advantage of opportunities.

3. Decentralize Decisions - Centralize Information Technology

Cisco's organizational structure centralizes the IT infrastructure while decentralizing the IT budget to individual divisions. Thus each division can decide what applications they require but a centralized unit would implement the budget information technology [Bunnell and Brate, 2000]. For example, Cisco implemented an enterprise-wide resource planning program at the initial cost of \$15 million in 1995.

This system, along with the rest of the internal technology is credited with giving Cisco the capability to manage information in real-time and thus results in the capability to make and implement decisions quickly [Bunnell and Brate, 2000]. This has provided the capability for decentralized organizational structure where decision making is pushed down the organization levels as much as possible.

Cisco's real-time information on sales requests and inventory levels allow lower inventory levels at less risk with a 45 percent reduction and saving of \$5.6M [Bunnell and Brate, 2000].

Technology-related

1. Build for the Next Generation of Technology

In the early days of Microsoft, product releases were often targeted to technology platforms that did not exist. For example, in 1979, when Microsoft was preparing the 8086 version of Basic they did not have available the 8086 chip and thus built the release version with a DEC 10 that was configured to emulate the 8086 chip [Tsang, 2000].

2. Modularity of Design

Modularity of design in physical products allows companies such as Sony to adapt as the market changes [Eisenhardt and Brown, 1998]. The Sony "Walkman" is built on a few basic designs such as: playback only, playback and record, professional playback and sports. This gives Sony the capability to introduce new products using the basic modules. This is even more relevant when the evolution of the technology is uncertain [John, Allen and Dutta, 1999]. For example, the original SUN Microsystem's Workstations were largely off-the-shelf technologies and an existing operating system.

3. Lower Costs By Including the Customer as Part of the Organization

SAP used a variety of techniques to ensure low operating costs such as using the customer's equipment, making special arrangements with customers that required significant changes to the software in order to allow the new code to be used as part of

the standard product [Meissner, 1997]. Customers have also been instrumental in SAP's initial export efforts. For example, when John Deere, the US manufacturer of agricultural machinery, purchased SAP, John Deere paid for the translation of the software into French [Meissner, 1997].

The Preparation Concept added to the Model

As represented in the following figure, the approach to preparation starts with the corporation deciding its strategy for the transition, for example, maximizing market share. The tactics to realize this strategy are decided upon, for example, to increase the responsiveness of the corporation to the customer. Finally, individual projects or activities are undertaken to realize each tactic.

Figure 13: The Anticipate and Preparation parts of the Research Model

Inducing

Introduction

In order to induce a transition, the corporation must convince the market that a superior approach is feasible that will result in significant change and that the risk and cost of change is minimal. Customers want a stable and global technology infrastructure. To induce a switching of technologies, it must be evident that the infrastructure itself is changing [Heide and Weiss, 1995] and compatibility with others is ensured by switching

to the new technology [Dhebar, 1996; Romer and Van Doren, 1993; Song and Parry, 1996].

This section outlines a few approaches that have been utilized by technology-based companies to cause the market to switch its product/technology to the new one offered by the company. While most the approaches get grouped into a marketing and sales category some of them are more directly related to the technology choices made by the company.

Marketing and Sales Approaches

1. Become Widely Distributed

This tactic essentially gives away the intellectual property of the company. For example, Cisco induced the transition to its router technology by giving its accompanying source code away [Bunnell and Brate, 2000]. This practice allows customers to become partners in code development. In the case of Cisco's DECnet routing and XNS routing products early customers added to the code. Approaches also include giving intellectual property away free of charge such as the web version of the Encyclopedia Britannica or Sun Microsystem's Java programming language or Netscape's browser code.

2. Sell Directly to Senior Management

SAP's sales approach includes attempting direct sales to the customer's corporate board of directors, and, soliciting current customers to allow SAP product demonstrations in the customer's facility [Meissner, 1997].

3. Make Purchasing Easy

Amazon.com has an ordering process in which orders can be recorded and processed in a very simple steps and in which the customer can track the order through its completion [Spector, 2000].

4. Sell the Solution - not the Technology

The uncertainty associated with the technology can be reduced by emphasizing the solutions it provides, not necessarily its features or underlying technology [Rackham, 1998].

Cisco's method of inducing the transition to new technologies in its customer base is to sell its "network solution" to management which allows them to concentrate on the business case for the technology [Bunnell and Brate, 2000]. SAP sells its software to senior executives (the decision makers), not necessarily the Information Technology (IT) executives, by declaring it results in "A better return on information" [Meissner, 1997].

Amazon.com's approach is to be a direct seller of a wide variety of merchandise including that of third party partners and to invest with other similar online product companies [Spector, 2000].

5. Reduce the Adoption Obstructions

Investigating the customer's usage of the technology may reveal problems in adoption that are related to a larger infrastructure problem or problems with necessary related technology [Eisenhardt and Brown, 1998]. When Intel introduced fast multimedia chips it realized that download time was a "bottleneck" and introduced network interface cards that had the necessary speed such that their multimedia chip could realize its potential.

6. Develop a Community

Developing a sense of community amongst user groups is feasible given internet technology. In such a community, users can get a sense of personal interaction as the company provides information or access to resources to assist in the usage of the product.

In the case of Amazon.com, a staff of editors provides book reviews and other information. In addition, the customers themselves and the book author can post their reviews and interact in forums [Spector, 2000].

This community can be used to provide customer education activities which are more complex and crucial for hi-tech products [Moore, 1995]. The role of marketing can involve reducing the uncertainty surrounding the new technology by educating the market about the new technology [Heide and Weiss, 1995; Robertson, 1993]. The literature suggests several mechanisms to educate the market, for example, preannouncing the product [Song and Parry, 1996] and introducing products as a mechanism for learning from the resulting market reaction [Heide and Weiss, 1995].

7. Organizational Segmenting

Each unit in the organization can be at a separate stage of adoption. For example, the accounting department might more readily adopt new technology than the manufacturing department due to the less immediate systems critical nature of the accounting process. This suggests that each unit of the organization might be at a different point on the adoption of innovation's life cycle [Cool, Dierick and Szulanski, 1997; John, 1984]. Marketing strategies are then aimed at producing campaigns dependent on the organizational unit type rather than by larger measures such as industry or the corporation.

8. Organizational Positioning

One position role of marketing is to communicate the corporation's position in the chain of suppliers, partners and customers [Moore, 1995]. Customers have a sense of comfort

that choosing this technology and vendor is not a mistake since the product is well supported by other well known companies.

Technology related approaches

1. Cluster the Technology

A technology cluster consists of one or more distinguishable technologies elements or components that are perceived by the customer as interrelated [Rogers, 1995]. As an illustrative example, the computer consists of a variety of technologies combined into one product, for example, hard drives and monitors are also separate products. The suggestion is to promote the technologies as a single package rather than separate ideas [Rogers, 1995]. The packaging should be based on the user's perception of interrelated technologies rather than the producer's [Rogers, 1995].

2. Reduce the Need for Services

In some cases, the services that accompany a new product are a significant revenue source. However, the suggestion is to reduce the requirement for services such as training, installation or even technical support [Moore, 1995]. This reduces the uncertainty in the customer's mind as to whether or not the technology is viable for a particular application and defines their maximum service costs since the need for extra services is limited. For example, SAP's ratio of product cost to implementation costs has

reportedly been from 1 to 8 or as high as 1 to 20 depending on the approach used to allocate costs to the implementation project [Meissner, 1997].

Greater uncertainty about technology evolution among customers favours migration assistance [John, Allen and Dutta, 1999].

3. Integrate the Product into a More Mature Product

Focus on integrating the product technology into a product already in its growth or mature stage [Moore, 1995]. By integrating a product into a more mature product, the newer product then skips forward in the adoption of technology life cycle to the stage appropriate to the more mature product and increases the viability of the technology.

4. Make the Product the Standard

The company should attempt to make their technology the standard [Robertson, 1993]. The technology that becomes the standard has increased its viability by reducing the possibility of success for competing technologies.

5. Curtail the Ability to Switch

It has been suggested that introducing discontinuous product releases could make switching of products easier [Moore, 1995]. This allows competitors an opportunity to

convince customers to try a competing product. For example, software releases that are incompatible with previous releases provide the possibility that an existing customer might use a competing product.

6. Technology Components

It has also been suggested that products based on a bundle of technologies can make individual component upgrades [Dhebar, 1996]. For example, a product that allows some of its components to be modular and upgradable, as is the case of some computer products, could allow the new technology to skip forward in the life cycle by being included in a more mature product [Lynn, Morone and Paulson, 1996].

6. Cycle Alignment

Cycle alignment is also important. Rather than an annual product release or planning session, they should be aligned to the natural cycle of the market, for example, the regular computer product review issues by technology magazines [Eisenhardt and Brown, 1998]. Releasing a product just before the review means the reviewer is examining the latest of the product along with perhaps an older version of the competitions. For example, like many companies TRW in its space and defense used to hold annual planning reviews set by the calendar year, however, their prime customer was the US government whose budget year starts in October. A simple realignment to October allowed TRW to more closely tune its service offerings and win more business [Eisenhardt and Brown, 1998].

Research Model Summary

This discussion has explored the value of anticipating, preparing and inducing a transition in the market and technology for a given technology-based product. Based on the experience of technology-based product companies such as Microstar and Wordperfect, a technology-based product company should not attempt to induce a transition unless it had anticipated and prepared for it. Thus, preparing and anticipating precede inducing. As represented in the following diagram, anticipating precedes preparing:

Figure 14: The Research Model

As mentioned previously, organizations have a fundamental goal(s) it is trying to accomplish, for example, maximizing shareholder return and maximizing employee satisfaction [Clemen, 1996]. Maximizing shareholder value is a general goal or "fundamental" objective for a corporation and accomplishing it is achieved by accomplishing other goals referred to as "means objectives" [Clemen, 1996].

In the case of the research model optimizing the ability to anticipate trends, prepare the company to take advantage of trends and inducing the market to change to new technology is undertaken to assist in accomplishing the objective of maximizing shareholder value [Stacey, 1992; Yoffie and Cusumano, 1999; Moore, 1995]. Two quotes from industry experts provide a direct linkage between the components of anticipate and prepare to maximizing shareholder value.

Don Valentine, venture capitalist to Apple, 3Com, Atari, Oracle and Cisco stated that his success is based on "being in the right place at the right time" [Bunnell and Brate, 2000]. If we can equate a venture capitalist's definition of "success" meaning maximizing shareholder value then he implies that preparing ("being in the right place") and anticipating ("at the right time") are ways to maximize shareholder value.

John Chambers, CEO of Cisco states that companies must stay ahead of the trends or risk losing all they have created [Bunnell and Brate, 2000]. This statement

implies the ability to anticipate and prepare for future scenarios has been important for Cisco.

Summary: The Research Model and the Proposed Framework

The research model presents a specific instance of the proposed framework presented in a preceding section. The adoption of innovations and technology life cycle curves are used to assist in anticipating possible future scenarios. The issue of finding where the product and technology are on the appropriate curves is done through activities such as informal networking.

The Anticipate, Prepare and Induce concepts are a high level set of goals for technology-based product companies. The selection of appropriate tactics and strategy set has been partially done by presenting a set that is applicable for technology-based product companies.

CHAPTER 5: RESEARCH APPROACH/METHODOLOGY

This section presents the research methodology utilized for the thesis.

The methodology utilized for this thesis is similar to the one utilized by Eisenhardt when the theories of "High Velocity Organizations" and "Competing on the Edge" were developed [Eisenhardt, 1989]. Given the methodology has been used in conjunction with the established Grounded Theory approach for developing theories for technology-based companies it was thought suitable for this thesis [Yoong, 1999]. Appendix A presents more details on theories, models and frameworks.

The research approach followed a five step process:

- 1) Identified a sample of approaches/heuristics such that positions can be found on the technology life cycle curve and the adoption of innovations life cycle curve.
- 2) The practitioner and academic literature were reviewed to derive practical strategies and tactics.

This is a dynamic and potentially large subject area. The material was gathered from the Carleton University library and the local Chapters bookstore during the summer of 2000.

- 3) A graphical representation of the model was developed.

- 4) Semi-structured interviews with technology-based product firm executives were conducted and recorded, and the tapes transcribed. The transcriptions were imported into the Nud*ist software package. The software provides the capability to number each line of text. Lines of text were then grouped into concepts. These concepts were grouped into hierarchies of abstraction until the resulting theoretical categories and the relationships between them could form the emerging theory [Yoong, 1999]. The Nud*ist software package is designed to conduct such analysis [Yoong, 1997]. See Appendix C for more information on the Nud*ist software package.

Research Design

A multiple company study was used in which cases can be treated as independent situations that confirm, refute or add to the emerging conceptual insights [Brown and Eisenhardt, 1997]. The interviews were conducted with senior managers who had knowledge about the company's approaches to the technology and market. This gives the high level strategies attempted along with the detailed tactics implemented.

Selection of Case Studies

Technology-based product companies were selected whose products have moved beyond or are near the initial inflection point on either one or both of the life cycle curves. The positioning of the products need only be

estimated such that it can be determined that they are either before, in or after the initial inflection point. The companies selected were from the population of those that produce technology-based hardware and those that produce software products.

- 5) Utilizing the Nud*ist software provided useful knowledge supporting the model and providing modifications or extensions to it. The Nud*ist software package provides the functionality to implement a Grounded Theory approach to research.

Grounded Theory Approach

This research undertook a grounded theory approach [Glaser and Strauss, 1967; Strauss and Corbin, 1990; Strauss and Corbin, 1994]. Grounded theory provides a strategy for examining the experience of participants and utilizes a process of data collection, coding, analysis and theorizing.

As data is collected it is coded into categories (possibly numerous) and subsequent coding will either confirm or deny these categories. Subsequent coding may also refine, extend and modify the categories to fit the new data [Yoong, 1999]. New categories may also emerge as the data collection progresses and thus determining the nature of the subsequent data to be collected. Grounded theory provides an

inductive approach to develop concepts, insights and understandings from patterns in the data [Yoong, 1999].

A grounded theory research approach can be facilitated with modern software products. A software package called Nud*ist was used to facilitate a grounded theory research project in the area of Group Support Systems [Yoong, 1999]. See Appendix C for more information about Nud*ist.

Grounded Theory will:

"...fit the situations being researched and work when put into use. By fit we mean, that the categories must be readily (not forcibly) applicable to and indicated by the data under study; by 'work' we mean that they must be meaningfully relevant to and be able to explain the behavior under study." [Lincoln and Guba, 1985]

Rationale for using grounded theory [Yoong, 1999]:

1. Little previous research on this topic. - This study is exploratory in nature and similar studies have not been found.

2. Study focus - Grounded theory is applicable for studies focusing on "the generation of theories, sequence and change pertaining to organizations..." [Glaser and Strauss, 1967].

3. Close ties to the data - Grounded theory provides a structured method to make sure that the emerging theory is linked to and consistent with the empirical data [Urquhart, 1997].

Comparison to the Approach Suggested by Eisenhardt

Eisenhardt utilized the following eight steps in previous research in constructing theories for time management and organization structures in technology based companies (see Appendix A for more information) [Eisenhardt, 1989]:

1. Definition of research question and a priori constructs.

The research conducted for this thesis involved constructing a model prior to the interviews in which a priori constructs and relationships were proposed. This began with a general framework and then based on the literature a model was developed focused on technology-based product companies.

2. Selecting cases based on theoretical applicability i.e., those that replicate or extend theory by filling conceptual categories.

Ten companies were selected based on their previous transition or near-to transition through the initial life inflection points of one or both of the life cycles as explained

earlier. As suggested by Eisenhardt (1989) and Phillips (1981) the interviewees were selected based on their knowledge and experience with the corporation's approaches to its technology and market development.

3. Instrumentation such as interviews.

Semi-structured interviews based on an initial set of questions were conducted. The interviewees were given a presentation of the concepts and asked prepared questions. The interviewees were allowed to give as much detail in their responses as they desired.

4. Data collection and analysis have some overlap to guide direction of interviews.

As the interviews progress some modification of the interview questions were used to focus on emerging ideas. For example new concepts arose such as non linear nature of anticipate, prepare and induce.

5. Analysis across and within cases.

The Nud*st software provided the capability to analyze concepts within and between interviews (and companies). Such an approach was used by Yoong to understand computerized group support systems. Yoong conducted semi-structured interviews, he transcribed the interviews and imported into Nud*st [Yoong, 1997]. Yoong used the Nud*st software to group segments of the transcribed text where concepts expressed within the text were similar. To complete his analysis he then

developed a hierarchy of concepts [Yoong, 1997]. In this thesis, Bettman's (1971) similarity coefficient approach was used to provide additional analysis.

6. *Shaping of hypothesis by tabulation of evidence for each construct to confirm, extend and sharpen model.*

The Nud*st software provided this capability.

7. *Literature review to determine internal validity and examine generalizability.*

The literature review was conducted prior to the interviews. In addition the resulting model was compared to another model concerning planning processes from the literature [Ryans et. al., 2000].

8. *Closure comes when marginal improvement becomes small given the data.*

Closure can be expected when only marginal improvements occur. For example, Glaser and Strauss suggest that when no additional data, coding or sorting appear to contribute to the extension of the theory then the analysis is completed. The researcher noted that towards the end of the interviews, there was similarity in responses, for example, in interviewee's voicing their opinion about the non-linearity of the anticipate, prepare and induce concepts.

Evaluation

There are a few criteria for evaluating a theory or a model from the theoretical sense as outlined in Appendix A [Weick, 1989].

Eisenhardt suggests that since the point of the theory construction process is to begin the life of a theory then evaluation criteria could focus on whether the new theory is logically coherent or testable and grounded in empirical evidence [Eisenhardt, 1989]. This would imply a logical set of constructs that have observable variables.

In general, a model for company executives should utilize available managerial judgement or historical data, represent the actual circumstances, and give guidance [Lilien and Rangaswamy, 1998].

Summary: Research Phases

In order to complete such a model, four phases were followed:

Phase 1 – Literature review

In this phase the academic and practitioner literature was examined in order to construct a knowledge base of strategies and tactics.

Phase 2 - Research

In this phase the research model was generated based on the literature review.

Phase 3 – Pre-testing the data collection procedure and collecting the data

During this phase, 12 senior executives from selected technology based firms were contacted. The aim was to present this model and discuss its usefulness. This phase consisted of a presentation session of the model and addressing the issues in a semi-structured format. The process for the selection of the executives is discussed in the following section.

Phase 4 – Revising the model

In this phase the results of the interviews were transcribed and analyzed. Analysis using Bettman's (1971) coefficient and the Nud*st software were performed. The analysis results were used to revise the model. As an indicator of its generalizability the revised model was compared to another planning model suitable for technology based product companies.

CHAPTER 6: INTERVIEWEE SELECTION, INTERVIEW PROCEDURE, AND PROFILE OF INTERVIEWED COMPANIES

This section outlines the approach for interviewee selection along with a profile of the interviewed companies.

Interviewee Selection

The population of companies to interview was defined as technology-based product companies listed in the Ottawa Carleton Research Institute's (OCRI) or the Ottawa Carleton Economic Development Corporation's (OCEDO) or the Ottawa Citizen's directory. This was supplemented with newspaper articles about technology-based product companies in the Ottawa Citizen and Silicon Valley North during the summer and fall 2000. From this population, a sampling frame of approximately 300 companies spread across four cities was developed. The companies in the sampling frame were located in one or more of the cities of Ottawa, London (Ontario), Montreal and Toronto.

This list was then examined for companies:

- 1) That had developed and sold their own products incorporating either computer hardware and/or software;
- 2) That had senior executives that were accessible. In some larger companies it was difficult to contact senior executives;

- 3) Where senior executives were familiar with or directly participated in the product's technology and market development;
- 4) That had products that were either going to, in or just past the first inflection points of the technology and adoption of technology life cycles; and,
- 5) Where senior executives would probably spare an hour of time.

A review of websites and a discussion with a knowledgeable industry expert resulted in a list of approximately 30 companies that defined the most desirable companies to interview. The sample selection approach followed the Eisenhardt approach of selecting companies that are most appropriate for the purpose of the research [Eisenhardt, 1989]. In the Eisenhardt research, 8 and 12 companies respectively were sampled. Given Eisenhardt's approach of using 12 or less companies for research it was decided to use 12 companies for this thesis research [Eisenhardt, 1989].

The assessment of where a company's product(s) were on the life cycles was a subjective assessment based on data from websites and directories. Fourteen companies were contacted by telephone and the nature of the research was explained. One declined to participate and one, while interested and despite repeated attempts, could not find an appropriate time for an interview. This one potential interviewee could not spare the time during the available interview time slots.

Of the 12 companies two were selected to serve for a "beta test" or pretest role. The questions and the presentation material were pre-tested by two individuals who, between the two of them, had experience with:

- 1) Computer hardware and software companies;
- 2) Large and small technology-based product companies;
- 3) Academic experience related to the concepts in question;
- 4) The perspective of venture capital firms; and,
- 5) Direct experience in operating and growing such companies.

After the pre-tests were performed there were no suggested modifications to the presentation material and questionnaire protocols. Thus the interview results of the two pre-test individuals were also used along with the other ten interviewees. The ten companies along with the two beta tests made a total of twelve interviewees.

Interview Procedure

The interviews were conducted over a three month period with each interview lasting approximately one hour per company. One individual was interviewed per company. The approach of interviewing one individual within an organization and asking this individual questions about his/her organization has been labeled the Key Informant Method [Phillips, 1981]. In studies using this approach, the key informant provides information at the aggregate or organizational unit of analysis and reports on group or

organizational properties. The individuals are not chosen on a random basis instead they are selected due to their status, specialized knowledge or even accessibility to the researcher [Phillips, 1981].

This approach has been widely used [Phillips, 1981]:

- Purchasing agents have reported on the structure of the industrial buying process, phases of the industrial adoption process and influences on the organizational purchasing;
- Division managers have reported on the amount of guidance in marketing and strategy received from headquarters;
- Division managers have reported on the amount of collaboration between headquarters and divisions in planning and executing marketing programs;
- Informants have been used to examine the quality of products sold by the business;
- Informants have reported on distribution channels and the amount of power between suppliers and customers;

Phillips [1981] noted concern about the reliability and validity of the usage of key informants when using surveys as a research approach. He conducted a survey of 682 firms involved in wholesale distribution. In each firm the CEO was asked to name two individuals who would act as informants. The assumption was that the CEO knew who was knowledgeable about the area of interest of Phillips' [1981] survey. Phillips [1981]

argues that more than one informant should be used and each set of informants should be focused on a single concept in the study.

The objective of this thesis was to uncover concepts and/or extend the ones derived from the literature rather than validate concepts as was the objective in the survey approach used by Phillips [1981]. In this thesis there was a requirement to find individuals within the sample companies who had knowledge of both their company's technology and market approach to their technology-based product. This requirement meant senior executives who had direct responsibility for, or direct knowledge of both marketing and technology development and this typically would be the President, CEO, or Vice President. This required senior executives to agree to use scarce resources (time) for the benefit of the research on the part of the responding firms. Another reason to limit the research to one individual per company. The interviews were conducted with Presidents, CEOs or Vice Presidents and in two cases with a surrogate appointed by the President.

The interviews started with an explanation of the research and goals of the interview, then the "Informed Consent Form" was introduced and completed. At this time the interview began. The interviews were recorded by a digital recorder. The digital file was uploaded to a computer and the interview transcribed by the researcher.

The procedure of the interview was to utilize a paper copy of a "powerpoint" presentation to introduce a concept and then associated questions were asked followed by the next concept and so on. The interviews were typically conducted in the interviewee's office

around a small table with the paper copy of the presentation placed on the table between the researcher and interviewee. The placement of the documents was such that both the researcher and interviewee could see the presentation documents.

In only one case did the interviewee request the presentation and questions in advance and thus had time to consider them prior to the interview.

The interviewees were promised a copy of the thesis and in a few cases kept copies of the interview presentation and questions.

Profile of Companies

The companies interviewed can be categorized by product focus, job title of interviewees, number of employees and years in business.

Product focus: While some interviewed companies sold products that had contained both a hardware and software component, typically, the emphasis of their product line was either hardware or software. Of the twelve interviewed companies, six were hardware focused and six were software focused.

Job title: Ten of the interviewees were Co-founders, Presidents or Vice Presidents, and the other two interviewees directly oversaw product development and marketing.

Number of employees: The size of the companies ranged from 15-3000 employees with the average being 440 employees.

Years in business: Over half the companies were formed in the mid-1990s.

Summary

The interviewed companies represented a broad perspective of technology-based companies with the potential to offer a rich source of ideas.

CHAPTER 7: THE RESEARCH RESULTS

This section presents the research results for each of the hypotheses.

The research model was used as the basis for the interviews. See Appendix E, F and G for the interview questions and presentations. The results of the interviews provided sufficient information to modify the research model as outlined in the following sections. See Appendix I, J and K for information concerning the revised model's concept hierarchy and each interviewee's concept hierarchy.

The grouped responses of the interviewees in the following sections have been expressed in terms of odds, for example, 3 interviewees of 12. In addition, as an aid to future researchers, the percentage of respondents agreeing with each other as compared to the total number of interviewees has also been given.

Hypothesis Results

The three hypotheses were asked to the interviewees as interview questions numbers 26, 27, and 28. The three questions were directed at the components of anticipate, prepare and induce. The other concepts outlined in the research model were covered in other questions.

Hypothesis 1: Interviewed senior executives will employ a strategic decision approach that includes components of the proposed model.

The first hypothesis stated that interviewed senior executives employ a strategic decision approach that includes components of the proposed model. Ten of the twelve interviewees (83%) agreed that the components of anticipate, prepare and induce were performed within their company. One (8%) of the twelve interviewees gave an irrelevant response. The interviewee gave a response that didn't address the question. However, one interviewee (8%) asserted that inducing or creating demand for a technology-based product was not possible unless the company was large.

Result of the Hypothesis 1 Related Question: 10 of 12 interviewees (83%) agreed with the Hypothesis.

Hypothesis 2: Interviewed senior executives do not use the components in the proposed order.

The response from the interviewees to the questions focused on this hypothesis was mixed. When directly asked this question 7 of the twelve interviewees (58%) agreed that the components were in the correct order but in response to other questions came the assertions by the interviewees that components were parallel, overlapping or iterative. One of the aforementioned 7 interviewees along with two other interviewees mentioned that the components were overlapping. Two of the aforementioned 7 interviewees discussed the

relationship between the components as synergistic. In addition, two interviewees (one interviewee being of the aforementioned 7 interviewees) suggested that there was no fixed ordering of the components and any one of them could come first, last or in middle depending on the situation.

In answer to this question, interviewees gave the following answers:

4/12 interviewees (33%) indicated that a company is continuously in a state of anticipating, preparing and inducing and thus it is possible to conclude that the components are not necessarily separable into three stages or phases.

8/12 interviewees (66%) indicated that the components are conducted in parallel.

2/12 interviewees (17%) indicated that inducing could be conducted first depending on the situation.

3/12 interviewees (25%) indicated that the components were iterative.

2/12 interviewees (17%) indicated that the components were not linear in sequence.

7/12 interviewees (58%) either had no suggestion or did not disagree with the proposed order.

2/12 interviews (17%) indicated that the components had a synergy³ between them.

3/12 interviewees (25%) indicated that the components overlapped.

The interviewees, in some cases, were saying that the components are implemented in parallel and/or in a continuous implementation. Of particular interest is the idea that the components had a synergy between them.

Result of the Hypothesis 2 Related Question: The question related to this hypothesis produced a variety of responses. While in 7 of 12 (58%) cases, interviewees agreed with the Hypothesis when directly asked, the interviewees also indicated that the components were parallel, overlapping and so on. Thus while the majority directly agreed with the statement, in actuality, at least 8/12 interviewee (67%) consider the components to be in parallel.

Hypothesis 3: Interviewed senior executives will utilize additional considerations beyond the ones currently being proposed in the model developed prior to the interviews.

The final hypothesis stated that interviewed senior executives utilize additional considerations beyond the ones currently being proposed in the model developed prior to the interviews. While eight of the twelve interviewees (67%) had no suggestion although at a later point one of the aforementioned eight interviewees suggested a feedback loop. Of the twelve interviewees three

³ Synergy is defined as an increased effectiveness or achievement produced by the combined action of the components. The effect is one that exceeds or enhances the sum of their individual effects. The Canadian Oxford Dictionary, edited by Katherine Barber, Oxford University Press Canada, Toronto, 1998.

(25%) suggested feedback loops and one (8%) discussed products as a knowledge creation process.

In answer to this question, interviewees gave the following answers:

4/12 interviewees (33%) said that a correction or feedback loop be included that provides the possibly for modifications in a company's approach.

1/12 interviewees (8%) said that knowledge is created as the components are completed creating a capability that increases over time.

8/12 interviewees (67%) had no suggestion for modifying the considerations being used in the proposed model.

2/12 interviewees (17%) said that few companies can completely induce.

Result of the Hypothesis 3 Related Question: Additional components were proposed by 4/12 interviewees (33%).

The Ordering of Concepts

From the interviewees came the idea that the concepts of anticipate, prepare and induce were not linear or sequential, instead they were parallel and iterative. In addition, some of the interviewees stated that companies are continuously implementing all three concepts. As well, there was the idea that there is a synergy between the concepts as noted in the following excerpts taken from 2 interviewees:

“When your preparing, right, the ability to anticipate increases because now you are smarter you can take a look at a lot clearly. So the induction and preparation clarifies or modifies your anticipation.”

“...what a company does to prepare has a direct impact on its ability to anticipate so there is a cycle that occurs between these two and of course as you anticipate and have more knowledge of that its going to change how you prepare. So these two things directly impact each other similarly how you prepare will have an impact on how you induce and what you can induce the action of inducing will also have an impact, once you see the results on how you prepare. Anticipating and inducing are also linked so all three of them are linked so its like one big system. It is not, it is definitely not a linear process.”

The above interviews imply a synergy between the concepts, in which each component affects the ability to complete the other two. The two implied references to a synergy between the component and the other interviewees’ direct references to parallelism and iterations leads to the conclusion that the three components should be considered a continuous state in which synergy exists between the components.

In response to the question concerning Hypothesis Three, four interviewees (33%) mentioned that a correction mechanism should be included, as demonstrated in the following two interviewee excerpts:

“There is definitely a correcting mechanism here so it’s not linear. Yeah then and that’s based on understanding what the market place is doing and understanding what the technology is doing. Being able to identifying it early enough and make the appropriate changes and rejig it. Whether it’s minor corrections it’s an adaptive process with a hopeful with a fairly small time constant.”

“...anticipating you have done your preparing and not you are busy trying to induce at the same time you are observing market behaviour. And changing your responses to that market behaviour so you are basically reacting to the market behaviour.”

The explicit mention of a correction concept re-inforces the concept that gathering external (and perhaps internal) information to align anticipating, preparing and inducing activities with the market and technology trends is a continuous activity for technology-based product companies.

Conclusions

It appears that the hypotheses were correct and that the interviewees agreed with the general approach suggested and provided new insights in terms of how they conduct their business decisions.

CHAPTER 8: REVISING THE MODEL

The remainder of the model will be examined in the following sections given the results of the interviews. The interviews uncovered several concepts that will have a significant impact on the model as it was presented in the Research Model section.

Time Segmented Information Stream

In this section several concepts expressed by the interviewees will be combined to form a new concept entitled: time segmented information streams.

Segmenting Time

The interviewees were each asked the time horizon that they use when they forecast market and technology trends. Four interviewees (33%) gave a forecasting horizon of 12-18 months while eight gave horizons of 2-5 years. Of interest was the linking of the forecast time horizons to defined intervals such as product cycles. Two interviewees (17%) specified that understanding trends two product cycles in advance was important. This is of interest because it introduces the concept of segmenting the trend forecast horizon. This type of segmentation means that trend information is to be gathered from each time fragment or section. Two interviewees (17%) expressed the segments in terms of technology or market generations. This suggests the need to identify and gather information from sources that are focused on providing information to understand particular future time segments of technology or market trends. Such information could

be gathered by soliciting opinions of future scenarios from leading market or technology visionaries.

It appears that understanding market and technology trends as time segments, with time segments being determined by product cycles or technology generations is a factor of consideration to the interviewees.

Information Streams

Each interviewee was asked a series of questions concerning the sources of information or activities undertaken to gather sufficient information to anticipate the market and technology trends. In addition, each was asked questions on approaches to inducing the market and preparing the company for inducing the market.

For anticipating, interviewees spoke of sources of information such as customers, competitive analysis, media, analysts, alliances, and associations.

While anticipating is an information focused activity, based on the answers given for preparing and inducing, these components are also information focused.

For preparing, interviewees were asked what made their company fast and/or responsive.

Two interviewees (17%) mentioned alliances as given in the following except:

“...one of the things we have done extremely well is work with partners of complementary technologies to understand what is happening to the bits and pieces that we are interconnecting. We typically have a better understanding of what is happening with those bits and pieces than just about anyone in the world. And as a result we are able to when those things change we are able to lead the market.”

As evidenced in the preceding excerpt, alliances are utilized to provide appropriate trend information.

In addition to the use of alliances for information gathering purposes, five interviewees (42%) mentioned knowledge of customer trends while one interviewee mentioned internal communication. These responses are all information focused with information divided into time segments.

The goal is to have advance notice of potential market trends or changes in order to prepare the organization to respond appropriately. Six interviewees (50%) said that knowledge of market trends is a significant consideration in being able to prepare the company to be fast and responsive. Five interviewees (42%) reported that identifying and tracking technology primitives is also a significant consideration.

This reinforces the earlier point that there is a synergy and overlap between the components because the information utilized in preparing comes from the Anticipate component of the model.

For inducing, a variety of approaches were suggested. However, a common thread with some of the suggestions was the concept of disseminating information about the new technology product to the market. Two interviewees (17%) mentioned communication with analysts, one interviewee (8%) mentioned disseminating information to the appropriate sources of information that end users of the product would utilize, and three interviewees mentioned the use of books, papers and seminars as dissemination approaches. One interviewee (8%) even expressed the activity of information dissemination to the market as a “conversation”. This conversation would be focused on disseminating the solution that the technology-based product offers and the conversation would change as the underlying technology or market environment changed.

There was a common information usage concept being expressed by interviewees when discussing anticipating, preparing and inducing. The interviewees were mentioning the concept that there exist sources of information or destinations for information that must be utilized in order to effectively anticipate, prepare and induce.

Time Segmented Information Stream

From the questions concerned with forecasting came the concept of a time segmented approach to forecasting. However, from the questions directed at anticipating sources of information for anticipating, preparing and inducing can also segmented by time. This means that for anticipating, it would be expected that sources of information or activities performed are chosen for their ability to understand the market and technology trends for a chosen time segment.

For anticipating the market and technology trends a number of responses given by the interviewees focused on understanding the current situation. Interviewees spoke of sources of information such as:

- 1) current customers (6/12 interviewees) (50%);
- 2) competitive analysis (1/12 interviewees) (8%);
- 3) analysts (2/12 interviewees) (17%);
- 4) tradeshow, conferences and media (3/12 interviewees) (25%); and,
- 5) associations (4/12 interviewees) (33%).

The preceding list could be sources of information on the current situation, and in some cases of future trends. Possible sources of information more clearly identified with future trends were:

- 1) Academic research (1/12 interviewees) (8%);
- 2) “fuzzy customer segments” (1/12 interviewees) (8%). Fuzzy customer segments were defined as customer sales outside a company’s defined niche market, for example, a software application targeted at the insurance industry being purchased by legal firms. The interviewee stated that these sales should be considered carefully because “Sometimes it is a precursor to the direction of the market”.
- 3) One interviewee (8%) indicated that a customer’s organization should be divided into segments and each segment interviewed or queried with some approach for indicators of future trends in the market. For example, queried individuals could include the individual in charge of deriving the client’s long term view of requirements, the individuals whose focus is on the next generation of requirements and the individuals whose focus is on the current requirements.
- 4) One interviewee (8%) mentioned customers who were “...customers who are a little bit further ahead curve than others who experience issues ... that everyone else will anticipate in future.”
- 5) Internal research was cited, by three interviewees (25%), as a source of information for future trends.

- 6) Alliances were cited as a means to gather information about future generations of the technology by two interviewees (17%).
- 7) Training was cited by one interviewee (8%) as an approach to generate ideas about possible future directions of technology.

“Because our experience is if you train someone in technology A you will fire up ideas about technology B, ... Or technology A plus one generation.”

These data show that information sources can be described in relation to an information stream segmented by time.

Anticipating: What Information Should be Gathered

Given a time segmented information stream, the next question to be addressed is what type of information should be gathered.

Market Trends

For market trends, one interviewee (8%) stated that the high level question to answer was to understand what clients want to do that they cannot do with the existing technology and, once these product constraints are identified, then build something that tries to remove the constraints. Another interviewee (8%) gave the questions to be addressed as:

“Where the market going to be, how big is it going to be, what is it going to look like, who are the players going to be, what are the customers going to be demanding.”

Technology Trends

Interviewees stated that the high level question for the technology trends was to discover what opportunities could be realized given the technology trends.

Six interviewees (50%) indicated the technology utilized in the product can be divided in “technology primitives”

“...what I am going to call primitives to some of the factors that are driving our markets just like there are shape primitives, you know, of which you can create other things. For example, if I took, I will call bandwidth a primitive, I’ll call processing speed a primitive, I’ll call network growth a primitive and other things...”

The concept expressed implies identifying the primitives and tracking the technology trends for the primitive.

The difficulty in determining possible opportunities inherent in the technology primitives lies in that the technology primitives can be combined in several ways to produce different products. Six interviewees (50%) indicated that a key competitive advantage comes from the right combination of technology primitives. Six interviewees (50%) indicated that opportunities can arise when the underlying support or infrastructure technology changes such as an increase in bandwidth. Four interviewees (33%) indicated that new opportunities arise when technologies that previously did not work together are converged to produce a new technology such as the computer and telephone that were converged to produce voice over the Internet.

Understanding the capabilities of a technology in the future is one question, the next question is which technology to chose from when there are competing technologies, as outlined in the following except:

“...we have on the technology side identified anywhere from 1-10 different types of technologies that we could investigate on which was these technologies evolve ... the evolution of any particular technology is it either splits up it either forks in the road or it dies.”

Understanding the Trend Information

Given the information is coming from the time segmented information stream and flowing into the company, the next question to be addressed is how to understand it such

that appropriate decisions can be made. Four interviewees (33%) indicated that in house expertise residing in the appropriate individuals is utilized to make sense of the information and make the appropriate decisions.

Nine interviewees (75%) utilize the adoption of technology life cycle and/or the technology life cycle in some way as an aid in their information analysis and decision making process. The interviewees don't make extensive analysis of the curves or use of the theories in detail. Instead the concepts derived from the theories are used to guide the process. The following two excerpts illustrate the usage of the theories as guidelines in the thinking process:

“ I don't know I mean this quite useful, crossing the chasm is quite useful. We talk about a lot of the terms James Moore⁴ brings to the table. So as a frame of reference we use it.”

“Yeah I mean we use them and reference them, its not sort of, you know, a huge part of our strategy and analysis and so on. But we do take elements from the ideas in there to sort of think what its more useful for us specifically the Moore model or whoever invented it before him.”

⁴ This is a reference to the book “Inside the Tornado” or “Crossing the Chasm” written by Geoffery Moore [Moore, 1995] in which he uses the Adoption of Technology Life Cycle Theory, originally developed by E. Rogers [Rogers, 1962], to give pragmatic guidelines for the growth of technology-based product firms.

or as one interviewee stated:

“Yeah we do, we use it as a tracking tool to create a common language around how we approach the market so that we can have that common language...”

Usefulness of the Technology Life Cycle

Ten interviewees (83%) indicated that their technology was influenced by changes in underlying technologies or by convergence of technologies or by one technology overcoming another and that individual technology primitives tend to follow the technology life cycle. Two interviewees (17%) indicated that the basic technology life cycle was not useful in situations where a corporation's technology was to some degree comprised of a composite or aggregate of a number of underlying technologies.

In addition, one interviewee (8%) noted that in many cases for software products old versions of the code almost immediately dropped off in sales when new versions were released. However, it should be noted that in some cases new versions of a software product contain the functionality of the old version as well.

One interviewee (8%) noted the use of partners would alter the curve's shape, ideally leading to a more rapid increment in capability than would normally be expected.

Indicators of Inflection points

Interviewees mentioned a number of indicators or sources of information that could indicate inflection points in the technology or market life cycle curves.

- 1) One interviewee (8%) mentioned that the first inflection point in the adoption of technology life cycle could have been achieved when customer referrers start becoming a significant source of new customers.**
- 2) Five interviewees (42%) mentioned that customer type was an indicator of the adoption of technology segment, particularly how the customer was going to use the product, for example, the early majority segment may buy a product in order to effect significant change in their capabilities:**

“You know are they buying to keep ahead of someone or are they buying to catch up with somebody. Those sorts of issues are indicators...”

- 3) One person (8%) mentioned analysts as a source to confirm the type of market segment that the product is now selling to.**
- 4) Three interviewees (25%) mentioned the rate of adoption or sales as indicator particularly as the rate changes.**

One interviewee (8%) mentioned that some technologies may never go through inflection points when the technology and market requirements are both undergoing rapid change. In such a situation, the technology and the market iterate back to the beginning parts of the life cycle curves.

Using the Life Cycles to Understand the Trend Information

It appears that with regard to the technology and market trends, executives at technology-based product companies are seeking the answers to the following questions:

- 1) How to combine technology primitives into a composite curve. Two interviewees (17%) indicated that the basic technology life cycle was not useful in situations where a corporation's technology was to some degree comprised of a composite or aggregate of a number of underlying technologies;
- 2) How to determine which of competing technologies is the appropriate choice;
- 3) How to discover technology opportunities when underlying technology primitives change. Seven interviewees (58%) mentioned that opportunities existed with changes in underlying technologies or convergence of technologies; and,

4) How to properly assess the direction of the market.

The technology life cycle curve can be utilized to gain an understanding of individual technology primitives and the adoption of technology life cycle curve can be used to provide an understanding of the market segments such as innovators and laggards. However, the four aforementioned questions appear to be largely dealt with through the expertise of the existing corporate personnel.

Preparing: Strategy

During the interviews the interviewees were asked to identify what type of strategy they employed. Six interviewees (50%) indicated that offering the total solution to the customer was their corporate approach. One person (8%) elaborated that services could be a significant part of the product offering. Four interviewees (33%) identified market niches, four (33%) indicated that their approach was to maximize growth, five (42%) indicated maximizing market share and two (17%) indicated to exploit emerging markets.

In addition, several approaches were suggested by the interviewees that were not outlined in the Research Model:

Technology Primitive Combinations

Four interviewees indicated that their strategy was to focus on achieving the optimal combination of technology primitives inherent in their technology. One interviewee

(17%) indicated that combinations that are successful in the market lead to the development of internal corporate knowledge on how to better recognize opportunities and make appropriate choices between various competing technologies.

Broad markets with Little Technology

One of the interviewees (8%) indicated that the strategy should be focused on choosing a technology-based product that has a large set of potential market niches with the minimum amount of technology development. The implications on preparing are that the organization has to be constructed in such a way to address a broad and possibly diverse set of markets.

Component Products

Two interviewees (17%) indicated that having a product that is made up of various component technologies allows fast response to changing market trends.

Partners to Broaden Resource Possibilities

Three interviewees (25%) indicated that partners were an integral part of preparing since they had resources that the company did not and thus could broaden the company's capabilities when required.

Knowledge of Trends

Five interviewees (42%) indicated that knowledge of customer trends was a significant factor in allowing the corporation lead-time for effecting the appropriate response to the customer environment. One interviewee (8%) mentioned alliances as a mechanism of achieving this lead-time since partners may have advance information of market trends.

Prepare Summary

In the revised model the first three approaches suggested by the interviewees imply that the organization should be structured to allow for flexibility⁵ concerning what technologies to utilize, what markets to service and what solution to offer. The focus on trend knowledge and partners suggest that an information orientation is critical to achieve the required flexibility.

⁵ Flexibility is defined as the ability to be adaptable, versatile; to adapt to circumstances; The Canadian Oxford Dictionary, edited by Katherine Barber, Oxford University Press Canada, Toronto, 1998.

In a military context, the decision process used by military commanders focuses on evaluating various military options, prioritization of those deemed feasible and implementation of the optimal option [Bowen and Liu, 2001]. In that context, one definition of flexibility is: "Flexibility is concerned with the ability to adapt to various possible changes that may occur in implementing a Course of Action (tactic). For example, flexibility is determined by mission time and location change flexibility, enemy change flexibility, enemy deception change flexibility, and resource availability change flexibility. " Basically, the definition covers the ability to react to changes in the environment.

Induce

Interviewees were asked questions focused on approaches to induce the market to adopt the new technology-based product. The responses covered a range of suggestions:

- 1) Two interviewees (17%) indicated that a new product should match prevailing technical standards;
- 2) Four interviewees (33%) mentioned the importance of initial sales to customer types or organizations that are significant in the customer's industry;
- 3) One interviewee (8%) mentioned the importance of pricing appropriately to the target market;
- 4) Three interviewees (25%) mentioned seminars or publishing papers and books on the affects of the new technology.
- 5) One interviewee (8%) mentioned the importance of encouraging third party applications to be developed using the new technology-based product;
- 6) Two interviewees (17%) mentioned that they attempted to make switching difficult for customers between their products and competitors;
- 7) Two interviewees (17%) mentioned the need for analysts to provide positive product information; and,
- 8) Three interviewees (25%) mentioned the need to sell the solution and not emphasize the technology.

In addition, there were the following suggestions:

Integrate with Other Products

While two interviewees (17%) indicated the potential of integrating a product with a more mature product, two other interviewees (17%) provided a variation of the integration concept. One interviewee (8%) emphasized the benefit of putting functionality or capability intended for future market needs, in a limited fashion into the current versions of the product. This provides a market awareness of the functionality when it is fully implemented in later versions of the product. In a similar fashion, one interviewee (8%) mentioned the importance of providing a product range with the low end product being an inducement to purchase the higher end product. The low end product contains limited functionality of the high end product.

Alignment with Partners

Two interviewees (17%) indicated that alignment with partners was a consideration but it should be such that the partner has a significant advantage from the partnership in relation to their market. For example, the partnership provides the partner with a greater lead time to market than competitors attempting to employ a similar technology.

“We do align our cycles with our partners...what we are trying to do for our customers is to provide them with a solution that allows them to get to market

faster one of the best ways to do that is to minimize the amount of R&D resources that they need to implement our solution.”

“...because it’s a technical sale and a technical supporting which consumes resources. So they in sense have the ability to introduce their products into the market place in advance to anyone else with the feature sets they get for ours. It’s a time to market advantage.”

Customer Core Business

One interviewee (8%) mentioned that innovators tend to be interested in realizing significant changes to their operating environment thus a new technology-based product selling into that market must be aimed at the customer’s core business. For example, a primary concern for airlines might be to keep the planes flying and a lesser interest might be in food services. Thus a new technology based product would maximize inducement potential by being focused on supporting the airline industry’s core business of flying.

Induce Summary

Inducing activities in the revised model can be grouped into two categories. The first category concerns the dissemination of information to the information stream through such mechanisms as seminars, books, papers, analysts and partners. The second category is appropriate technical and market alignment. Alignment, is broadly defined for the

purpose of the revised model, it covers alignment with standards, the customer's core business, partners, other products, third party vendors, and appropriate pricing models.

Representation

The preliminary representation scheme outlined in Appendix G was presented to the interviewees. Three interviewees (25%) had no suggestions for change. However, five interviewees (42%) expressed an opinion that the representation was too complicated and had suggestions ranging from labeling to utilizing representations such as Gantt charts, utilizing linear decision process frameworks, and computer software representation techniques such as object oriented views.

Anticipating

In order to anticipate market and technology trends properly each source of information should be considered for its potential to generate information in a particular time segment. In the following two dimensional figure the X and Y axis represent the foreseeable time horizon for a particular technology-based product, and, the market and technology trends of importance for that product. Within the two dimensional space are represented the time durations that each source of information provides.

As an illustrative example consider the following figure, it may be that market analysts can be utilized to understand market trends for a time duration starting in six months and

continuing to 30 months in the future, while industry associations can provide possibilities on more futuristic time segments. In addition perhaps lead customers might be more near term in their perspective on technology possibilities while the corporation's partners might provide possibilities for more futuristic time segments

Figure 15: Mapping Sources of Information to Time Segments

Obviously sources of information are not all the same in terms of reliability. Steps to include a reliability factor on information or examining the potential resulting from multiple sources of information covering the same time period were not examined in this research. For example, one interviewee (8%) stated they don't tend to listen to analysts because they are the source of information for the analysts and therefore simply hear back what they told the analysts. For them analysts are an unusable source since the analysts do not incorporate other sources of information.

Since information about technology trends is to be focused on the technology primitive of importance then, as illustrated in the following figure, the sources of information about technology possibilities must be further divided by identifying each primitive and the information source that will provide relevant information about it.

Figure 16: Detailed Sources of Information to Time Segments

As an illustrative example, the following technology primitives are estimated to begin the steepest part of each technology's adoption curve in the given year. This means that a figure such as preceding figure would need to be drawn detailing the source of trend information for each technology into the future (AMS, 2001):

- 1) Wireless web - 2002.
- 2) Bluetooth (short range wireless data transfer) - 2003.
- 3) Natural Language Processing - 2003.
- 4) Speech Recognition - 2005.
- 5) E-cash (electronic cash systems) - 2005.
- 6) Embedded miniature computers - 2007.

Assess

Assessing the information can be accomplished with the combination of expertise and the technology and adoption of technology life cycle theories.

As explained previously, the technology life cycle curve can be utilized to gain an understanding of individual technology primitives and the adoption of technology life cycle curve can be used to provide an understanding of the market's general position with respect to product acceptance. However, based on the interviews, company executives have four additional questions that they are concerned with:

- 1) How to combine technology primitives into a composite curve.
- 2) How to determine which of competing technologies is the appropriate choice;
- 3) How to discover technology opportunities when underlying technology primitives change; and,
- 4) How to properly assess the direction of the market.

Preparing

In the revised model preparing the company to induce a change in the market focuses on a single strategy: organizational flexibility. An information orientation is utilized to assist in achieving flexibility. In the following figure, there is only one strategy: flexibility. Tactics are focused on mechanisms to achieve flexibility.

Figure 17: Preparing the Organization

Inducing

Inducing activities in the revised model can be grouped into two categories as presented in the following figure.

As seen in the following figure, the first category of activities is titled: Alignment. This is broadly defined for the purpose of the revised model: it covers proper technical and market alignment with standards, the customer's core business, partners, other products, third party vendors, and appropriate pricing models.

Figure 18: Inducing

The second category of activities concerns the dissemination of information to the information stream through seminars, books, papers, analysts, partners and so on.

The approach of devising charts to indicate sources of information for anticipating would also hold for inducing the market.

Consider the use of technology standards. Technology standards ensure that a product matches applicable standards. This is a common technique to ensure market acceptance

of a new technology. However, it appears that standards can also be used in a proactive manner as indicated in the following interviewee quote:

“It tends to do two things one is it tends to drive the technology forward up the curve faster so and the other is it tends to help the market develop much more quickly.”

Standards can be used to create a common environment for a multitude of companies to work from and thus result in technology being developed faster than when a single company is developing the technology.

This implies that a similar chart needs to be prepared for inducing the market. The adoption of technology life cycle implies a time segmented information stream where innovators are near term users of the product and laggards are several time durations into the future.

In the following chart the market has been approached by ensuring each information source applicable to each adoption segment has been considered. For example, the following chart shows for Product A that the optimal way to reach innovators are through market analysts while the optimal way to reach laggards are through newspapers and magazines. In addition, the chart shows that innovators should be targeted some time before laggards.

Figure 19: Utilizing Time Segments to Induce

The Revised Model's Representation

The representation approach for the revised model follows the means-ends approach also referred to as the means-fundamental objectives approach [Clemen, 1996].

The fundamental goals of an organization would include maximize shareholder value [Clemen, 1996]. This goal might be accomplished by maximizing profitability and/or growth as in the situation of Amazon.com [Spector, 2000]. The interviewees specified goals in terms of finding opportunities, and dominating a market or creating new markets or market segments.

The revised model can be represented in the following objectives hierarchy. With anticipate, prepare and induce being means to accomplish the objectives of finding opportunities to dominate or create new markets or market segments [Clemen, 1996] which in turn are used to accomplish the fundamental goal of maximizing shareholder's value.

Figure 20: The Revised Model's Representation

In the above figure:

- Information is shown as time segmented and the technology-based product company's executives deliberately chose activities or sources of information that are focused on each time segment of interest;
- The technology and adoption of technology life cycles are used to gain a basic understanding of market and technology primitive trends. Expertise is used to address the higher level questions concerning technology and market trends;

- Anticipating, preparing and inducing are continuous states with synergy between the states;
- The objective of preparing is flexibility; and,
- The objective of inducing is to provide appropriate information to each of the relevant time segments and to align the company to the appropriate partner or standard, etc.

Summary of the Revised Model

The model presented in the preceding section is information oriented. Accessing the appropriate information, assessing such that anticipation of future trends is possible, preparing the organization appropriately and inducing the market by communicating the organization technology product or solution to the market are the main components of the revised model.

Perhaps the life cycle theories already offer some precedents for this approach. The theories, from one perspective, divide possible future events into segments and provide executives with an indication of actions to undertake given their technology/product position on a particular cycle.

CHAPTER 9: THE REVISED MODEL WITHIN THE OVERALL PLANNING PROCESS

In this section, the generalizability of the revised model will be examined by comparing it to an existing model in the literature that was designed for technology-based product companies.

A Planning Process for Technology-Based Product Companies

The strategic planning process is focused on selecting the business opportunities to be pursued by a corporation [Ryans et. al., 2000]. One planning process model suited for technology based companies contains ten phases and was developed by Adrian Ryans and his colleagues [Ryans et. al., 2000]:

- 1) Define the business area of opportunities - In this phase the corporation's planners must determine the market areas in which the corporation will target, for example, the financial industry or the automotive. For technology-based product companies this represents an additional challenge in that a given technology could be used in a variety of products and markets.
- 2) Identify attractive opportunities - In this phase, the market should be segmented and the potential profitability of each segment estimated. In addition, upcoming changes in the market or technology should be understood.
- 3) Understand the market environment - the flow of materials between the producers of raw materials and the end user should be defined in order to understand what

will cause the corporation's customers to switch suppliers. This requires an understanding of the customer's buying process and buying criteria. This analysis should result in information about barriers to adoption of new products or barriers to entry into existing markets.

- 4) **Assess resources and competencies** - The corporation's resources, both tangible such as manufacturing equipment, and intangible such as intellectual property must be assessed along with its knowledge and skills. The assessment could be an experience-based determination of the corporation's capability to meet the market requirements.
- 5) **Understand the competition** - The competition must be assessed relative to the corporation's resources and competencies. The focus is on the likelihood of market success as well as the strategy and tactics necessary for success.
- 6) **Make tough strategic choices** - In this phase the corporation reviews its experience, the individual opportunities and the opportunities as a group in order to determine where to focus its resources.
- 7) **Plan critical relationships** - In order to implement the strategic plan partners and alliances must be implemented. In this phase key partners are identified and plans to implement the relationships are devised.
- 8) **Complete the winning strategy** - The strategic plan's details are devised.
- 9) **Understand the profit dynamic** - At this point estimates of the market acceptance rates, product price, costs and investment forecasts can be made.
- 10) **Implement the strategy** - in this phase the plans are communicated to the organization, and, the necessary resources and responsibilities are allocated.

For technology-based companies with rapid changes in the market and technology, the plans need continuous modifications which leads to an iterative process (Ryans et. al., 2000).

Comparison to the Revised Model

The revised model in this thesis presents an approach that consists of three components:

- 1) Anticipate the market and technology possibilities;
- 2) Prepare the company; and,
- 3) Induce the market to change to the new technology-based product.

The revised model presented in this thesis could be merged with the Ryans model in the following way:

Anticipate - The revised model expands on the Ryans model by explicitly incorporating technology trends into the planning process. The revised model's anticipate component fits between the Ryans' Phase 1 and phase 2. In addition, the anticipate component overlaps phase 2. After the business area is identified in phase 1, the corporation needs an approach to anticipate both the technology and market. The revised model provides the approach to gather information and understand future possibilities. Phase 2 explicitly mentions the need to gather information about upcoming changes with providing detail on how to do that.

Prepare - The revised model's prepare component focuses on flexibility as its core strategy and provides a number of tactics for technology based products. The revised model's Prepare component provides an approach to implement the Ryans model's Phase 8: completing the winning strategy.

Induce - The revised model's induce component can supplement the Ryans model's Phase 10: Implement the strategy phase. The revised model gives an approach to inducing the market by understanding and influencing the time segmented information stream of the market and the product's underlying technology.

Suggested Modifications to The Planning Process Model

The Ryans et. al. planning process model is meant to be iterative and continuous [Ryans et. al., 2000]. This means that the process begins in phase 1 is followed to the end and then restarted. During the interviews additional concepts came forth that suggest modifications to the Ryans model.

First, of the revised model's three components: anticipate, prepare and induce, it is not clear as to which is actually the first, middle or last. In the Ryans planning process Phase 1 and 2 are similar to Anticipate, Phase 8 is similar to Prepare and Phase 10 is similar to Induce. The interviewees suggested that these phases could be implemented in a different order depending on the situation of the technology-

based product company. This suggests that a planning process model should be categorized along the lines of anticipate, prepare and induce without a fixed statement of ordering between the phases.

Second, the interviews also indicate that the technology-based product companies are continuously implementing the three components. This leads to the suggestion that Phases 1, 2, 8, and 10 of the Ryans planning process are always being implemented. In order for that to occur the rest of the phases to some degree need to be continuously implemented. Obviously major strategic decisions are not made every day, however, refinements can be considered frequently [Ryans et. al., 2000]. This leads to the suggestion that certain phases need to be designated as being constantly in an implementation state while others would be designed in an frequently or partially implementation state.

Third, the interviewees mentioned that the three components are synergistic. For example, the ability to prepare is influenced by the ability to anticipate. This suggests that in a planning process that a capability is developed for each phase which is influenced by the capability of the previous phases. Thus it should be clear to the planner that the capability of one component or phase influences the capability of another and planning should be focused on not just following the process but the process needs to be tailored to the company situation such that these influences are realized.

The Company's External Relationships

During Phase 7 of the Ryans planning process, the technology based product company is expected to develop the necessary relationships that are needed to implement the company's strategy [Ryans et. al., 2000]. A number of relationships are possible between the company, and, its suppliers, its customers and its partners [Ryans et. al., 2000]. One such relationship is the "learning alliance", the purpose of this relationship is for companies in the alliance to inform each other of trends, emerging needs and changing market conditions [Ryans et. al., 2000]. This concept was clearly expressed during the interviews. For technology-based product companies this learning alliance needs to focus on both the market and technology trends in a time segmented approach. In such an approach, alliance members are sought who have a perspective on a time segment of interest to the company.

Another relationship cited is the influence relationship. The influence relationship is a relationship whose purpose is to communicate with those who in turn influence a decision [Ryans et. al., 2000]. During the interviews this concept was expressed and, as in the previous relationship, members of this relationship need to be chosen for their ability to influence the market and/or the technology trends in required time segments.

Summary

It appears that the revised model can be integrated with a model published in the literature and by doing so takes into account issues such as competition and other external factors.

CHAPTER 10: A FURTHER ANALYSIS OF INTERVIEWS

This section describes a further analysis performed on the interview transcripts. To some degree, the interviews reveal the information processing models of the executives of technology-based product companies [Bettman, 1971]. When revising the research model with the results of the interviews it is useful to gain some understanding, for each interviewee, of the similarity/agreement with the other interviewees and with the revised model.

Bettman's Similarity Coefficient

One approach to analyze individual information processing models was developed by James Bettman (1971). His approach treats decision processes as directed graphs and measures similarity between the processes [Bettman, 1971]. A directed decision process assumes each concept in a decision process is connected by a directional arc leading from each concept or node to the next.

His approach involves examining the order and sequencing of the nodes through the individual decision process. Two decision processes would represent similar processes if the same nodes were ordered in the same manner and processed in the same sequence. Thus similarity can be measured with the "reachability" between nodes and the path taken to move from one node to another. A similarity coefficient would then be measured as follows: if two decision processes have a similar node i that reaches another similar

node j (node j is similar between the processes not with node i) then they are similar. If a decision process has unique nodes or unique paths this decreases similarity. The Bettman similarity coefficient ranges in value from zero to one [Bettman, 1971] if two or less paths exit each node.

Bettman's approach implicitly assumes only two or less arcs stem from each node. As evidenced in the analysis performed in this thesis, if a large number of arcs exit from a node, the maximum value of the Bettman coefficient is more than one. However, the Bettman coefficient is primarily to be utilized to examine relative similarity between process and is useful for such comparisons [Bettman, 1971] even when more than two paths exit from nodes.

The computation of this similarity coefficient is relatively straightforward and lends it self to computerized spreadsheet analysis (see Appendix E).

The first step of the computation is to construct a matrix for each decision process. For the matrix the number of rows and columns equals the number of nodes. The intersection of spreadsheet "cells" is the number of arcs between the nodes. For example, for a process consisting of nodes A, B, and C (A->B->C), the intersection of B and C in the matrix is one while the intersection of A and C is two. This means that the distance between B and C is one arc or a distance of one.

The similarity coefficient formula is computed by dividing a numerator by a denominator. The formula states that:

The numerator = number of nodes (maximum number of arcs + one)

The denominator = number of nodes (maximum number of arc+1) – half (sum of the cells for each matrix/process)

The similarity coefficient then equals the numerator divided by denominator.

The similarity coefficient should be interpreted only in making relative comparisons [Bettman, 1971]. It has no meaning in an absolute sense. In general, the higher the similarity coefficient the more similar the decision models are.

As an illustrative example, consider the node "Infrastructure company trends" in Appendix L. This node is one node away from the node "tech trends", two nodes away from "trends", three nodes away from "Anticipate" and four nodes away from "Anticipate, Prepare & Induce". Thus its matrix would look like:

	Anticipate, Prepare & Induce	Anticipate	trends	tech trends	Infrastructure company trends
Anticipate, Prepare & Induce	0	1	2	3	4
Anticipate	1	0	2	2	3
trends	2	1	0	1	2
tech trends	3	2	2	0	1
Infrastructure company trends	4	3	2	1	0

In the spreadsheet analysis, shown in Appendix E, all nodes are included in the computations, including nodes unique to an interviewee. Obviously a similarity coefficient would be higher if unique nodes were removed from the calculations [Bettman, 1971]. Table 3 displays the computed similarity coefficient according to Bettman approach for each interviewee compared with each other interviewee. As can be seen the numbers are similar ranging from .6 to .66 suggesting that the decision processes of each interviewee are similar to each other interviewee. The most similar were interviewees 6 and 2 while the least similar were interviewees 10 and 11, 10 and 12, 11 and 12.

Table 3: Interviewee vs. Interviewee Similarity Coefficients

	1	2	3	4	5	6	7	8	9	10	11
1											
2	0.65										
3	0.64	0.63									
4	0.65	0.65	0.63								
5	0.64	0.63	0.62	0.64							
6	0.66	0.65	0.64	0.66	0.64						
7	0.65	0.65	0.63	0.65	0.63	0.66					
8	0.64	0.63	0.62	0.64	0.62	0.64	0.63				
9	0.65	0.64	0.63	0.65	0.63	0.65	0.64	0.63			
10	0.62	0.62	0.61	0.62	0.61	0.63	0.62	0.61	0.62		
11	0.63	0.63	0.61	0.63	0.61	0.64	0.63	0.62	0.62	0.6	
12	0.63	0.63	0.62	0.63	0.62	0.64	0.63	0.62	0.63	0.6	0.6

In the following table each interviewee is compared to the revised model. The similarity coefficients range from 1.04 to 1.13 suggesting that interviewee one was most similar and interviewee 10 was the least similar to the revised model.

Table 4: Interviewee vs. Revised Model Similarity Coefficients

Interviewee	Bettman's Similarity Coefficient
1	1.13
2	1.11
3	1.08
4	1.12
5	1.08
6	1.14
7	1.12
8	1.08
9	1.11
10	1.04
11	1.06
12	1.06

Uniqueness Similarity Coefficient

Borrowing from the research completed by Bettman, an additional similarity coefficient is proposed in this thesis.

Assume that a similarity coefficient should be 1 when all twelve interviewees expressed each of the same concepts and it is zero when there are no shared concepts. Leaf nodes are then the individual concepts expressed by the interviewees, typically the right most node in the tree given in Appendix I. For example a "leaf" node is the concept of using prototypes to anticipate technology trends.

Thus a numerator would be: total number of leaf nodes * number of interviewees
– number of interviewees for each unique concept an interviewee expresses.

The denominator would be: total number of leaf nodes that an interviewee shared
with another interviewee * number of interviewees that shared the concept.

For example:

Let N = total number of leaf nodes

Let Y = total number of unique leaf nodes expressed by a given interviewee

Let Z = number of leaf concepts expressed by a given interviewee

$N=Y$ when all concepts are uniquely expressed by one individual and other interviewees do not express anything.

$N=Z$ when all concepts are shared by all interviewees

Therefore a completely unique interviewee should result in $((N*12)-(Y*12))/0*0 = 0$

An interviewee that completely expressed the same concepts (nodes) would result in $((N*12)-0)/Z*12 = 1$ (because $N=Z$)

In the following table for each interviewee, the number of leaf nodes, unique nodes, shared nodes and the interviewee's similarity coefficient is given. As can be seen the similarity coefficient ranges from .13 to .231.

Table 5: Interviewee Uniqueness Similarity Coefficients

Interviewee	Total Nodes	Unique Nodes	Shared Nodes	Number shared	Uniqueness Similarity Coefficient
1	29	10	19	57	0.211
2	28	1	20	70	0.231
3	24	8	15	62	0.206
4	26	7	19	73	0.164
5	23	2	21	78	0.154
6	31	7	24	76	0.158
7	30	10	20	65	0.185

8	25	7	18	83	0.145
9	28	7	21	92	0.13
10	18	6	12	58	0.207
11	21	4	17	71	0.169
12	21	4	17	86	0.14

In the following table the two similarity coefficients are compared sorted in ascending order by Bettman's coefficient. The second table display the coefficients sorted in ascending order by the similarity coefficient.

Table 6: Coefficients Sorted by Bettman's Coefficient

Interviewee	Bettman's Coefficient	Uniqueness Similarity Coefficient
10	1.04	0.207
11	1.06	0.169
12	1.06	0.14
3	1.08	0.206
5	1.08	0.154
8	1.08	0.145
2	1.11	0.231
9	1.11	0.13
4	1.12	0.164
7	1.12	0.185
1	1.13	0.211
6	1.14	0.158

Table 7: Coefficients Sorted by Similarity Coefficient

Interviewee	Bettman's Coefficient	Uniqueness Similarity Coefficient
9	1.11	0.13
12	1.06	0.14
8	1.08	0.145
5	1.08	0.154
6	1.14	0.158
4	1.12	0.164
11	1.06	0.169
7	1.12	0.185
3	1.08	0.206
10	1.04	0.207
1	1.13	0.211
2	1.11	0.231

Coefficient Issues

Several considerations concerning the applicability of such similarity coefficients to the present data should be mentioned:

- 1) Because an interviewee did not express a particular concern does not necessarily mean the interviewee doesn't agreed or utilize the concept, merely that the interviewee did not express it. Thus the interviewee might have agreed with a concept if it had been presented and the coefficients might have been different
- 2) There are in the revised model a number of nodes that are parallel or concurrent, for example, the approach to the market may utilize a number of parallel approaches such as analysts and media. Thus the position of the node is important, in addition, to the path and sequencing. This is not accounted for in the Bettman similarity coefficient.
- 3) If the research model had not been presented and the interviewees had been asked to explain their own model, the interviewees may have expressed somewhat different information processes.
- 4) The top sections of the revised model are stable in structure. It is in the bottom section or "leaf" nodes of the tree of nodes/concepts that differences appears. Thus similarity would be relatively high since a major part of the tree is the same across interviewees.

Similarity Coefficient Comparisons

The differences between the two coefficients are not surprising since they measure different things. The Bettman coefficient focuses on the structure and paths of the concept tree while the other coefficient measures the amount of unique and shared concepts at the “leaf” level without regard to the tree structure. In the preceding tables (Table six and seven), the Bettman coefficient is measuring each interviewee’s similarity to the revised model while the other coefficient is comparing each interviewee’s similarity to a complete shared or unique set of “leaf” nodes.

Summary

In general it appears that the interviewees were similar to each other and similar in their similarity to the revised model.

CHAPTER 11: IMPLICATIONS OF THE RESEARCH

This section presents some of the implications of the research. The original research model presented constrained choices that the executive in the technology-based product company must chose from a limited perspective of technology products was also presented. This perspective presented such products as being a single entity rather than being a composite of underlying technologies.

In the original research model executives would need to understand the market and technology trends and chose which strategy the company would undertake, for example, fast growth and/or concentration on market niches. The company must then prepare itself to induce the market by undertaking a number of activities. This was a sequential or linear model.

The revised model presented an information-oriented view of a technology based product company. The focus is on the activities associated with obtaining and disseminating information. Information is considered to be time dependent. Time is segmented and the company makes explicit efforts to obtain or disseminate information into the appropriate information time segments.

Preparing the organization means structuring the organization such that flexibility exists. Preparing relies on the information obtained from anticipating activities and involves implementing activities that will achieve flexibility for the organization. Inducing the

market is focused on disseminating information and enacting the appropriate technology and market alignment.

Within the revised model, there is only one strategy - creating flexibility. Only the sources of information and/or the activities utilized to obtain or disseminate information are varied given the corporation's situation.

When asked about constraints in growing a technology based product firm (such as a shortage of resources), two interviewees indicated that resources should not be considered a problem. One interviewee indicated their significant constraint was the ability for customers to understand leading edge technology. One interviewee indicated that the link between their customer and their customer's customer was a significant constraint since if the interviewee's business customer was not providing a solution of value to their customer then the interviewee's company suffered.

In the revised model, constraints are inherent in the ability to access or disseminate information. For example, analyst reports tend to be expensive, however, other approaches to derive similar information may be possible.

CHAPTER 12: LIMITATIONS AND GENERALIZABILITY

This section discusses both potential limitations and generalizability of the revised model developed.

Limitations

Some attempt was made to draw out limitations of the model from the interviewees themselves as expressed by the following interviewee:

"So in another words, if the technology is changing would I change to a different form of inducement? Displacement, I would say that there is no fundamental change in my in the preparation we use whether it's a convergence or displacement. I think the tools are absolutely the same."

This attempt did not result in any clear limitation ideas.

The available interview time was a limitation. Each interviewee was promised the interview would be approximately one hour and thus it was not always possible to explore some ideas in more depth or to provide much time to deviate from the interview questions.

This research focused on technology-based product companies, predominately with companies selling in the business to business market. The research results may not be applicable in variety of different situations, for example:

- 1) Non-technology related product companies;
- 2) Technology related service companies;
- 3) Consumer oriented products;
- 4) Large well established companies; and,
- 5) In different geographical/cultural environments.

The research did not gather information from companies that had failed. In addition, the research did not explicitly focus on companies who continued to market and support a technology until it had been replaced by another technology. While one of the companies had a broad enough product line that it covered a mature technology the research did not examine the approach of exploiting a technology until it matures and is eventually withdrawn from the market.

The revised model does not take into account a variety of external factors beyond technological and market trends, for example, financing opportunities for growth or competitive actions or possible government actions in terms of regulations.

The small number of interviewees could limit the generalizability of the revised model. While the research model was based on the literature, the revised model was developed

based on interviews with only 12 interviewees. In order to examine the generalizability of the revised model the literature was re-examined for confirmation of the revised model's concepts.

Generalizability

The literature has some indicators of the potential generalizability of the revised model.

Continuously Anticipating, Preparing and Inducing

Supporting evidence for the generalizability of the revised model can be found in literature that suggests approaches for technology-based product companies should be iterative [Garvin, 1995] or overlapping [Eisenhardt and Brown, 1998] or parallel [Moore, 1995]. Feedback from the market has been suggested in the literature as a method to provide the firm the ability to find appropriate markets and shape the product and its services [Lynn, Morone and Paulson, 1996].

The need for iterative and continuous models has been expressed in other models that focus on technology-based product companies [Ryans et. al., 2000]. In the model developed by Ryans et. al. (2000) the model contains the components of prepare and implement (induce) with a great deal of focus on the prepare component. The prepare component is further expressed in integrated phases such as [Ryans et. al., 2000]:

- 1) Define the business area of opportunities;
- 2) Identify attractive opportunities;
- 3) Understand the market environment;
- 4) Assess resources and competencies
- 5) Understand the competition
- 6) Create strategic options;
- 7) Plan critical relationships;
- 8) Complete the strategic plan; and,
- 9) Develop price, cost investment forecasts.

The revised model combines the iteration, overlapping, parallel and feedback concepts suggested by other models by suggesting that anticipating, preparing and inducing are continuous and synergistic states. Continuous implies that the company never leaves the state rather than the notion that a state is completed and then revisited at a later time. Synergistic implies that the components, when implemented in conjunction with the others, becomes greater than the sum of the parts.

The revised model further suggests that anticipating or understanding the market and technology in a time segmented fashion are also key requirements for technology based product companies.

The revised model further suggests that anticipating, preparing and inducing are not linear components. Indeed, as can be implied from the comments of some of the

interviewees there is no clear need to identify a component as definitely first, middle or last.

Time Segmented Information Streams

The revised model suggests technology-based product companies should consider the information stream as time segments. Similar concepts have been suggested in the literature, in particular that research activities by a technology-based product company should be focused on the near future along with longer range potential, and, the most likely future and lesser likely futures [Brown and Eisenhardt, 1997].

It has been stated in the literature that customer input into products that take several years to develop may not be appropriate [Veryzer, 1998]. In such situations, the product would not be completed for several years after the input would have been gathered and customers may have difficulty understanding or appreciating the potential product. This suggestion from the literature implies that other sources of input or insight should be considered given a product's development time frame.

In the model developed by Ryans et. al. (2001) the model contains the concept of a market web. A market web is defined as the relationships that a technology-based product company needs to create and manage. This market web of relationships can include [Ryans et. al., 2000]:

- 1) Collaborative product development;
- 2) Co-marketing;
- 3) Suppliers; and,
- 4) Influence.

Of interest is the learning alliance relationship [Ryans et. al., 2000]. This relationship is defined as a relationship between companies with the purpose of keeping each other informed of trends, emerging needs and market conditions.

The result of the research conducted in this work has expanded this need for learning beyond formal relationships into continuous informal contacts.

In addition, this learning requirement should be focused on both the technology and market in a time segmented approach.

Flexibility

Being flexible is not without precedent. It was a Netscape strategy during its early years [Yoffie and Cusumano, 1999]. In part Cisco's success comes from sticking to core values while switching tactics, products and people as necessary which suggests flexibility is prime concern [Bunnell and Brate, 2000].

Microsoft appears to practice such an approach with its systematic approach to examine the environment and develop plans to both react and shape it which suggests flexibility in their operations [Yoffie and Cusumano, 1999].

Model vs. Theory

A model is defined as: "a simplified description of a system, process, etc. put forward as a basis for theoretical or empirical understanding: a conceptual or mental representation of a thing." [Canadian Oxford Dictionary, 1998]

A theory is: "a supposition or system of ideas explaining something, esp. one based on general principles independent of the particular things to be explained." [Canadian Oxford Dictionary, 1998]

The researcher's goal in this thesis was to understand the particular approach used by technology-based product companies in bringing new technology products to market and through the first inflection point on the adoption of technology life cycle. This goal implies:

- A direct investigation of the system or process used by technology based product companies; and,
- The development of a conceptual or mental representation of this process or system that is not independent of the particular things to be explained.

Thus the thesis has been focused on developing a model of the system or process rather than a theory.

Summary

While the research was focused on technology-based companies and did not explore other types of companies, however, it does appear that there is support in the literature for many of the concepts uncovered during the research.

CHAPTER 13: CONCLUSIONS

The conclusions are divided into those about the hypotheses, the research approach and the revised model.

Hypotheses

In the research proposal there were three hypotheses:

Hypothesis 1

The first hypothesis stated that interviewed senior executives employ a strategic decision approach that includes components of the proposed model. Ten of the twelve interviewees (83%) agreed that the components of anticipate, prepare and induce were performed within their company. One (8%) of the twelve interviewees gave an irrelevant response and one (8%) of the twelve interviewees stated that the induce component should not be part of the model.

The responses to this question indicated that the concepts are understood and used by the interviewees. The statement by one interviewee indicated that inducing should not be part of the model, however, the other 11 interviewees did not indicate this. Perhaps this difference in interviewees means that the ability to

induce is depended on the situation of the technology-based product company. However this was not explored in the revised model and could be a topic for further research.

Hypothesis 2

The second hypothesis stated that interviewed senior executives do not use the components in the proposed order. The response from the interviewees to the questions focused on this hypothesis was mixed. When directly asked this question 7 of the twelve interviewees (58%) agreed that the components were in the correct order but in response to other questions came the assertions by the interviewees that components were parallel, overlapping or iterative. One of the aforementioned 7 interviewees along with two other interviewees mentioned that the components were overlapping. Two of the aforementioned 7 interviewees discussed the relationship between the components as synergistic. In addition, two interviewees (one interviewee being of the aforementioned 7 interviewees) suggested that there was no fixed ordering of the components and any one of them could come first, last or in middle depending on the situation.

The responses to this question provided the basis for the revision of the research model such that the concepts of preparation, anticipate and induce are represented

as continuous and parallel activities. In this approach there is no pre-determined starting point but it depends on the situation. The responses to this hypothesis-related question also provided the basis for the synergistic nature of the concepts since the success in one concept, such as prepare, affects the success in another such as induce. In order to build such a model without a predetermined starting point, with parallel and continuous activities, and, overlapping synergistic concepts it became necessary to envisage such an organization as being flexible. As one interviewee stated "...so its like one big system."

Hypothesis 3

The final hypothesis stated that interviewed senior executives utilize additional considerations beyond the ones currently being proposed in the model developed prior to the interviews. While eight of the twelve interviewees (67%) had no suggestion although at a later point one of the aforementioned eight interviewees suggested a feedback loop. Of the twelve interviewees three (25%) suggested feedback loops and one (8%) discussed products as a knowledge creation process.

The mention of a feedback loop and knowledge creation emphasized the synergistic nature of the components. Anticipating, preparing and inducing are knowledge creation activities such that technology-based products increased their

ability to be successful as they learned from during the execution of each activity and modified their approach accordingly.

Discussion of Hypothesis

During the interviews each hypothesis was addressed by posing a direct question to the respondents. For each of the three hypotheses the majority of the respondents agreed with the hypothesis. However, during the course of the interviews many ideas came forth which expanded or even contradicted their earlier responses to the hypothesis related questions. It appears that asking the questions in such a blunt manner may not have captured the respondent's true opinions. A binary yes/no response may have hidden a range of responses, for example:

- Agree;
- Mostly agree with some differences;
- Disagree with some similarities; or
- Disagree.

It was during the course of the interviews that the three major points discussed in this thesis came out as outlined in the preceding Generalizability section.

1) Flexibility

The following two quotes from two interviewees suggest the need for flexibility.

"For an internal perspective we are fairly we're fairly agile. We are kind of in a position right now we're kind of coming from a small company to a slightly larger company but at the same time we are fairly non bureaucratic we're streamlined empowering fairly flat organization we like to think we empower people people are still very creative. Like I said its fairly non bureaucratic."

"Well I think first of all we are a company which is purely focused on classifiers so we don't have 30 different products in here that are all fighting for resources. So we have a very specific narrowed scope and as the market and as our customers suggest different avenues for us to go down we are also not we are currently not encumbered with a backlog of customers so we at a fairly clean sheet. So very focused without a history and the ability to go in and tailor a solution to a customer's needs. And in a sense the first customer even a start up customer gets a lot of our attention so we are extremely responsive as an organization to small

startups and as a way of building credit because we recognize to get large tier one customers we need to have track record so we tend to be very responsive to the smaller start up customers of ours where other established companies would not be able to be any where as responsive to that. And tailor and prepare tailor our products very quickly to their needs."

2) Time Segmented Information Streams

The following three quotes from three interviewees suggest the need treat the future as separate time segments with different sources of information for the segments.

"However, we tend to look at it in terms of two major product cycles which is about three years and then we look at beyond and we have discrete things for that. You know, Blue sky sessions."

"...of looking that far into the future unless, you know, you are being funded to do that and we are not we are funded, you know to show fast growth and thus we sort of you know maybe 18 months max at a time. But generally were have shorter product cycles like 9 months or less and that's a function of the fast changing internet market..."

"... you know, you got to look a little further out just look at the whole area that we're involve with wireless data 3rd generation networks that in it self is 3-5 years that's where the number comes out. Like people talk about 3-G people talk about something come out in 2002, 2003, 2004. The industry itself is not clear right now from a technology point of view when products will come out for the device infrastructure point of view people aren't clear what their revenue generating applications are going to be. So there is a lot of unknowns and the further you go up the more nebulous and ambiguous..."

3) Continuously Anticipating, Preparing and Inducing

The following two quotes from two interviewees suggest the need to continuously anticipate, prepare and induce.

"You have to keep sampling and keep interpreting and keep revisiting the data and gathering more data and in the danger in a small organization especially is that you simply don't have the resources to continually manage the mining of all that information and the analysis of it."

"Yeah at the end of day what you're talking about here you've got a thought for some idea that you think there is a market need for that you need to test that through all of the phases until you actually have product

to deliver to customers so the inducing or testing is a constant effort it certainly. If that's what you mean by inducing then you do that all the time."

Research Approach

The research approach utilized in this dissertation performed satisfactorily. Preparing the model in advance resulted in two benefits:

- 1) It appears interviewees were more willing to grant an interview when they heard that a pre-existing model was going to be presented; and,
- 2) During the interview, the preexisting model provided a better basis for discussion than such a discussion probably would have been otherwise. This remark is based on the author's prior experience with open-ended interviews.

The Revised Model

Models are generally simplified versions of phenomena of interest and may not fully capture reality but focus on only some aspects [Davis and Cosenza, 1988; Lilien and Rangaswamy, 1998]. In other words, they are a "picture of reality" [Hartman et. al., 1998].

Models have a number of benefits [Lilien and Rangaswamy, 1998]:

- 1. Improves consistency of decisions.**
- 2. Facilitates exploring of options.**
- 3. Facilitates the assessing of the relative impact of variables.**

An appropriate framework for planning would appear to provide a mechanism for the corporation to focus on [Stacey, 1992]:

- 1) Generating new perspectives on what is going to occur;**
- 2) Structuring the planning issue in useful forms; and,**
- 3) Noticing potential and possibility.**

The information orientation of the revised model suggests that utilizing the "time segmented information stream" is of importance in technology-based product companies and that the key strategy of this model is to develop corporate flexibility. The revised model in response to Stacey's and Lilien and Rangaswamy's suggested guidelines for an appropriate framework provides:

- 1) Questions regarding the technology and market trends that need to be addressed.**
- 2) The indication that the technology and adoption of technology life cycle curves or some of the concepts within them coupled with human expertise can generate perspectives on what could occur. Perhaps the usage of the life cycle curves**

focuses on just the likely timing of inflection points between states [Goodman and Lawless, 1994].

- 3) A model to assist in structuring the executives' approach to the growth of the company for improved and consistent decisions.
- 4) A model focused on determining potential opportunity or options in the market and the technology.

In developing a model there are several ways to evaluate it [Lilien and Rangaswamy, 1998]:

Specification – Given the model represents the variable and their relationships, are the model results actionable by management?

Calibration – Can the model be calibrated (data values entered) with managerial judgement or historical data?

Validity and Value – Does the model provide value to the user; does the level of detail match that in available data; does the model reproduce the business environment reasonably well?

Usability – is the model easy to use; is the model as implemented easy to understand; does the model give guidance that makes sense?

In terms of assessing the revised model, it was the focus of the interviews to gather information to a model such that the results are actionable by management. The data utilized in the model can be calibrated by managerial judgement or historical data. In terms of value to the user one interviewee made the following comments:

"Let me take a second to kind of internalize it but in terms of a model, the model makes sense as discrete steps it makes complete sense to me. You know each one of these represents a world of activities. off the top of my head I would have to say that it makes total sense to me ... So these are these are, I think this is a reasonable approach. This is a reasonable example."

In terms of usability, the model was designed to provide guidance.

In keeping with a pragmatic focus, the revised model is a descriptive model and therefore focuses on modeling the approaches utilized by the executives interviewed. It does not attempt a more normative approach and provide an outline of what executives should do [Ryans et. al., 2000].

Finally, perhaps the real purpose of planning is not to make plans but to make mental models for decision makers to utilize when making decisions. Since plans in fast moving companies can become out-of-date in a relatively short time period. The mental model then provides the basis for daily decisions [Ryans et. al., 2000].

The Evolution of the Model

The original framework presented an approach to determining where a technology was in its technology and market life cycle and then presented the need to find suitable strategies and implementation tactics. This framework had several unanswered questions such as how to determine the best approach to select the most suitable strategy.

Based on the literature review this framework evolved into a model suitable for technology-based product companies. The life cycles were used to anticipate future possibilities for the technology and its market. Activities were suggested that could gather or generate the necessary information to find the technology's appropriate position on the life cycles. Three main concepts were suggested (anticipate, prepare and induce) as the abstract activities of the company. Strategies and tactics suitable for technology-based product firms were selected for preparing and inducing.

The revised model incorporated information on the non-linear nature of the three main concepts and the continued role of managerial expertise in anticipating possible future scenarios for the technology and the market. As well, the revised model incorporated the need for flexibility as an important strategy for technology-based product companies. In addition, the revised model took into account the need to carefully monitor and influence the technology-based product's future. This involved actively gathering information about relevant time segments and influencing the possible future market and technology environment for the better of the company.

Interviewee Emphasis

During the interviews the interviewees sometimes put great emphasis on certain ideas. This emphasis may have been expressed in body language or other non verbal clues. The interviewees emphasized:

- 1) The non-linear nature of the anticipate, prepare and induce concepts. In particular, they emphasized that these concepts were parallel, overlapping, iterative, and synergistic. They also emphasized the issue that there may not be any one concept that precedes the others.
- 2) That life cycles, while useful, would not be used if mathematical or other forms of analysis were necessary to determine the position on the life cycle. In particular management judgement was the preferred approach.
- 3) Any visual representation of the revised model should not be complicated.
- 4) One interviewee (8%) emphasized that products were really knowledge and as a company progresses this knowledge grew and thus he emphasized that the company should be focused on this knowledge growth. Another interviewee (8%) partly echoed that concept when he described the company's product line as a "conversation" with the customer. Over time this conversation evolved but doesn't

necessarily focus on product functionality or price but on the "solution" and improvement possibilities for the customer's organization.

- 5) One interviewee (8%) strongly emphasized the need for all technology-based product companies to have a single individual responsible for the product's technology development and marketing.
- 6) The use of time as a segmented concept and that each segment had to be influenced and monitored was strongly emphasized as seen in the following quote by one interviewee:

" Anyhow, as an example we have some technologies we are developing which are addressing markets that might only exist for another two years. We have other technologies we are developing that we think will address markets that we think we reach their prime in the next five years. We have some technologies that we think will address markets in the next ten years. And in the later technologies we are focusing mostly on what we think the technology will look like and the market will look like when it reaches its prime but we are also talking about where the next step will be beyond that. So we have conversations discussions within the company, our partners, customer and what have you. That talk about next next year and we have ones that talk about ten years out. Beyond that its you know

beyond ten years its tough to have to have too much of a vision about, we do have some conversations beyond ten years. Not many. "

Implications of the Evolution in the Model and the Interviewee Emphasis

The revised model contains differences from the research model. Given that the research model was based on the literature, this suggests implications in terms of how interviewed executives actually approach taking technology-based products to market.

- 1) Executives interviewed don't see a start and end point in their planning and implementation process since each start point could differ depending on the company's goals or resources.
- 2) Activities such as anticipate and prepare are not sequential but concurrent and thus planning approaches must incorporate a method where preparing and inducing could be happening at the same time.
- 3) Planning approaches need to be simple to utilize and communicate since the implementation of the end-result is through out the organization.
- 4) For technology-based product companies, the ability to anticipate and influence the future is an ongoing and critical activity. Thus planning approaches need to incorporate the strategy of influencing the future as an important approach.

- 5) If products are considered manifestations of a particular technology and a particular technology as a manifestation of the corporation's knowledge. Then planning process models need to incorporate a growth in corporate knowledge as the corporate progresses and thus each planning iteration is not independent of other iterations.
- 6) Interviewed executives indicated that they are always in a combined anticipate, prepare and induce state. Thus models presented in the literature need to incorporate the continuous state of the combined concepts.

Comment on the Revised Model

The revised model presents an approach that has overlapping, parallel phases that are synergistic and continuous in nature. The companies interviewed for this thesis are all technology based product companies. One question that can be asked was whether the business decision approach encountered in these companies reflects the technical background of the senior company executives. A complete answer is beyond the scope of this thesis, however, this section suggests that the technical background of the senior executives of such companies may influence the decision approach they employ in the business aspects of their companies. The business aspects or business decisions being their approach to anticipating, preparing and inducing the market for new technology-based products as presented in the revised model. This section presents concepts prevalent in the development of software systems as compared to the aforementioned concepts of the revised model.

Sequential Software Development Phases

As discussed previously software development has a life cycle beginning with a requirement and ending in a maintenance phase [Roetzheim, 1991; Shumate and Keller, 1992]. The definition phase attempts to gain a sufficient understanding of the user's problem in order to estimate cost, resources required and time [Rakko, 1990]. The analysis phase is focused on defining exactly what the system will do for the user and how it will fit into the user's computer environment. The design phase involves specifying the details of each function in the system. The programming phase is the coding of the system in a computer language(s). The next phase involves testing the system to ensure it works and meets the design. The system is then installed, used and maintained [Rakko, 1990]. In some cases a prototyping phase is conducted as part of the design or analysis phases. In such a phase sample screens or functions may be constructed as an aid to clarifying the users requirements or clarifying the necessary design of the system [Rakko, 1990]. Each phase usually has a clear transition from one to the next [Shumate and Keller, 1992]. This transition could be a formal meeting to accept that a phase is completed and the next may begin.

Some software systems require the use of code modules that operate in parallel [Shumate and Keller, 1992]. Thus the design must consider the concurrency of code modules that might be operating in parallel in such a system. The operating system gives each module a duration of execution time and holds the state values in memory for all the other

modules [Shumate and Keller, 1992]. The other modules are also being executed when they are allocated processing time by the operating system.

Given the preceding description, the software life cycle shares some similarities to the research model discussed in previous sections. The revised model and the software life cycle are both phased models with movements from one phase to the next. While modules of code may operate in parallel the preceding software development methodology's phases does not.

Iterative Software Development Phases

Another software development methodology focuses on situations where the requirements are uncertain or volatile [Fowler, 2001]. In such situations the user group may be unable to clearly articulate or envisage the functionality of the proposed software system. As the user sees the system during various stages of development, new ideas or changes to ideas may occur that then ripple changes through requirements, design and code [Fowler, 2001]. Without stable requirements the design is also unstable and the coding process can experience frequent change requests resulting in cost and duration overruns [Fowler, 2001].

A development methodology that is designed for such situations is termed "agile" [Fowler, 2001]. In such an approach a general concept of the system is agreed upon and the system is build with iterative phases. Each phase begins with a short list of features

or functions. These features are completely or partly constructed and tested as one iteration of the methodology. For example, the functions of a data entry screen are discussed and then programmed including any necessary database. This is then tested and the functions for the next screen, perhaps a report generation screen, are then discussed and so on. The iterative approach has the following phases:

1. **Develop an Overall Model** - the user group and development team gain an understanding of what the overall system should do, for example, the general functions of an accounting system.
2. **Build a Features List** - a screen or functionality is chosen and detailed in a list. Perhaps a screen prototype is constructed to illustrate ideas. For example, the data entry fields for entering personnel information in the accounting system are discussed along with the necessary functions to add, delete, and modify entries.
3. **Plan by Feature** - a development plan involving time, resources and costs is developed for some or all of the functions in the list.
4. **Program and test the Feature** - the agreed upon features are programmed and tested.

Phases 2 to 4 are iterative, the methodology cycles as phase 4 is done. With each iteration the features designated as part of the development iteration could be specified as completed or re-worked.

The Two Software Development Methodologies

The first software development life cycle described involved providing a detailed plan followed by development and then usage.

The agile approach involves developing enough of a plan such that work can begin on a function or screen or other such module. With a shorter development cycle, changes can be accommodated at the end of each phase. During each iteration new ideas and suggestions for modifications can be accumulated and reviewed prior to the beginning of the next iteration. For example, a simple base system could be constructed perhaps a report generation screen and future development focuses on building on that base system [Fowler, 2001].

While the first software development approach discussed was phased, the phases were not revisited and the system architecture was completed in advance of any programming.

However, with the latter approach, phases could be implemented in parallel. After a sufficient number of phases are completed parts of the system could be used operationally by the users, for example, perhaps data entry modules could be implemented in an attempt to begin data gathering before the report functionality is ready. Phases could be repeated when a module doesn't completely represent what the user needs or those needs have changed. Thus such an approach could mean a development approach with parallel, overlapping and synergistic iterations or phases. In

addition, some of the phases could be out of order if coding samples of screens or modules began first as an approach to assist in uncovering requirements. Or if parts of the system were implemented before other parts were started. A project could continuously be in each of the phases until the system is deemed completed. Such a description is similar to the description of the revised model.

Examples

Cisco is a large manufacturer of switches, routers and other telecommunications gear [Keuffel, 2000]. Cisco build an "Internetworking Products Center" (IPC) system that could grow with the company [Keuffel, 2000]. The system's usage grew from 300 to 1,200 orders per day. The system was built in 1997 on a server-side Java system and such that Cisco could link the IPC with Cisco's Oracle financial system [Keuffel, 2000].

The project team employed a defined four-phase life cycle development process, which included needs assessment, requirements analysis, development, and testing and deployment activities [Keuffel, 2000]. Within the needs assessment phase, the capabilities, scope, requirements, costs and schedule are defined and delivered to the client as findings and recommendations. In the analysis phase, the deliverables include a requirements specification, a system model and project plan, specifications for the system architecture, and prototypes for the architecture and user interfaces. In the development phase, design documentation and source code are created, and unit testing begins. Functional demonstrations are provided as each milestone is completed. Finally, in the

testing and deployment phase, system testing and user acceptance are addressed [Keuffel, 2000].

One interesting aspect of this project is the organization structure of the business unit that build the IPC application reflects software engineering methodologies. The development business unit has a CEO with a software background and he has structured the company around small software development teams and extensive communication with other teams for verification of results. He has developed an internal knowledge base for constant preparation of software developers for the challenges that they may encounter in future projects [Keuffel, 2000]. Essentially the CEO has developed a company that reflects software engineering methods including an internal knowledge base which could reflect the engineering technical notes used by some companies. Such notes are sometimes referred to as "tech notes" and document lessons learned on various projects or issues.

While the aforementioned Cisco project used an approach that followed the first methodology mentioned in this section. A continuously online retail point-of-sale (POS) product built in Java on a distributed system used an "agile" development approach [Evans, 2001].

The POS (point of sale) software product for grocery stores allows shoppers to check out and pay for their own groceries without a store cashier [Evans, 2001]. The system consists of four Customer Work Stations (CWS) and one Attendant Work Station (AWS), at which a store employee monitors and intervenes in the checkout sessions on the CWSs.

Each CWS and the AWS can also be operated as a regular, staffed checkout lane to meet peak-demand needs. The system tracked 100,000 items in some grocery stores, including their physical weight. It interacts with other related software systems, this allowed more than 250 individual configuration parameters to be modified for any store [Evans, 2001].

Conclusion: Software Methodologies as a Business Approach

The two software approaches described in this section contain some similarities to the research model and the revised model. The first example described a system build using the first methodology and the second described a system build using the second methodology. In answer to the question as to whether business decision approaches in technology-based companies could be influenced by technology development methodologies of senior executives with technical backgrounds, the first example, described a technology company in which the CEO used software development methodology concepts in his organization structure.

It may be possible that senior executives of technology based companies who have a technical background might have been exposed to technology development approaches such as the "agile" methodology. Such people might adapt this methodology to problems they face in strategic planning. Therefore, the results in this research study could have been influenced by such technology development methodologies. In addition executives might inherently use a business decision approach similar to the "agile" method description in this section, and therefore, similar to the research model.

CHAPTER 14: FURTHER RESEARCH

This research has resulted in a number of further research questions.

There are several areas for further research already discussed in the limitations section, for example, the research could be repeated for a larger sample of companies or in different geographical areas or for larger sized companies. The focus could be on devising a standard questionnaire that lends itself to statistical analysis, measurement of reliability, and sampling approaches leading to defined generalizability.

The revised model itself can be explored further. For example, accessing the information gathered, gathering more tactics, making appropriate decisions for preparing and inducing, and, providing a more direct consideration of competitive actions are all topics the research identifies as worthy of further exploration.

Assessing

It appears that executives of technology-based product companies utilize the basic concepts of the Adoption of Technology and the Technology Life Cycle Theories but the executives do not formally position their technology/product on the curves in order to generate the potential to perform further analysis. While the Technology Life Cycle theory might be useful in providing assistance in assessing the possible trends of technology primitives there are several open questions:

- 1) There needs to be an approach to combine technology primitives into a composite curve.
- 2) There needs to be an approach to determine which of competing technologies is the appropriate choice.
- 2) There needs to be an approach to discover technology opportunities when underlying technology primitives change. These opportunities could result from the convergence of technologies, discontinuities between technologies or changes in the technological infrastructure.
- 4) One interviewee speculated on whether the Adoption of Technology Life Cycle and the Technology Life Cycle curve could be combined. Perhaps if the two curves were combined into one it might reveal market opportunities given different technology primitive combinations.

Approaches devised to address each of the aforementioned issues have major constraints imposed on them by executives in technology-based product companies. The approaches need to be easy to use and can be used with limited data requirements. Based on the results of the current research, specially when the interviewees were presented with a graphical representation of the model, any devised approaches should preferably be graphical or can be utilized with small amounts of textual information.

Tactics

Further research could uncover more information sources or activities for anticipating, preparing and inducing.

Decision Making

Further research could explore the tradeoffs between different anticipating, preparing and inducing tactics and devise a mechanism to chose the most appropriate given the company's situation.

Competition

Competitive actions need to be investigated further. One interviewee mentioned that their approach was to follow the market and not induce. This suggests that anticipating competitive actions is important. While competitive actions could be covered under the concept of anticipating market trends, the inducement actions, in some cases, may need to properly consider the actions of significant competitors.

Other Factors

In addition to competition, there are other considerations that the model could incorporate, for example, other strategies than flexibility could be addressed.

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APPENDIX A: THEORIES, MODELS AND FRAMEWORKS

Theory

A theory can be defined as an interrelated set of statements whose purpose is to explain and predict. A theory can also be described as "an ordered set of assertions about a generic behaviour or structure assumed to hold throughout a significantly broad range of specific instances [Weick, 1989]. A theory is a way of making sense of a situation. Theory would appear to be a device for interpreting and unifying established laws and modifying them to fit situational data and guiding the enterprise of discovering new and more powerful generalizations.

It is suggested in the literature that scientific inquiry should contain three elements, theory building, development of correspondence rules and observation [Hartman et. al., 1998]. These three elements are a process beginning with theory and leading to observation [Hartman et. al., 1998]. Correspondence rules give definitions for some of the theoretical terms in the form of observation terms, for example, "Managerial success" could be defined as constantly increasing profits and labour peace [Hartman et. al., 1998]. These rules suggest how to apply the theory to appropriate facts. In general, the theory forms the relationship between concepts that are unobservable such as micro-particles or potential or motivation while at the observation level is a model of utilizing observed terms such as profit.

In the exploratory stage of research the focus is on defining and providing operational definitions of the theoretical constructs and linking the observed variables to the unobservable theoretical constructs [Hughes, Price and Marrs, 1986]. Later the research focus could shift to confirming a theory. For example a model is constructed that represents the hypothesized relationships among the theoretical constructs and to the operational measures [Hughes, Price and Marrs, 1986].

Model

A model can be defined as a highly formalized representation of a theory. Models are used as representations of theoretical systems so they can be examined, tested and analyzed. Models are generally simplified versions of phenomena of interest and may not fully capture reality but focus on only some aspects [Davis and Cosenza, 1988; Lilien and Rangaswamy, 1998]. In other words, they are a "picture of reality" [Hartman et. al., 1998].

Models have a number of benefits [Lilien and Rangaswamy, 1998]:

1. Improves consistency of decisions.
2. Facilitates exploring of options.
3. Facilitates the assessing of the relative impact of variables.

Models and Theories

A model-based theory is built by first constructing a conceptual approach and subjecting this network to an empirical test. For example, the segmentation theory explores relationships between customer characteristics, responses to product and marketing strategy. A segmentation model based on the theory utilizes dependent and independent variables to formulate a testable model of consumer segmentation [Lilien and Rangaswamy, 1998].

Theory Building

One approach to theory building is through case studies [Eisenhardt, 1989]. A general methodology that has been used to study decision making in eight high tech microcomputer firms is:

1. Definition of research question and a priori constructs. A priori constructs help shape the initial design of the theory building interviews and allow a well defined focus aimed at specific sought after data. However, each of the apriori constructs are not certain of survival when exposed to the data gathered in the field, since the collected data could refute a particular construct.
2. Selecting cases based on theoretical applicability i.e. those that replicate or extend theory by filling conceptual categories. Selection helps control extraneous variation and define the limits for generalizing.

3. Instrumentation such as interviews.
4. Data collection and analysis have some overlap to guide direction of interviews. In some cases multiple investigators allow separation of duties between recording notes and asking questions which can result in different perspectives.
5. Analysis across and within cases. Analysis can include a focus on differences between interviewed companies or between similar companies. Analysis can also look for similarities between different companies.
6. Shaping of hypothesis by tabulation of evidence for each construct, and replication logic across cases to confirm, extend and sharpen theory. Replication logic implies that emergent relationships between constructs fit with the evidence in each case.
7. Literature review to determine internal validity and examine generalizability.
8. Closure comes when marginal improvement becomes small given the data. This can occur when an observed phenomena becomes repetitive.

Such an approach has the strength of potentially developing novel theories and resulting in testable empirically valid theories [Eisenhardt, 1989]. Such an approach provides a closer link to the empirical data and moves beyond the weaker approaches of developing theory by combining observations from previous literature with common sense and experience. For example the development of theories in which the relationships between the theoretical constructs are not directly observable [Hughes, Price and Marrs, 1986].

It is useful in situations where little is known about a phenomena, or the literature suggests a new approach is possible. Weaknesses of case-based theory building include: development of narrow focused theories or theories which are too broad in nature to be useful.

Theory Evaluation

The term theory is more of a measure rather than a description of an absolute term [Weick, 1989]. This means that the more fully a generalization satisfies the criteria of theory the more it deserves the theory label. The theory can be measured along the dimensions of ordered, generic and range. As the generalizations become more hierarchically ordered, behaviours and structures become more generic and the range of specific instances that are explained becomes broader then the more appropriate of the theory label.

A theory is a plausible theory and of higher quality if it is interesting, a source of unexpected connections, high in narrative rationality, aesthetically pleasing, or corresponds to realities [Weick, 1989].

Verification and validation are used interchangeably to indicate that it has been demonstrated beyond random chance that the ordered relationship predicted by the hypothesis exists.

Eisenhardt suggests that since the point of the process is to begin the life of a theory then evaluation criteria could focus on whether the new theory is parsimonious, logically coherent, testable [Eisenhardt, 1989] and grounded in convincing evidence.

Kuhn suggests that absolute verification of a theory is impossible, since it is impossible to expose a theory to all possible tests and thus the question could be: what is the probability of theory validation given current evidence [Kuhn, 1970]. This clearly is a difficult task given all the new evidence that constantly arises in some fields. A short cut could be through the usage of the "falsification" approach in which the aim is to find evidence which will render the entire theory invalid. The difficulty is determining true falsification evidence from anomalous evidence that may not be cause for falsification. This approach has the weakness in that no theory ever solves all the puzzles at a given time. Indeed, it is the incompleteness and imperfection of the existing data-theory fit that defines many of the puzzles that characterize normal science otherwise all theories would be rejected at one time or another. It therefore seems to make little sense to suggest that verification is establishing the agreement of fact and theory.

Another approach is to then compare a theory to other competing theories given the same set of evidence e.g. observed data, the focus would be on which theories fit the facts better e.g. competing theories. This could be as easy as counting the number of problems solved by one theory vs. another. This approach also has problems in that theories might

have different perspectives/definitions and/or not be completely focused on the same problem set. Thus arguments arise as to whether the tests are truly fair.

In the end, for new theories perhaps given their crudeness the most suitable verification may be subjective measures such as a theory's "suitability" or "simplicity" given the available evidence. In some cases such subjective measures are decisive since a new theory may have been tested against fewer problems than established theories and its solutions may be far from perfect. However, the subjective expertise or experience of the reviewer may be used to gain an indication of the potential superiority of the theory over any others. According to Kuhn (1970), theories are evaluated on the accuracy, consistency, scope, simplicity and fruitfulness.

Kuhn's approach takes a relativist view of the world and suggests that concepts are explained relative to a specific conceptual framework or paradigm [Bernstein, 1983]. As opposed to objectivism that believes that is a permanent, ahistorical matrix or framework that provides universal truths, standards, evaluation criteria, etc. It has been argued that social science needs relativism since data is not necessarily detachable from theory, understanding of theory gives meaning to facts and intentions rather than deductive explanation [Bernstein, 1983].

Frameworks

A framework is a basic conceptual structure (as of ideas) <the framework of the constitution> or a skeletal openwork, or structural frame [Merriam-Webster, 2000] perhaps used to classify observations.

The word theory is used instead of the phrase "framework" to imply the development of a structure that could be tested and utilized in a pragmatic setting [Davis and Cosenza, 1988]. A "framework" is often taken to imply a conceptual structure that is not testable in the sense of testing hypothesis.

APPENDIX B: SIMILARITY COEFFICIENT SPREADSHEETS

In the enclosed spreadsheet the calculations for Bettman's similarity coefficient are performed (Bettman, 1971).

The spreadsheet is divided into the following parts:

- 1) Each interviewee's matrix is presented.
- 2) The formulas for denominator and numerator are presented. In cell D1984 the value of lambda used throughout the calculations is given.
- 3) The calculations for comparing each interviewee vs. each other interviewee are given.
- 4) The revised model is presented next; and,
- 5) The calculations for the revised model vs. each interviewee is performed the end of the spreadsheet.

The spreadsheet is a Microsoft Excel 97 spreadsheet for Windows.

APPENDIX C: ANALYZING UNSTRUCTURED TEXT DATA ⁶

Introduction

NUD*IST (Nonnumerical Unstructured Data by Indexing, Searching and Theorizing) [Sagepub, 2000] offers a toolkit for exploration and analysis of qualitative data. By supporting processes of coding in an index system, searching and theorizing about data such as unstructured, rich and complex text, for example, transcripts of unstructured conversational interviews, evidence transcripts, historical or literary documents, personnel records, or an anthropologist's field notes.

NUD*IST is designed to support both creativity and efficiency.

- Discover new ideas, make locations (nodes) to keep them stored safely and build on them, and then link these with with ideas from literature or prior study;
- Store and change (and immediately view) definitions and memos on your ideas;
- Record hunches, guesses, and theories early in a project;
- Explore and code documents, (imported or external);
- Build up thinking about data by combining and exploring categories, re-coding documents;
- Develop ideas flexibly, altering, merging and shifting the categories, refining dimensions;
- Apply prior concepts and theories to documentary data;

⁶ This appendix is an abridged version of information from the product website www.sagepub.com, 2000

- Browse and rethink coded data, recoding as you explore what has been coded, and moving between the ideas and the source or other linked ideas;
- Clarify ideas, discover and monitor the occurrence of themes;
- Minimise the clerical routine of importing, sorting and retrieving data;
- Automate the coding of your documents for demographic information etc.;
- Import and export data in tables to link with statistical programmes, spreadsheets, etcetera;
- Handle cases and materials about them;
- Monitor analysis processes or team contributions in dated memos about the data.

Figure 21: Example Transcript Being Coded

Indexes and Nodes

NUD*IST creates an Index System in which ideas and categories can be created, managed and explored. The Index System allows storage of references to the data (documents) and analysis at "nodes".

Nodes are the containers for thinking about the data, places to keep emerging ideas and their links with data. The index system can contain any number of nodes, at which can be done any amount of coding of documents and storing of ideas.

- Nodes are also the way to ask many qualitative questions, about the intertwining of themes, or the occurrences of patterns. These are asked through the Text and Index Search tools and nodes are the way to identify the text to be searched or restrictions to be placed on the search.
- Nodes are also the results of the questions asked; when searching, NUD*IST saves the answer as a node so you can continue to ask another question.
- Nodes can be stored in either a "free" collection of categories or a hierarchical "tree" structure
- The management of nodes in trees allows researchers to explore and order categories.
- Nodes can be graphically viewed and reports generated.

- Information about coding of sectors of documents or whole documents at these categories;
- A record of the ways these ideas are developed.

Researchers find the index system becomes an image of and container for thinking about the project. By exploring and searching it, they see the state of the project, the range and relationships of ideas generated by data, the nature of prior theory, the amount of data collected in each area under investigation, and the need for new directions of data collection.

Analysis

The search tools allows questions to be asked about the relationships between the categories and patterns. This includes not only questions about the presence of concepts but their relationship between them

Index Search has been mentioned as a way of asking a question (do I have any document annotations coded at this topic?), or pursuing a theme (collect up all the coding at the nodes below “CONFLICT”) or teasing patterns apart (is it just the women saying this?).

Questions about the relationship between categories, are done by searching the index system for relationships between the coding at two or more of the nodes. In this way you can explore your ideas, how they are linked and the relationships between them and the

data. If you just want to know what is coded at one particular category all you need to do is browse, or make a report on, that node.

Interesting questions, about the relationship between categories, about patterns of coding, about the differences between text coded at one and another category, are necessary to interrogate the emerging meanings, push theory forward and test and build on guesses, to get very fine access to data, exploring just some material, or “fracturing” the data to compare different areas, or to ask questions about broader pictures, scooping up a lot of material to rethink and recode. For example, do I have any document annotations coded at this topic?, or pursuing a theme (collect up all the coding at the nodes below “CONFLICT”) or teasing patterns apart (is it just the women saying this?). You ask such questions by searching the Index System.

Here is a simple example (see the following figure), suppose you want to find where people talk about smoking in the office as unpleasant. There is already a node for all text (on-line or off-line) where people are talking about smoking in the office (node (2 2 1) “/smoking/contexts/office”), and another for where people are talking of smoking as unpleasant (node (2 1 1) “/smoking/images/unpleasant”). You can get the desired result by doing an Index Search for the Intersect of those two nodes. Their intersection is all the text units coded by both those nodes - here that will be the text units where people are coded as talking about both smoking in the office and smoking as unpleasant.

Figure 23: Example Analysis

APPENDIX D: UNCERTAINTY AND RISK

Uncertainty

Uncertainty is defined as the extent to which a number of alternatives are perceived to possibly occur for an event and the relative probability of these alternatives. Uncertainty implies a lack of predictability of structure or information. An increased amount of appropriate information could be used to reduce uncertainty. [Lilien and Rangaswamy, 1998; Rogers, 1995].

Uncertainty has also been defined as simply the absence of necessary information [Daft and Lengel, 1984; Lewis, 1998]. Uncertainty can be defined as the lack of sureness about someone or something and may range from a falling short of certainty to an almost complete lack of conviction or knowledge especially about an outcome or result [Merriam-Webster, 2000].

Uncertainty can also be defined: "as a situation in which the decision maker is "completely ignorant" (vague) as to which state of nature prevails." e.g. no probabilities known by the decision maker. [Luce and Raiffe, 1957]

Technical uncertainty is the extent of difficulty in determining reliability, capacity and precision of the new technology or whether the newer technology will appear to make current technology obsolete [Gerwin, 1998].

Financial uncertainty is the extent to which the innovation will produce an acceptable return on investment [Gerwin, 1998].

Uncertainty in Planning

A plan can be defined as a sequence of intended actions established before the action is undertaken [Stacey, 1992]. Uncertainty makes the planning process difficult due to the difficulty in predicting outcomes or setting reasonable performance levels [Goodman and Lawless, 1994]. In addition, monitoring of results is complicated by the uncertainty of knowing what data to collect, how to account for unexpected effects and even how to measure the results [Goodman and Lawless, 1994].

With the high level of uncertainty in the technology-based product field, practices that mitigate risk and manage uncertainty are a key to success [Mullins and Sutherland, 1998]. Although many strategy formulation techniques exist, little information is provided to guide decision makers as they attempt to determine the appropriate strategy [Goodman and Lawless, 1994].

Preparing for Uncertainty

Uncertainty can be addressed in a variety of ways, one of which is to attempt to forecast various outcomes and then prepare for them, perhaps focusing on the most likely outcome. However, in some cases the events unfold and fail to fit into foreseen

scenarios, this reduces the potency of such plans [Allaire and Fisirotu, 1989]. Uncertainty can be reduced by properly defining the risk and passing it on to others [Allaire and Fisirotu, 1989]. For example, fixed price arrangements, minimum volume, cost-plus arrangements. A third approach is to increase flexibility and adaptability to reduce the vulnerability to uncontrollable events [Allaire and Fisirotu, 1989]. This calls for broadening the product and market scope of the firm. Canon concentrates on developing a number of generic technologies that may be combined to generate new products, new markets or react to new opportunities [Allaire and Fisirotu, 1989].

Risk

One definition of risk is: "a probability distribution over a set of states is known - or, better yet, the decision maker deems it suitable to act as if it were known." Then it is a case of decision making under risk. [Luce and Raiffa, 1957].

Ambiguity

Epstein and Zhang (2001) present a summary of the relationship between uncertainty and risk.

At least since 1921, economists have provided a distinction between risk and ambiguity [Epstein and Zhang, 2001]. Risk refers to situations where the likelihood of events can be represented by a probability measure. Ambiguity is present when an event does not

have sufficient information available such that the decision maker can assign probabilities to events [Epstein and Zhang, 2001]. Uncertainty can be defined to encompass both risk and ambiguity.

APPENDIX E: REPRESENTATION SCHEME PRESENTED IN INTERVIEWS

This section presents an approach to graphically represent a technology-based company's approach to anticipate, prepare and induce a transition. This section defines the components of the graph, and then defines the rules for utilizing the components [Thorpe, 1999].

In general, each tactic is an implementation of one or more strategies. In some situations when devising strategies and tactics there might be a number of assumptions that have been utilized that should be expressed. As well, there might be uncertainty regarding the possibility of achieving an outcome, for example, the competitor's reaction to a market initiative.

The Graphical Components

Strategies are the relatively stable concepts that the company is following such as an attempt to maximize market share.

Tactics are initiatives undertaken to realize a corporate strategy. A tactic should not be undertaken unless it supports a strategy.

Activities are the individual projects or tasks to gather information or implement a tactic.

Outcomes are results of activities that the company undertakes. Typically outcomes are expressed such that measurement can be taken, for example, increased sales

or reduced time to processing cycle time. Outcomes are always expressed in the past tense.

Assumptions are necessary conditions for realizing the outcomes or initiatives they can include situational factors such as resource constraints. Assumptions may involve the competitor's reaction to a market launch or a statement about the product user or an internal factor such as learning curve requirements. Assumptions may be outside the company's control.

Links are connections between the various components on the graph. Links could be expressed as action sentences, for example, a link between a tactic and outcome could be "will reduce the online transaction cost".

Uncertainty is a measure assigned to an outcome or assumption and notes the possibility that the outcome may not occur. It should address questions such, as are present conditions likely to persist, are new players likely, what will the competition do?

Graphical Component Rules

Each component on the graph has rules regarding its usage.

Strategies:

- 1) Each strategy is connected to a tactic.
- 2) Each strategy is represented as a square.

Tactics [Porter, 1996]:

- 1) Each tactic is connected to one or more strategies.
- 2) Represented as a rounded rectangle.

Activities:

- 1) Each activity is succeeded by an outcome.
- 2) Activities can be ongoing or unique internal projects or external initiatives.
- 3) Each activity is represents as a double bordered rounded rectangle.

Outcomes:

- 1) Are preceded by one or more activities.
- 2) Are expressed in the past tense, for example, increased gross sales.
- 3) Could be preceded by one or more assumptions.

4) Should be measurable. While there could be some outcomes which contain subjective measures or not directly measurable. Outcomes, that are final, in other words are not succeeded by another activity should be directly measurable.

5) Represented by a circle.

Assumptions:

1) Are linked to outcomes.

2) There are of two kinds - That which the corporate has some control over such as hiring, internal processes, communication approaches, etc. That which the corporation has lesser control over such as favourable R&D results, legislation, competitor reactions or customer adoption rates.

3) Are represented by a hexagon.

Links:

1) Links connect all the other components on the graph.

2) Can be expressed as an action or effect statement such: Will reduce process time

3) Are represented as a line.

Uncertainty:

1) Connected to an outcome that has an assumption.

2) Express the possible effect on the outcome if the assumption is wrong.

- 3) Each alternate assumption has an uncertainty.
- 4) Has a likelihood of occurrence.
- 5) Could be connected to alternate outcomes. Depending on the level of complexity desired.
- 6) Represented as an octagon.

Representation Example

In the following example, assume that a hypothetical company desires to represent its approach to anticipate, prepare and induce a market transition. Assume it is a software company that produces a web based voice recognition product and the company desires to create a transition in the market for voice over the internet. The company's approach is as follows:

Assumptions:

The company assumes that new resources or alliances are not forthcoming and must operate with what it has e.g. limited resources and alliances.

Information Gathering Activities:

Due to limited resources publicly available information must be utilized. The information sources are patent applications, Intel press releases, market research

reports, technology conferences and magazine articles on dynamic HTML (DHTML).

Information Assessment Activities:

The company utilizes heuristics to anticipate the possible transition time frame utilizing the technology and adoption of technology life cycles.

Strategy:

The company decides that maximizing market share in a new market is the optimal approach.

Tactics:

In order to realize the market share the company decides that responsiveness is the optimal tactic.

Activities:

The company implements a web-based real-time software application that provides the functionality for the web site user to interact with sales personnel.

Induce the Transition:

The company decides to give away its software to the media.

Figure 24: Graphical Representation Example

APPENDIX F: INTERVIEW QUESTIONS

Interviews

This document contains the set of interview questions. There is always a risk involved in revealing corporate strategy/tactics that competitors might benefit from. This risk will be alleviated by ensuring that companies will not be identified in the dissertation and by informing them of this risk.

The interview will be accompanied by a presentation that contains the proposed model including the three components of anticipating, preparing and inducing along with the Technology Life Cycle and Adoption of Technology Life Cycle Theories. The interview will be semi-structured, in that the questions could serve as starting points for a discussion.

Transitions

Q1. Are the following the only transitions?

- 1.1) When a technology or product passes through the first inflection point on one or both of the curves.**
- 1.2) When a technology is ready to replace the current market infrastructure's technology for example, 286 computer with a 386 computer.**

1.3) When two technologies are converging to produce a new technology and market, for example, communications and computers.

1.4) When a technology required to support the current infrastructure is changed, for example, an increase in network band width could drive a higher demand for visual/audio internet-based phones.

Anticipating

Q2. What activities does your company do to anticipate future directions/trends in the market?

Q3. What information sources does your company utilize to anticipate future directions/trends in the market?

Q4. What activities does your company utilize to anticipate future directions/trends in technology?

Q5. What information sources does your company utilize to anticipate future directions/trends in the technology?

For the above activities:

- How far into the future does your company project for market and technology trends?

Q6. Does your company use the Technology Life Theory to anticipate possible future technology scenarios?

Q7. Does your company use the Adoption of Technology Life Cycle Theory to anticipate possible future market scenarios?

Q8. Does your company use any other framework or theory or approach to provide guidance in understanding current technology and market observations? Please describe it.

Q9. How are the information sources or activities utilized to guide in understanding current technology and market observations?

Q10. How does your company know the technology is in or about to be in transition?

Q11. How does your company know the market is in or about to be in transition i.e indicators or heuristics are used?

Q12. Is your product(s) near, in or beyond the transition point?

Preparing

Q13. Does your company follow any of these strategies:

- **Get big fast - maximize revenue and size of the company.**
- **Provide the total customer solution.**

- Focus on achieving maximum market share.
- Watch for emerging markets and utilize them.
- Other?

Q14. What does your company do to make it responsive to market and technology changes?

Q15. What does your company do to make it's processes short in duration (operating at so called "internet time")?

Inducing

Q16. What activities does your company do (or could do) to make the technology go through a transition point?

Q17. What activities does your company do (or could do) to make the general target market switch to a new product based on new technologies?

General Questions

The following questions focus on the interactions between the preceding ideas or their applicability to different situations.

Q18. Must all the preparation ideas you suggested be implemented?

Q19. Are the preparation ideas linked in some way e.g. sequentially?

Q20. Must all the inducing ideas you suggested be implemented?

Q21. Are the inducing ideas linked in some way e.g. sequentially?

Q22. How does corporate constraints e.g. resources, alliances, size, competition, etc. effect corporate ability to anticipate, prepare and induce?

Q23. How could tactics, strategies or activities be tailored to fit the firm's resources or capabilities?

Q24. Would the preparing or inducing approaches change given the type of transition e.g. convergence or infrastructure transition?

Q25. Would the preparing or inducing approaches change given the type of technology-based product, for example, a hardware product vs. a software product?

Q26. Does your company utilize a strategic decision approach that includes components of the proposed approach e.g. anticipate, prepare and induce?

Q27. Does your company use the proposed components, etc. in the proposed order?

Q28. Are there any other approaches, components that your company uses that are not covered in the proposed approach?

Representation

Q29. Do you have any suggestions on the proposed representation approach?

APPENDIX G: INTERVIEW PRESENTATION

A Model for Assisting in the Growth of Technology-based Product Firms

**James Bowen
Ph.D. Student
School of Business
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722-3008 ext. 225**

Anticipate, Prepare and Induce

- Anticipate - Assess the technology and market for potential rapid growth in technology capability or market growth.
- Prepare - Implement a set of actions to prepare the company for rapid growth in technology capability or market growth.
- Induce - Instigate a change in the technology's product market penetration and/or create a rapid increase in the technology capabilities of a technology.

Transitions

- The introduction of a new technology-based product might change the market by providing new functionality, requiring new user behaviours or allowing new possibilities. This change in the represents a "transition" e.g. Microprocessors.

Technology Life Cycle Curve

- Relationship between the amount of resources (personnel, effort and investment) and improvements in technological performance.
- In general, a new technology's performance improves as more R&D resources are spent.
- At the beginning of its life cycle, a technology's performance capabilities start to increase. At a certain point the technology starts to reach its maximum and additional R&D begins to show small increments in additional performance. The limit at the top of the S curve means that eventually the technology will not show further improvement.
- Question 1

Anticipating

- Conduct activities and/or gather information to understand current state or future directions/trends of the the technology and the market.
- Utilize activity output or information gained in an some approach to anticipate a possible transition.
- Questions 2, 3, 4, 5.

Adoption of Technology Life Cycle

- The introduction of something new in the market as *perceived by the customer* is an innovation.
- The adoption of technology follows a life cycle.
- Each stage has some distinguishing characteristics.
- Questions 6, 7, 8, 9, 10, 11.

Percent of Adoption

Rate of Adoption

Preparing

- Conduct activities to prepare the company for the transition. • Questions 12, 13, 14, 15.
- For example, concentrate on growing the size of the organization or its post-transition market share potential.

Inducing

Activities to make a technology or market go through a transition point.

Become Widely Distributed

Reduce the need for Services

Develop a Community

Integrate the Product into a More Mature

Media and Advertising

Curtail the Ability to Switch

Make Purchasing Easy

Organizational Segmenting

Sell the Solution, not the Technology

Organizational Positioning

Cycle Alignment

- Questions 16, 17.

Inducing

Heuristics Explained

- Activities to make a technology or market go through a transition point.

Become Widely Distributed

- Give away the intellectual property of the company. For example, Cisco induced the transition to its router technology by giving its accompanying source code away or Sun's Java or Netscape's browser code.

Develop a Community

- Users can get a sense of personal interaction as the company provides information or access to resources to assist in the usage of the product. In the case of Amazon.com, a staff of editors provides book reviews and other information.

Media and Advertising

- At SAP press coverage is always handled at the senior level and while sometimes not favourable, coverage increased their profile

Make Purchasing Easy

- Amazon.com has an ordering process in which orders can be recorded and processed in a very simple steps.

Sell the Solution, not the Technology

- The uncertainty associated with the technology can be reduced by emphasizing the solutions it provides, not necessarily its features.

Reduce the need for Services

- In some cases, the services that accompany a new product are a significant revenue source. For example, SAP's ratio of product cost to implementation costs has reportedly been from 1 to 8 or 1 to 20.

Integrate the Product into a More Mature

- Focus on integrating the product technology into a product already in its growth or mature stage.

Curtail the Ability to Switch

- Introducing discontinuous product releases could make switching of products easier.

Organizational Segmenting

- Each unit in the organization can be at a separate stage of adoption.

Organizational Positioning

- Communicate the corporation's power position in the chain of suppliers, partners and customers. Customers have a sense of comfort that choosing this technology and vendor is not a mistake.

Cycle Alignment

- For example, the annual computer review by technology magazines. Releasing a product just before the review means the reviewer is examining the latest of the product along with perhaps an older version of the competitors.

- Questions 16, 17.

General

- Following questions focus on the interactions between the preceding ideas or their applicability to different situations.
- Questions 18, 19, 20, 21, 22, 23, 24, 25.

Decision Approach

- Questions 26, 27, 28.

Representation

A methodology to facilitate the technology-based firm's graphical representation of its approach to anticipate, prepare and induce a transition.

Strategies

Tactics

Activities

Outcomes

Assumptions

Links

Uncertainty

Example

• Question 29.

APPENDIX H: INFORMED CONSENT FORM

Informed Consent Form

Page 1 of 2

An informed consent form is required by the Carleton University Ethics Committee to ensure human subjects participating in a study are informed of the conditions of the research including its risks, and the subject's rights and privacy. Informed consent assists in fulfilling the requirement in both ethics and law: to protect and promote human dignity in human subject based research.

The Carleton University Ethics Committee Chair is Professor Klaus Pohle who can be reached at 520-2600 ext 7434 or 520-2516 if complaints should arise.

The research is in support of a Ph.D. dissertation from the School of Business. If any further information is required, please contact:

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Purpose of Research: A model has been proposed that could assist executives in technology-based product companies to anticipate, prepare and induce market changes that could positively affect their new technology-based product. The purpose of the research is to present this model and determine if the executives can validate or modify/enhance the model.

This research will involve the presentation of the model and an interview discussion that will utilize the enclosed questions.

The duration is expected to last 1-1 1/2 hours with only one interview, with the possibly of some follow-up questions aimed at clarification at a later time.

The locale is in the subject's office or meeting room.

Risks/benefits: Each participant could benefit from the introduction of the model. There is always a risk involved in revealing corporate strategy/tactics that competitors might benefit from. Companies will only be identified in the dissertation given prior permission.

The participants will receive a copy of the research results by email.

Informed Consent Form

Page 2 of 2

Anonymity/confidentiality:

- The interviews will be transcribed by a commercial organization or by the researcher.
- A software package will be used that provides functionality to identify concepts and structure them into frameworks.
- The data and analysis will be store and conducted on the student's personal computer of which no one else has access to. This laptop is password protected.

The subject retains the right to withdraw or not answer all questions without any penalty.

This signature merely documents that the subject was informed about what the research would entail, and, on this basis, agrees to participate. A research subject's signature in no way constitutes a waiver of her/his rights.

Name of Subject:

Signature of Subject

Signature of Researcher

Date:

Date:

Company:

Address:

City:

Postal Code:

Email:

Phone Number:

I hereby agree to have the aforementioned company identified in the dissertation as appropriate:

Name of Subject:

Signature of Subject:

Date:

APPENDIX I: CONCEPT HIERARCHY

In this section is presented the hierarchy developed using Nud*st. At the end of “leaf” is the number of interviewees who mentioned the concepts.

(1)Anticipate, Prepare&Induce

(1 1)Anticipate

(1 1 2)trends

(1 1 2 1)tech trends

(1 1 2 1 1)infrastructure company trends(1)

(1 1 2 1 2)internal research(1)

(1 1 2 1 3)prototype/trials(3)

(1 1 2 1 4)seminars,tradeshows,conferences(2)

(1 1 2 1 5)training(1)

(1 1 2 2)market trends

(1 1 2 2 1)academic research(1)

(1 1 2 2 2)analyze customer by technology generation (1)

(1 1 2 2 3)anaysts(2)

(1 1 2 2 4)competitive analysis(1)

(1 1 2 2 5)customer to limited degree(1)

(1 1 2 2 6)customers(6)

(1 1 2 2 7)customers'customer(2)

(1 1 2 2 8)customers: look for their constraints(1)

(1 1 2 2 9)internal staff(2)

(1 1 2 2 10)lead customers(1)

(1 1 2 2 11)associations(4)

(1 1 2 2 12)fuzzy customer segments(1)

(1 1 2 3)tech and market trends

(1 1 2 3 1)customer(3)

(1 1 2 3 2)innovative culture(2)

(1 1 2 3 3)Alliances with companies(2)

(1 1 2 3 4)innovative culture: product development

manager(1)

(1 1 2 3 5)media(1)

(1 1 3)forecasting intervals

(1 1 3 1)12-18 months(4)

(1 1 3 2)2 product cycles(2)

(1 1 3 3)2-5 yrs(5)

(1 1 3 4)update frequently(1)

(1 1 3 5)depends on market window(1)

(1 1 3 6)different intervals for different generations of

technology(1)

(1 1 3 7)review old forecasts(1)

(1 1 3 8)several time windows: 1-10 yrs(1)

- (1 1 3 9)tech:2-3 yrs(1)
 - (1 1 3 10)what to forecast(1)
 - (1 1 3 11)market: 1-2 yrs(1)
- (1 1 4)anticipate: concept of product (1)
- (1 1 5)anticipate/prepare/induce concept: same regardless of tech (1)
- (1 1 6)indicators of curve position
 - (1 1 6 1)customer referrers(1)
 - (1 1 6 2)customer type/behaviour(2)
 - (1 1 6 3)customers type/sales,etc.(4)
 - (1 1 6 4)rate of adoption(1)
 - (1 1 6 5)analysts(1)
 - (1 1 6 6)rate of growth(2)
 - (1 1 6 7)inflection points in tech: industry gurus(1)
 - (1 1 6 8)inflection points in market:sales force(1)
- (1 1 7)use of TLC and ATLC curves
 - (1 1 7 1)use of them informally(8)
 - (1 1 7 2)Informally(8)
 - (1 1 7 3)formally(3)
 - (1 1 7 4)no(1)
 - (1 1 7 5)use other theories?
 - (1 1 7 5 1)no(3)
 - (1 1 7 5 2)internal developed(2)
 - (1 1 7 5 3)sort of(9)
- (1 1 8)technology life curve
 - (1 1 8 1)technology convergence = opportunity(4)
 - (1 1 8 2)effected by business environment(1)
 - (1 1 8 3)discontinuities(1)
 - (1 1 8 4)technology infrastructure= opportunity(3)
 - (1 1 8 5)overlay market and tech curves(1)
 - (1 1 8 6)not useful for technology clusters(1)
 - (1 1 8 7)not useful for software(1)
 - (1 1 8 8)never progress always in first part of curve(1)
 - (1 1 8 9)examples cover all(10)
 - (1 1 8 10)alliances modify investment(1)
- (1 1 9)ATLC: measures risk tolerance of market type(1)
- (1 2)Prepare
 - (1 2 1)fast/responsive
 - (1 2 1 1)culture(2)
 - (1 2 1 2)knowledge of customer trends(5)
 - (1 2 1 3)education/communication internally(1)
 - (1 2 1 4)good anticipate/prepare/induce capability(1)
 - (1 2 1 5)management preferences(1)
 - (1 2 1 6)product is components(2)
 - (1 2 1 7)trials/prototypes(2)
 - (1 2 1 8)alliances make speed(1)
 - (1 2 1 9)narrow product range(1)

(1 2 2)Strategy

- (1 2 2 1)total customer solution(6)**
- (1 2 2 2)service with product(1)**
- (1 2 2 3)prechasm=solution(1)**
- (1 2 2 4)market niche(1)**
- (1 2 2 5)little tech, broad market(1)**
- (1 2 2 6)get big fast(4)**
- (1 2 2 7)alignment with current tech(1)**
- (1 2 2 8)sell solution(3)**
- (1 2 2 9)products= knowledge creation(1)**
- (1 2 2 10)primatives insync(2)**
- (1 2 2 11)market share(5)**
- (1 2 2 12)identify key technology primatives(6)**
- (1 2 2 13)financing:delayed(1)**
- (1 2 2 14)emerging markets(2)**
- (1 2 2 15)define perfectly whole product/solution(1)**
- (1 2 2 16)competitive advantage right primitive combination(4)**
- (1 2 2 17)community(1)**
- (1 2 2 18)alliances:expand resources(3)**

(1 3)Induce

- (1 3 1)customer lead time(1)**
- (1 3 2)customer portals(1)**
- (1 3 3)development kits(2)**
- (1 3 4)inflenuceers(2)**
- (1 3 5)integrate with other products(2)**
- (1 3 6)link with community of users(1)**
- (1 3 7)Look for customer's core business(1)**
- (1 3 8)low and high product(1)**
- (1 3 9)message broadcasting(1)**
- (1 3 10)price/value(1)**
- (1 3 11)profile to right audience(1)**
- (1 3 12)solution is a conversation that changes(1)**
- (1 3 13)switching difficult(2)**
- (1 3 14)alignment with partners(1)**
- (1 3 15)analysts(2)**
- (1 3 16)ensure matches standards(2)**
- (1 3 17)org segmenting(1)**
- (1 3 18)put new ideas in current products(1)**
- (1 3 19)seminars(1)**
- (1 3 20)standards: drives techn(1)**
- (1 3 21)use leading edge customers(1)**
- (1 3 22)tech paper/books(2)**
- (1 3 23)create markets and be recognized(1)**

(1 4)constraints

- (1 4 1)customer understanding(1)**
- (1 4 2)internal availability(1)**

(1 5)Hypothesis**(1 5 1)H1****(1 5 1 1)Concepts: same(10)****(1 5 1 2)concepts:not same(1)****(1 5 1 3)H1: no appropriate response(1)****(1 5 2)H2****(1 5 2 1)concept order: continuous(4)****(1 5 2 2)concept order: in parallel(8)****(1 5 2 3)concept order: induce first(2)****(1 5 2 4)concept order: iterate(3)****(1 5 2 5)concept order: not linear(2)****(1 5 2 6)concept order: same order(7)****(1 5 2 7)concept order: synergy(2)****(1 5 2 8)concept order:overlapping(3)****(1 5 2 9)H2: we prepare first but not necessary correct(1)****(1 5 3)H3****(1 5 3 1)model addition/subtractions: knowledge/capability grows
as expertise in API grows(1)****(1 5 3 2)model addition/subtractions: no suggestion(8)****(1 5 3 3)model addition/subtraction: Not induce(2)****(1 5 3 4)model addition/subtractions:
interaction/feedback/correction loop(4)****(1 6)graphical representation****(1 6 1)better labeling(1)****(1 6 2)GANNT chart(1)****(1 6 4)ok(3)****(1 6 5)too complicated(5)****(1 6 6)need feedback loop(1)****(1 6 7)object oriented(1)****(1 6 8)show start and end points(1)****(1 7)how to make decision based on API data****(1 7 1)expertise(2)**

APPENDIX J: INTERVIEWEE TO CONCEPT MAPPING

Interviewee One

++ Coded at 29 nodes.

(F 1)	/TLC: technology convergence = opportunity
(F 2)	/anticipate: tech/market trends: customer
(F 3)	/anticipate: market trends: customers: look for their constraints
(F 4)	/anticipate: market trends: customers'customer
(F 6)	/TLC: not useful for technology clusters
(F 7)	/strategy: identify key technology primitives
(F 8)	/strategy: primitives insync
(F 9)	/strategy: competitive advantage right primitive combination
(F 11)	/anticipate: tech/market trends: Alliances with companies
(F 12)	/strategy:total customer solution
(F 13)	/strategy: financing:delayed
(F 14)	/fast: trials/prototypes
(F 15)	/fast:knowledge through alliances
(F 17)	/induce:org segmenting
(F 19)	/induce:use leading edge customers
(F 20)	/H2: concept order: in parallel
(F 21)	/H2: concept order: iterate
(F 22)	/H2: concept order: synergy
(F 24)	/constraints: resources not problem
(F 25)	/constraints: link between customer and their customer
(F 27)	/forecast: 12-18 months
(F 28)	/strategy: products= knowledge creation
(F 29)	/representation:object oriented
(F 33)	/anticipate: tech trends: prototype/trials
(F 46)	/H2: concept order: same order
(F 69)	/H1:Concepts: same
(F 71)	/H3: knowledge/capability grows as expertise in API grows
(F 112)	/life cycles: use: formally
(F 119)	/use of other theories: no

Interviewee Two

++ Coded at 28 nodes.

(F 1)	/TLC:technology convergence = opportunity
(F 7)	/strategy: identify key technology primitives
(F 14)	/fast: trials/prototypes
(F 21)	/H2: concept order: iterate
(F 30)	/TLC: examples cover all
(F 31)	/TLC: technology infrastructure= opportunity
(F 32)	/anticipate: tech trends: seminars,tradeshows,conferences
(F 33)	/anticipate: tech trends: prototype/trials
(F 36)	/indicators: customer type/behaviour
(F 37)	/strategy:prechasm=solution
(F 39)	/fast: culture
(F 40)	/fast: education/communication internally
(F 41)	/fast: management preferences
(F 42)	/induce: price/value
(F 43)	/constraint: customer understanding
(F 44)	/constraint: resources: internal availability
(F 45)	/anticipate/prepare/induce concept: same regardless of tech
(F 46)	/H2: concept order: same order
(F 47)	/representation: ok
(F 48)	/life cycles:use: no
(F 58)	/use of other theories: sort of
(F 63)	/anticipate: market trends: associations
(F 68)	/induce: integrate with other products
(F 69)	/H1:Concepts: same
(F 81)	/H3: no suggestion
(F 91)	/forecast: tech:2-3 yrs
(F 98)	/forecast:market:1-2 yrs
(F 130)	/strategy: market share

Interviewee Three

++ Coded at 24 nodes.

(F 12)	/strategy:total customer solution
(F 24)	/constraints: resources not problem
(F 30)	/TLC: examples cover all
(F 34)	/Indicators: customer referrers
(F 36)	/indicators: customer type/behaviour
(F 38)	/H1: no appropriate response
(F 46)	/H2: concept order: same order
(F 49)	/anticipate: tech/market trends: innovative culture
(F 50)	/anticipate: tech/market trends: innovative culture: product development manager
(F 51)	/anticipate: market trends: internal staff
(F 53)	/inflection points in market:sales force
(F 54)	/inflection points in techn:industry expert
(F 56)	/induce: low and high product
(F 57)	/strategy: sell solution
(F 59)	/strategy:get big fast
(F 60)	/induce: tech paper/books
(F 61)	/strategy:little tech, broad market
(F 78)	/representation: GANNT chart
(F 80)	/anticipate: market trends: customers
(F 81)	/H3: no suggestion
(F 87)	/forecast: 2-5 yrs
(F 112)	/life cycles: use: formally
(F 113)	/representation: too complicated
(F 119)	/use of other theories: no

Interviewee Four

++ Coded at 26 nodes.

- (F 2) /anticipate: tech/market trends: customer
- (F 7) /strategy: identify key technology primitives
- (F 9) /strategy: competitive advantage right primitive combination
- (F 10) /life cycles: use of them informally
- (F 12) /strategy: total customer solution
- (F 18) /H2: concept order: continuous
- (F 30) /TLC: examples cover all
- (F 31) /TLC: technology infrastructure= opportunity
- (F 46) /H2: concept order: same order
- (F 49) /anticipate: tech/market trends: innovative culture
- (F 57) /strategy: sell solution
- (F 62) /anticipate: tech trends: internal research
- (F 63) /anticipate: market trends: associations
- (F 64) /strategy: market niche
- (F 65) /strategy: service with product
- (F 66) /induce: seminars
- (F 69) /H1: Concepts: same
- (F 70) /H2: concept order: not linear
- (F 72) /H3: concepts: interaction/feedback/correction loop
- (F 74) /representation: show start and end points
- (F 75) /anticipate: tech/market trends: media
- (F 76) /fast: product is components
- (F 77) /strategy: alignment with current tech
- (F 87) /forecast: 2-5 yrs
- (F 119) /use of other theories: no
- (F 146) /Forecast: update frequently

Interviewee Five

++ Coded at 23 nodes.

- (F 10) /life cycles: use of them informally
- (F 20) /H2: concept order: in parallel
- (F 30) /TLC: examples cover all
- (F 57) /strategy: sell solution
- (F 58) /use of other theories: sort of
- (F 59) /strategy: get big fast
- (F 63) /anticipate: market trends: associations
- (F 68) /induce: integrate with other products
- (F 69) /H1: Concepts: same
- (F 73) /representation: better labeling
- (F 79) /anticipate: market trends: analysts
- (F 80) /anticipate: market trends: customers
- (F 81) /H3: no suggestion
- (F 82) /indicators: customers type/sales, etc.
- (F 83) /fast: knowledge of customer trends
- (F 84) /strategy: alliances: expand resources
- (F 86) /induce: analysts
- (F 87) /forecast: 2-5 yrs
- (F 88) /constraints: speed to hire
- (F 90) /how to make decision based on API data: expertise
- (F 92) /H2: concept order: overlapping
- (F 97) /use of other theories: internal developed
- (F 147) /Forecast: review old forecasts

Interviewee Six

++ Coded at 31 nodes.

- (F 1) /TLC:technology convergence = opportunity
- (F 7) /strategy: identify key technology primitives
- (F 10) /life cycles: use of them informally
- (F 11) /anticipate: tech/market trends: Alliances with companies
- (F 12) /strategy:total customer solution
- (F 20) /H2: concept order: in parallel
- (F 21) /H2: concept order: iterate
- (F 30) /TLC: examples cover all
- (F 32) /anticipate: tech trends: seminars,tradeshows,conferences
- (F 35) /Representation: need feedback loop
- (F 39) /fast: culture
- (F 58) /use of other theories: sort of
- (F 59) /strategy:get big fast
- (F 69) /H1:Concepts: same
- (F 70) /H2: concept order: not linear
- (F 72) /H3:concepts:interaction/feedback/correction loop
- (F 80) /anticipate: market trends: customers
- (F 83) /fast: knowledge of customer trends
- (F 84) /strategy: alliances:expand resources
- (F 87) /forecast: 2-5 yrs
- (F 90) /how to make decision based on API data: expertise
- (F 93) /anticipate: market trends: competitive analysis
- (F 95) /anticipate: market trends: academic research
- (F 96) /induce:create markets and be recognized
- (F 97) /use of other theories: internal developed
- (F 99) /strategy: emerging markets
- (F 100) /strategy: define perfectly whole product/solution
- (F 101) /induce: switching difficult
- (F 103) /constraints: choices possible
- (F 130) /strategy: market share
- (F 152) /Forecast: different intervals for different generations of technology

Interviewee Seven

++ Coded at 30 nodes.

- (F 4) /anticipate: market trends: customers' customer
- (F 16) /ATLC: measures risk tolerance of market type
- (F 18) /H2: concept order: continuous
- (F 20) /H2: concept order: in parallel
- (F 22) /H2: concept order: synergy
- (F 23) /H3: Not induce
- (F 30) /TLC: examples cover all
- (F 33) /anticipate: tech trends: prototype/trials
- (F 46) /H2: concept order: same order
- (F 58) /use of other theories: sort of
- (F 59) /strategy: get big fast
- (F 64) /strategy: market niche
- (F 69) /H1: Concepts: same
- (F 72) /H3: concepts: interaction/feedback/correction loop
- (F 76) /fast: product is components
- (F 80) /anticipate: market trends: customers
- (F 82) /indicators: customers type/sales, etc.
- (F 92) /H2: concept order: overlapping
- (F 101) /induce: switching difficult
- (F 104) /TLC: curves: alliances modify investment
- (F 105) /anticipate: market trends: analyze customer by technology generation
- (F 106) /anticipate: tech trends: training
- (F 107) /fast: alliances make speed
- (F 108) /forecast: several time windows: 1-10 yrs
- (F 109) /induce: alignment with partners
- (F 110) /induce: ensure matches standards
- (F 111) /induce: standards: drives techn
- (F 112) /life cycles: use: formally
- (F 113) /representation: too complicated
- (F 148) /Forecast: depends on market window

Interviewee Eight

++ Coded at 25 nodes.

- (F 1) /TLC: technology convergence = opportunity
- (F 7) /strategy: identify key technology primitives
- (F 9) /strategy: competitive advantage right primitive combination
- (F 10) /life cycles: use of them informally
- (F 20) /H2: concept order: in parallel
- (F 30) /TLC: examples cover all
- (F 47) /representation: ok
- (F 58) /use of other theories: sort of
- (F 60) /induce: tech paper/books
- (F 64) /strategy: market niche
- (F 69) /H1: Concepts: same
- (F 81) /H3: no suggestion
- (F 82) /indicators: customers type/sales, etc.
- (F 83) /fast: knowledge of customer trends
- (F 87) /forecast: 2-5 yrs
- (F 92) /H2: concept order: overlapping
- (F 114) /anticipate: market trends: fuzzy customer segments
- (F 115) /induce: put new ideas in current products
- (F 116) /Induce: solution is a conversation that changes
- (F 118) /induce: message broadcasting
- (F 120) /induce: customer portals
- (F 121) /induce: influencers
- (F 144) /TLC: discontinuities
- (F 145) /TLC: effected by business environment
- (F 149) /Forecast: 2 product cycles

Interviewee Nine

++ Coded at 28 nodes.

- (F 7) /strategy: identify key technology primitives
- (F 8) /strategy: primitives insync
- (F 9) /strategy: competitive advantage right primitive combination
- (F 10) /life cycles: use of them informally
- (F 12) /strategy: total customer solution
- (F 18) /H2: concept order: continuous
- (F 20) /H2: concept order: in parallel
- (F 27) /forecast: 12-18 months
- (F 30) /TLC: examples cover all
- (F 51) /anticipate: market trends: internal staff
- (F 52) /H2: we prepare first but not necessary correct
- (F 58) /use of other theories: sort of
- (F 63) /anticipate: market trends: associations
- (F 64) /strategy: market niche
- (F 69) /H1: Concepts: same
- (F 80) /anticipate: market trends: customers
- (F 81) /H3: no suggestion
- (F 84) /strategy: alliances: expand resources
- (F 87) /forecast: 2-5 yrs
- (F 99) /strategy: emerging markets
- (F 113) /representation: too complicated
- (F 121) /induce: inflenuceers
- (F 122) /TLC: overlay: market and tech curves
- (F 125) /TLC: never progress always in first part of curve
- (F 126) /induce: Look for customer's core business
- (F 127) /induce: link with community of users
- (F 130) /strategy: market share
- (F 153) /Strategy: community

Interviewee Ten

++ Coded at 18 nodes.

- (F 5) /H1: concepts: not same
- (F 10) /life cycles: use of them informally
- (F 23) /H3: Not induce
- (F 26) /Indicators: rate of adoption
- (F 27) /forecast: 12-18 months
- (F 46) /H2: concept order: same order
- (F 47) /representation: ok
- (F 55) /indicators: analysts
- (F 58) /use of other theories: sort of
- (F 81) /H3: no suggestion
- (F 83) /fast: knowledge of customer trends
- (F 87) /forecast: 2-5 yrs
- (F 90) /how to make decision based on API data: expertise
- (F 113) /representation: too complicated
- (F 128) /anticipate: market trends: customer to limited degree
- (F 129) /anticipate: tech trends: infrastructure company trends
- (F 130) /strategy: market share
- (F 150) /Forecast: what to forecast

Interviewee Eleven

++ Coded at 21 nodes.

- (F 10) /life cycles: use of them informally
- (F 20) /H2: concept order: in parallel
- (F 27) /forecast: 12-18 months
- (F 30) /TLC: examples cover all
- (F 31) /TLC: technology infrastructure= opportunity
- (F 58) /use of other theories: sort of
- (F 67) /H2: concept order: induce first
- (F 69) /H1: Concepts: same
- (F 79) /anticipate: market trends: analysts
- (F 81) /H3: no suggestion
- (F 82) /indicators: customers type/sales, etc.
- (F 83) /fast: knowledge of customer trends
- (F 86) /induce: analysts
- (F 90) /how to make decision based on API data: expertise
- (F 130) /strategy: market share
- (F 131) /TLC: not useful for software
- (F 132) /anticipate: market trends: lead customers
- (F 134) /indicators: rate of growth
- (F 135) /fast: good anticipate/prepare/induce capability
- (F 136) /anticipate: concept of product
- (F 149) /Forecast: 2 product cycles

Interviewee Twelve

++ Coded at 21 nodes.

- (F 2) /anticipate: tech/market trends: customer
- (F 10) /life cycles: use of them informally
- (F 12) /strategy: total customer solution
- (F 18) /H2: concept order: continuous
- (F 20) /H2: concept order: in parallel
- (F 30) /TLC: examples cover all
- (F 46) /H2: concept order: same order
- (F 58) /use of other theories: sort of
- (F 67) /H2: concept order: induce first
- (F 69) /H1: Concepts: same
- (F 72) /H3: concepts: interaction/feedback/correction loop
- (F 80) /anticipate: market trends: customers
- (F 81) /H3: no suggestion
- (F 87) /forecast: 2-5 yrs
- (F 110) /induce: ensure matches standards
- (F 113) /representation: too complicated
- (F 134) /indicators: rate of growth
- (F 138) /induce: profile to right audience
- (F 139) /fast: narrow product range
- (F 140) /induce: development kits
- (F 141) /induce: customer lead time

APPENDIX K: CONCEPT TO INTERVIEWEE MAPPING

(F 45) /anticipate/prepare/induce concept: same regardless of tech

This node codes 1 document.

1: Interviewee 2

(F 136) /anticipate: concept of product

This node codes 1 document.

1: Interviewee 11

(F 95) /anticipate: market trends: academic research

This node codes 1 document.

1: Interviewee 6

(F 105) /anticipate: market trends: analyze customer by technology generation

This node codes 1 document.

1: Interviewee 7

(F 79) /anticipate: market trends: analysts

This node codes 2 documents.

1: Interviewee 5 2: Interviewee 11

(F 63) /anticipate: market trends: associations

This node codes 4 documents.

1: Interviewee 2 2: Interviewee 4 3: Interviewee 5 4: Interviewee 9

(F 93) /anticipate: market trends: competitive analysis

This node codes 1 document.

1: Interviewee 6

(F 128) /anticipate: market trends: customer to limited degree

This node codes 1 document.

1: Interviewee 10

(F 80) /anticipate: market trends: customers

This node codes 6 documents.

1: Interviewee 3 2: Interviewee 5 3: Interviewee 6 4: Interviewee 7
5: Interviewee 9 6: Interviewee 12

```

*****
*****
(F 4)          /anticipate: market trends: customers'customer
This node codes 2 documents.
1: Interviewee 1      2: Interviewee 7
*****
*****
(F 3)          /anticipate: market trends: customers: look for their constraints
This node codes 1 document.
1: Interviewee 1
*****
*****
(F 51)         /anticipate: market trends: internal staff
This node codes 2 documents.
1: Interviewee 3      2: Interviewee 9
*****
*****
(F 132)        /anticipate: market trends: lead customers
This node codes 1 document.
1: Interviewee 11
*****
*****
(F 114)        /anticipate: market trends:fuzzy customer segments
This node codes 1 document.
1: Interviewee 8
*****
*****
(F 129)        /anticipate: tech trends: infrastructure company trends
This node codes 1 document.
1: Interviewee 10
*****
*****
(F 62)         /anticipate: tech trends: internal research
This node codes 1 document.
1: Interviewee 4
*****
*****
(F 33)         /anticipate: tech trends: prototype/trials
This node codes 3 documents.
1: Interviewee 1      2: Interviewee 2      3: Interviewee 7
*****
*****
(F 32)         /anticipate: tech trends: seminars,tradeshows,conferences
This node codes 2 documents.
1: Interviewee 2      2: Interviewee 6

```

```

*****
*****
(F 106)          /anticipate: tech trends: training
This node codes 1 document.
1: Interviewee 7
*****
*****
(F 11)           /anticipate: tech/market trends: Alliances with companies
This node codes 2 documents.
1: Interviewee 1    2: Interviewee 6
*****
*****
(F 2)            /anticipate: tech/market trends: customer
This node codes 3 documents.
1: Interviewee 1    2: Interviewee 4    3: Interviewee 12
*****
*****
(F 49)           /anticipate: tech/market trends: innovative culture
This node codes 2 documents.
1: Interviewee 3    2: Interviewee 4
*****
*****
(F 50)           /anticipate: tech/market trends: innovative culture:product development
manager
This node codes 1 document.
1: Interviewee 3
*****
*****
(F 75)           /anticipate: tech/market trends: media
This node codes 1 document.
1: Interviewee 4
*****
*****
(F 16)           /ATLC: measures risk tolerance of market type
This node codes 1 document.
1: Interviewee 7
*****
*****
(F 43)           /constraint: customer understanding
This node codes 1 document.
1: Interviewee 2
*****
*****
(F 44)           /constraint: resources: internal availability
This node codes 1 document.
1: Interviewee 2

```

```

*****
*****
(F 103)          /constraints: choices possible
This node codes 1 document.
1: Interviewee 6
*****
*****
(F 25)          /constraints: link between customer and their customer
This node codes 1 document.
1: Interviewee 1
*****
*****
(F 24)          /constraints: resources not problem
This node codes 2 documents.
1: Interviewee 1      2: Interviewee 3
*****
*****
(F 88)          /constraints: speed to hire
This node codes 1 document.
1: Interviewee 5
*****
*****
(F 39)          /fast: culture
This node codes 2 documents.
1: Interviewee 2      2: Interviewee 6
*****
*****
(F 40)          /fast: education/communication internally
This node codes 1 document.
1: Interviewee 2
*****
*****
(F 135)         /fast: good anticipate/prepare/induce capability
This node codes 1 document.
1: Interviewee 11
*****
*****
(F 83)          /fast: knowledge of customer trends
This node codes 5 documents.
1: Interviewee 5      2: Interviewee 6      3: Interviewee 8  4: Interviewee 10
5: Interviewee 11
*****
*****
(F 41)          /fast: management preferences
This node codes 1 document.
1: Interviewee 2

```

```

*****
*****
(F 76)          /fast: product is components
This node codes 2 documents.
1: Interviewee 4      2: Interviewee 7
*****
*****
(F 14)          /fast: trials/prototypes
This node codes 2 documents.
1: Interviewee 1      2: Interviewee 2
*****
*****
(F 107)         /fast:alliances make speed
This node codes 1 document.
1: Interviewee 7
*****
*****
(F 15)          /fast:knowledge through alliances
This node codes 1 document.
1: Interviewee 1
*****
*****
(F 139)         /fast:narrow product range
This node codes 1 document.
1: Interviewee 12
*****
*****
(F 27)          /forecast: 12-18 months
This node codes 4 documents.
1: Interviewee 1      2: Interviewee 9      3: Interviewee 10      4: Interviewee 11
*****
*****
(F 149)         /Forecast: 2 product cycles
This node codes 2 documents.
1: Interviewee 8      2: Interviewee 11
*****
*****
(F 87)          /forecast: 2-5 yrs
This node codes 8 documents.
1: Interviewee 3      2: Interviewee 4      3: Interviewee 5      4: Interviewee 6
5: Interviewee 8      6: Interviewee 9      7: Interviewee 10      8: Interviewee 12
*****
*****
(F 148)         /Forecast: depends on market window
This node codes 1 document.
1: Interviewee 7

```


 (F 152) /Forecast: different intervals for different generations of technology
 This node codes 1 document.
 1: Interviewee 6

(F 147) /Forecast: review old forecasts
 This node codes 1 document.
 1: Interviewee 5

(F 108) /forecast: several time windows: 1-10 yrs
 This node codes 1 document.
 1: Interviewee 7

(F 91) /forecast: tech:2-3 yrs
 This node codes 1 document.
 1: Interviewee 2

(F 146) /Forecast: update frequently
 This node codes 1 document.
 1: Interviewee 4

(F 150) /Forecast: what to forecast
 This node codes 1 document.
 1: Interviewee 10

(F 98) /forecast:market: 1-2 yrs
 This node codes 1 document.
 1: Interviewee 2

(F 38) /H1: no appropriate response
 This node codes 1 document.
 1: Interviewee 3

(F 69) /H1: Concepts: same
 This node codes 10 documents.
 1: Interviewee 1 2: Interviewee 2 3: Interviewee 4 4: Interviewee 5
 5: Interviewee 6 6: Interviewee 7 7: Interviewee 8 8: Interviewee 9

9: Interviewee 11 10: Interviewee 12

(F 5) /H1: concepts: not same

This node codes 1 document.

1: Interviewee 10

(F 18) /H2: concept order: continuous

This node codes 4 documents.

1: Interviewee 4 2: Interviewee 7 3: Interviewee 9 4: Interviewee 12

(F 20) /H2: concept order: in parallel

This node codes 8 documents.

1: Interviewee 1 2: Interviewee 5 3: Interviewee 6 4: Interviewee 7

5: Interviewee 8 6: Interviewee 9 7: Interviewee 11 8: Interviewee 12

(F 67) /H2: concept order: induce first

This node codes 2 documents.

1: Interviewee 11 2: Interviewee 12

(F 21) /H2: concept order: iterate

This node codes 3 documents.

1: Interviewee 1 2: Interviewee 2 3: Interviewee 6

(F 70) /H2: concept order: not linear

This node codes 2 documents.

1: Interviewee 4 2: Interviewee 6

(F 46) /H2: concept order: same order

This node codes 7 documents.

1: Interviewee 1 2: Interviewee 2 3: Interviewee 3 4: Interviewee 4

5: Interviewee 7 6: Interviewee 10 7: Interviewee 12

(F 22) /H2: concept order: synergy

This node codes 2 documents.

1: Interviewee 1 2: Interviewee 7

(F 92) /H2: concept order: overlapping

This node codes 3 documents.

1: Interviewee 5 2: Interviewee 7 3: Interviewee 8

(F 52) /H2: we prepare first but not necessary correct

This node codes 1 document.

1: Interviewee 9

(F 71) /H3: knowledge/capability grows as expertise in API grows

This node codes 1 document.

1: Interviewee 1

(F 81) /H3: no suggestion

This node codes 8 documents.

1: Interviewee 2 2: Interviewee 3 3: Interviewee 5 4: Interviewee 8
5: Interviewee 9 6: Interviewee 10 7: Interviewee 11 8: Interviewee 12

(F 23) /H3: Not induce

This node codes 2 documents.

1: Interviewee 7 2: Interviewee 10

(F 72) /H3: concepts: interaction/feedback/correction Interviewee 6op

This node codes 4 documents.

1: Interviewee 4 2: Interviewee 6 3: Interviewee 7 4: Interviewee 12

(F 90) /how to make decision based on API data: expertise

This node codes 4 documents.

1: Interviewee 5 2: Interviewee 6 3: Interviewee 10 4: Interviewee 11

(F 34) /Indicators: customer referrers

This node codes 1 document.

1: Interviewee 3

(F 36) /indicators: customer type/behaviour

This node codes 2 documents.

1: Interviewee 2 2: Interviewee 3

(F 82) /indicators: customers type/sales,etc.

This node codes 4 documents.

1: Interviewee 5 2: Interviewee 7 3: Interviewee 8 4: Interviewee 11

(F 26) /Indicators: rate of adoption

This node codes 1 document.

1: Interviewee 10

(F 134) /indicators: rate of growth

This node codes 2 documents.

1: Interviewee 11 2: Interviewee 12

(F 55) /indicators: analysts

This node codes 1 document.

1: Interviewee 10

(F 141) /induce: customer lead time

This node codes 1 document.

1: Interviewee 12

(F 120) /induce: customer portals

This node codes 1 document.

1: Interviewee 8

(F 140) /induce: development kits

This node codes 1 document.

1: Interviewee 12

(F 121) /induce: inflenuceers

This node codes 2 documents.

1: Interviewee 8 2: Interviewee 9

(F 68) /induce: integrate with other products

This node codes 2 documents.

1: Interviewee 2 2: Interviewee 5

(F 127) /induce: link with community of users

This node codes 1 document.

1: Interviewee 9

(F 126) /induce: look for customer's core business

This node codes 1 document.

1: Interviewee 9

(F 56) /induce: low and high product

This node codes 1 document.

1: Interviewee 3

(F 118) /induce: message broadcasting

This node codes 1 document.

1: Interviewee 8

(F 42) /induce: price/value

This node codes 1 document.

1: Interviewee 2

(F 138) /induce: profile to right audience

This node codes 1 document.

1: Interviewee 12

(F 116) /Induce: solution is a conversation that changes

This node codes 1 document.

1: Interviewee 8

(F 101) /induce: switching difficult

This node codes 2 documents.

1: Interviewee 6 2: Interviewee 7

(F 60) /induce: tech paper/books

This node codes 2 documents.

1: Interviewee 3 2: Interviewee 8

(F 109) /induce: alignment with partners

This node codes 1 document.

1: Interviewee 7

(F 86) /induce:analysts

This node codes 2 documents.

1: Interviewee 5 2: Interviewee 11

(F 96) /induce:create markets and be recognized

This node codes 1 document.

1: Interviewee 6

(F 110) /induce:ensure matches standards

This node codes 2 documents.

1: Interviewee 7 2: Interviewee 12

(F 17) /induce:org segmenting

This node codes 1 document.

1: Interviewee 1

(F 115) /induce:put new ideas in current products

This node codes 1 document.

1: Interviewee 8

(F 66) /induce:seminars

This node codes 1 document.

1: Interviewee 4

(F 111) /induce:standards: drives techn

This node codes 1 document.

1: Interviewee 7

(F 19) /induce:use leading edge customers

This node codes 1 document.

1: Interviewee 1

(F 53) /inflection points in market:sales force

This node codes 1 document.

1: Interviewee 3

```

*****
*****
(F 54)          /inflection points in techn:industry expert
This node codes 1 document.
1: Interviewee 3
*****
*****
(F 10)          /life cycles: use of them informally
This node codes 8 documents.
1: Interviewee 4      2: Interviewee 5      3: Interviewee 6      4: Interviewee 8
5: Interviewee 9      6: Interviewee 10     7: Interviewee 11     8: Interviewee 12
*****
*****
(F 112)         /life cycles: use: formally
This node codes 3 documents.
1: Interviewee 1      2: Interviewee 3      3: Interviewee 7
*****
*****
(F 48)          /life cycles:use: no
This node codes 1 document.
1: Interviewee 2
*****
*****
(F 73)          /representation: better labeling
This node codes 1 document.
1: Interviewee 5
*****
*****
(F 78)          /representation: GANNT chart
This node codes 1 document.
1: Interviewee 3
*****
*****
(F 35)          /Representation: need feedback Interviewee 6op
This node codes 1 document.
1: Interviewee 6
*****
*****
(F 47)          /representation: ok
This node codes 3 documents.
1: Interviewee 2      2: Interviewee 8      3: Interviewee 10
*****
*****
(F 113)         /representation: too complicated
This node codes 5 documents.
1: Interviewee 3      2: Interviewee 7      3: Interviewee 9      4: Interviewee 10

```

5: Interviewee 12

(F 29) /representation:object oriented

This node codes 1 document.

1: Interviewee 1

(F 74) /representation:show start and end points

This node codes 1 document.

1: Interviewee 4

(F 84) /strategy: alliances:expand resources

This node codes 3 documents.

1: Interviewee 5 2: Interviewee 6 3: Interviewee 9

(F 153) /Strategy: community

This node codes 1 document.

1: Interviewee 9

(F 9) /strategy: competitive advantage right primitive combination

This node codes 4 documents.

1: Interviewee 1 2: Interviewee 4 3: Interviewee 8 4: Interviewee 9

(F 100) /strategy: define perfectly whole product/solution

This node codes 1 document.

1: Interviewee 6

(F 99) /strategy: emerging markets

This node codes 2 documents.

1: Interviewee 6 2: Interviewee 9

(F 13) /strategy: financing:delayed

This node codes 1 document.

1: Interviewee 1

(F 7) /strategy: identify key technology primitives

This node codes 6 documents.

1: Interviewee 1 2: Interviewee 2 3: Interviewee 4 4: Interviewee 6

5: Interviewee 8 6: Interviewee 9

(F 130) /strategy: market share

This node codes 5 documents.

1: Interviewee 2 2: Interviewee 6 3: Interviewee 9 4: Interviewee 10
5: Interviewee 11

(F 8) /strategy: primitives insync

This node codes 2 documents.

1: Interviewee 1 2: Interviewee 9

(F 28) /strategy: products= knowledge creation

This node codes 1 document.

1: Interviewee 1

(F 57) /strategy: sell solution

This node codes 3 documents.

1: Interviewee 3 2: Interviewee 4 3: Interviewee 5

(F 77) /strategy: alignment with current tech

This node codes 1 document.

1: Interviewee 4

(F 59) /strategy: get big fast

This node codes 4 documents.

1: Interviewee 3 2: Interviewee 5 3: Interviewee 6 4: Interviewee 7

(F 61) /strategy: little tech, broad market

This node codes 1 document.

1: Interviewee 3

(F 64) /strategy: market niche

This node codes 4 documents.

1: Interviewee 4 2: Interviewee 7 3: Interviewee 8 4: Interviewee 9

(F 37) /strategy: prechasm=solution

This node codes 1 document.

1: Interviewee 2

(F 65) /strategy:service with product

This node codes 1 document.

1: Interviewee 4

(F 12) /strategy:total customer solution

This node codes 6 documents.

1: Interviewee 1 2: Interviewee 3 3: Interviewee 4 4: Interviewee 6

5: Interviewee 9 6: Interviewee 12

(F 104) /TLC: curves: alliances modify investment

This node codes 1 document.

1: Interviewee 7

(F 30) /TLC: examples cover all

This node codes 10 documents.

1: Interviewee 2 2: Interviewee 3 3: Interviewee 4 4: Interviewee 5

5: Interviewee 6 6: Interviewee 7 7: Interviewee 8 8: Interviewee 9

9: Interviewee 11 10: Interviewee 12

(F 125) /TLC: never progress always in first part of curve

This node codes 1 document.

1: Interviewee 9

(F 131) /TLC: not useful for software

This node codes 1 document.

1: Interviewee 11

(F 6) /TLC: not useful for technology clusters

This node codes 1 document.

1: Interviewee 1

(F 122) /TLC: overlay:market and tech curves

This node codes 1 document.

1: Interviewee 9

(F 31) /TLC: technology infrastructure= opportunity

This node codes 3 documents.

1: Interviewee 2 2: Interviewee 4 3: Interviewee 11

(F 144) /TLC:discontinuities

This node codes 1 document.

1: Interviewee 8

(F 145) /TLC:effected by business environment

This node codes 1 document.

1: Interviewee 8

(F 1) /TLC:technology convergence = opportunity

This node codes 4 documents.

1: Interviewee 1 2: Interviewee 2 3: Interviewee 6 4: Interviewee 8

(F 97) /use of other theories: internal developed

This node codes 2 documents.

1: Interviewee 5 2: Interviewee 6

(F 119) /use of other theories: no

This node codes 3 documents.

1: Interviewee 1 2: Interviewee 3 3: Interviewee 4

(F 58) /use of other theories: sort of

This node codes 9 documents.

1: Interviewee 2 2: Interviewee 5 3: Interviewee 6 4: Interviewee 7
5: Interviewee 8 6: Interviewee 9 7: Interviewee 10 8: Interviewee 11
9: Interviewee 12