Managing Uncertainty in New Business Development

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Abstract

The basic premise of this thesis is that uncertainty creates opportunities and that dealing with uncertainty demands a structured and simple framework. Uncertainty has many different sources and for approaching issues with high level of uncertainty a manager should try to understand this sources in a structured way.

This work I address the multiple issues involved in the formulation of strategies for the development of new businesses based on the core competencies of the firm and taking advantage of the environmental trends and opportunities. Relevant findings of different scholars and authors that have addressed development of new businesses, implications of diversification, management of uncertainty, and financial valuation are analyzed. It is proposed a framework to deal with uncertainty in a structured and simple way.

For a case study, Sun Microsystems' Jini Technology was chosen, given that it represents a technological disruption generating high levels of uncertainty in the computing industry. It is a technology oriented to take advantage of the computing and communications infrastructure and to increase value for the customer. The proposed structured framework is applied to the case of study as an exercise to show a practical use in developing new business and to demonstrate its validity.

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To Marisol, for her love, support and patience; everyday you make of me a better human being

To my Parents, for being there for me; I will always be there for you

To Guillermo and Teo, without your affection and support this would have not been possible

Jim, a million thanks for your thoughtful and wonderful conversations

Contents

Introduction

The basic premise of this thesis is that uncertainty creates opportunities and, certainly dealing with uncertainty is a difficult task for managers. Uncertainty has many different sources and for approaching issues with high level of uncertainty a manager should try to understand this sources in a structured way.

In this work I address, through a bibliographical research, the multiple issues involved in the formulation of strategies for the development of new businesses based on the core competencies of the firm and taking advantage of the environmental trends and opportunities. Chapters 1, 2 and 3 are dedicated to analyze relevant findings of different scholars and authors that have addressed development of new businesses, implications of diversification, management of uncertainty, and financial valuation. Also I propose a framework to deal with uncertainty in a structured and simple way. These chapters provide a theoretical frame before analyzing a case that involves high uncertainty and applying a methodological approach to manage uncertainty.

Sources for uncertainty are various and its impact in an industry can be at different levels. In chapters 4 and 5 a case where uncertainty raises from a technological disruption is studied. Network computing has been a movement that its roots can be traced back to the 1970's, however it could become a reality by the dawn of the XXI Century with the development of adequate protocols. Such is the case of Jini technology from Sun Microsystems that allows the interoperability of different platforms and generations of devices over a network. This represents a shift in the way that business its done in the computer industry and sensible alterations in the value chains of the industry.

For dealing with uncertainty a manager should look at various elements. In Chapter 6 I apply the framework developed in Chapter 3 using as example the technological disruption and its implications for competition of involved companies analyzed in chapters 4 and 5. The main objective of the exercise is to show a practical use of the structured framework for dealing with uncertainty based on the case analysis made about the disruptions in technology.

Chapter 1

The Intentions of the Organization

May be the first question that should be answered before going any further in this work is why a very well established organization should seek for new businesses?

First of all, there is no such thing as a "very well established organization". This premise implies that the organization will stay where it is in the market (or industry) forever, that its competitors will stay where they are, and that the competing conditions (in terms of market, technology and regulations) will always be the same. This is, by all means, false. It has been subject of study for many years now the rise and fall of what used to be big great corporations, and the sustainable success of others. In all this studies the dynamic elements of the competition are easily identifiable.

Certainly, there is a lot of organizations that have accomplished so many stages in the industries and markets in which they compete, that have been always regarded as icons and are considered role models –and their captains as legends-, either for their long term successes or their courageous recoveries.

Nevertheless, in almost any case, organizations have had to be reinvented at a certain point in time in order to assure their future existence for a wide variety of reasons and, once an organization has decided to reinvent it self, this has been done in a wide variety of means.

Technology has played a key role for reshaping organizations, mostly in the second half of the XX Century. Disruptive technologies have allowed new start-up companies to enter emerging markets and create value for both, customers and shareholders. Technology has also been the driving force of the fall of "very well established organizations" in what used to be "known competition arenas". However, there have been a significant number of companies that,

despite the appearances of new disruptive technologies have been able to maintain their position and also to enter new markets.

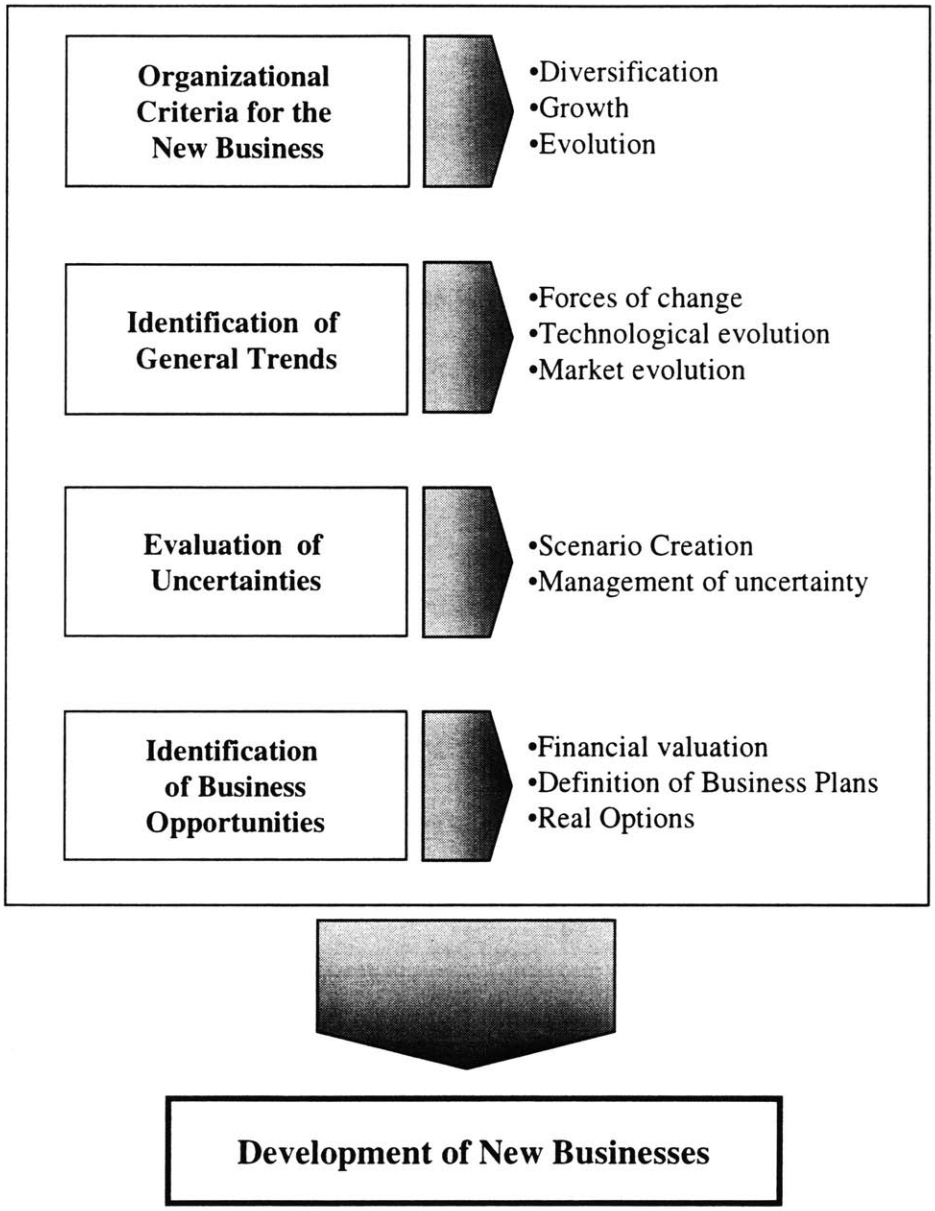
On the other hand market evolutions and the necessity for growth –driven by market value- have forced many companies to seek for new ventures in markets that not only were unknown for them, but hard to conquer with their existing organizational capabilities.

Those organizations that have dared to reinvent their business have done it in dramatically different ways. These ways have ranged from, diversification and integration –the strategies of choice for growth in the 1970's and early 1980's—to new product developments and mergers and acquisitions it the later 80's and the 90's.

All of these strategies had proven to have different probabilities of success, indeed. What has been the "home run that saved the day" for some companies, has been beginning of the end for others. The surging of fads and fashions trying to be adopted in standardized processes for many organizations have ended in dismal and frustration leading to dramatic stories of failure and loss of value.

Reinventing an organization's business requires the analysis of multiple elements for the formulation of strategies and actions needed for the organization. A strategy needed for such reinvention has to be based on the intersection of multiple issues and elements. The analysis of technological and market trends, an adequate organizational model, and an adequate financial strategy is not only key, but is the basis for the formulation of an acceptable strategy for identifying and to develop the initial steps for entering new businesses. The following figure points out those elements that I believe are the key for formulating strategies and that will be discussed in the upcoming sections.

Integrated Strategies for New Businesses

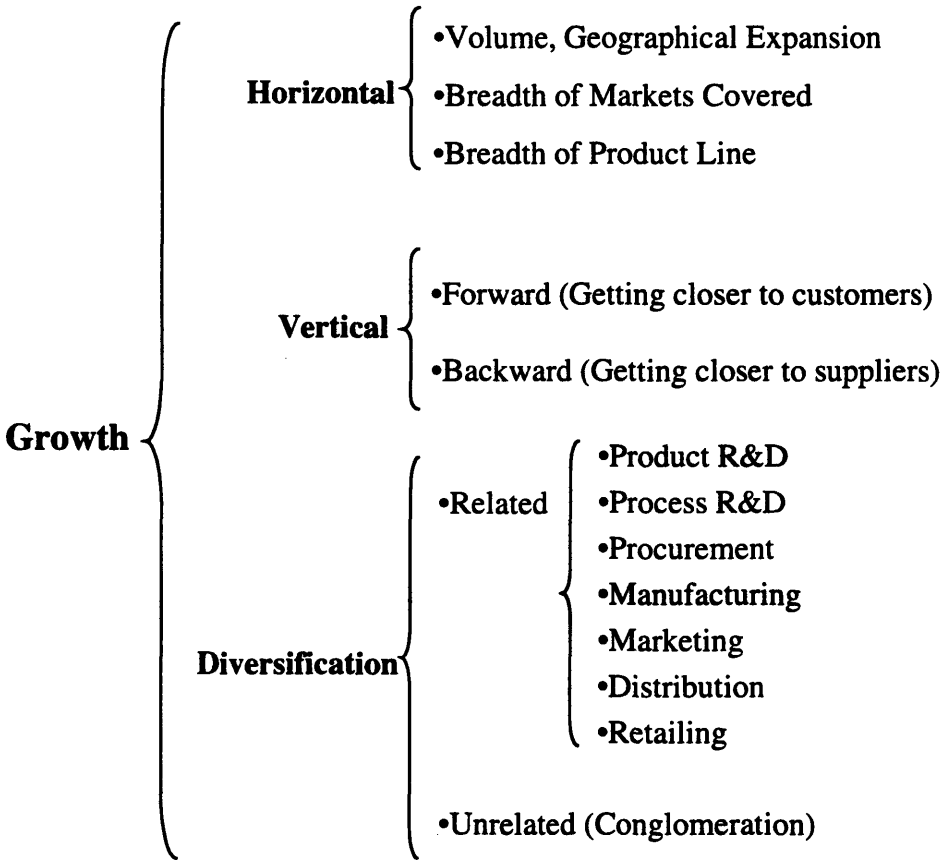


Each organization has its own organizational capabilities; has developed a unique culture and the individuals that integrate the internal network have developed organizational skills that underlie in the inherent strengths of the company. No two organizations look alike, and no strategies have the same outcome. Let us tackle the relevant issues from the organizational point of view when analyzing firms' evolution.

Growth, Diversification and downscoping

One of the most studied phenomena in strategic management literature is that of companies entering new businesses –or growing- either, through augmenting the breadth of their markets, products and geographical areas, integrating into their value chain or diversifying their businesses to related and unrelated areas. In the following chart Hax and Maljluf (1991) show those generic strategies followed by companies to grow and diversify.

Generic Strategies for Growth and Diversification



Source: Hax and Majluf, 1991

Although, these strategies may be generic not all diversified firms look alike, however diversification means moving into new lines of business for all companies. This movement into new business is present in any of the different streams for growth shown in the chart. However, the necessities for analyzing the implications of the strategy are different for each stream.

After developing a successful product, and also having success in a particular market, many companies will see logical to follow a horizontal growth; this means to expand the existing business within its current product and market structure. This expansion can be accomplished by increasing the market penetration that may lead to a higher level of sales and, perhaps, the introduction of the products into new geographical markets. In addition, new related products or new evaluated versions should be introduced in the existing markets. This strategy is usually called horizontal integration.

The second generic strategy involves an extension of the stages of production and distribution in which a company operates. The company might consider producing materials or products that are currently purchased from suppliers from outside of the boundaries of the firm. Or the company could decide to "integrate" its production operations toward "follow up" products or services based in the current products of the firm. This strategy is called vertical integration, and can be forward (follow-up) of backward (preceding) integration depending on the extension of the operations.

In addition to the latter strategies a company might decide to enter new segments, broadening its offerings to other markets and products not offered before. This would lead a company to a diversification strategy that could be into related and/unrelated businesses.

Related business units support or complement one another, typically in marketing, research, or production. Unrelated business usually has very few elements to share (skills or resources) with the rest of the organization. This broadening of corporate portfolio would lead to conglomerate diversification. The reasons for adopting a diversification strategy are diverse, and include the desire to take advantage of synergies, stabilizing profits, using internal capital markets and cash maximization in the company.

Certainly, many companies have had great success after a strong diversification strategy in the past, however many companies have refocused their efforts and, after having years of diversification had gone into a divesting spiral in order to take advantage of their own core competencies. This will lead us to discuss the "downscoping" of the companies.

Hoskisson and Hitts (1994) argue that "there is connection between extensive diversification and a decline in the competitiveness of large firms". Among the causes of this decline we can found the unwillingness of many managers to bear the risks of long term R&D efforts to innovate products and processes. It seems that those companies that have diversified their businesses into related areas, or that have a lower level of diversification, have a higher expenditure in R&D activities and, somehow, have generated more innovations for the market.

As the firm diversifies the managers face and increasing difficulty to apply strategic corporate controls on the different businesses, given the large amounts of information that have to be processed and the spans of control needed. In less diversified companies a manager have less information and span of control, therefore is easier for them to understand the nature of the business and the dynamics of the environment.

Once the company has reached high levels of diversification strategic controls are substituted by financial controls. Managers are evaluated on the basis of financial outcomes rather their strategic intends. This eases the amount of information that the corporation has to process for corporate executives. In the end what may happen is that executives are less able to ascertain weather poor financial outcomes are the result of ineffective strategy formulation and implementation or of events out of the control of the division manager.

Furthermore, this financial control emphasizes the short-term results over the long-term results. Managers whose performance is measured only by financial controls turn into risk-averse managers and try to accomplish short-term financial goals, rather than long term commitments with innovation in the company. This is particularly true in the acquisitions strategy for diversification.

Many companies have felt the necessity to refocus their activities and to downscope their businesses. Downscoping means restructuring the company in order to reduce diversification. This will allow the firm to reinstall strategic controls and hold a portfolio of businesses that takes advantage of their own core competencies. This does not mean that diversification is necessarily negative for the firm, but the level of the diversification (and new businesses) has to be correlated to the core competencies of the firm.

Companies like General Electric are examples of downscoping. Between 1981 and 1992, GE divested $9 Billion assets of unrelated businesses and "squeezing" 350 product lines in 13 divisions (Hoskisson and Hitts, 1994). This strategy did not kept GE from growing; GE acquired in the same period $12 Billion in assets of related businesses.

The point that I try to make is that companies can still grow and enter new businesses without losing their strategic focus. Also, diversification should have a rationale that resembles the companies core competencies and with a full understanding of the environment in which they operate. Although the strategic approach for developing new businesses is key, it is also important to define how organizations evaluate the decision to enter a new business and the implications of the most common methods.

Economic Valuation of New businesses at a Glance

In the end, the motivation for developing new businesses in any organization –or for an individual- is to increase growth. This means to add economic value to the organization. It is true that I have mentioned in the latter section the need of managers to have strategic controls, and that emphasizing financial control produces risk adverse mangers. However, it is also true that any business that do not add economic value for itself –even non-profit organizations- will eventually "cannibalize" the rest of the economic income of an organization –or personal income, at the individual level.

Given this situation, it is important to understand those adequate tools for evaluating new businesses, in order to assure creation of value for the stakeholders of the business. Notice that I do no use "shareholders", I strongly believe that there is more than share value maximization in managing businesses, a manager should create value for her employees as well as for her employers. One the goal is to develop, along with core competencies, technology, and understanding the competitive environment, a sustainable competitive strategy for the business.

Copeland, Koller and Murrin (1994) have suggested that the best measure for evaluating the performance of a particular organization be through measuring value creation. Value is defined as discounted cash flows. This measure requires complete information, this means to manage the cash flows on both the income statement and the balance sheet, and to be able to compare cash flows from different time periods on a risk-adjusted basis.

One of the advantages obtained by measuring value is that value cannot be short-term oriented; however other measures can be. For example, earnings per share (EPS) or return on equity (ROI) are usually used in a short-term orientation, requiring information about the next few years in the best cases. Other measurers such as the spread between return on invested capital (ROIC) and the cost of capital can also be used in a short-term manner, encouraging underivestment (harvesting the business to increase ROIC) (Copeland, Koller and Murrin, 1994). This reflects a risk adverse manager.

Using value for measuring the performance of a business –new or existing- requires a long-term perspective. It requires a focus on long-run cash flow return. It also requires "a willingness to adopt a dispassionate, value-oriented view of the corporate activities that recognizes businesses for what they are –investments in productive capacity that either earn a return above their opportunity cost of capital or do not" (Copeland, Koller and Murrin, 1994).

The manger committed to value creation should take an "outsider's view" that allows her to take opportunities that create value for the firm. This is particularly important for the development of new businesses, where there is a risk of diversifying the firm towards areas where creating value is difficult for the organization.

When using internal capital market –or any other source, in fact- for developing new businesses, using discounted cash flows (DCF) –or net present value- gives information about the business in the light of other opportunities for investment. The rate of discount used is the cost of opportunity for the firm for investing in other instruments i.e. bonds, stock portfolio, real estate. Thus if a new business yields higher "real present value" than the cost of opportunity (or cost of capital), the possibility of creating value for the firm through the development of that new business is also higher.

There is a clear difficulty in using DCF; this is, actually identifying the cash flows. However an intelligent manager will use different scenarios with different levels of cash flow. If the present value of those scenarios are negative or near zero, one should reevaluate that investment, due to a low value creation in the future. The adoption of this value creation oriented management, is called Value-Based Management (VBM); elaborating on this concept is not the objective of this research, although is an important area to be studied.

DFC emerged as the practice or choice during the 1970's (Luerhman, 1997). In those years the calculation of cost of capital was represented a real difficulty and a tedious work. To solve the problem, the DFC version that emerged as best practice was to discount the cash flows at a weighted-average-cost-of-capital (WACC). WACC based DFC, allowed companies to apply a specific discount rate based on its own performance. This practice has been around since then.

WACC helped managers to make faster calculations, however the advancements in computing has allowed to make more sophisticated calculations –that certainly improves the performance of WACC- but really eliminates the necessity of having a one-size-fits-all approach, such as WACC. Computing really enables the possibility of calculating discount rates for each type of project rather than using a "company" discount rate. Unfortunately, many managers still use WACC nowadays –when risk and uncertainty are higher than ever- to evaluate new businesses as well as strategic investments of the companies.

Given the facts described in the latter paragraphs, a new approach was developed for DFC, dubbed, "adjusted present value" (APV). APV is "the basic approach of DFC relationship to each of a business's various kinds of cash flow and then add up the present values". APV was suggested by Stewart Myers of MIT, and is based in the analysis of two categories of cash flow, the first, "real" cash flows (such as revenues, cash operating costs, and capital expenditures) – real business.

The second are "side effects" that are associated with its financing program (such as values of interest tax shields, subsidized financing, issue costs, and hedges). This method relies on the principle of value additivity, this means to split a project into pieces, value each piece, and then to add them back up (Luehrman, 1997).

The main advantage that APV offers is that before –even after- a manager evaluates a new project (new business or strategic investment) is able to split the effects of many factors. For example, if an acquisition is being considered, APV will help how much value will be created by cost reductions, operating synergies, regional risk, and new growth or tax savings.

On the flip side of APV is that in numerous occasions calculating a discount rate for the projected cash flows is extremely difficult for numerous reasons. The wide variety of capital structures of a particular project or new venture increases the difficulty of calculating an adequate discount rate. On the other hand, the accuracy of the valuation is based on the accuracy of the projected cash flows, as I already stated, which are often based on assumptions on the economy, economy of an industry or market evolutions.

An alternative to DFC based analysis is the use of Option Pricing Theory (OPT) applied to every day decisions. This approach is known as Real Options. Stewart Myers coined the term "real option" at the Sloan School of Management at the MIT and is an extension of the OPT applied to non-financial assets. It is not the objective of this thesis to discuss the details of the real options approach, but to point some cases where is prudent to use it.

Basically an option is the right, but not the obligation, to take an action in the future. Options are valuable when there is uncertainty. For example, one option contract gives to the holder the right to buy (call option) or sell (put option) a stock in the financial market to a pre-set price (exercise price) in some point in the future.

The real option approach uses the principles of the OPT writing options on assets such as land, natural resources, equipment, production i.e. non-financial assets and calculating its value. The inputs needed for the real option calculation are: the current value of the asset, the changes in value of the asset in a specified time frame, the volatility of the asset value (i.e probability of value change-usually historical based on the market) a private risk level (similar to the latter but inherent to the firm) and a risk free rate of return based on short term financial instruments (Treasury Bonds, for example).

The underlying premise in the real option approach is that a higher level of uncertainty increases the value of an option. Uncertainty widens the range of outcomes in the future and that a greater uncertainty has only the effect of increasing upside potential (Amram and Kulatilaka, 1999).

Amram and Kulatilaka suggest that the real option approach should be used under the following situations:

- In contingent investment decisions.
- When uncertainty is large enough to wait for more information and not to be locked in to irreversible investments.
- The value of a project is based on growth options rather than current cash flows
- When uncertainty allows flexibility in the future investments
- When there are updates and mid-course strategy corrections

Approaches, such as option pricing, have been applied to evaluate future opportunities, however there is a strong opposition of many scholars to apply these sophisticated tools to projects where there are no assets underlying the option analysis, this would be the case of R&D

projects. Luerhman suggests that this tools still remain in the domain of specialists and the generalists (managers, for instance) would gain some insights from these analysis, but the gains are not proportional to the great efforts needed to understand and apply this tools correctly. Furthermore, real projects have many more factors to be analyzed and that reducing them to a "put" or "call" analysis is way too risky.

Financial tools are all important, however they are not replacement for each other, but supplements. Simple DFC, WACC based DFC and APV, have the same principles, what is important is to understand why those methods were developed and to understand which are their strengths and weaknesses. Also, option valuation is a supplement for gaining insights about an uncertain project. Basing a strategic investment analysis on only one of the methods could be misleading.

In the next section I will approach the issue of understanding "the big picture" in order to help to develop successful strategy for entering new businesses.

Chapter 2

Change, Uncertainty and the Future

Understanding the Forces of Change

In the task of identifying new businesses for an organization and dealing with uncertainty it is key to understand the driving forces that are shaping the future. It is important to mention that I am not suggesting that the future can be predicted, but that the elements behind changes are understood and the meaning for a particular organization are identified.

This section could be dedicated to list all those elements and changes that have been studied in the last 15 years by a long list of futurists and scholars, such as John Naisbitt, Herman Kahn and Alvin Toffler, among others. However, I believe that it is more important to understand a way in which those elements can be put together and be used for decision making at the corporate level.

Risk and Uncertainty

Uncertainty arises from the ambiguous and complex causal situations underlying the internal operations and external environment of an organization. It also defined as an inability to assign probabilities to the likelihood of future events (Starbuck and Milliken, 1988). Risk refers to the potential loss if the outcome is bad, which in the evaluation of differing strategies is a primary management concern.

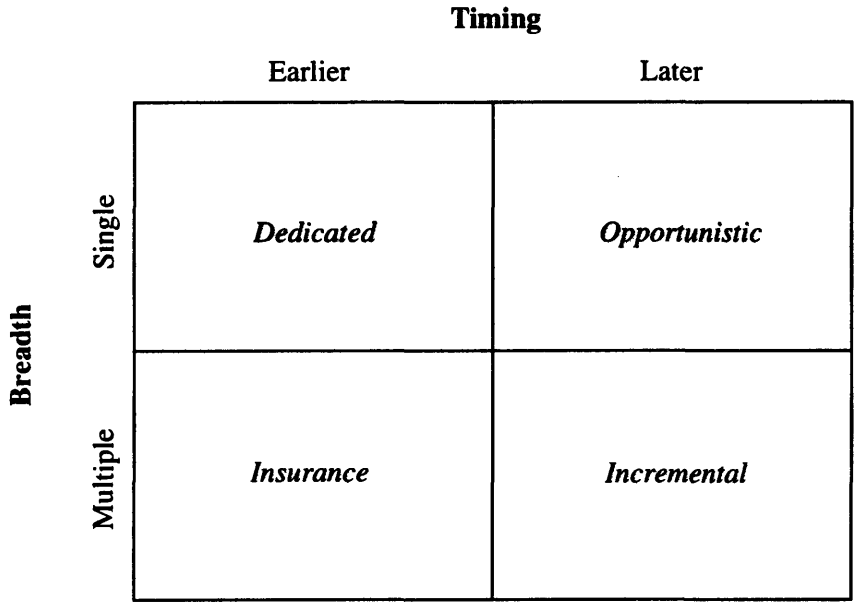
Risk and uncertainty need not be fully correlated. Rather, the risk for a strategy is a combination of the inherent environmental uncertainty and the asset exposure a firm opts for in its pattern of decision. While uncertainty can never be completely controlled or eliminated,

choices about the pattern and timing of resource commitments, which are clearly subject to managerial discretion, can therefore be made to achieve a desired level of risk.

Generic Approaches to Deal with Uncertainty

In general, dealing with uncertainty means taking actions, making decisions and/or allocating resources given certain facts or events either in the environment or the firm itself. Collis (1992) has proposed that the dimensions of timing and breadth define the generic approaches to uncertainty. In the following matrix the two dimensions define the four generic approaches proposed by Collis.

Generic Approaches to Uncertainty



Source: Adapted from "The Strategic Management of Uncertainty", Collis, 1992

Certainly no strategic decision requires the instantaneous allocation of all the resources that will be involved over the life of a strategy, and it is unusual to establish a strategy that does not require any allocation of resources at the beginning. In that sense the timing axis is intended to capture variability in the timing of a particular decision making, regarding investment, resources or managerial commitment. It differentiates between those strategies that are "de

facto", and therefore more vulnerable to unpredictable outcomes later, and those where decisions are deferred until later when any uncertainty is likely to have been resolved.

The breadth axis differentiates the strategies according to the range of future options that are kept open. It covers both the number of alternatives that are pursued simultaneously, and the extent of options opened up by deciding for a particular single course of action.

In general, delaying a decision, lets say an investment, increases flexibility. When an investment is deferred, choice is retained. Alternatives remain open and decisions can be made contingent on the resolution of uncertain events. Unfortunately, delays come at the cost of the lost opportunity to a first mover advantage and build a competitive advantage. The options available today gradually expire as competitors move first, so that when (and if) the investment is made, the returns are reduced by competition. Delay is therefore a less risky strategy, but it is potentially less profitable.

In a similar way, although investing on a wide range of alternatives increases the security of a strategy, it comes either at the cost of the additional investment programs incurred, or at the cost of the inherent flexibility of the investment. Following I describe the four generic approaches to uncertainty.

Insurance

The Insurance approach reduces risk by committing at time "zero" (the moment of the making a decision) to multiple strategic alternatives that guarantee a return to the company under all foreseeable future outcomes. Even if some of the alternatives become redundant as uncertainty is resolved, they are worthwhile because of their value were the uncertainty to resolve itself another way. Once the outcomes of the future are known a manager might wish she had not made all the investments. *A priori* a manager chooses to ensure a favorable outcome.

The inherent problem with the Insurance approach is the risk of being 'caught in the middle'. A firm wants to pursue a low-cost strategy, for example, but invests in a flexible project to protect itself in case the market demand for one product does not materialize. In so doing, it

ends up as a higher-cost administrative system (let us say manufacturing facilities) than a competitor which only invested in a specialized project. Insurance can be just too expensive.

Dedicated

The Dedicated approach, in contrast, essentially 'bets it all' on one uncertain outcome. It requires focused decisions that commits today to one specific strategy and is predicated on a belief that the uncertainty will resolve itself a particular way. Everything is focused around positioning the firm for that hoped-for future state of the world, and no safety net investments are made to ensure against unfavorable outcomes. This maximizes the payoff if the uncertainty resolves itself the way the strategy assumed, but it provides no security if the outcome is any different.

The main risk of the Dedicated approach is the divergence of the outcome from that expected. Furthermore is the risk that competitors duplicate the dedicated decision. It is common that in capital-intensive industries, a number of firms attempt to preempt rivals by making a focused capacity expansion, only to find that no one pre-empted anyone else and that excess capacity has been installed which destroys industry profitability.

Incremental

The Incremental approach delays decisions until it is absolutely necessary to support the strategy or until key uncertainties have been resolved favorably. Although the full strategy is often defined in advance, its completion is only revealed as time passes by. The critical element in this approach is a strategic road map that describes the timing and the sequence of three parameters that determine the development of the strategy.

The essence of the Incremental approach is therefore that it is sequential and gradually escalates in response to the appearance of information. Therefore, pursuing contingent contracts and phased investment projects are examples of this approach.

Opportunistic

The fourth approach, Opportunistic emulates an 'entrepreneurial' approach where strategy is not predetermined but adopted and altered, as uncertainties are resolved and opportunities open and close. It employs a strategy of organizational flexibility and responsiveness rather than up front decision making.

The Opportunistic approach aims to capitalize on unanticipated opportunities that may develop, investments for example should therefore be minimized, and contracts avoided or kept as short-term. In this approach the fight for resources is fierce among organizational units. It is this breadth of investment which distinguishes the Opportunistic from the Incremental approach.

The Opportunistic approach is merely one generic approach to managing uncertainty. It is not applicable in every situation. When is each generic approach appropriate? No hard and fast rules can be given. The answer is case specific, however Collis states that the approach will be dictated by three factors which should be well understood: the nature of uncertainty, the economics of the industry and the state of competition. These elements are somehow embedded in the methodological approach that I will present in the following chapters.

Not Forecasting but Plotting the Future

I will argue that a clear understanding of the possible outcomes of the future will lead to a better way to identify those businesses that have a better promise of success and will also help to respond quickly with changes in the organization, as well as a better decision making. In fact, as Davis and Davidson (1991) point out, "the best place to look for the basis of organizational change is in the future business, and the worst place to look is in the current organization".

One way to accomplish the task of understanding the forces of change is by creating future scenarios. Scenario creation is not a forecasting technique. It pretends to tell stories about the future by identifying the driving forces behind the change, presenting different alternative images about the future. Scenarios "are vehicles for helping people to learn" (Schwartz, 1991).

Often managers prefer to rely in the "certainty" of the forecaster work. However, very often forecasters fail in their task. The creation of scenarios will allow managers to be prepared for whatever happens. "It is this ability to act with a knowledgeable sense of risk and reward that separates both the business executive and the wise individual from a bureaucrat or a gambler" (Schwartz, 1991).

Scenario creation begins with the identification of the critical uncertainties for the business. In the case of evaluating a new business it is necessary to identify the uncertainties related with the possible success or failure. Once these uncertainties are identified, the next phase is to select the two most critical ones. This selection will lead to define four different scenarios. Using the two critical uncertainties, the next task is to create a chart in which the uncertainties take different (and contrary paths).

Once the different scenarios have been characterized, the decision-maker should analyze the new business in the light of the possible outcomes. One should identify which are the characteristics that a product or service should have; which are the elements for a supporting organization; the profile of the employees and executives; which are the markets that the business should serve now and in the future, etc.

The factors identified in this exercise are basically the strategic elements of control that a manager should monitor. This, regarding chapter 1, is only possible when the organization has an adequate level of diversification and financial controls are important but not absolute. The main difficulty in this exercise is the identification and selection of the key uncertainties for the new business, Schwartz (1991) suggests a list of four areas where to look at for "driving forces" of change, which could be uncertainties for a particular decision to make.

- ***Science and Technology***. This force is an important driver for change; once an innovation is released into the world, it cannot be taken back. I will approach the technology evolution later in this report.

- ***Perception-Shaping Events***. Public perception changes in time. It reveals the beliefs system of the society and can pivot the direction of history.

- ***Music.*** "If television suggests what people are perceiving, music shows what people are feeling". Popular music affects kids not only a local level, but also at a global level. There is a commonality in the global music preferences and it carries a particular message for every individual in the world.

- ***Fringes***. These are ideas that are not totally rejected but only accepted by a few. The difficulty of the acceptance of these ideas is a matter of diffusion, but once they make it to the mainstream population, the inertia that they gain is enormous. Normally they carry a high level of creativity

Among other things, Schwartz argues that the sources of where to see these driving forces are multiple, but widely available to the public. He suggests that remarkable people such as artists, scientists and "right side" thinkers are a great source of information. Also what he calls filters i.e. magazine editors and commentators that have access to information and "filter" it to the mainstream public.

I believe that theses particular sources are important but have a high level of risk of biasing the information depending on their interests, and that is more important to find personal trustful sources for valid information. On the other hand, it is also suggested that challenging environments and networking are valuable sources for getting information as well as for validating whatever we have gathered by ourselves.

Other element that should be evaluated in understanding the forces of change to be included in a scenario analysis, is the competitive profile of the region in which an organization operates. The sources for competitive advantage of a region are multiple, and typically involve local natural factor conditions, demand conditions, related industries and rivalry among competitors (Porter, 1990).

Intuitively, one can think that a new business that is related to those industries, in which a region has competitive advantage, has more probability of success. This might be true, however, it is also important to understand that a region can lose its competitive advantage for a number of reasons and that the factors in the "diamond" described by Porter in his book "The Competitive Advantage of Nations" can change in time.

Utterback and Afuah (1996) suggest that a region can lose its competitive advantage as a result of the emergence of a dominant design or the arrival of a technological discontinuity. Before the arrival of a dominant design in an industry there is an emphasis on product innovation. Once a dominant design has arrived, the emphasis of the companies is to innovate the process to deliver products under the dominant design. If there is difficulty in the region to start new businesses (firms) the incumbent firms will tend to dominate and the expected outcome would be less product innovation, thus the region will lose its competitive advantage due to lack of innovation.

On the other hand a technological discontinuity –the replacement of one technology for another- may obsolete the capabilities of manufacturers, suppliers, customers and related industries due to the inability to adopt a new technological wave or a disruption in the relationship among the players of an industry. This would create a high level of uncertainty for all the stakeholders.

This phenomenon should not only be of interest of businessmen, but policy makers and government officers. If a region is capable to recognize this changes in the competitive conditions, should also be capable to develop incentives for starting up new innovative businesses and make "social" investments to establish mechanisms for promoting innovation and creativity within its key economic sectors.

In the latter paragraphs has been described one of the elements which I believe is key for scenario creation oriented to new business identification, that is the evolution of technology. I will dedicate the next section to highlight what I believe are the most relevant elements for evaluating technology evolution and its implications when dealing with uncertainty.

Uncertainty due to the Evolution of Critical Technology

In this section I will address the issues about the evolution of the technology that is critical for the business, the *critical technology.* Every business within a company has a critical technology associated. Although in some cases the technology underlying the operation of a business is "state of the art", in others can be trivial, however in every case a full understanding of its performance and evolution is key. In any case changes and evolution in the technology can create significant uncertainties for the business opening up opportunities or threatening the competitive position of the firm.

The role of the technology can also vary from business to business. Some businesses are built on a certain technology that enables a particular product or a specific process that represents the business' competitive advantage. Furthermore, in other cases, the technology is the product.

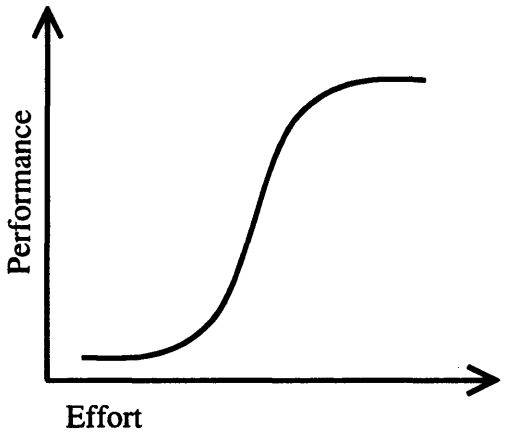
This critical technologies in every business as different paths and speed in their evolutions. In the past ten years many authors have studied and written about the future of certain technologies and the linkages among them, as well as the benefits for the general public.

More important than trying to forecast what will happen with particular technologies, managers should understand the way that technologies affect their businesses and the way that they do business. While it is true that technology by itself open opportunities, it is also true that those who understand its impact in business are the ones that take advantage of its benefits.

The first step of understanding the evolution of technology the uncertainties that creates and the opportunities that opens, it is key to have a full knowledge of the critical technology for a business. Far from the technical understanding of a product or a process a manager should know –at minimum- those key parameters for evaluating the performance of a particular technology. Foster (1986) has proponed the S-Curves for forecasting and evaluating the performance of technologies. This is an easy-to-use tool for managers to understand the critical technology of their business.

"The S-curve traces out the path of development of new products and processes with each successive point on the curve representing an improvement in performance" (Foster, 1986). He argues that the pattern of the S-curve repeats in every industry and, in an empirical manner, he suggests that the behavior that these curves describe will continue to do so in the future.

Figure 3: S-Shaped Curve



An S shaped curve describes the increase in performance (Y-axis) as a function of effort (X-axis). The performance is measured in what is considered the key parameter of performance of the technology. It is important to mention that the parameters of performance can be multiple, this suggests that more than one S-curve is needed to describe the evolution of a particular technology.

The effort represents the amount of resources spend –or invested- in the improvement of performance of a product or technology. This effort can be measured in accumulative time dedicated to R&D activities, capital invested in innovation, etc. The behavior of the performance described by the S-curve can be interpreted as follows: In the early stages of a technology the efforts that are dedicated to its improvement are high, and the yields are relatively low.

This represents, in some cases, the stages in which breakthroughs are obtained. This stage is characterized by the emergence of dominant designs. A dominant design of a product is an

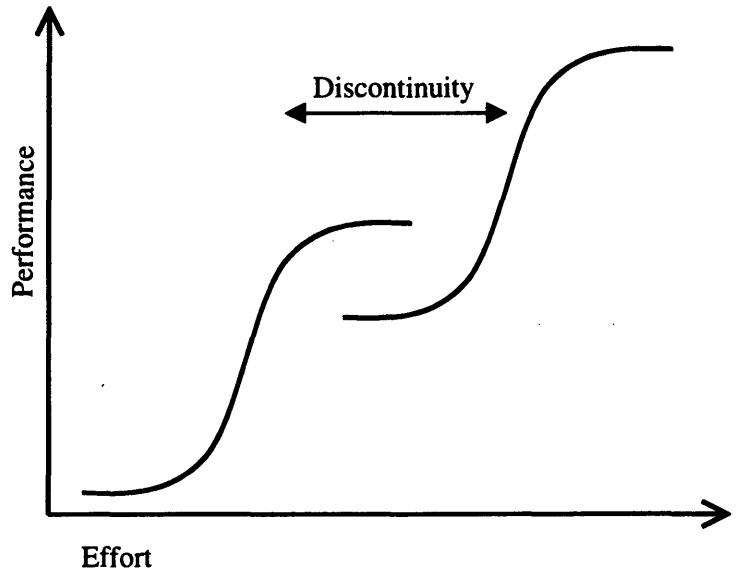
accepted "architecture" by the market and producers that is built on a set of established standards.

Once the technology has gained momentum the resources needed to yield higher results are less than in the beginning and the improvements obtained are result of incremental innovations over the technology. This stage is characterized by decreasing innovation in product and a increasing emphasis in the process improvement.

The top of the curve comes once the technology has reached, either a physical limit or the design behind the technology is exhausted, therefore the yields in performance improvement are low and the efforts are high again, resembling the initial stages of the technology. Once a technology has reached this stage is considered to be mature.

Almost in every case the S-curves representing the technology of a business come in pairs. This represents a new development in the same market that allows better results compared with that of the existing technology, and the second technology replaces the first one. A classic example of this phenomenon is the replacement of vacuum tubes by solid-state electronics.

Figure 4: Technology replacement



Source: Foster, Richard, "Innovation, The Attacker's Advantage", 1986

This technology displacement represents discontinuities. This gap between two S-curves is very difficult to identify and sometimes these periods are regarded as chaotic in an industry and within the organizations.

Solving the uncertainty created by this gap is one of the most difficult tasks for the managers; the capital needed to invest in new generations of technologies are difficult to show; the skills of the organization may not be the needed to use and be efficient; and the outcomes of the investments are uncertain. If well managed this change of S-curves can be a great success for a firm. If not, it could represent its doom.

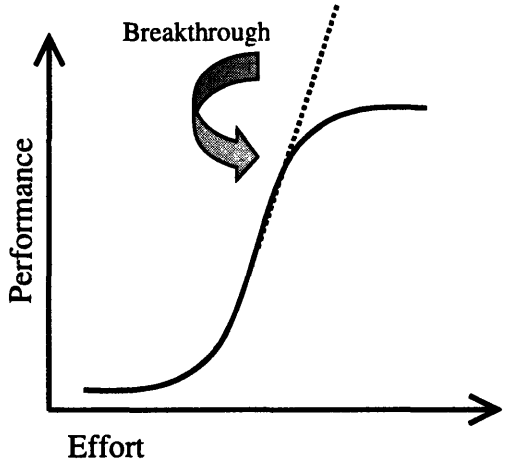
One of the fundamental dilemmas is that protecting old technologies appears to be more economic. Again, if a manager has high pressure on financial controls, therefore her risk profile can be low.

This means that, in order to meet financial and short-term goals the risk averse manager could prefer to stick with the more economic action, and lose the opportunity to step ahead of the competition by developing skills in a new technological generation.

One of the most important setbacks of S-curves, the way that Foster present them in his book, is that these are constructed in historical data. This means using historical data to describe the technology performance over time. The main problem found in this approach is that identifying the pattern of behavior of a developing technology can be very difficult.

One can easily argue that technologies can have an unexpected breakthrough during its incremental innovation phase, therefore the "life cycle" of the technology could be extended to a point where there is a real unknown limit, as showed in the following figure.

Figure 5: Technological Breakthrough during the Incremental Phase



The way that I believe this issue can be raised is first, to really know which are the key parameters to evaluate in a particular technology, and to be acquainted with the developments (research labs, universities, "fringe" companies and start-ups) that could improve the technology. Second, once this information is mastered, to create scenarios with the possible outcomes of these developments, using frameworks such as those proposed by Schwartz (1991).

Since the intention of these first three chapters is to create a theoretical framework, I would like to leave concrete examples of this proposition for later discussion. Although, there are many historical examples in previous work (Foster, 1986; Utterback, 1996, Christensen, 1997) that could be presented to demonstrate the S-Curve approach, I feel more appropriate to put aside them for a while, and identify new ones and address them in Chapters 4.

Chapter 3

Towards a Structured Methodological Framework for Managing Uncertainty in New Business Development

In general, a methodology consists of a set of prescribed components or techniques, singly or in sequence, each of which is dedicated to attain specific products, both tangible and intangible related to problem solving and design (Warfield, 1990). Traditionally the design of methodologies has thought to lie in specific applications, such as engineering, software development, etc. However, these methodologies use so specific language, concepts and context that are unintelligible for those who are not related with a particular field. In the task of designing methodologies with a managerial orientation the approach to follow should be such one that allows integrating different disciplines and be comprehensive for all those involved parties.

The need for methodologies for achieving tasks at the managerial level has as objective to give a framework to have a structured way to put together different kinds of elements and having a logic direction for decision making. This last assessment is probably, what I believe, the most important for a manager that faces uncertain issues.

I will discuss in this section the elements that a methodology should take in account when dealing with uncertain managerial situations. The elements that I believe are relevant is the decision making process, the types of decisions, the complexity of the situations, and creativity.

The Decision Making Process

Management is about making decisions, deciding among a series of alternatives and using the available information for establishing what is best for the organization. Simon (1994) proposes that managing and decision making are almost synonymous, and that decision-making

should be studied and "interpreted broadly" to understand the role of the manager that often acts as a coordinator or facilitator among her peers.

Certainly, the process of decision making is not made by just one person -or a manager- and is not circumscribed to just one set of data. It implies the integration of facts, opinions and policies surrounding an issue; implies the coordination of more than one stakeholder in a particular situation and implies the communication of a comprehensive way to deal with multiple issues.

Having said that, I will argue that a methodology for dealing with uncertainty should involve not only the concept of decision making but should follow the process of executive decision making in order to take in account all the elements that impact a particular situation.

According to Simon, the decision making process typically comprises four stages: finding occasions for making a decision, finding possible courses of action, choosing among courses of action, and evaluating past choices. Each of these stages involves different tasks from managerial staff and use specific sets of data and information for designing alternatives and choosing among them. At a more generic level these stages can be divided into four activities:

- *Intelligence,* searching the environment for conditions calling for decision;
- *Design*, that implies inventing, developing and analyzing possible courses of action;
- *Choice*, which is selecting a particular course of action from those available;
- *Review*, which is the phase in which the decision maker assesses the past choices

These elements, along with the ones to follow, should be the spine of a methodology to deal with uncertainty. The decision making process is very close related to the type of decision that a manager faces. Following I discuss two relevant types of decisions.

Types of Decisions

Decision-making processes are very much driven by the type of decision that the manager should made. In this regard, Simon has divided the types of decision making into two broad categories: *Programmed* and *non-programmed* decisions. This discussion is relevant in managing uncertainty given the nature of decisions that uncertainty involves. It is true that decisions do not fall always in one or another category, however there is a wide variety of decisions that fall in between. In the following paragraphs I will describe these categories and the relevance for managing uncertainty.

Decisions will fall into the programmed spectrum to the extent that they are repetitive and routine, and that a definite procedure has been established to deal with them. Therefore, these type of decisions are not treated as novel each time they occur, instead, managers are aware of them and have a clear course to take. The sources of these decisions are various, and typically are related to recurrent problems and issues, such as pricing, determination of salaries, etc.

As opposed to programmed decisions, non-programmed decisions are usually novel, unstructured and there is no clear way to deal with them. These type of decisions arise when complex and elusive situations appear or because its importance require a "tailored method" to deal with them. One example of these kind of decisions is the development of a new business along a product line of the firm but in a different region or country, the diversification of the portfolio of products of the firm and of course the appearance of a new disruptive technology. No wonder this type of decision increases the level of uncertainty for the firm and require a broader framework for corporate strategy. Other authors, such as Bronner (1993) had called non-programmable decisions as "pure" management decisions.

Now, the fact that those non-programmed decisions are fuzzier to deal with does not imply that the methods and approaches should be as fuzzy as the situations. I would say that in this kind of situations, managers should have a more structured framework and a set of steps to deal with novel situations.

Every day managers face a blend of programmed and non-programmed decisions and certainly they also face uncertainty in many of them. As I have already stated in Chapter 1, managers should take advantage of uncertainty, given that uncertainty creates opportunities, however this should be done in a structured manner. The need for a structure in decision making under uncertainty is yet increased by another element already mentioned: complexity.

Complexity

Decisions and situations are more complex, the more functional areas and stakeholders are objectively affected by the issue at stake and/or involved in a decision-making process (Bronner, 1993). This fact is the result of the necessity to face frequently conflictive arguments and of the requirement to coordinate content matter and procedure of the problem-solving process.

Warfield (1990) states that while the concept of complexity is fairly understood and for having a written definition of it would be enough to read it in a dictionary, the most important issue is to understand its meaning. The meaning of complexity is derived of the relation of the individual and the context in which a situation arises. Under this premise the individual would experience a complexity related directly to her role, this is called *situational complexity*. For example a particular situation is perceived in a different way if the individual if she is part of the situation or is only and observer, this would arise her own biases towards the situation and therefore to the possible solutions and decisions.

On the other hand, complexity has other dimension that involves the information and knowledge available to approach a situation, this can be defined as cognitive complexity. Under this dimension, the individual is affected by the lack (or overload) of information available about a particular issue or by her own ignorance (or knowledge) regardless her role. Furthermore there is a lack of knowledge of content matter to solve the given or presumed problem and there is a lack of experience in the procedural handling for approaching the situation.

Complexity also has a direct relation with the novelty of the occurrences. Problems requiring decision are perceived as complex if they constitute first-time confrontations with a specific issue. Complexity results from the novelty or even first-time character of the occurrence of a problem. Totally contrary to programmed decisions, proven patterns of action are missing. In such cases the risk of wrong decisions is estimated to be relatively high.

Finally, the complexity of decisions depends on the volume of the respective problem. This is the result of the number of alternatives, the quantity and diversity of criteria of evaluation as well as of the quantity of information to be processed mentally. In this case, complexity results from the physical and psychic workload of the decision-makers.

It can be said that complexity is a central characteristic of management decisions and is a real phenomenon of decision-making practice. Complexity and uncertainty are usually the main characteristic of non-programmable decisions and dealing with them will always demand a high level of creativity, even sometimes absurdity. Following I will discuss the last element of a methodological approach for dealing with uncertainty: creativity.

Creativity

Creativity is the ability of an individual –or a group- to create new relevant ideas and perspectives (Mauzy, 1999). The creativity system in any organization must start with strategy. Creativity is not only about new products and services; it is about new strategic processes and new perceptions of opportunity. It is one thing to think that creativity is fundamentally and strategically important for a business. It is another to have a system in place for managing creativity, a system that people understand, that works effectively, and that regularly leads to the realization of significant value for the company (Kao, 1997).

Pierre Wack, the head of group planning at Royal Dutch Shell during the 1970s, introduced the notion of strategy as "the gentle art of re-perceiving". As such, strategy is also an inherently creative process –which by the way led Royal Dutch Shell to dodge the 70's oil crisis minimizing its impact on the company (Schwartz, 1991). Creativity should be thought about in

much broader terms, encompassing both innovation and entrepreneurship i.e. taking advantage of uncertainty for identifying new opportunities. Creativity is how value is realized from those great new ideas and the processes by which those ideas are developed.

In determining how creativity occurs in organizations, a useful metaphor can be found in the world of music. There are two basic ways of playing music. One way is to go to the music store and buy sheet music. Sheet music tells you exactly what notes to play, how loud to play them, how fast to play them, and so on. Any person with a basic level of skill can sit down and play those notes.

The other way of making music is jamming, a word that comes from jazz. Jamming demonstrates the importance of improvisation (Kao, 1996). Improvised music has no sheet music to dictate how it should be performed. In jamming, there is a set of understandings that guide the execution of the music, and there is no distinction between rehearsal and performance. The great thing about jazz musicians is that they just take their instruments and play new notes that sound good.

If the art and discipline of jazz improvisation can be understood, it is possible to learn how to practice that art in the world of business. Improvisation is probably one of the critical skills for businesses to learn in the future, and the process of improvisation must underlie how organizations formulate strategy going forward. It is very important to clarify that I do not mean by this to change direction continuously, what I mean is once an objective has been determined the organization should be able to adapt itself (or its strategies) to changes in the environment.

The functionality of "corporate sheet music" is obvious, everyone knows what to do, how to do it and when to do it. But its limitations are also easily identifiable, the "corporate sheet music" can become the end rather than the mean; can lead to oversee opportunities (or threats) just for the sake of the corporate strategy. In a world where competitiveness depends on how fast, smart, agile and, above all, creative the organization is, the "corporate sheet music" loses value.

Recently the Wall Street Journal published an article called "A New Model for the Nature of Business: It's Alive", in the article the author suggests that the new paradigm in business models is one that resembles the natural model. A more biological model, with continuos adaptation, as opposed to a mechanistical model which is static, rigid and mostly centralized.

Following I show what I believe is a structured way to deal with uncertainty, analyzing not only the impact in the new business development, but using uncertainties and trends to identify new opportunities for the firm.

A methodological approach to deal with uncertainty

The main objective of the methodological approach that I will present in this section is to deal with uncertainty identifying those opportunities that emerge from the relevant environment of a particular industry. The methodology also pretends that a manager be able to make adaptations given future events in the environment that create uncertainty.

This methodological approach also pretends to evaluate the most relevant uncertainties that the business opportunity will face and that will deter the success in the market. Finally once this uncertainties have been evaluated their impact will have to be translated into a strategic layout in the business plan.

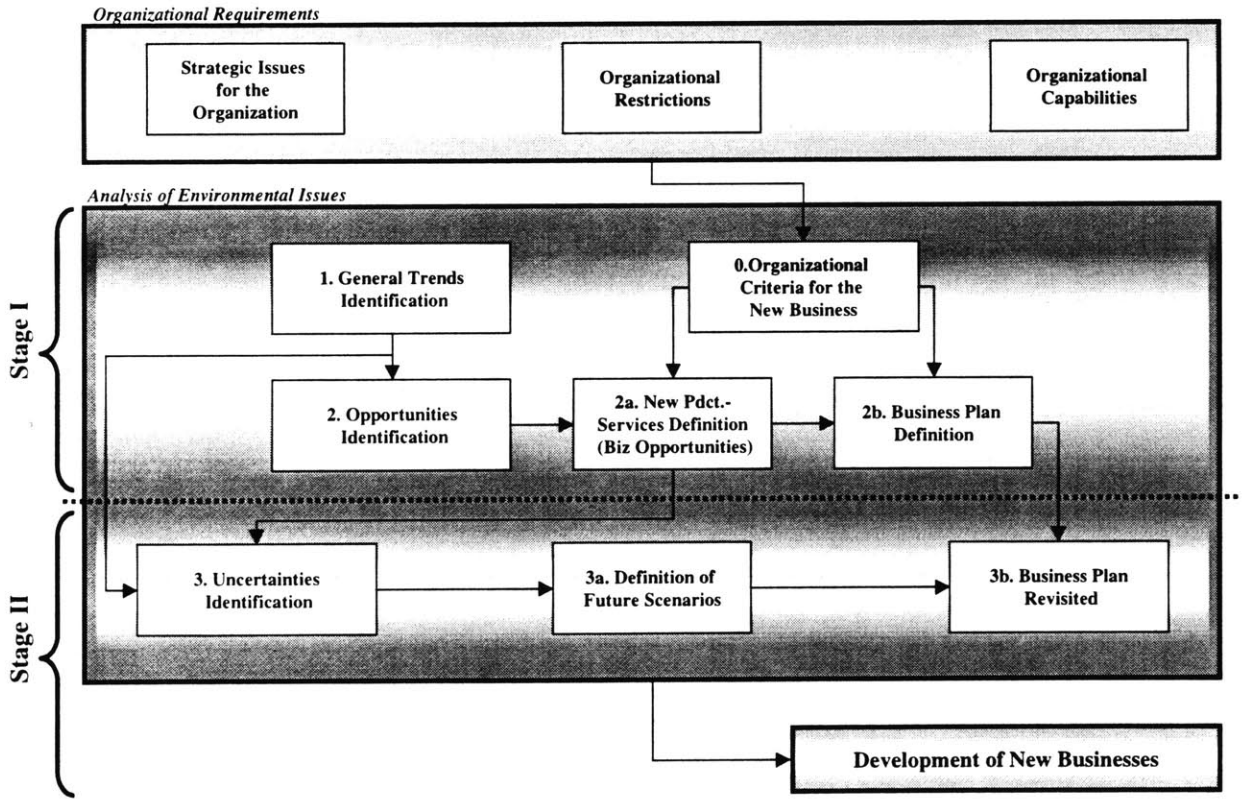
It is important to mention that the objective of the methodological approach presented in this thesis is to have a structured way to deal with uncertainty in the development of new businesses, therefore no methodology for developing a business plan will be discuss in this work. For this matter I will point some relevant elements for a business plan and some bibliographical references will be mentioned when applying this framework in Chapter 6.

I have divided the methodological approach into two areas: Organizational Requirements and Analysis Environmental Issues. I will explain in the following sections the implications of each of them and the way they interact.

The first area mentioned related to the organizational restrictions that a particular organization may have for development of new business. Notice that I am using the word organization instead of firm or company given the fact that this methodology is intended in the first place for organizational environments, however its use may be expanded to other entities such as venture capitalists or not-for profit organizations.

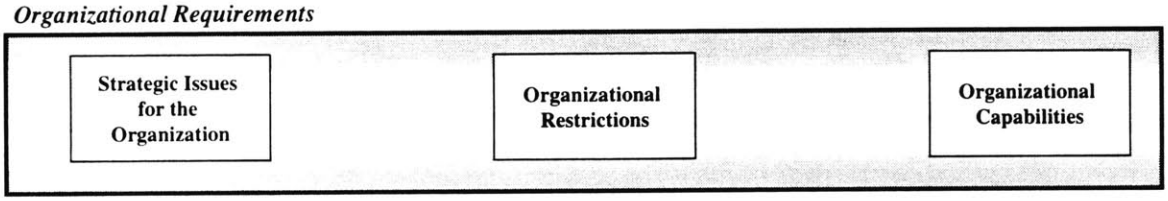
The following figure is a schematic representation of the methodology in which two stages are shown, however the first block could be considered stage "zero" where the organization defines parameters and criteria for developing businesses and that involves the strategic process of the firm as whole. This stage is where the organization establishes normative issues regarding the governance of the firm and that should be reflected in developing new businesses. This "zero" stage is inherent to each company, this will certainly define the distinctive seal of the firm over any new venture.

A Methodological Approach to Deal with Uncertainty in New Business Development



Stages I and II are directly related to environment of the firm and the industry it competes. Both stages are designed with the intention of provoking in managers the need of having insights from the environmental issues that surrounds their firms, the uncertainties that exist and the opportunities for developing new businesses. Stage II includes rolling out a new venture; this is with the intention of insisting in the need of having "radars" continuously activated to identify the changes in the environment of the business.

Organizational Issues



As discussed in Chapter 1, an organization should establish in advance the firm's strategic direction; this will dictate which are the overall restrictions for developing new businesses within the organization. It is a requirement that the organization decides what it wants to be and from then on decide to which types of businesses will grow or will invest in the future.

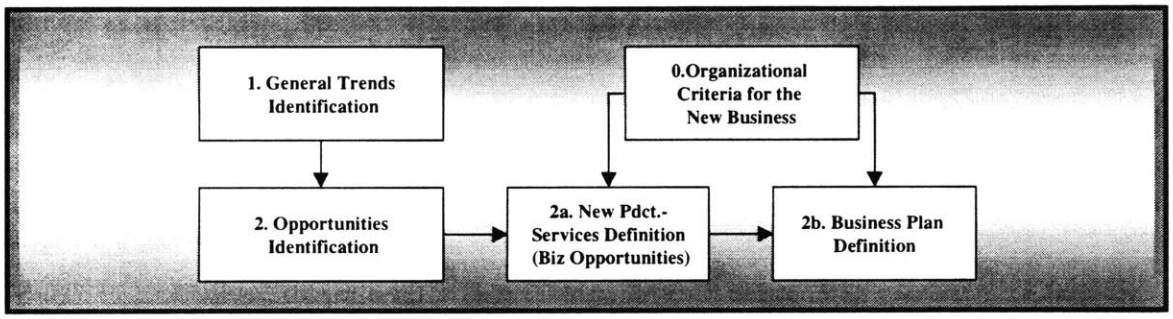
Certainly, in many instances the type of business will determine which type of organizational approach should be applied for the business. For example in some cases an organization will decide to grow the business as a part of the existing organizational structure, while in others an organization would opt for starting up a new division or even more spinning off a business from the core organization.

The discussion of the intentions of the organization in Chapter one was intended to show which are the most common alternatives for an organization to develop a new business and the implications that some of them have had in the past. This issue is key in the success of a new venture. The exercise of evaluating the organizational capabilities and strategic direction should be an iterative process. This means that an organization should establish what it should be and then define which are the requirements to accomplish those objectives. The next phase of this

methodological approach has as objective to evaluate the environment of the firm and take advantage of the trends for developing business, as well the impact in the organizational structure.

Stage I: Environmental Issues

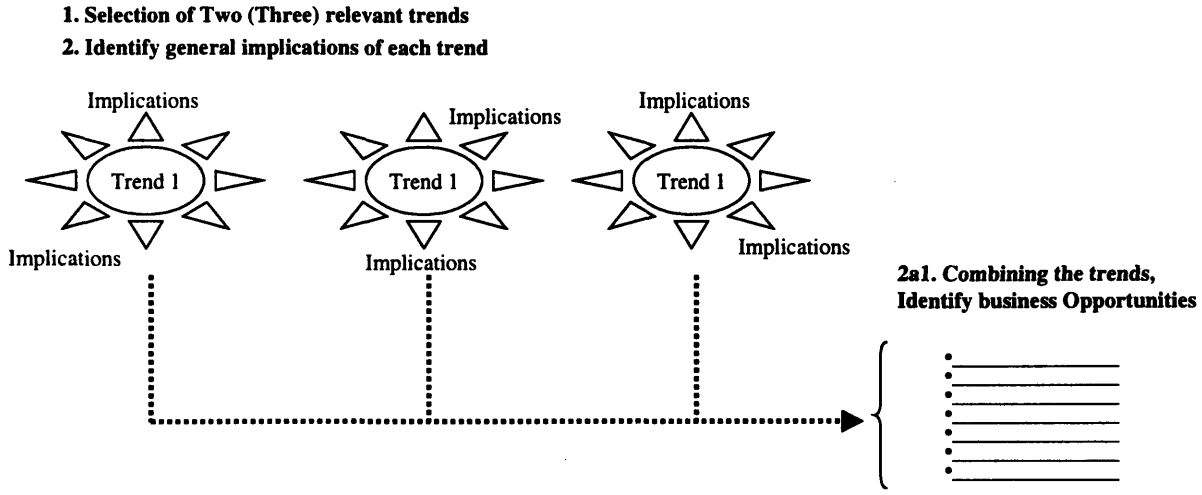
Stage I



For the development of this section of the framework the firm should have a full understanding of the environment surrounding its business practices. This means to develop an extensive evaluation of the dynamics of the industry in which the firm operates, to define which are the sources of competition and try to establish the "state of the art" of the key technologies as well as the trends at a general level.

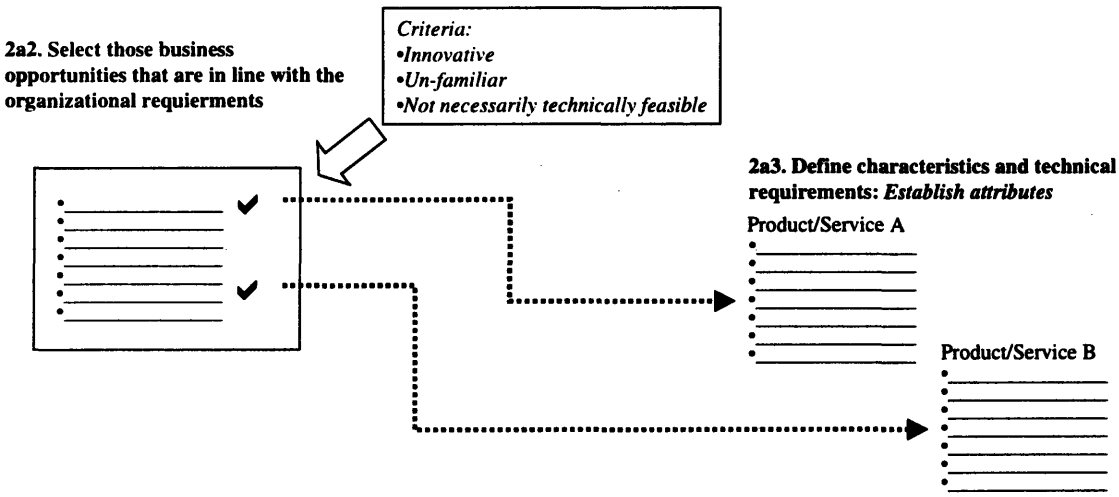
This analysis will lead to identify the most important trends and the meaning for the industry. Another way to approach this stage is to identify "fringe" technologies and based on them to analyze the impacts and implications for the different stakeholders. This is the approach taken for analyzing the computer industry in Chapter 4 where, based on a technological disruption, opportunities and uncertainties are identified.

Methodological Development



The result of this stage is the identification of business opportunities combining the different trends. This exercise will require a great amount of creativity given the nature of the analysis. This is particularly true in the cases where industry trends have no intuitive overlaps, and the teams in charge of the analysis will have to ignore issues as feasibility or technical restrictions.

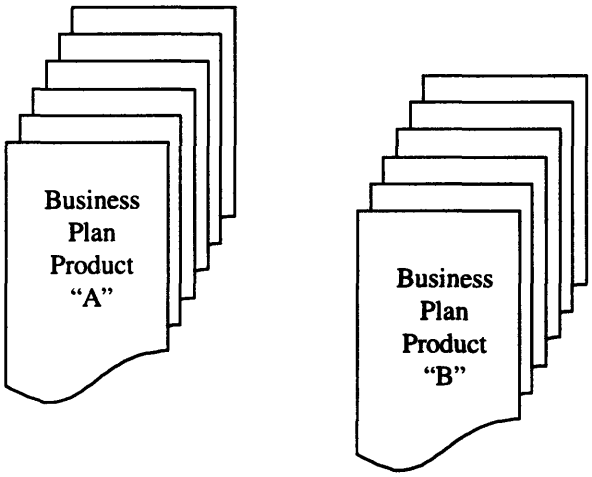
Once the business opportunities have been analyzed the second part of the phase will require to select those business opportunities that seem to be more synchronized with the strategic direction of the organization. Finally, for each of them the team will define the attributes from the consumer's point of view as shown in the following diagram.



This section of the framework complies with the sequence of managerial decision making developed by Simon and discussed at the beginning of this Chapter. In the first part identifying opportunities for decision making within the industry is basically and Intelligence task. Later establishing business opportunities is a Design task given the amount of innovation that requires; and, finally a Choice task is done when deciding which business opportunities are more in tune with the organization plus a new Design task in establishing attributes.

Finally a business plan for each of the new ventures must be fully developed

2.b Develop a Business Plan for Each (or one) of the New Product Services



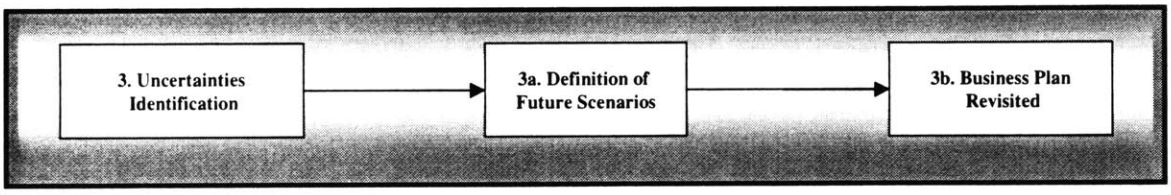
Stage II: Evaluation of Uncertainties

In some sense, stage two is the central point of the framework. As Simon states "Review is the phase in which the decision-maker assesses the past choices". This stage pretends to be a Review task based on the analysis of the uncertainties found in the environment that will affect the new venture.

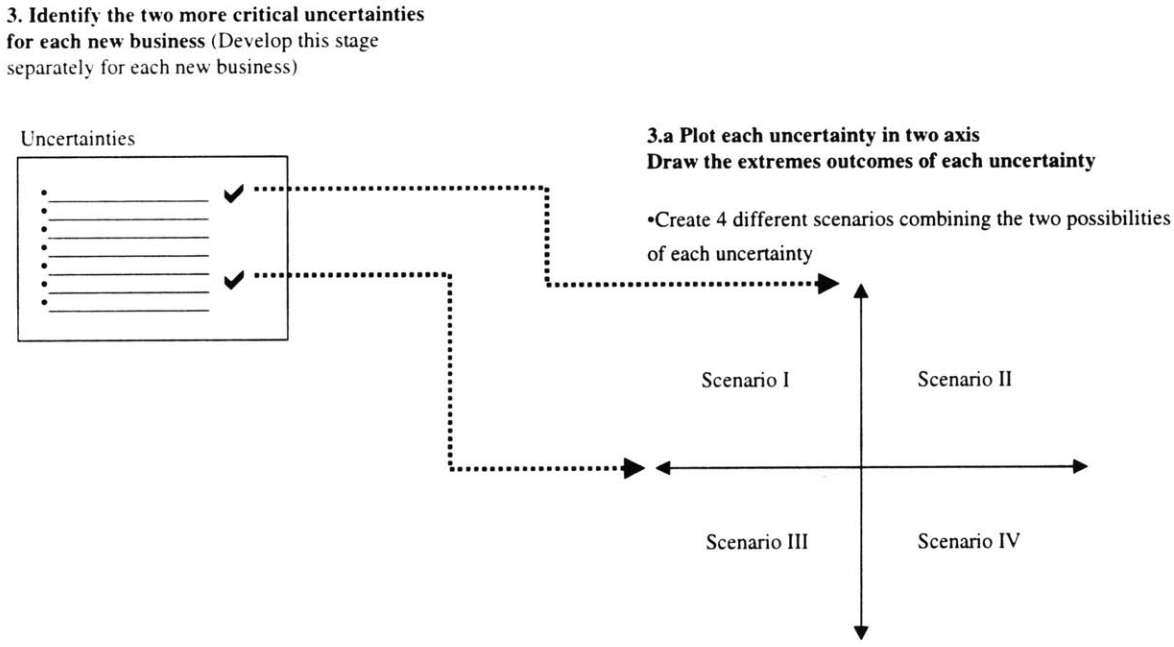
I would suggest that his stage be done after completing the business plan, however, there is no reason to restrain a team to develop the uncertainty analysis in parallel with the development of the business plan. Certainly this will demand more resources to be allocated for

the project valuation team, however would result in a reduction of time to completing the plan and avoiding important issues to take in account in different sections, such as financial assumptions and strategic structures of the new venture.

Stage II

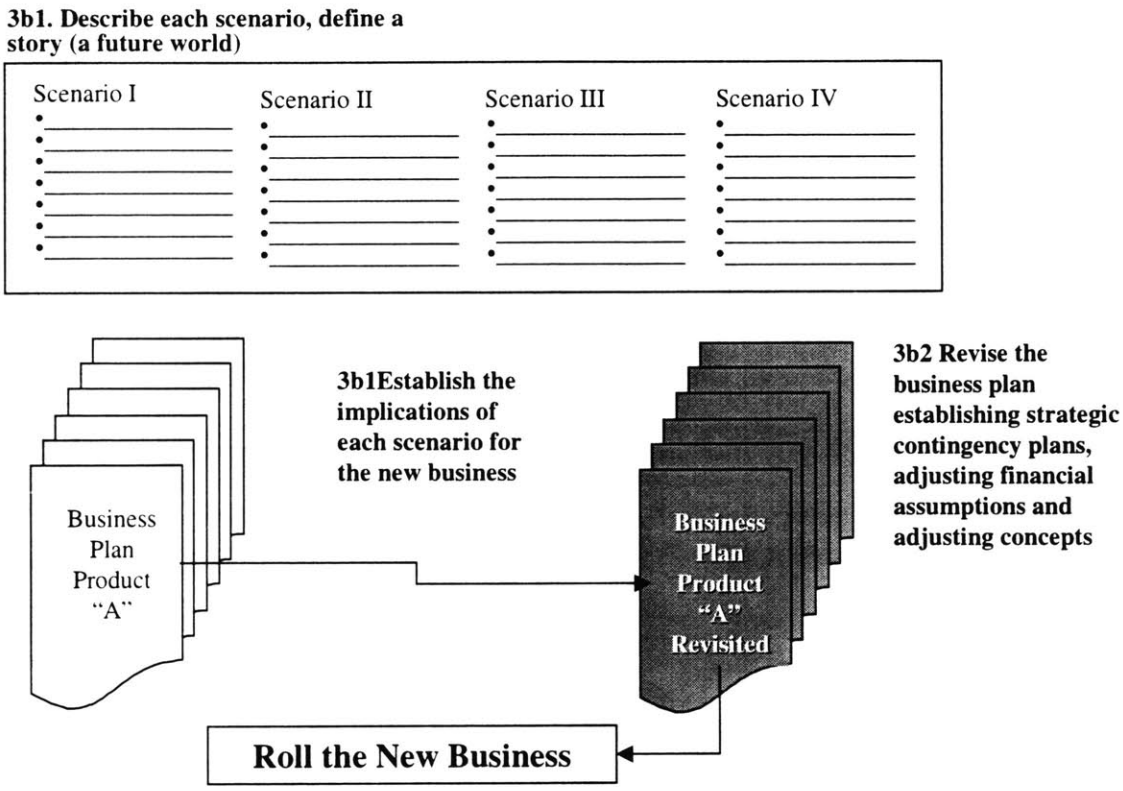


In the following diagram I show the requirements to develop this stage of the framework.



As the reader will quickly deduct this section of the framework is drawn directly from the work of Schwartz (1991) and his approach to dealing with uncertainty using scenario creation. The value added of my proposal underlies in the analysis of the sources of the uncertainty.

The next step after creating the possible scenarios is to describe them and establish the impact on the new venture, as shown in the following diagram, as well as to establish which parts of the business plan will be modify as a result of the analysis of the industry environment.



Integrated Strategies

My goal in these first chapters was to explore those elements that will determine the quality of a strategy aimed to develop new businesses within organizations under uncertainty from a theoretical standpoint. Certainly some of these elements were presented in a isolated manner making links where appropriate, however, it is clear that in the task of defining strategies these elements must be integrated and its analysis should be made in parallel in many parts of the process.

I showed how firms have addressed in the past the issue of growth and how the diversification strategies have needed fine tuning after some time bringing the necessity of downscoping the firms. Many of the diversification movements were developed with a financial spirit underlying the strategy and the lack of analysis of other elements have forced managers to reevaluate their corporate strategies.

Furthermore, many investments have been done in the absence of technological evolution, and even those investments made for innovation within the firm have been made on economic basis, keeping firms from managing successfully the discontinuities of the emergence of new S-curves.

Regional competitive analysis is also a key for the development of new businesses. The competitive advantages of a region and the competitive conditions of industries are not static. Theses conditions change in time for a number of reasons, in this paper I made emphasis in the relationship between lack of innovation in a region and the lost of competitive advantage, however many other factors, such as political and economic conditions, regulations, etc. play central roles in this analysis.

Finally an adequate strategy for economic evaluation of new businesses and investments is fundamental. Applying methods that are flexible enough to take in account, risk and uncertainty, cash flow scenarios and future opportunities must be fully understood by managers.

Identifying businesses is not a task of one or two disciplines, nor is the result of the "illuminated" mind of an individual; it is an integrative effort that combines many perspectives and the adequate evaluation of critical factors that are unique for each venture. The methodology used for this analysis can change, but based on the full understanding of the tools and approaches upon which a methodology is built. The following three chapters will be dedicated to study a particular technological disruption that creates uncertainty and the impact in the industry as well as some applications of the framework already presented.

Chapter 4

Uncertainties and Opportunities due to Technological Disruptions

In this chapter I will describe and analyze a case in which the development of a technological disruption creates both, uncertainty and opportunities. I will use some of the concepts presented and discussed in Chapter 2, such as S shaped curves and scenario creation, for making parts of the analysis, as well as public information about the computing industry.

Future Scenarios

Michael Dertouzos in his book "What Will Be" describes what, in his view, the future will be in terms of technology integration, as well as its benefits for the average citizen. One of the future scenarios that Dertouzos describes in his book is one where the life of a gentleman is saved while vacationing, along with his wife, in a remote location in Alaska and is suffering a severe asthma attack. He is saved thanks to the wonders of the technology integration. A health kiosk installed in the hotel allows his physician, located in Philadelphia, to read the data sent from the kiosk via the hotel network and to make a quick evaluation of his condition saving valuable hours.

Stories about the future, as those described by Michael Dertouzos, had been heard many times in the past and have always been told as part of the science fiction lore. Today, less than a year before the beginning of the XXI Century, those stories are leaving the world of make believe and are jumping into the stories of newspapers and news magazines and being told as real possibilities.

Although the scenario mentioned above is described by Dertouzos based on a single unit (the "kiosk"), in reality what he describes is a typical situation where different types of devices have been able to communicate among themselves, and then, transmit specific data over a telecommunications network.

One of the problems underlying this setting is how the devices have been able to "talk" to each other efficiently and in a transparent fashion for their users. Sun Microsystems has announced their solution for technology integration called JINI ™. This technology has many strategic implications and creates uncertainties for the industry, for the company and the end users

Spontaneous Networking or the Ultimate Plug-and-Play

Another setting regarding technology integration is described by Kevin Kelly and Spencer Reiss in the article "One Huge Computer" (Wired, August 1998), where the transparent communication among devices is a reality:

> *"In a windowless second-floor room in a deliberately obscure Sun Microsystems outpost in Sunnyvale, California, half a dozen anonymous chunks of expensive-looking hardware sit on long folding tables. Some barely rate a first look: a not particularly recent printer, what look like a pair of flat-screen monitors, a video camera, a couple of keyboards. Others are clearly prototypes: overdesigned purple computer-somethings with curved sides and stylized vents. Any Demo, Silicon Valley, USA.*
>
> *Turn any of the devices around, however, and only two wires are visible: electric power and a RJ-45 Ethernet connection. Each box - even the display screens and the little handheld camera - is a fully independent network citizen, able to hold its own on the system, unencumbered by specialized cables, software drivers, or the rest of the usual array of digital life support.*

Say you want to use the camera. Plug it in, and poof - a second later, an icon appears on your display screen. All the configuration chores are done automatically by one of those purple boxes - a low-end server called a lookup device - and by a 25K communication program in the camera. What's in the viewfinder? Bring the camera image up on a monitor - any one you like. Store a clip? The 10-gig storage device - a slightly smartened-up disk drives – is waiting. Edit? There's another of those purple boxes, the computing device, with full workstation power. Pull some video-edit software out of the storage module, and you're off.

That's one possibility. Or maybe you'd rather batch print some letters from your laptop. Done. Or get that old laser printer online. A pocket-sized adapter does it. Or add another 10 gigs of storage - no need to call a sysadmin, just grab a drive off the shelf, and plug it in."

What it is described in the above paragraphs is one of the demos set of the new protocol designed by Billy Joy, VP of Research of Sun Microsystems, dubbed Jini™ (pronounced like "gee-nee", from the Arabic for magician). The demo is what network administrators, technicians and users have dreamed about every time that a peripheral device is added to any particular network or work environment: Spontaneous networking; the ultimate plug-and-play technology – "plug-and-work".

Kelly and Reiss also point out in their article that "not surprisingly, some of the Jini demo's most interested visitors have been from hardware companies that would dearly love to find a way for us all to snap a few billion more microprocessors, disk drives, and other smart devices into our personal networks". These visitors, as we may suspect, are those who will drive the initial diffusion of the technology.

This technology becomes particularly important, due to the fact that scenarios such as those described by Michael Dertouzos are becoming a reality from a strong technology based firm, and not as part of a research lab in some university or from a garage in a remote location in

California. I do not mean by this to undermine the importance of both, the research lab and the entrepreneur, but once a market-driven company embraces an innovation, the possibilities of making it available to the consumer are much higher.

On the other hand, the importance of a technology like this one are the implications to the existing business models in the industry, the partnerships between companies and the opportunities created from such a new technological wave. And the obliged question is when and how will this be available for the common citizen (and if it will really be). By now, I will set aside the question and I will address it later.

Now, I would like to turn the direction of this discussion towards the technology behind this spontaneous networking setting, described above, and try to analyze, not only its performance, but the possibilities that it enables in terms of technology integration and the value that creates for the consumer.

A closer look to Jini™ and Spontaneous Networking

First let us look at the real hero behind the story: Java™. In 1995, Sun Microsystems amazed the –then young- Internet community with a cross-platform object programming language called Java, that ran programs over a Netscape Navigator browser, adding movement, and functionality to websites freeing them from the mind-blowing boredom of the static of the pure HTML creations. I remember myself being at Seybold Seminars, in San Francisco, one of the most important events for the graphic design and printing industry, when a jumping penguin, in a computer running Netscape Navigator, showed to the gathered attendees the beginning of a new era in computing.

In a simplified manner (very simplified), Java is a programming language that allows the same code to run on different computers, devices or gadgets - regardless their platforms or operating systems - and suppresses the necessity to re-compile or "traduce" the code for the embedded language in the device's microprocessor.

Java programs are able to run on many different kinds of systems thanks to a component of the platform called the "Java Virtual Machine", a kind of translator that turns general Java platform instructions into tailored commands that make the devices execute the indicated tasks.

So far, the most visible examples of Java software are on the Internet and on enterprise networks. These examples are interactive programs called "applets" that work inside Web browsers on computers and other devices. In other cases Java programs can run directly on computers (without requiring a browser), or on servers, on large mainframe computers, or other devices. These programs range from simple animations on a website to information tracking over a particular process inside the organization.

The most important setback that the developer's community finds in the Java platform is the time that a Java applet lasts to be invoked and begins to work in the Web browser. The Sun labs, however, are aggressively addressing this problem, by developing a new faster compiler that will be released by the end of the year.

Furthermore, Sun announced on November, 2, 1998, the support of the Linux developer community to port the Java platform. Linux is a UNIX version based on Open Source Development i.e. thousands of programmers developing a platform. This will enable faster incremental improvements over the platform.

Let Jini out of the bottle

Networking today is complex, brittle and inflexible. Attaching a PC to the network and accessing a networked printer is a very complicated task. A slight change in a network can cause complications that can be impossible to fix. To add a disk drive for storage capacity typically one must open a chassis, deal with setting algorithms and deal with amounts of setup questions. From the consumer's perspective, what is needed is a simple way to plug in hardware and software into a networked environment and then use the available services immediately. Just like plugging in a telephone.

Jini is a Sun Microsystems project that expands the Java technology and enables spontaneous networking of a wide variety of hardware and software - anything that can be connected to a network. It consists of a small amount of Java code in class library form and some conventions to create a "federation" of Java virtual machines on the network. Jini follows one of the deepest mantras of Sun: The Network is the Computer –or Network Computing. Network computing is a distribution of tasks along a network eliminating the need of being locked to any particular device to do everything; in some way is an attempt to combine the virtues of the old-fashioned central time-shared computing with the advantages of the flexible personal computing. This also allows dedicating specific devices to specific tasks. Explaining the components of Jini, is a better way to explain network computing.

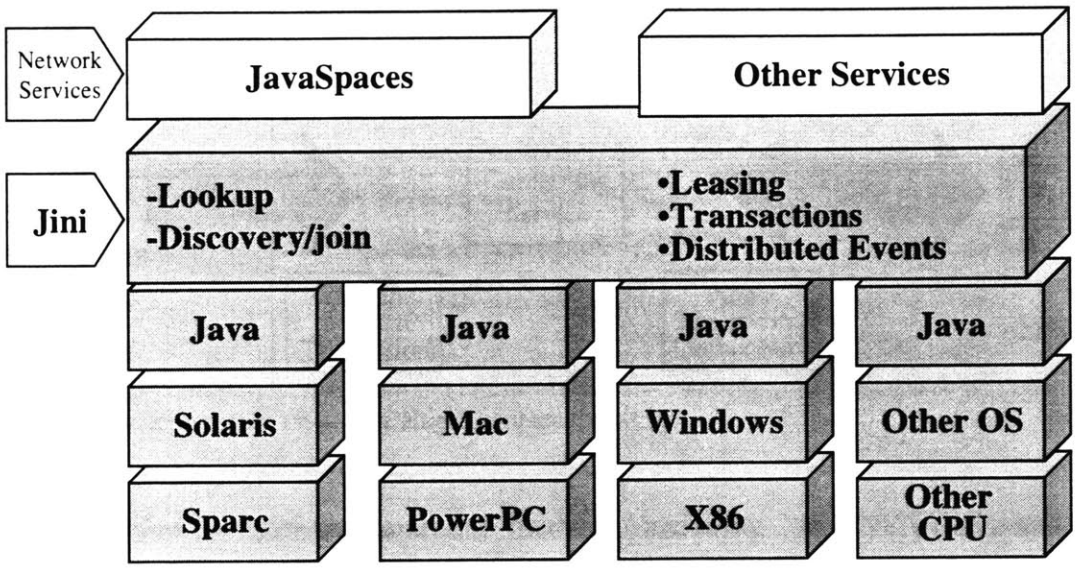
The Components of Jini

Jini moves us closer to network computing; spontaneous networking is a result –and a condition- of network computing; just plug into the network and use all the resources available. The Jini technology can be separated into two categories: Infrastructure and Distributed Programming. In addition, Network Services can be provided to run on top of Jini.

❖ Infrastructure

Jini Infrastructure addresses the fundamental issue of how devices and software connect to and register with the network. The first Infrastructure element is called Discovery and Join. Discovery and Join solves the problem of how a device or application registers itself with the network for the first time with no prior knowledge of the network. The second Infrastructure element is Lookup. Lookup can be thought of as a bulletin board for all services on the network.

Components of Jini



Source: Jini™ White Paper, Sun Microsystems, 1998

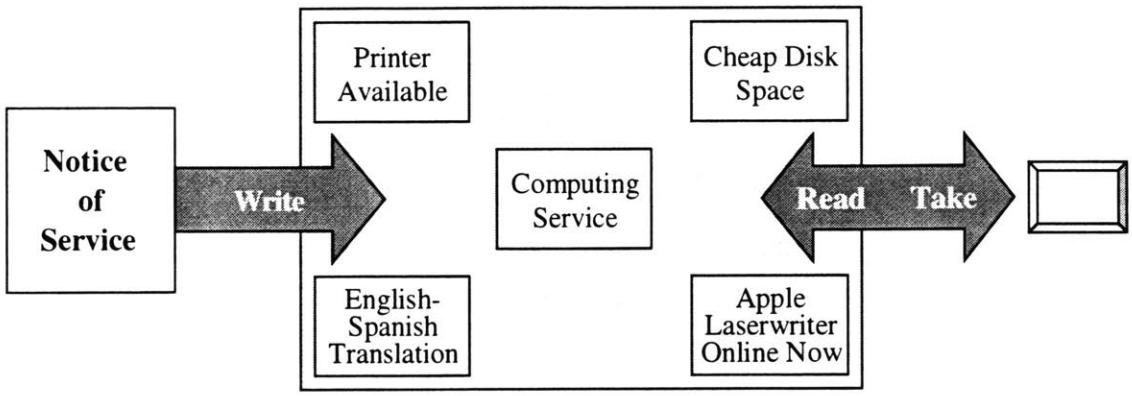
❖ Distributed Programming

Jini Distributed Programming adds to Java additional functionality required for building distributed systems. Specifically, Jini Distributed Programming provides leasing, distributed transactions, and distributed events. With these elements, objects in a Jini enabled network are allowed to "borrow" operational time and capabilities from other devices on the network, negotiating only with those devices involved.

❖ Network Services

On top of the Jini Infrastructure and Distributed Programming, Network Services will be provided to facilitate distributed computing. An example of Network Service is JavaSpaces. JavaSpaces are virtual "market places".

JavaSpace



Source: Wired Magazine, August 1998,"One Huge Computer"

Using a few simple programming methods, including "read", "write", and "take" JavaSpaces make software objects available to anyone in a network. The objects themselves can define a job to be done, a problem to be solved, or a service being offered. A JavaSpace can be as small as 10k and as large as 100MB.

If all this capabilities described above are for real, and if Jini is able to deliver them, we are just about to witness the beginning of the end of the desktop computing as we know it (I say). Having briefly explained the elements of this technology, I would like to turn the focus towards the strategic implications of this protocol for Sun as well as for their competitors.

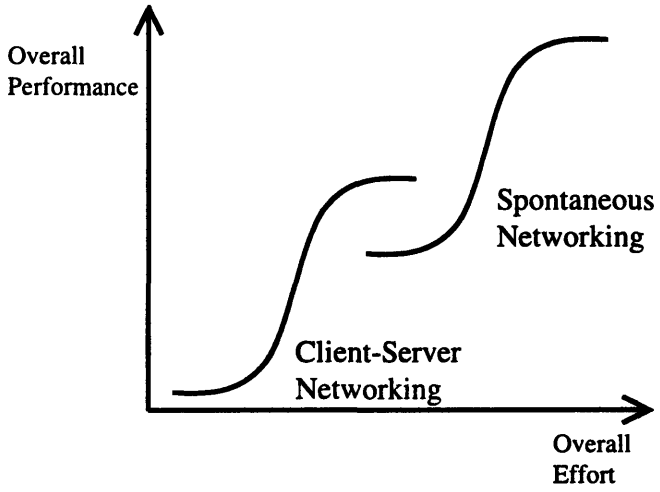
Can Jini grant my wishes?

Three wishes: I wish not to deal with configuration drivers and configuration wizards; I wish to have intercommunication across platforms and generations of devices; I wish to configure home and office appliances remotely. Can Jini grant my wishes? Certainly can. Clearly Jini offers new features in networking capabilities and also enables a number of new possibilities that outperform, in many ways, the current standards in the market. However, Jini's success is function of various factors.

In general, spontaneous networking is a new "S curve" in networking technology that outperforms –in its Beta testing- the existing technology based on OS and client-server architecture. Notice that I am using spontaneous networking rather than Jini. Jini is one of the possibilities to make spontaneous networking to happen –so far, the only "known" protocol.

Other companies such as Microsoft, Lucent Technologies and IBM claim to be working in alternative solutions (but nobody has even seen an Alpha test, from them). The following figure depicts the overall performance of spontaneous networking.

Spontaneous Networking: A new S Curve

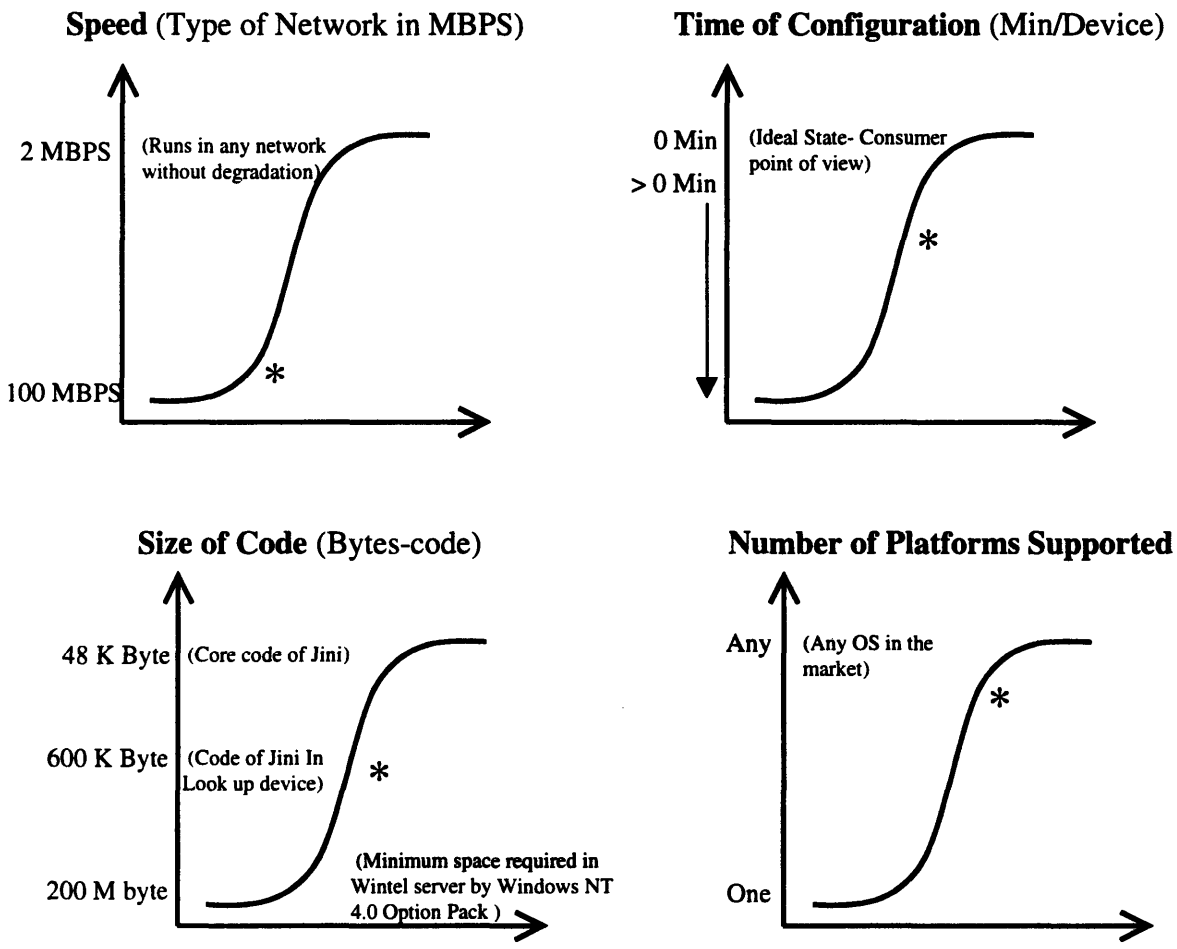


Underlying the three wishes made –which may sound hypothetical, but they are not- are four elements that I believe are key to evaluate the performance of this new technology: Speed (Bandwidth), Time of Configuration, Size of Code and Number of Platforms Supported. In the following chart I describe the relevance of each parameter as well as their market implications.

Parameter	Relevance	Market Implication
Speed	Related with efficiency of the code. Defines the possibility to use any type of network (from 2mbps to 100mbps type networks)	Any protocol for networking should be enabled to work in any network. Although the tendency is towards High Speed Ethernet (100mbps), there are still other types (Ethernet 10mpbs, BNC Coaxial)
Time of Configuration	Reduces the need for administration and maintenance time of the network.	This is the result of the "easy-to-use" protocol that will have two impacts: 1) Home users will be able to "administrate" their own networks with out being tech savvy. 2) Commercial users will be able to dedicate time to other activities and minimize idle time of resources, saving costs.
Size of Code	Increases the efficiency of resources usage. Eliminates the need of high cost servers.	Once the size of code that enables the networking services is reduced, the need for "high end" servers for administration also decreases. High-end servers then, can be dedicated to computing tasks.
Number of Platforms Supported	Eliminates the "lock-in" to one particular platform, allowing any device (type and generation) to be part of a network.	This simply eliminates the need of OS based standards for networking services.

Having specified the key parameters for evaluating spontaneous networking under Jini, following I analyze and compare them using S-curves.

Performance Evaluation of JINI: S-Curves



For each parameter I have identified a physical limit based on available information. These physical limits are proxies extrapolated from other technologies, however are useful for the analysis.

For Speed, I have based the analysis in the reports that exist about the Beta tests of Jini that suggests that there has not been problems in bandwidth, but it is unknown if this is going to be problem. Sun has claimed that Jini-enabled devices would work on 10mbps Ethernet networks without significant performance degradation. However it is suggested that if users do not want to see any performance degradation it is better for them to use 100mbps Ethernet networks.

Although, the number of networking architectures based on 100mbps is growing, networking devices (Switches, hubs and smart-hubs and networking cards) are still supporting BNC (Coaxial) and 10mbps Ethernet, thus, these architectures are expected to be around for a while.

Regarding Time of Configuration, devices under Jini would identify themselves to a network when they are plugged in, "publishing" to other peripherals and to the system itself details as whether a printer is color or black and white, its resolution and the like. This will free the user from making changes in the configuration of a particular machine; thus reducing the time dedicated to non-value-added activities.

Certainly, Jini is reported to yield near "zero" time of configuration, however, devices will still have to be enabled and a "look up" server have to be set up in the network. This means that system administrators will still have to dedicate some time to these tasks.

As shown in previous sections, Jini is just Java software code. It can run on any Java platform, for example a computer, a server, a printer, etc. The Size of code can be analyzed under to elements: Kernel and Look-up. First, the core (kernel) of Jini is just 48 KB of code and has less than 15 application programming interfaces, it is reported that programmers at Sun stopped when there was nothing left to cut out.

Second, Jini source and binary code, which includes a lookup service and other models, fits on a single 1.44 Mbytes floppy disk; the full Jini software is 600Kbytes (Look-up device – low-end server). This code is enough to put a network to work, i.e. to create a Java space with only 20,000 lines of code. Just for amusement, let us look at other platform: Windows NT workstation requires a minimum of 110MB of Hard Disk (HD); Windows NT Service Option Pack 4.0 requires minimum of 200 MB HD –may need double; Windows NT has Approx. 16.5 Millions of lines of code. The efficiency of Jini is obvious compared with the most popular software for networking services.

Finally and probably the most important factor regarding competition, is the Number of Supported Platforms (or OS) in the network. As explained earlier in the report, Jini is capable to support any OS and CPU in the market. It is also expected to support other platforms that may emerge; for example, Sun has already committed the support of Linux, the Open Source UNIX, even when this OS competes directly with Sun's proprietary UNIX version, Solaris.

Although Jini is still a "child" in the market, it is clear that represents a breakthrough in networking technology. It has rapidly reached levels of performance that other protocols have not even reached yet, either, because companies have not been able or, simply, because they have not wanted to, fearing to threaten their own competitive positions.

Clearly network computing is a disruptive technology for the computer industry. Who will take advantage of it and who will not is a different question. So far Sun Microsystems certainly has a first mover advantage. The next issue to be address is the competitive factors that will drive the success of Jini-like technologies in the market.

Will it be?

As already discussed, Jini can become the technological disruption that allows a real integration of technology and network computing. However, there are some uncertainties with which both, users and providers, have to deal with. This uncertainties clearly are relevant not only for Sun, but for all the players and possible players in the market. The key uncertainties that I believe have to be analyzed are:

- *If original equipment manufacturers (OEM) will take network computing for real and will embrace protocols like Jini. And if,*

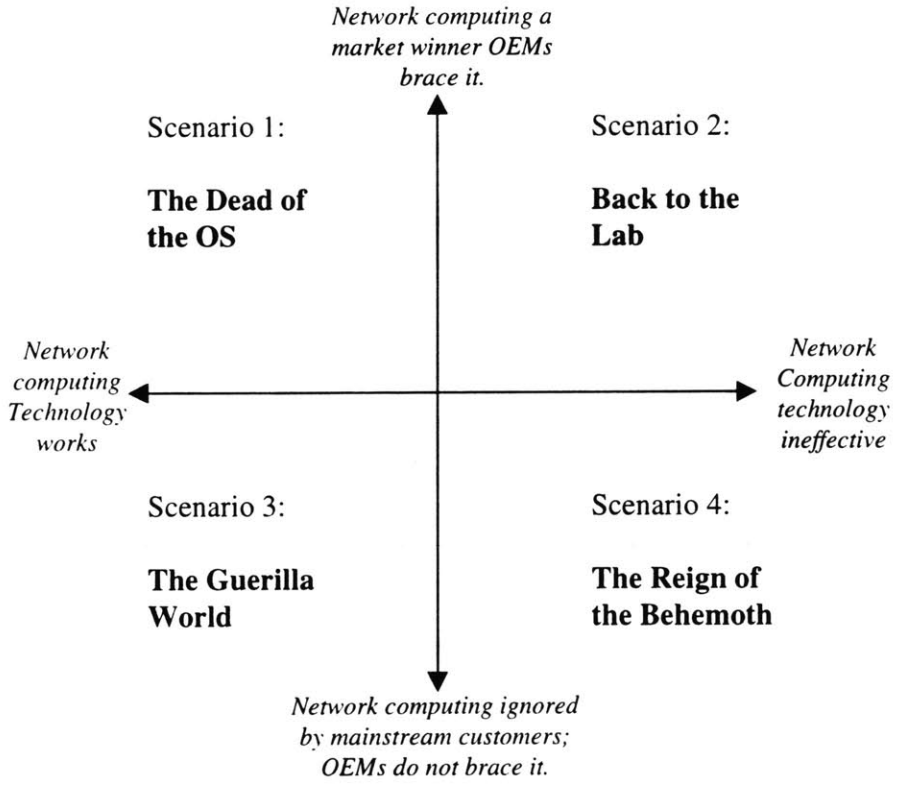
- *Movements such as network computing and spontaneous networking turn out to be the standards of computing in the future.*

Using these uncertainties, and plotting the possible two extreme outcomes in a double-axis chart it is possible to obtain four possible scenarios as a result of the combination of both uncertainties. The possible outcomes that I believe are feasible for this combination are:

Support of OEMs (function of market)	**Evolution of Computing**
1a. OEMs find that network computing is a winner in the market and embrace it (Consumers acceptance: home networking; reinvention of the office networking).	**2a.** Network computing technology delivers all its promises: It works.
1b. Mainstream consumers ignore network computing; OEMs do not embrace it.	**2b.** Network computing is not effective; desktop computing (OS based) stays as the "way of life"

In the following chart I map the outcomes of the uncertainties mentioned above and the four scenarios that their combinations create.

Uncertainties and Scenarios of Network Computing



Following I will describe the resulting scenarios.

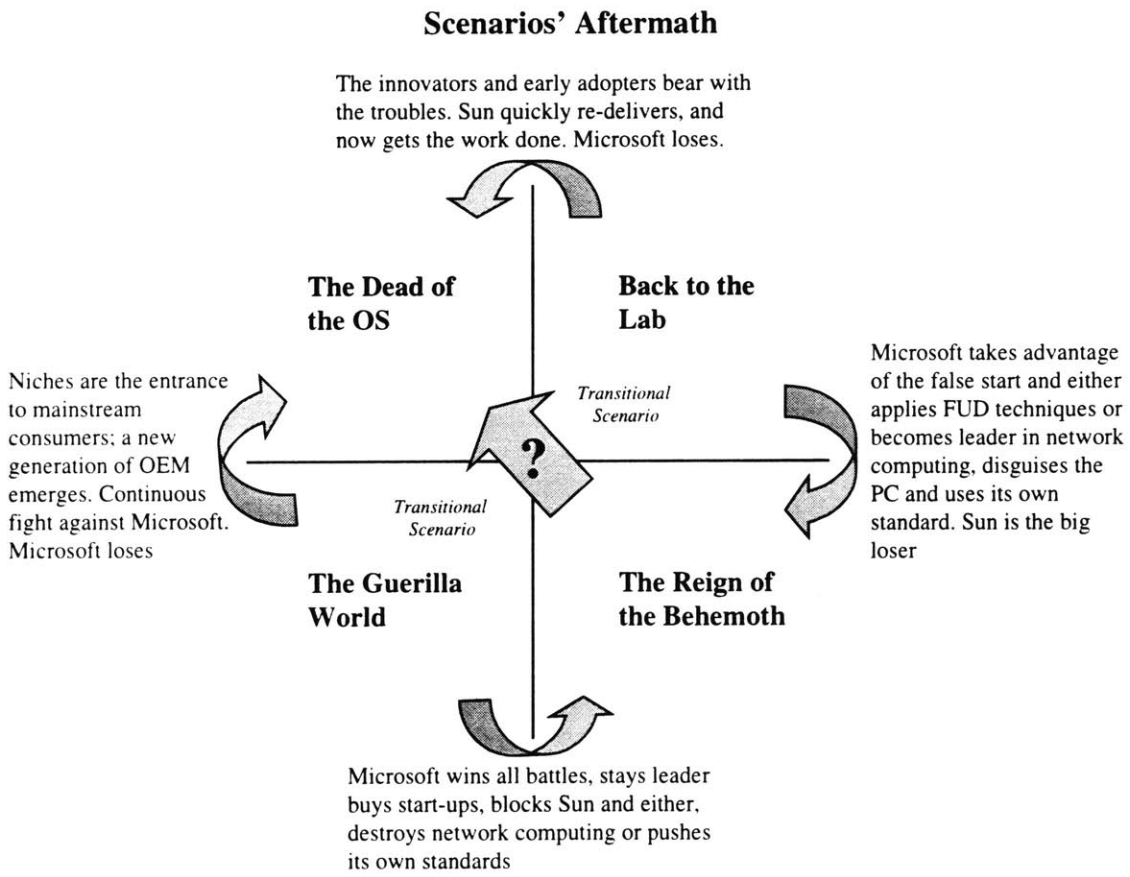
Scenario 1: **The Death of the OS**. This scenario is the result of a wide acceptance of network computing and, therefore Jini, combined with a great performance of the technology in the market. This scenario means that customers are no longer obliged to buy a specific OS, or even more, computers do not have OS, run little code in the CPU and share computing capabilities, in both homes and working environments. Sun is one of the great winners, and Microsoft has to reinvent its business model because having a specific OS is no longer an issue for the customer or simply the scenario reduces the OS's value. Companies such as Apple also gains market share using a great product strategy (iMac and PowerPC G3) taking advantage of the less importance over the OS issue.

Scenario 2: **Back to the Lab**. Under this scenario, the acceptance of distributed computing capabilities is greatly embraced by the market. OEMs manufacture enabled devices, but their performance is poor. This obliges vendors to re-launch some products, Sun to go back to the research lab and innovators and early adopters accept "bugs", while companies solve the problems and upgrades are available. The acceptance of the technology by mainstream customers is delayed until products are robust. Microsoft applies FUD techniques (Fear, uncertainty and Doubt) and tries to take advantage of the situation. This scenario will not last much, will move as the companies learn what to do. A transitional scenario that means hard times for Sun, depending on the speed of the response can defend the turf or lose it forever.

Scenario 3: **The Guerilla World.** In this world, mainstream customers do not find the technology useful; they ignore the network-enabled devices and choose stand-alone appliances. However, the technology performs very well. This competitive environment resembles the "guerilla" wars i.e. many isolated battles, not high profile and no clear enemies. This is a "niche" driven market. Some new OEMs embraces the technology and pushes their products among "Techies" and early adopters. The role of Sun Microsystems is not clear. Many "start up" companies try to take advantage of the niches. This is a transitional scenario, as well.

Scenario 4: **The Reign of the Behemoth.** The complete failure of the technology, as a result of the combination of poor performance of the technology and lack of diffusion in the market. In this scenario Microsoft is still the dominant brand and keeps on pushing its products as standards in the market. If the technology is accepted in the future, Microsoft will take advantage of it, reinventing its business without losing market share and using its muscle to give credibility for the technology using its brand. The great loser in this scenario: Sun Microsystems.

Now, these scenarios are not "de facto". In the following chart I show the paths that the future could follow given different situations. In the paths it is clear that I am implying that an alteration to the dominant design of computing is likely, either with new standards or a modification of the existing. If scenarios 2 or 3 are reached, depending on the response of the firms involved, they could be transformed into 1 or 4, which are more stable scenarios, or unless where the competition is more clear.



It is clear that the driving forces of the scenarios are performance and diffusion, however it seems that technology, as I showed in the latter section, is working and delivering results. However it is not clear what will the diffusion be like; this is where Sun has to do its homework getting on-board big names and doing a strong marketing of the benefits that the mainstream customers will get with the new technology. Given the identified scenarios and the evaluation performance, diffusion seems to be the "Achilles' Heel" of these architecture. In the next Chapter I will discuss the issue of diffusion and some elements that will be key for the acceptance of this technology.

Chapter 5

Technology Diffusion and Value Chains

Donald Norman in his book "The Invisible Computer" (1999) claims that the computing technology as we know it today i.e. PC based computing, should be replaced for another concept. Among other things Norman states that the level of complexity that computing has reached a point where it is impractical: "Try to make one device do many things and complexity increases. Try to make one device suffice for everyone in the whole world and complexity increases even more. The single general purpose computer is a great compromise, sacrificing simplicity; ease of use, and stability for the technical goals of having one device do all".

Norman proposes that the solution for the PC based problem is to break through the difficulty by using devices specialized for the task to be performed (appliances) and that a combination of computation and communication infrastructures would provide a tool for communicating, socializing and working creativity. This is where technologies like Jini have an important role to answer the question of how to coordinate and communicate these devices.

These "devices" are called Information Appliances, and are appliances specializing in information: knowledge, facts, graphics, images, video, or sound. An information appliance is designed to perform a specific activity, such as music, photography, or writing. A distinctive feature of information appliances is the ability to share information among themselves (Norman, 1999).

I consider Norman to be right, a new model in computing has to be developed either with of without the PC. In the scenarios that I drew in Chapter 4 I make the point that there are elements existing in the market that are somehow pushing technology to a new model. For this to happen there is the need of not only of a technological disruption but the adoption of a new concept.

Somehow Norman's proposition is being backed up by the behavior of the PC market. The price war that the industry is experimenting has aroused concerns by some analysts that growth in the $174 billion worldwide PC market may be nearing an end. Dell, Compaq, Packard Bell and IBM reported lower that expected sales in the first quarter of 1999 (Wall Street Journal, 1999). And out of them IBM and Compaq are investing in other areas such as information appliances (hand-held personal data assistants –PDAs). (Business Week, 1999)

International Data Corp. reports that we are within sight of the revenue peak in the consumer-PC market and not many years away from the peak of revenue in the commercial market. In fact, because of rapid price declines in home-PCs, it is possible that we have already passed the revenue peak in consumer sales (Wall Street Journal, 1999).

Market Intelligence, a Ziff Davis research agency, found in a January poll of 13,500 technology firms that, new computer purchases by small businesses fell 8% in January compared with the year-early period. The same poll showed an increase in sales to medium and large businesses that brought total unit sales up 3%. However, price declines likely will produce lower overall revenue (Market Intelligence, 1999).

In general PC shipments should grow 15% in 1999 (Business Week, 1999), down from levels of over 35% of growth during the mid 1990's. It is estimated that this slowdown added to the falling of prices, would yield and overall growth in revenues of 5% by the end of 1999.

On the other hand, International Data Corporation (IDC) estimates that the access to the Internet through the PC will come down from 94%, as of today, to 64% in 2002 due to the use of set top boxes, web phones and palm-size computers. IDC do also estimates that the sales of information appliances by 2002 will surpass the sales of PCs to consumers.

While 48% of U.S. homes now have a PC, analysts don't expect that to rise above 60% because information appliances will take on many of the jobs now handled by the PC. That means PC makers, for the first time, will have serious competition in the use of the Internet.

Adding to that, it is estimated that more people will spend more time online. In today's PC-based world, Internet users spend up to 40 hours a month online, says Sky Dayton, from the Internet service provider EarthLink Network Inc. But by giving consumers the devices to log on to the Web more often and more conveniently doing trivial tasks such as checking the local movie schedule or even buy a car the online time could rise to 200 hours the monthly time that consumers spend online.

To reach the mainstream consumers companies have to offer cheaper and easier to use devices, this will certainly drive a fundamental change in how products are conceptualized and designed. Instead of designing tech-based products and hoping they find uses, companies will have to dreaming up services with consumer value and then build devices that can deliver them. This lead me to discuss the other side of the equation: who is going to manufacture the devices.

Partnering and finding value

OEMs and mainstream consumers –actually their attitudes- will be the key players to drive the diffusion of a technological disruption like Jini. And as seen in the scenarios its outcome will characterize the competitive environment for the involved firms.

OEMs have resisted the notion of embedding networking capabilities into their products because they have not seen a marketing need to do so. However many of them hide behind the excuse of not knowing which networking protocol will emerge as the standard. With Jini-like technologies acting as a translator, the debate over the protocol emergence is no longer and issue.

For explaining this issue I will take Jini and Sun's strategy, given the fact that is the only protocol that is known today in the market. The first factor of the diffusion of Jini, is a function of a widespread acceptance of Java. A critical step was taken during 1996 with the development of the Java application-programming interface (API) for microcontrollers that are found in cost-sensitive products to be programmed using Java. This is expected to become more popular in the near future, as there are many more programmers familiar with Java than with proprietary and

old codes unique to specifics brands of microcontrollers. Products whose microcontrollers have been programmed by Java would be much easier to integrate into a Jini-based network.

Another key move from Sun is the licensing to 80 or so manufacturers to use Java in consumer products. Some examples include Motorola pagers and cell phones, TCI set-top boxes for cable TV, Sony audio and video products, and Visa International smart cards. Delphi Automotive Systems (General Motors) is working on a Java-based system for navigation and remote diagnostics.

The acceptance of the protocol by OEMs is key for the success. Sun claims to have currently about 30 companies evaluating and testing the Jini Technology for specific product opportunities. Among other manufacturers, Sun reports to have on board Sony, Phillips, Axis, Canon, Computer Associates, Datek, Encanto, Epson, Ericsson, FedEx, Mitsubishi, Norwest Mortgage, Novell, ODI, Oki, Quantum, Salomon Brothers, Seagate, Nokia and Toshiba. If these OEMs really emembraces the technology, Sun would have had walked half of the trip to success (with Jini). Nevertheless, the fact that OEMs are testing Jini does not mean that they will actually emembrace it; they will have to prove a real market meaning and, if they do not, they would easily drop it, regardless its performance. These would lead to either, a "The Reign of the Behemoth" or a "World of the Guerillas" scenario.

The second half of the story is solving the issue of who is going to buy these devices. Certainly, office networking will be reinvented under the Jini technology. However the real measure of the wide acceptance and the real test of easy-to-use technology will be "home networking". Resembling "the kiosk' of Dertouzos, many people have imagined domestic scenes where a variety of smart devices communicate with each other to make life easier and more fun.

Forrester Research predicts that more than 7% of U.S. homes will have computing networks by 2002, creating a $1 billion market that year. Some of the driving forces behind this emergent market are current facts about home electronics. Today more than 20 million U.S. homes have products like home theater and digital satellite systems that enhance the TV

experience, generating spending of about $5 billion per year. Furthermore, the number of part-time teleworkers has topped 12 million and continues to expand at a 15% annual rate.

On the other hand, suddenly the boundary between office and the home networking becomes fuzzy; households with more than one PC will increase from 10.5 million in 1997 to almost 24 million by the year 2002, reports Forrester Research, and is estimated that 90% of those households will be on-line.

Some of the drivers that will deploy that growth in home networks will be simplicity and security of the networks and plug-and-play hardware; Jini can enable both. If these elements are not present the diffusion of this technology will be slowed down seriously.

Certainly, the first group that would embrace these integration in the market will be those who are not afraid of new technology. My personal prediction is that those people whose lives are changed by network computing and spontaneous networking in the working environments, will be the ones who carry these technological innovations to their homes. If Sun's partnerships with the OEMs are successful it would be possible to have "The Death of the OS" scenario. However, if Jini is not able to "grant wishes", the outcome would be a highly risky "Back to the Lab" scenario in which Sun will have to demonstrate its organizational wisdom and capability to overcome a false start.

In general it seems like Sun knows perfectly this situation, the fact that they are trying to develop partnerships with OEMs is and evidence of that. If Sun and the OEMs are able to capture the niche of the "innovators", and then exploit some specific niches in home usage, such as security systems, energy saving, and pure "household" applications, the transition of the technology to the mainstream customers will be easier. OEMs will find a much profitable market in home networking and the widespread use of networks will mark the new era of home and office computing.

Let us imagine that positive scenarios are the outcome, the next question is, how Sun Microsystems will capture the value that is creating.

Value chain under Spontaneous Networking

I have shown the benefits that Jini brings to the consumers, and that the level of performance achieved in comparison with the current standards in the market. From the Sun's management point of view, it is important to analyze the value that this innovation will create for the company.

I will argue that Sun has the possibility to become the computing icon of the first decade of the New Millenium. While this may sound over optimistic, let us remember that Apple is the icon of the computer industry of the 80's –it is not necessary to explain the rest of the story.

What I really mean is that, certainly, Sun is about to revolutionize the computer industry, however, how is Sun going to capture value is a different story. I say, that if this technology takes off and goes to the mainstream consumer, Sun will make a lot of money. Following I explain why.

Sun is licensing the technology to OEMs to embed it on various devices. Through licensing Sun will receive a royalty for every device sold in the market. These loyalties are estimated to be at around 0.10 USD per device sold if they show a Jini logo outside –or $250,000 per year of use. This implies an appropriability situation where Sun appropriates the value of the innovation and, in time, frees the complementary assets.

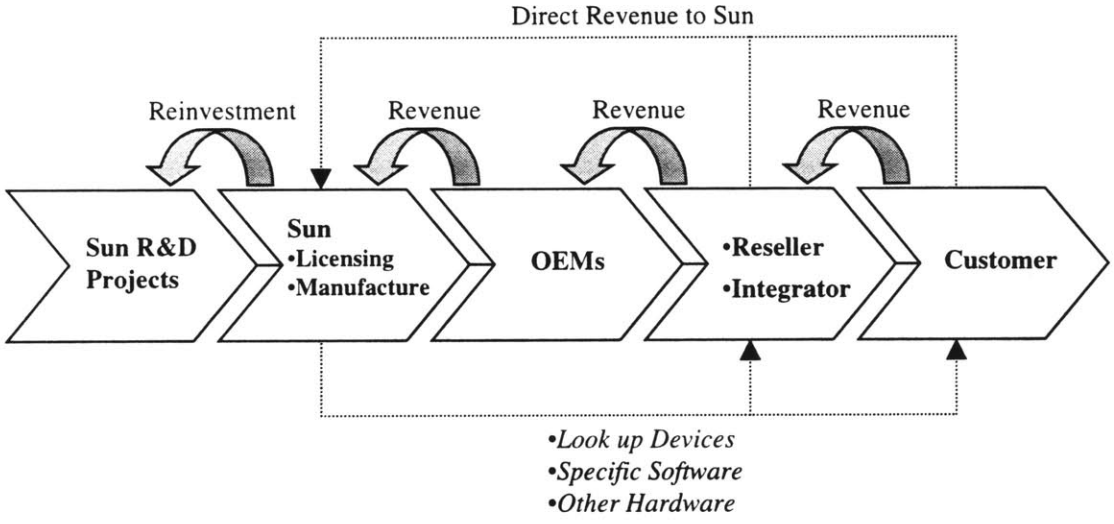
Sun is releasing Jini's code in the new open source-code model used by Linux and Netscape's Mozilla, and it really is open. Specifications, concepts and standards are already available, and the first source code was out at the end of 1998.

Sun's goal is for Jini to become a networking standard. It will be used by the JVMs that are part of Windows 98 and NT, as well as JVMs for UNIX and Macintosh. That sets up a potential confrontation: Microsoft could provide a deeper, more integrated solution that works only with its own OS-Windows. Meanwhile, Sun could have a broader solution that works with all OS but isn't as well integrated with any one-say, Windows.

If that is the case, the technology that was created to open and unite computing may have precisely the opposite effect, with Microsoft and Sun offering rival infrastructures and fragmenting the market even further. Of course, they might yet work together to create a simple networking scheme. This resembles a "The guerilla World Scenario".

In any case Sun would obtain revenues from both, licensing and manufacturing specific devices for Jini enabled networks, either in work environments and home networking as shown in the following figure.

Expected Value Chain for Spontaneous Networking under Jini Technology



In general Sun is aiming to an architecture strategy pushing Jini as the standard for networking. This would trigger a complementarily necessity in the market, where the "many to many" dynamic would be a key driver. The company would allow third parties to develop their own modules, similar to programmers writing their own Java Virtual Machines today, to encourage the presence of the technology in the market.

A brief look into the future

A new wave in the computing industry history is about to begin in which Sun could be one of the greatest winners. The use of OS is now in the verge of being suppressed from the computing scene. More flexible, open and friendly working environments are enabling new possibilities for both, end users and system administrators.

However, this wave will not be an isolated movement, nor Sun will be alone. Players such as Microsoft will try to take advantage of it. Nevertheless, Microsoft will have to reinvent their business model and try to compete in a new turf. So far, Sun has won an important battle against Microsoft on Java –through the Department of Justice- that strengthens its position in Java technology, which is great news to help Jini in its diffusion and appropriability. Also, Sun will have to watch out for other disruptive technologies, such as networking chips.

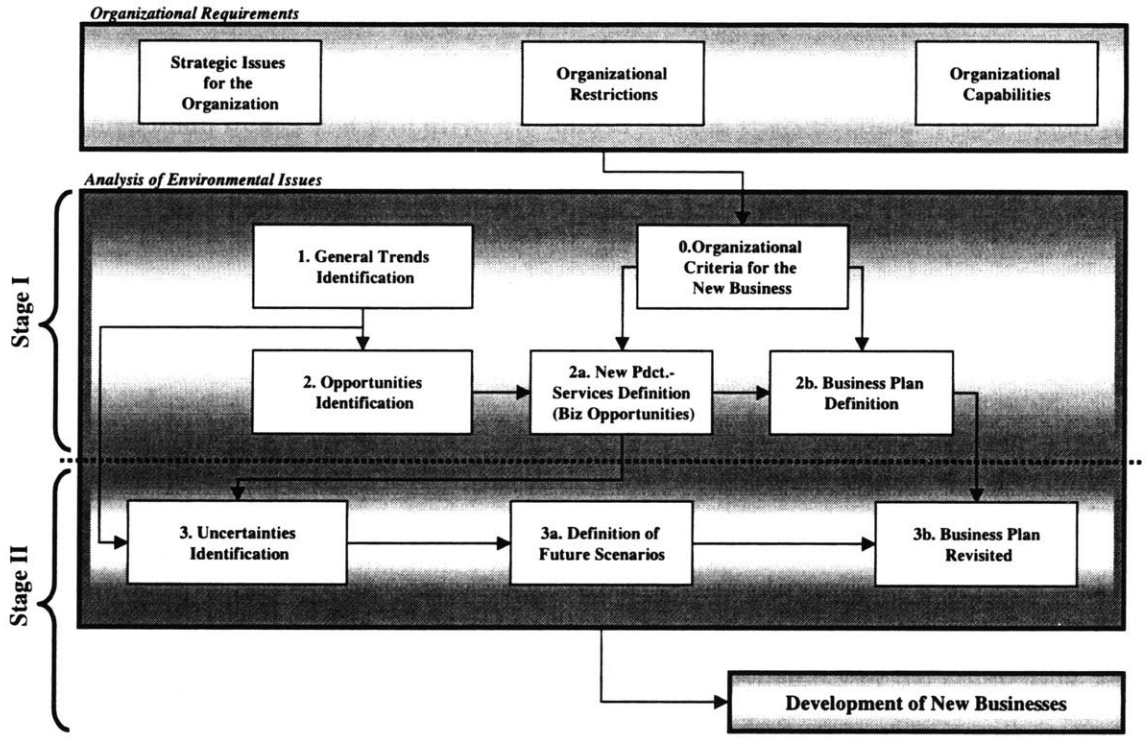
It is clear that the success will depend on the strength of the diffusion and the strategies that Sun design to make Jini the networking standard in the new era of computing. Although it is hard to predict how many users will be in the near future, some estimation are made and they seem to be attractive; the speed of diffusion is in part function of how much OEMs embrace the technology and make it part of their architecture. Developing niches to get into the mainstream customers is key.

Also, Sun's business with AOL and Netscape is good news; this will push easier Jini and Java through their corporate software division making and the adoption of these technologies in the companies' work places faster. I think all this means, a great future for the customers, great technologies, many alternatives, many possibilities for work and entertainment environments. In the following chapter I will apply the framework presented in Chapter 3 to identify business opportunities dealing with the uncertainty created by a disruptive technology such as Jini.

Chapter 6

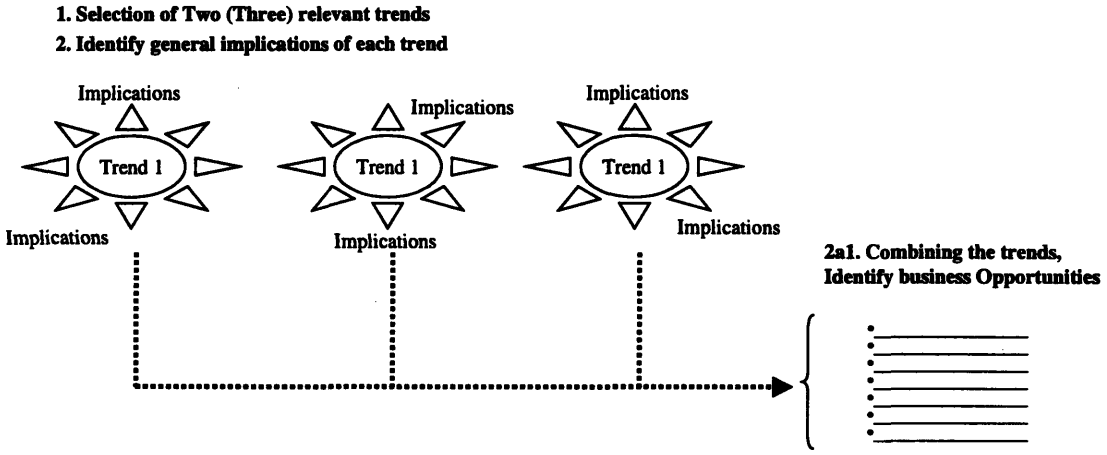
Applying a Structured Methodological Framework for Identification of Business Opportunities

In this chapter I will use the analysis made in chapters 5 and 6 and apply the framework presented in chapter 3. The main objective of this exercise is to show a practical use of the structured framework for dealing with uncertainty based on the case analysis made about the disruptions in technology in the computing industry. Certainly, some parts of the example will be incomplete (business plan, for instance), however, the results are based in true developments in the industry and should be of use in taking advantage of uncertainty for developing new businesses. As shown in Chapter 3 the proposed general framework is as follows:



Environmental Analysis

The first stage of the framework is related to the developments in the environment of an industry. In this part the relevant trends for a firm should be identified and all its implications should be laid down. The sequence proposed is as shown in the following methodological diagram.



Based on the analysis made about the computing industry in Chapters 4 and 5 I have identified three main trends that will drive the industry in the years to come. These trends are:

1. *An increased use and diffusion of information appliances for specific tasks in the mainstream market.*

2. *A significant reduction in the dependence of a specific computing platform (OS) i.e. cross-platform computing.*

3. *Increase in the diffusion of network computing.*

As I discussed in the latter two chapters, the market dynamics in the computing industry will go through an important shift in the years to come. The shipments of PCs will decrease and the sales of information appliances will increase in an important way. This shift will be driven by the impact of this appliances in trivial tasks that are today performed using PCs; the simplicity of

this appliances will take over this tasks and more complex systems will be used for more sophisticated uses.

Activities such as e-mail, access to non-graphic information (stock quotes, etc), personal organization, etc. will be among the more impacted ones. This, of course, will be driven by the use of the Internet as a medium to communicate these devices, as already discussed, more access to the Internet will be made using information appliances.

By the same token, since more information appliances will be in the market and there will be a higher demand for services in networks, the necessity of having cross-platform equipment will also be increased. This means that one person using an information appliance and needs to access a particular service will demand not only simplicity in its own device, but from the working or networking environment. This implies that many more solutions to have cross platform interoperability will be demanded in the market; no more "I have to use Windows, otherwise I won't be able to have access to the network services".

Since many of these appliances will not have enough processing capabilities, the use of services over a network will be increased. What I mean with this is that a person using an information appliance with limited processing capacity will be able (and will demand) processing (or storage) capacity from other devices that will offer the service over a network. This will steadily increase the demand for a new paradigm such as that proposed for Sun in which spontaneous networking for accessing services over a network independently of the appliances platform (OS) is enabled. This will certainly imply a change in the computing paradigm, as we know it today.

These three trends in the computing industry are closely interrelated, and somehow are a result of one another. I will show in the following section of the methodological framework that each of them have specific implications for the industry and the possible new services and products that can be developed taking advantage of the opportunities.

If these trends hold, the computing industry will certainly go under a dramatic transformation in the years to come. Thus, the implications of each of these trends for the industry would be related to all the stakeholders. This means that the impact of the trends will be felt in how the products are designed, how the consumers perceive the products and how these products are marketed to the consumers. Inevitably this trends will also modify the business models in the industry. Following I show which are the most significant implications of each of the mentioned trends.

- **Implications of *"An increased use and diffusion of information appliances for specific tasks in the mainstream market".***

1. Reduction in PC time for simple tasks (e-mail, check movie listings, etc)
2. Need for networks both at home and at office spaces
3. Need for "low-weight" software applications (simplicity)
4. Need for efficient hardware (low use of energy) for mobility
5. Easier access to the Internet
6. Different content oriented services
7. More telecommunication infrastructure needed
8. Increase in the number of users of networked services
9. Lower cost (price) computing devices
10. Increased mobility for users
11. Easier access to on-line services for non-PC users (late adopters)

- **Implications of *"A significant reduction in the dependence of a specific computing platform (OS) i.e. cross-platform computing".***

1. Cross platform compatibility marketing
2. Change in business models of firms
3. More software code in open source diffusion (Linux-like availability) model
4. Reduction of many-to-many effect (network externalities)
5. More software applications available

❖ **Implications of *"Increase in the diffusion of network computing"*.**

1. Need for common communication protocols
2. Availability of readily to use networking infrastructure (ex: wireless Ethernet)
3. Need for easy-to-use and easy-to-install networks (ex: Ethernet home-packages)
4. More dedicated devices for networking
5. Need for personal software for network administration
6. More telecommunication infrastructure needed

Once the implications of the trends have been identified the next step is to identify possible business opportunities in the industry, or which type of businesses could be more successful based on these trends. The outcome of the current analysis could represent either a diversification or integration for a particular company.

Identifying Business Opportunities

As discussed in Chapter 1 this augmentation in the breadth of the firm's products and services should be part of a previous strategy revision of the company, in other words, the firm should have had decided in advance to what extend should diversify or integrate its businesses.

However, independently of the type of the business (in the computing industry three types of companies are relevant: Software companies, hardware manufacturers and service providers) the outcomes should be useful in identifying not only new business opportunities directly for the firm, but new opportunities for establishing partnerships and strategic alliances.

Given the implications of each of the trends, it is possible to identify cross-trend patterns the lead to define business opportunities. Is important to mention that the resulting opportunities should be thought with a lot of creativity, therefore, technical constraints should be ignored. Thus, combining the implications of the trends the following is a partial list of possible business opportunities.

Software
1. A browser for identifying services in a network from an info-appliance 2. An application to play MPEG layer 3 compressed music files downloaded from the Internet or "ripped" from the home audio system on a palm size computer 3. An application for remote home administration (utilities, infrastructure, home security system) for PC or palm size computer 4. Improved voice recognition applications for info appliances leasing computing power from the local area network

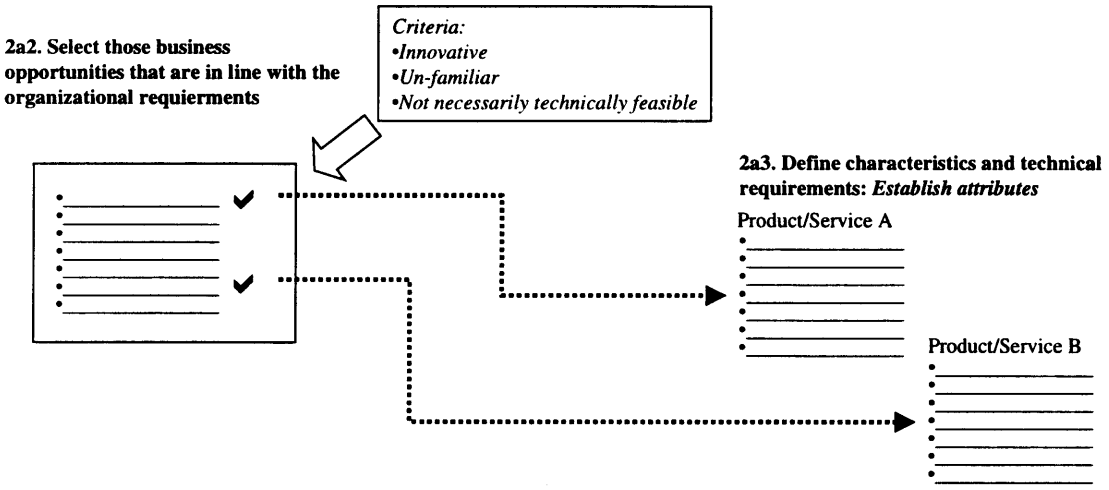
Hardware
1. An attachment for Palm Pilots to allow playing MPEG 3 layer music file (In search for backwards compatibility) 2. Kiosks for accessing the Internet on the street and public areas from a laptops or info appliances (palm-size computers, e-books) 3. A global positioning system (GPS) device that also connects to the Internet on the go, for outdoor enthusiasts, that retrieves maps and information and allows e-mailing

Services
1. Integration and distribution of home networking applications and hardware, aimed to the mainstream market 2. Integration of commerce services to home networks (grocery stores, video rentals, etc) for direct ordering 3. A Website for home and info appliances software distribution

It is very important to mention that the partial list of business opportunities shown in the latter lists are intended to be an example of how to use this framework, it is easily arguable the validity of some of the ideas. The recommendation that I would make in using this framework is that a multidisciplinary team should be in charge of generating those lists, therefore, the ideas would be not only be generated in a more educated way, but generated from different perspectives of the issues. Particularly, the hardware list is not intended for mentioning all the info-appliances that are being developed, but to mention possible new types of hardware as the result of the trends.

Establishing Attributes for Business Opportunities

Once the list of business opportunities, the process requires to select those opportunities that are aligned to the organization (or investors') strategic requirements, and that may be possible to develop. The following diagram shows the methodological development of this section of the framework.



From the list of products above I have selected one (only for exemplification reasons) which I believe integrates the three types of businesses in the computing industry. In the case of application of this framework within an organization, it is necessary to select the opportunities under the scope of the strategic direction of the firm, as well as the possibilities of the organization to deliver and capture the value of the business.

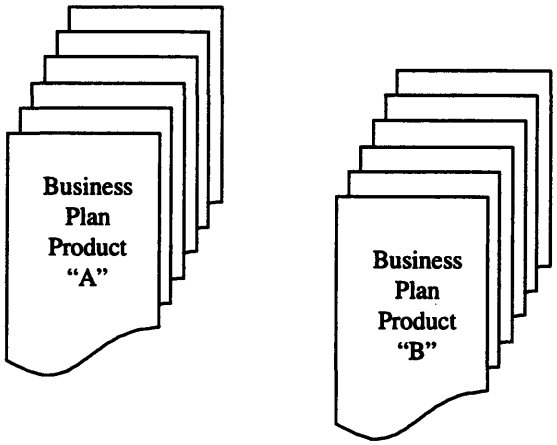
Although, this exercise should be developed with a high level of creativity it should stay close to the possibilities of the firm from the organizational and technical point of view. These attributes should capture elements from the consumer point of view, in other words, to define which are the technical necessities given the needs of the consumer and then establish the technical needs for delivering the features. As mentioned in Chapter 5 these is one of the most important modifications of the industry, to dream up services with consumer value and then build devices that can deliver them. Following I define the attributes of the business opportunity as dictated in the framework.

Attributes of "Kiosks for accessing the Internet in the streets or public areas from laptops or info appliances (palm-size computers, e-books, etc)"
1. Offers security for the user from the digital point of view
2. Offers security for the user from the physical point of view (booth-type to protect from burglars)
3. Cross-platform
4. Printing services for short documents (e-mail)
5. Wide availability (airports, train stations, public buildings, etc)
6. Access to specific services (airline and train reservation systems, etc)
7. High speed connections
8. Billing of kiosk time usage through user's on-line service provider
9. Wireless, wired and dial-up connections available (wired and wireless Ethernet, infrared)
10. Easily movable from place to place. Can be used in fairs, conferences, etc.
11. Use of Jini-type technology for plug-and-work and access the kiosk services.
12. Allows multi-users (up to 5 to 10 at one time)
13. Supports all kinds of mobile info appliances with access to online services and the Internet.
14. Must have computing power and capacity in order to be "leased" from the users' equipment (Ex: say you want to perform a financial simulation from your Palm Pilot)
15. Must have capacity to make video conferencing based on IP technology

16. Scalable to future technologies

Once defined the business opportunities and its most relevant attributes the next phase is to develop a complete business plan for the venture. As I have indicated before, it is not the intention of this thesis to define a methodology for a business plan. However, I will point out some of the common elements that are included in a business plan, either for a new enterprise or for developing a business within an organization.

2.b Develop a Business Plan for Each (or one) of the New Product Services



Typically a business plan for a new venture or product would include the points shown in the following table. For further reference I would recommend to follow the guidelines suggested by Geoffrey Timmons in his book " New Venture Creation, Entrepreneurship in the 21st Century" and the book by Edward B. Roberts, "Entrepreneurs in High Technology, Lessons from MIT and Beyond".

Although the books mentioned above are oriented for the new venture creation, both contain important insights for new business development within organizations and should be useful for different applications.

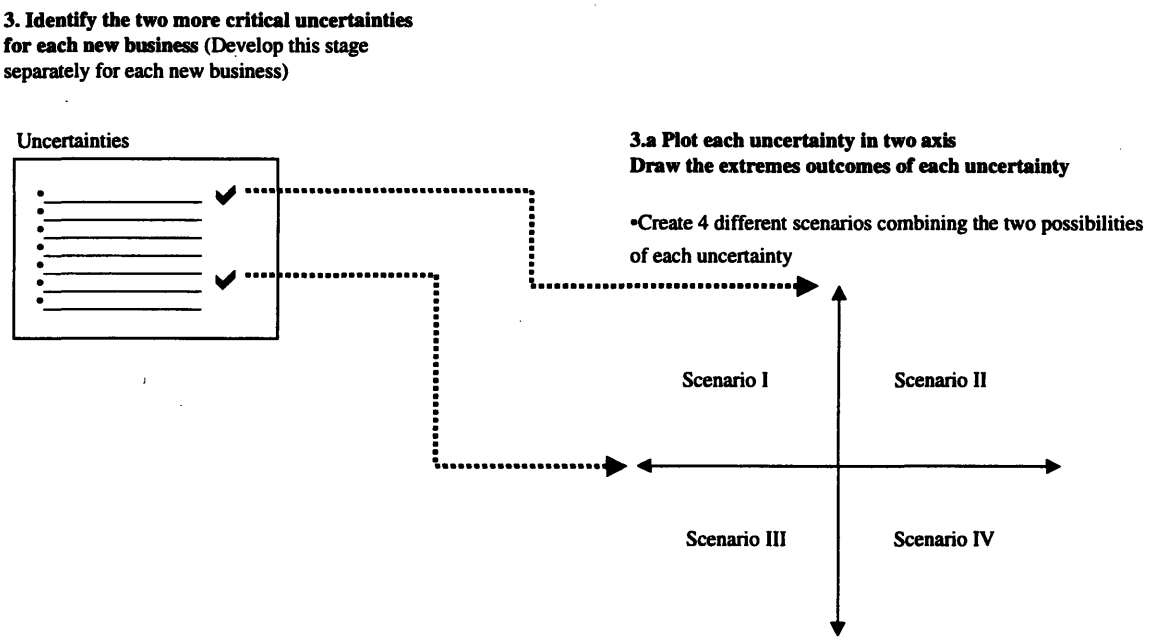
Sections of a Typical Business Plan for a New Venture

1. Description of Industry, Technology, Company, Products and/or Services	**2. Entry and growth strategy**
3. Market Research and Analysis: • Customers and Market Segments • Customer Profiles • Market size and trends • Competition and competitive factors • Estimated market share and sales • Ongoing market evaluation	**4. Economics of the Business:** • Gross and operating margins • Profit potential and quality of profit • Fixed, variable, and semi-variable costs • Months to breakeven • Months to positive cash flow
5. Market Plan: • Overall marketing strategy • Pricing • Sales tactics • Service and warranty policies • How to compete with competitors • Advertising and promotion • Distribution channel	**6. Design and development plan:** • Proprietary technology • Competitive edge • Products, product improvements, new products, and follow-on products • Special design tools and processes • Design and development status and tasks • Design and development costs • Difficulties, risks, and contingency plans
7. Manufacturing and Operations Plan: • Operations overviews • Manufacturing strategy • Strategic make-or-buy decisions • Geographic location • Plant, property, and equipment • Process technology • Management of inventories • Organization and work force • Management of quality • Regulatory and environmental issues • Operations difficulties, risks, and contingency plans	**8. Financial Plan:** • Past and current financial statements • Profit and loss forecasts • Pro forma cash flow analysis • Pro forma balance sheets • Breakeven chart • Cost improvement and control • Summary of financial plan
9. Critical Risks and Problems	**10. Overall schedule**

Certainly, at the end of developing a business plan the original business opportunity could have been changed, which is, by all means, valid and expected. Even more, the next phase of the process pretends to modify both the business opportunity as well as the business plan. In the next phase, as shown in the following diagram, the most important uncertainties should be identified for the new venture. The objective is to define how the future looks, and with that adjust the strategic plan according to the resulting scenarios.

Evaluating Uncertainties for Business Opportunities

The scenario creation process has been already discussed in Chapter 2, and was applied in Chapter 4 regarding the new developments in the computing industry; as a matter of fact I will use the analysis made in Chapter 4 to keep the consistence of the exercise.



Drawing from the analysis in Chapter 4 the scenario analysis should be as follows. Key uncertainties:

- *If original equipment manufacturers (OEM) will take network computing for real and will embrace protocols like Jini.*

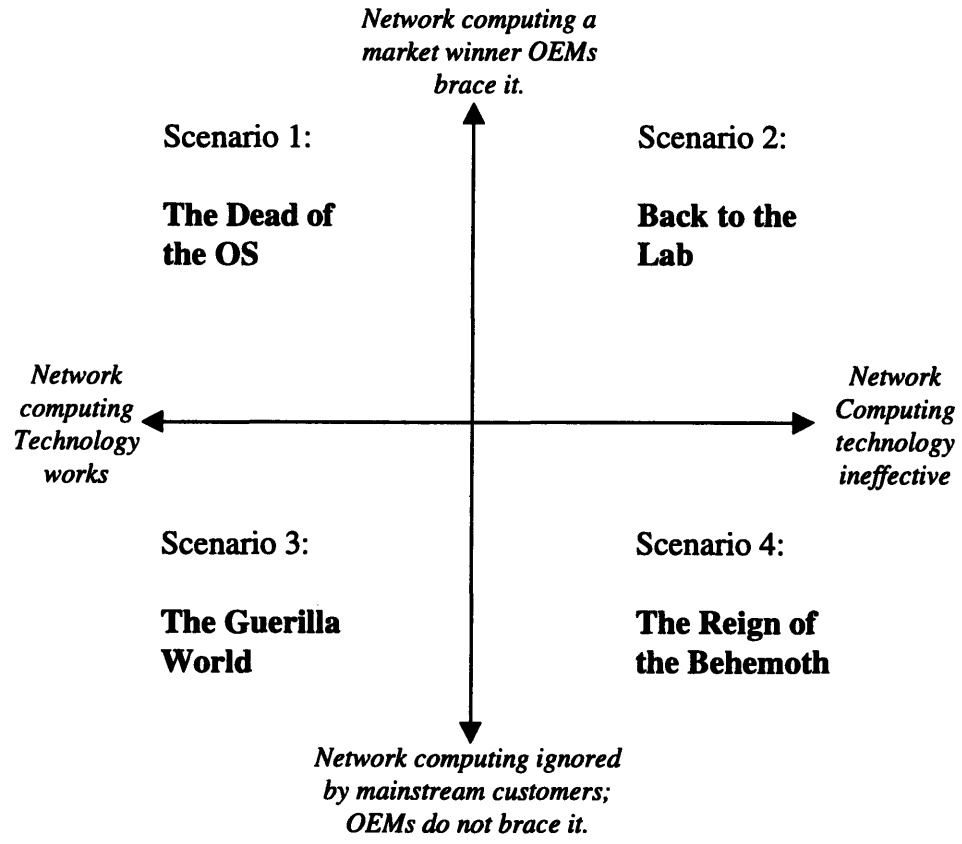
❖ *If movements such as network computing and spontaneous networking turn out to be the standards of computing in the future.*

Possible outcomes:

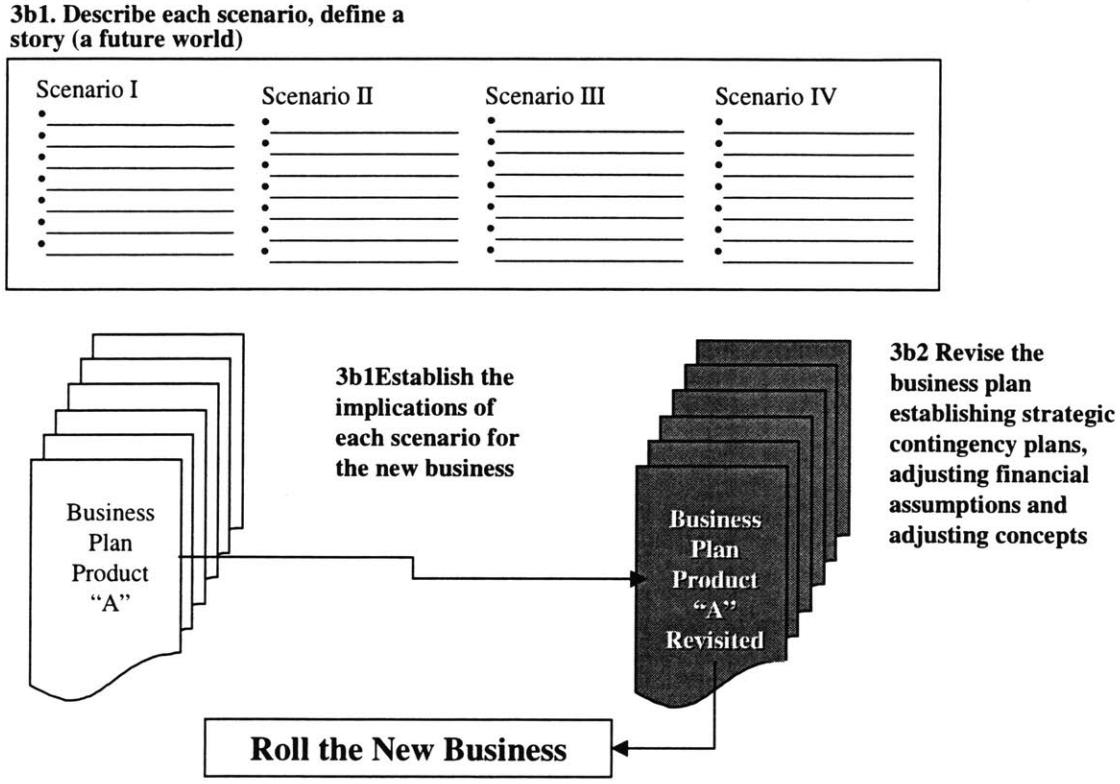
Support of OEMs (function of market)	*Evolution of Computing*
1a. OEMs find that network computing is a winner in the market and embrace it (Consumers acceptance: home networking; reinvention of the office networking).	2a. Network computing technology delivers all its promises: It works.
1b. Mainstream consumers ignore network computing; OEMs do not embrace it.	2b. Network computing is not effective; desktop computing (OS based) stays as the "way of life"

The map of the outcomes of the uncertainties and the four scenarios are shown in the following chart.

Uncertainties and Scenarios of Network Computing



Once the scenarios have been defined, it is necessary to characterize them as indicated in the methodological diagram below.



Since these scenarios have been already analyzed in Chapter 4, I will point out the main ideas of each of them and emphasize the impact on the new venture selected for the exercise.

Scenario 1: **The Death of the OS.**

- ❖ Wide acceptance of network computing
- ❖ Great performance of the new technology
- ❖ Customers are no longer obliged to buy a specific OS
- ❖ Computers do not have OS, run little code in the CPU and share computing capabilities
- ❖ Success in homes and working environments
- ❖ Reduction of the OS's value
- ❖ Common use of info appliances enabled for spontaneous networking

Scenario 2: **Back to the Lab.**

- ❖ Acceptance of distributed computing capabilities is greatly embraced by the market.
- ❖ OEMs manufacture enabled devices, performance is poor.
- ❖ The acceptance of the technology by mainstream customers is delayed
- ❖ Microsoft applies FUD techniques (Fear, uncertainty and Doubt)
- ❖ A transitional scenario

Scenario 3: **The Guerilla World.**

- ❖ Mainstream customers do not find the technology useful
- ❖ Technology performs very well.
- ❖ Competitive environment that resembles the "guerilla" wars
- ❖ "Niche" driven market.
- ❖ Some new OEMs embraces the technology

Scenario 4: **The Reign of the Behemoth.**

- ❖ Complete failure of the technology
- ❖ Lack of diffusion in the market
- ❖ Microsoft will take advantage of it, reinventing its business without losing market share and using its muscle to give credibility for the technology using its brand name.

The next step is to analyze what is the meaning of each of these scenarios to the identified venture. In the following matrix I will try to establish these implications. Some of these implications have already been discussed in the latter chapters, however I believe that it is important to put them in the context of this framework.

Scenarios	Implications for *"Kiosks for accessing the Internet in the streets or public areas from laptops or info appliances (palm-size computers, e-books, etc)"*
1. *The Death of the OS.*	Favorable: ▪ Availability of off-the-shelf technology for integration ▪ A growing market of info-devices, therefore a need for access to on-line services ▪ Growing need of info devices to perform sophisticated tasks ▪ Availability of protocols to serve different platforms Unfavorable: ▪ Rapid improvements on info devices including wireless communications ▪ Easier access from individual devices to on-line services
2. *Back to the Lab.*	Favorable: ▪ Consumers understand the concept and wait for improvements of the underlying technologies ▪ Many companies try to win the early race, therefore many protocols and technologies are available Unfavorable: ▪ Some consumers do not trust the service and walk to other alternatives, such as wireless communications and stick to computing power in their laptops
3. *The Guerilla World.*	Favorable: ▪ There is available technology ▪ Services may be embraced by some innovators and early adopters (niche driven market) Unfavorable: ▪ Since there is no mainstream market consumers the original concept of services in public areas has to be changed ▪ Hard to bring credibility back
4. *The Reign of the Behemoth.*	Favorable: ▪ In the next wave some technologies may appear Unfavorable: ▪ Time to market of the concept is too long and may be too late to introduce any service ▪ Hard to bring credibility back

An important threat for this type of equipment (the "kiosk") is the increasing importance of wireless technology that would enable mobile equipment to connect direct to dial-up services or to download messages from on-line services. In this case the value of a booth to connect a variety of devices to the Internet or other on-line services would be seriously reduced.

The value of the kiosk, in a wireless world, would be circumscribed to devices that did not have wireless communication capabilities or for computing tasks (one of the desired attributes). As a matter of fact, as of today the only equipment with wireless capabilities to connect to the Internet are digital PCS (Personal Communication Systems) based services, basically cellular phones and paging services. However the connection have to be made through a specific service provider and the small screens in the phones are uncomfortable for the user to read e-mails or browse the Internet.

I foresee convergence of wireless and portable computing technologies into two basic devices: a small, digital, sleek wireless phone, whose primary appeal is weight and convenience; and a handheld data device combining computing power with two-way data capability for non-voice communication and net access supported by a developed telecommunications infrastructure.

Furthermore, almost every house with a PC has a television, and the most wired consumers of tomorrow will want both their PCS handset and a handheld computer with two-way data capability. The industry recognizes the trend; Motorola is only one of several companies selling a Palm Pilot pager card, for example, and Microsoft is aggressively pushing CE into the wireless space.

In the light of the discussion on wireless technology I would rescue from the original list of business opportunities the following ideas to be included in a similar analysis:

- *A browser for identifying services in a network from an info-appliance*
- *An application for remote home administration (utilities, infrastructure, home security system) for PC or palm size computer*

Both business opportunities would be very close related to a Jini-type technology and would be very well suited in a "Death of the OS" scenario, where network computing is widely used using desktop devices or hand-held computers.

In any case I would argue that the kiosk would have a short life until the technologies in dispute get settled and in the mean time would be a device of use that will evolve into other services. Even more important the kiosk has accomplished its mission in serving as a small case study for demonstrating the use of the methodological framework.

After the discussion about the impact of the future scenarios on the venture the next task is to modify the business plan developed for the new venture, which certainly is not a trivial one, in fact is critical, however is not in the scope of this work. I would encourage the reader to take advantage of this thesis and expand it to other areas.

Final thoughts

I belong to a generation that likes to think is living in the fastest paced time in history; that changes are more rapid that ever; that uncertainty is the hallmark of "our days" and that "our days" are far more exciting than those of our preceding generations. My generation also likes to think that, now more than ever, technology empowers us, makes our living better every day and that the future looks brighter than ever. My parents' generation had a similar perception, so did my grandparents'.

The reality is that we have been living in an incremental innovation time and, certainly, these innovations have changed significantly the way we live. However, the changes that the generations at early 1900's went through were far more dramatic. Rapid travel, communications, imaging, sound recording, transportation machines (trains, ocean liners and cars), etc., were innovations that appeared at the end of the 1800's and truly changed the way that generation was living. We have been living in a pattern that began a century ago. We have been actually refining those innovations.

But let me give some credit to my generation. We have started trends were frontiers are less significant. Computing and communications infrastructure is changing dramatically the way each of us interact with the rest of the world. Information (and consequently business and financial sectors) is going beyond governmental boundaries and controls. In fact, both, computing and communications are converging into one force. Indeed, it is really difficult to forecast were the world is going. I believe that my children's generation will see far more dramatic changes from those that I have seen.

Now, more than ever, is important to learn from the past, to understand that there are certain type of phenomena that repeats again and again; it is crucial for us to understand which are the forces behind change and to establish simple, comprehensive ways to put things in perspective. The work that I tried to do in this thesis is precisely aimed to this. I did not pretend to develop a sophisticated way of evaluating uncertainty, but to develop a simple framework to integrate different insights from the environment of an industry and developing new businesses.

For the case analysis in this theses I chose Sun's Jini technology because is the promise of a better industry. A technology oriented to put computing and communications infrastructure at service of people and liberate us from the brittleness of today's model. I do not know if Sun's product is going to succeed. What I know is that is the beginning of a new era in computing, an era that I wish had arrived earlier.

The results of applying the proposed framework to the case are certainly arguable. I would not dare to say that the outcomes are winners in a new market, however, the information for the developing the analysis came from a documented sources and that concepts as those described would exist in a near future, in a somewhat different shape. In fact, after writing those sections I jumped into two start-up companies working in surprisingly similar concepts.

It is my hope that anyone who reads this document will be a critic and that, somehow, the criticisms lead to new findings and improvements. I hope that further work is done and that these works help my generation to build a better world for the ones to come.

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