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Readings in Innovation

Arcot Desai NARASIMHALU
Singapore Management University, desai@smu.edu.sg

Institute of Innovation and Entrepreneurship

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Singapore Management University

Preface

This is a collection of practice oriented papers that I had written from 2005 – 2010 and published in relevant conferences. The papers were written primarily to share my experiences as an innovator and an innovation manager over thirty five years of my professional life. They are a collection of frameworks, heuristic algorithms and processes that I have penned down from my experience. They are neither theories nor only options available to innovators and innovation managers. This is yet another offering in the world of "Innovation Buffet" that innovators could consume. The sole purpose in compiling these papers is to share my practice experience and resulting observations with a larger community. These papers do not attempt to discover or establish theories using social science research methodologies.

The papers are organized into five sections. The first collection is dedicated towards a new innovation methodology presented across a trilogy of papers – Innovation Cube describing, a new extensible and customizable framework; Innovation Engine, a method to generate innovation opportunities and Innovation Stack, a method to prioritize the identified innovation opportunities.

The second collection has two papers addressing service innovations. The first paper presents a method for identifying service innovation opportunities while the second paper tries to balance the creation of service innovations with the supply chain that the service providers depend on.

The third collection is directed at the management aspects of technology transfer. It consists of three papers. The first paper presents a framework for technology transfer, the second paper shares a real life example of technology transfer in a IT research lab and the third paper presents a method for monetizing technology innovations.

The fourth collection addresses research and innovation management. The first paper presents a research capability maturity model for managing technology innovations, second paper presents a maturity model for innovation management, the third paper presents an approach to managing technology deployed in service innovations while the fourth paper discusses how a service innovation can be designed using the value curve described in Blue Ocean Strategy taking into consideration the budget available for a project.

The fifth collection is a case study of a company and contains two papers. The first paper discusses how the company managed to get a technology innovation across the proverbial chasm and the second paper shows how the company tried to reposition itself in a new market using their core competencies when they found the selling to their original markets to be very challenging. The second paper was included primarily to emphasize the need for start up companies to be nimble and respond to what the markets say.

I hope you will enjoy reading the papers and benefiting from them.

Arcot Desai Narasimhalu (Desai)

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Section 1: A New Innovation Methodology

Innovation Cube

Published in the proceedings of the 2005 Annual Conference of the International Society for Professional Innovation Management (ISPIM), Porto, Portugal.

INNOVATION CUBE: TRIGGERS, DRIVERS AND ENABLERS FOR SUCCESSFUL INNOVATIONS[1]

Arcot Desai Narasimhalu
School of Information Systems
Singapore Management University
Arcotdesai@smu.edu.sg

Research on innovation has explained the relationships between institutions of higher learning, companies and the markets from both market driven and resource driven perspectives. However, innovation still remains more of an art than a science. Key researchers have lamented that it is difficult for most companies to scan the market place to identify new innovation opportunities. This paper describes a framework called Innovation Cube that is the building-block for helping companies identify new innovation opportunities. This cube is constructed using three attribute-pairs called drivers, triggers and enablers of innovation. The paper discusses examples of the types of innovations represented in each of the four quadrants of the three planes that result from the drivers, triggers and enablers of innovation.

1. INTRODUCTION

All of the innovation related research beginning (Schumpeter, 1934) can be broadly divided into two major camps – market driven perspective and resource driven perspective. (Porter, 1985) and (Slater and Narver, 1994) argue that it is the market conditions that drive innovation in firms. (Cohen and Levinthal, 1990) suggest that few companies have the ability to scan the market place to recognize such market driven innovation opportunities. The resource driven

[1] This paper has been accepted for presentation at the Annual Conference of the International Society of Professional Innovation Management to be held in Porto, Protugal from the 19th to the 22nd of June. This paper is the first in the series of three defining a framework for innovation. The other two papers will focus on the Innovation Engine and Innovation Stack.

camp made up of (Penrose, 1959), (Prahalad and Hamel, 1990), (Wernerfelt, 1995), (Grant, 1996), (Conner and Prahalad, 1996) and (Eisenhart and Martin, 2000) show how it is a firm's rare and not easily copied resources, capabilities and skills result in sustainable competitive advantage in the form a continued string of new products.

Several examples from the history of innovations show that serendipity has played an important role as well. It is not that the discoveries happen without effort. Louis Pasteur's quote '*chance favors the prepared mind*' reminds us that one has to actively pursue the innovation path in order to taste success.

There have been several models of innovation, the earliest being Linear models of innovation. The first linear model of innovation was based on technology push. Research in institutions of higher learning resulted in science that was transformed into technology by industry players and offered as products in a market place. The second linear model of innovation was the result of a study by von Hippel that proposed a market pull based innovation. The market was said to drive the research and development directions which in turn passed on the results to the manufacturing who later delivered the products sought by the markets. (Galbraith, 1982) in his article suggested that a simultaneous coupling between research and development, manufacturing and marketing fostered innovations. (Rothwell and Zegveld, 1985) showed that innovation is a result of the market pull and technology push through the interaction between the marketplace, science base and an organization's competencies / resources. The interactive and simultaneous coupling models did not assume any explicit starting point for innovations.

(Kelly and Kranzberg, 1978) describe innovation as a management process that involves one or more of the following three:

- a context dependent response to a need
- a successful creative effort that introduces a novelty
- the need for changes in the current offerings.

None of these models explain how innovations are triggered. It is as if somehow the bridges were built across the technologies and markets using a firm's resources. There has been suggestion on how one decides where to build a bridge and when.

The work on the innovation cube is motivated from the observation by (Cohen and Levinthal, 1990) that few companies have the ability to scan the market place to recognize such innovation opportunities. The resources required to scan all of the market shifts and technology discontinuities and determine which of them were relevant to a firm would be enormous. Very few companies can afford to carry out such scans on a continued basis. Further, companies would only be interested in expanding into markets without abandoning their roots as explained by (Zook, 2003). It would be nice to have a framework that can call a firm's attention to selected market shifts and technology developments of interest to it. The innovation cube provides such a framework. This paper describes the innovation cube. The use of innovation cube to identify new innovation opportunities will be discussed in a future publication.

2. INNOVATION CUBE

The Innovation Cube uses three pairs of attributes that define successful innovations. "Pain-Pleasure" is the first pair of attributes. "Market shifts-Technology discontinuities" is the second attribute pair. "Price-Speed" is the third pair of attributes.

Each attribute pair plays a different role. "Pain-Pleasure" attribute pair is the most fundamental of the three since it defines why people would want innovations. An innovation that identifies a solution for a pain experienced by a community or that addresses the needs for their pleasure would certainly be attractive to the markets. The automobile is an example of a solution to a pain experienced by human societies. It helped people commute from an origin to a destination fast, in comfort and with protection from sun and rain. The roller coaster is an example of an innovation that addresses the needs of human society on the pleasure dimension. Given that these

Pain and Pleasure are the basic drivers of innovation, this pair is labeled the Drivers of innovation.

The second attribute pair is Market shifts-Technology discontinuities. Whenever markets change or when a new technology becomes available then there is an opportunity for innovation. Even if the pains experienced by the society or their needs for pleasure have been identified, the markets may not be ready for them or the required technology might not be available. It is the opening of the markets and / or availability of a new technology (arising due to a technology discontinuity) that would trigger the timing of the innovation. Hence we call this attribute pair the Triggers for innovation. It is important to note that a technology discontinuity will lose value over time when that technology gets commoditized. Once a technology discontinuity is commoditized, it is the market shifts that come into play. Information technology is an example. Companies treated information technology as a strategic investment in its early days. When information technology became a commodity, companies had to focus more on effective use of technology to create new products rather than on the technology itself.

The third attribute pair defines the pragmatics of an innovation. Any innovation has to be affordable for wide spread acceptance by the markets. Speed of delivery is as important as relevance. A company that has identified an innovation but is slow to deliver it to the market will surely not be successful. Price and Speed of delivery enable an innovation succeed in a market that is ready for exploitation. (Moore, 1995) is very clear that only one firm ends up as a gorilla when the tornado for market share of a new product has settled down. The speed of capturing the market share of a product is certainly influenced by the speed of delivery to the market. Hence the Price-Speed pair is called Enablers of innovation.

The innovation cube (See Figure 1) captures the three key dimensions required for a successful innovation. The X axis represents the Drivers of innovation, the Y axis represents the

Triggers for innovation and the Z axis represents the Enablers of innovation.

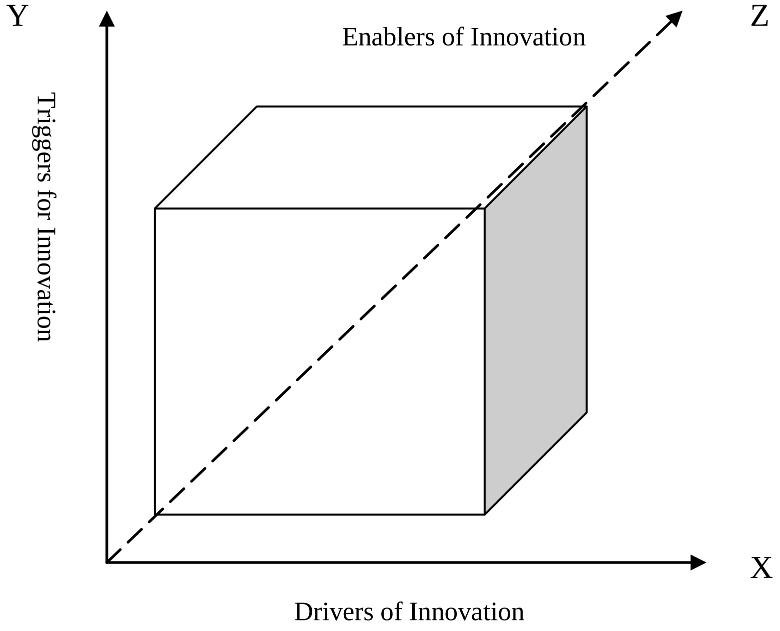

Figure 1. The Innovation Cube

A discussion on the innovation cube can be decomposed into a discussion of the three planes of the cube, viz., XY, YZ and XZ planes. The three following sections provide examples of the type of innovations that is addressed by each of the three planes of the innovation cube. The term product is used in the following discussions to refer to both products and services based that are innovation based.

2.1. Innovations along the X-Y Plane of the innovation cube.

The XY plane is defined by the drivers of innovation and the triggers for innovation (See Figure 2). Some examples of pains are inconvenience, bottlenecks and immobility. Some examples of technology discontinuities are miniaturization, high speed computing elements, broadband communications, increased capacity and higher resolutions. Examples of market shifts are new regulations / deregulations, user maturity with respect to new skills, willingness to pay, and familiarity with new technologies, new residential and commercial geographies, and new user preferences. Examples of pleasure are ego trips, thrills and personalized products and services.

The quadrant that is the intersection of Technology discontinuity and Pain represents innovations that can be collectively termed transformational products. Examples of transformational innovation are automobile and E-Commerce. Internal combustion engine was the technology discontinuity that was used to address the need for reliable, fast, comfortable long distance travel, resulting in a product that we now call automobile. Internet was the technology discontinuity that was used to create desk top shopping resulting in E-commerce related products. These two have transformed the way human society operates and hence this quadrant deserves to be called transformational innovations.

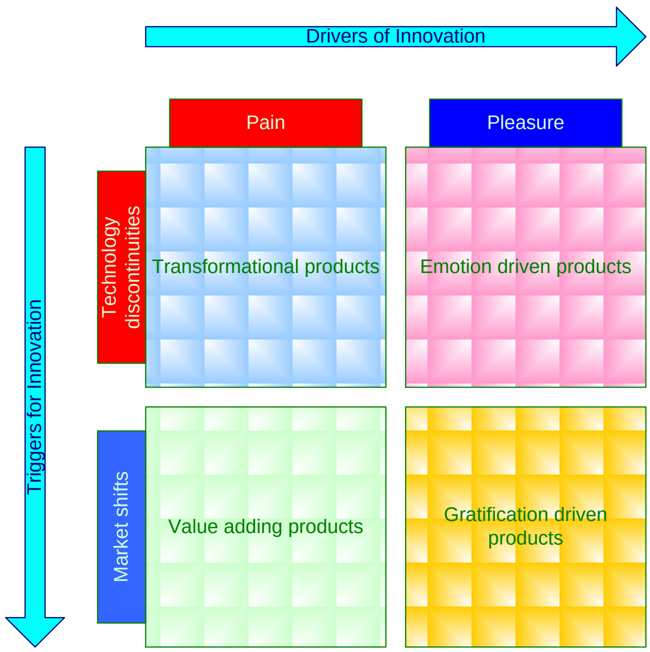

Figure 2. X-Y Plane of the Innovation Cube

The quadrant that is the intersection of Technology discontinuity and Pleasure represents innovations that are labeled emotion driven products. Examples of such innovations are science based vanity products and leading edge joy rides in Disneyland.

The innovations at the intersection of pain and market shifts are value adding products. Examples are Pork Floss buns created by BreadTalk in Singapore and Almond filled croissants created by Au Bon Pain in the east coast cities of US (See end notes).

The innovations at the intersection of market shifts and pleasure are gratification driven products. Examples of such products are downloadable ring tones and Swatch watches.

2.2. Innovations along the Y-Z Plane of the innovation cube

The Y-Z plane of the Innovation cube is defined by the Triggers of Innovation and Enablers of Innovation (See Figure 3). This plane is used to understand the impact price and speed to market has on innovations that are created based on market shifts and technology discontinuities.

The innovations that arise from technology discontinuities will be high priced given that it takes some time for technology discontinuities to be commoditized. Hence the innovations that are represented in the quadrant intersected by Price and Technology discontinuities are likely to be Niche and Special purpose products. Two examples are Space and Defense related products.

The innovations that are at the intersection of Price and Market shifts represent Cost Down mass market products. Market shifts happen when technology is mature and hence commoditized. The technology price would have fallen to be low enough for addressing mass market products. Some examples are video game products and personal computers.

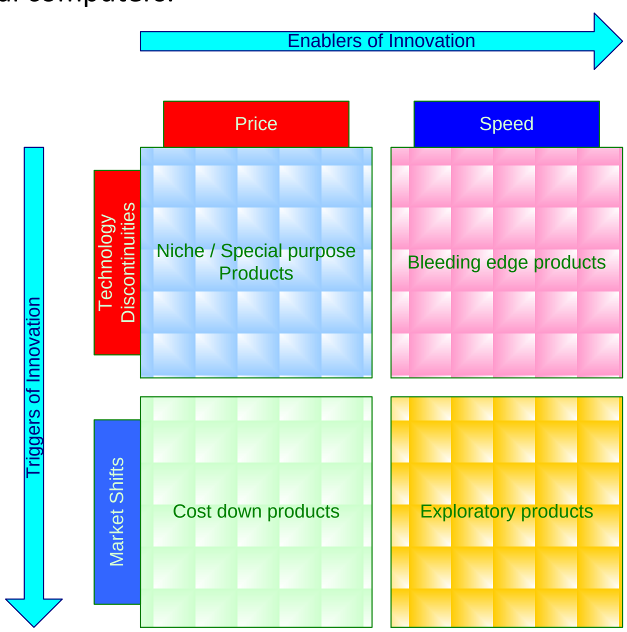

Figure 3. The Y-Z Plane of the Innovation Cube.

Innovations that arise out of new technology discontinuities are often rushed to the market to capture the largest possible market share. These often end up as bleeding edge products that are of interest to a select few early adopters. Some current examples are fuel cells and hybrid cars.

Innovations that are released quickly after new market shifts often end up being exploratory products. These often are experimental and are released to understand market reaction. Some examples are 3G telecom products that were rushed out immediately after deregulation of the telecom industry.

2.3. Innovations along the X-Z Plane of the innovation cube.

The X-Z plane is defined by the Pain-Pleasure and Price-Speed attribute pairs. This plane can be used to identify the impact of price and speed to market on the products that are created in response to the pains and pleasures of human societies.

Innovations that are at the intersection of Pain and Price tend to be utility products that are for the mass markets. There are many examples and two of them are shoes and blenders. The competition in this dimension is often driven by price sensitivity.

Innovations that are at the intersection of Price and Pleasure are mass market entertainment products. Examples include video games and movies.

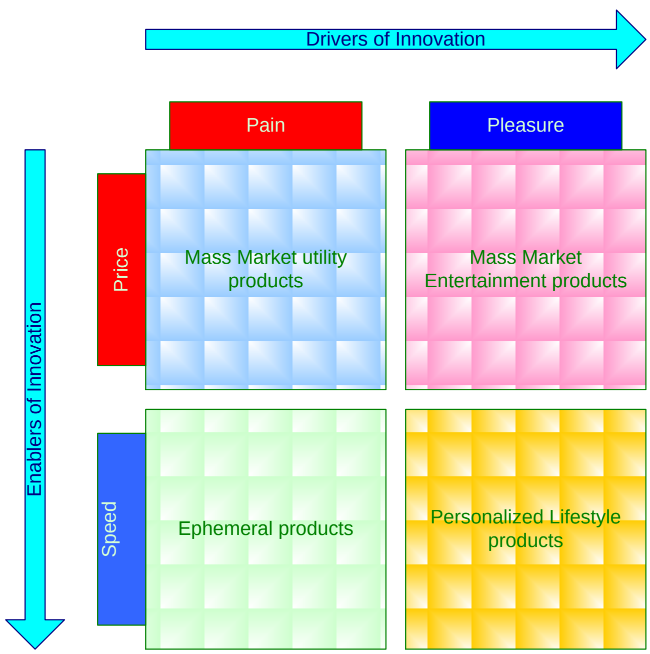

Figure 4. The X-Z Plane of the Innovation Cube

Innovations that are at the intersection of Pain and Speed are Interim or Ephemeral products. Firms rush to offer interim solutions with no concern for price or market size. Such products are often replaced by more cost effective mass market oriented products over time. Examples of such products include Apple computer and Haut Couture products.

Innovations that are at the intersection of Pleasure and Speed are most likely to be Personalized Lifestyle products. Lifestyle products are driven by consumer tastes and they change very often and very frequently. Hence it is important for firms to rush products to the market within the narrow window of opportunity.

3. USE OF INNOVATION CUBE FOR IDENTIFYING NEXT INNOVATION OPPORTUNITY.

This framework was developed as a taxonomy that can form the building block for developing a strategy (or an algorithm) for identifying when to initiate new innovation drives. Suffice it to say that such a strategy is beyond the scope of this paper due to space constraints. For the sake of curious readers, the general approach to using this taxonomy to identify the timing for the innovation is explained below in brief.

A strategy for identifying innovation opportunities for a company will be determined by the mission of the company. The mission in turn will define the markets addressed by the company and the resources assembled in the company. The company can use the adjacency principles discussed in (Zook, 2003) to identify the pains and / or pleasures that it would like to address next. The type of product would define the plane that the company needs to consider. This in turn will bring into play the attribute pairs that should be of interest to the company. The company should identify the attributes required to become active for the launch of the identified innovations.

We call the strategy and the algorithm for determining when and how to launch an innovation an “Innovation Engine”. This work will be reported in detail in a future publication.

4. SUMMARY

This paper defines a framework for innovation that is called “Innovation Cube”. The planes bounded by pairs of the three attribute pairs define different type of products. A company can ascertain which of the planes or even quadrants in any of the three planes are of interest to it. This can then lead to setting up a innovation watch to identify when to launch an innovation.

Notes

BreadTalk founders observed that consumers used to buy a bun and then struggle to lay pork floss on top of the bun before consuming the bun and the floss. This observation helped them decide to create a hugely successful product wherein the pork floss was laid on the bun before the bun was baked.

Au Bon Pain in a chain of bakery / coffee shop with presence on the east coast cities of the USA. They product delightful croissants whose center is filled with almond paste – another very popular and successful innovation.

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Innovation Engine

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Innovation Engine

Arcot Desai Narasimhalu
School of Information Systems
Singapore Management University

Abstract

This paper describes a meta-model for innovation using an automobile engine as a metaphor. This innovation meta-model is used to explain why innovations occur and succeed. This model also recognizes timing as an important aspect of a successful innovation. This meta-model can be used by corporations and individuals to identify plausible innovations at any given point in time.

1. Introduction

There have been many innovation models beginning Schumpeter's constructive destruction (Schumpeter 1934, 1939, 1942; Christen 2003, Kim and Maughbourne 2005…). Each of these models has shed new light on the process of innovation.

Disruptive innovation discusses how what is considered to be an inferior solution for a well established product may well meet the demands of an emerging market. It also discusses how product lines considered unprofitable for large businesses may turn out to be opportunities for setting up new businesses with lower business costs.

Value Innovation proposed by Chan Kim and Renee Mauborgne focuses the innovation on the values that are important to customers. They describe the six paths to innovation – across industries, across product lines, Emotion Vs function, etc. They also discuss about the utility levers, "Before-During-After" and other interesting concepts such as Utility levers and Buyer Experience Cycle.

These are excellent efforts to provide well defined innovation methodologies for corporate managers to adopt. It is time that all these good concepts are captured in a meta-model that will provide a single source of value for individual innovators and corporate innovation managers. We call this meta-model InEng which is a short form for Innovation Engine.

We draw parallels between an automobile engine and the Innovation Engine InEng in section 2. We then describe the Innovation Chamber in detail in section 3. Section 4 discusses some examples using InEng. Section 5 presents an approach towards implementing InEng. Conclusions and Summary are presented in Section 6.

2. InEng Meta-model

A simple block schematic of an automobile engine is presented in Figure 1. Air-Fuel mix enters the combustion chamber in the cylinders and the pistons in each of the cylinders compress this mixture up to a point where sparks from spark plugs ignite the air-fuel mixture. The enormous pressure created and released by the combustion pushes the pistons away and this motion is translated into power.

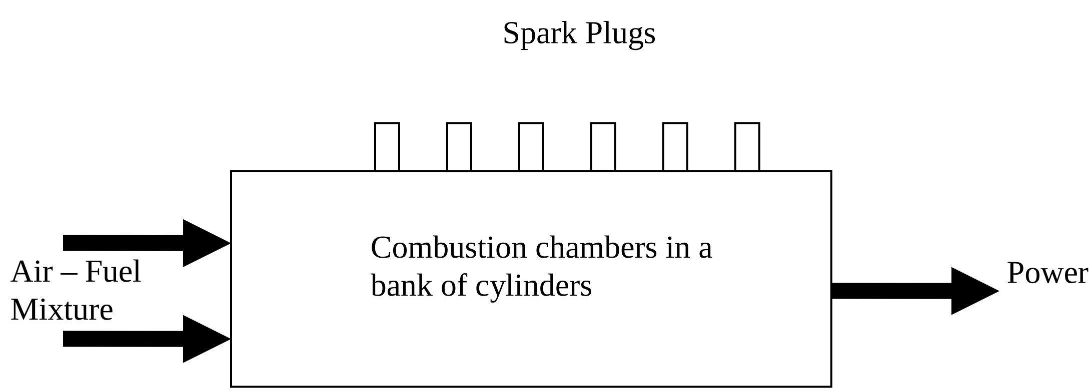

Figure 1.Block Schematic of an Auto Engine

Let us now compare innovation processes to an auto engine. The spark plugs will correspond to Innovation Triggers discussed in (Narasimhalu 2005). Pain and Happiness, identified as the drivers of innovation in (Narasimhalu 2005) correspond to the Air-Fuel Mixture. The combustion chambers in the bank of cylinders will correspond to a collection of the different models of innovation discussed above. The power produced from the engine will correspond to innovations. Innovation chamber corresponds to the bank of cylinders and is made up of all the models of innovations currently known and those yet to be defined. The engine oil corresponds to maintenance and enhancement of each of the innovation models. An innovation engine corresponding to an automobile engine metaphor is presented in Figure 2.

2.1. The Air-Fuel mixture of InEng

It is important to recognize that innovations that either reduce a pain suffered by a large group of people or enhance the happiness of a large group of people will certainly be accepted by the markets with open arms without any or a minimal of adoption hurdles. When the reduction in pain or increase in happiness is not significant in certain innovations, then there will surely be hurdles experienced in the adoption of such innovations. The same adoption hurdles will fall like ninepins if either the reduction in pain or enhancement in happiness is significant. Hence the pains suffered by a large mass of human society and new avenues of happiness sought by another large mass of the same human society correspond to the Air-Fuel mixture that is pumped into the InEng.

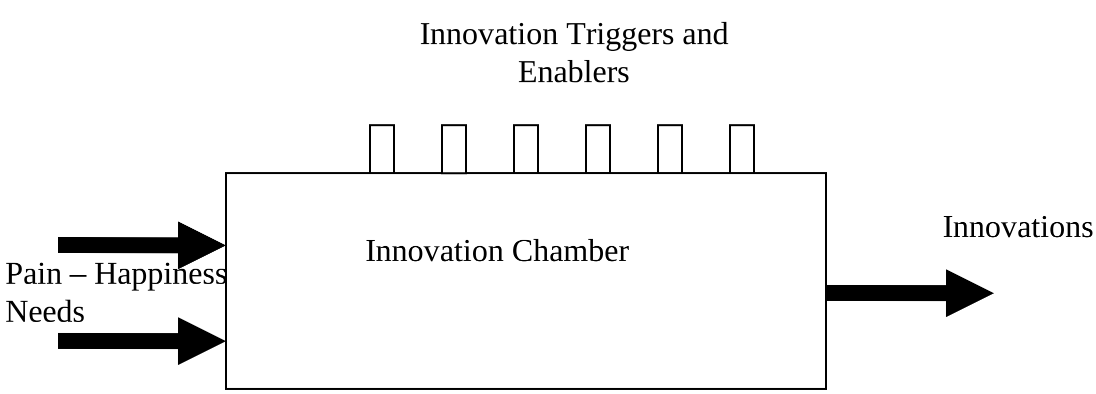

Figure 2. Block Schematic of an Innovation Engine

Some discussion on Pain and Happiness is in order. Reduction in pain can be interpreted as increase in happiness in some form or shape. When we discuss Pain and Happiness as the Air-Fuel mixture, the Happiness refers to increasing happiness from whatever level of happiness one is experiencing and not that arising from the reduction of some form or shape of pain.

2.2. The spark plugs of InEng

Technology discontinuities and market shifts identified as the triggers of innovation (Narasimhalu 2005) form the spark plugs of the Innovation Engine. Each of these plugs helps create the spark that drives the creation and adoption of innovation. We reproduce the definition of these three categories of innovation spark plugs.

Triggers of Innovation: Market Shifts and Technology discontinuities trigger new innovations.

The following are examples of broad technology discontinuities

- Miniaturization
- High speed computing elements
- Broadband communications
- Increased storage density
- High resolution displays

The following are examples of specific technology discontinuities

- USB port in computers
- Miniature cameras
- Internet Browsers
- MP3

The following are examples of broad market shifts.

- New regulations / deregulations
- User maturity with respect to new skills
- User familiarity with new technologies
- New residential and commercial geographies
- New user preferences.

The following are examples of specific market shifts.

- Teenagers addiction to cell phones
- Camera phones
- PDAs

- MP3 players

Enablers of Innovation: Product pricing and speed of delivery of the product to the markets of interest are enablers of innovation. These enable new innovations to be accepted quickly by the markets.

Just as the spark plugs ignites the Air-Fuel mixture at the right time, the triggers of innovation also determine the best timing for the creation and mass adoption of innovation.

2.3. Innovation Chamber of InEng

Innovation chamber consists of a set of innovation models. The number or the type of these models is not limited. New models or "cylinders" can be added to the innovation chamber and existing models can be replaced, enhanced or discontinued. Such an extensible approach allows for the continuous "tuning" of the innovation chamber.

The innovators themselves are the "pistons of innovation" in each of the "cylinders of innovation". They are the ones who translate the sparks produced by the Innovation Spark Plugs into "power" or innovations.

The friction between the pistons and cylinders result in wear and tear in an automobile engine. Analogously, review, refinement of existing models of innovation and the creation of new models of innovation is the "innovation oil" that lubricates the "innovation cylinders"

3. The cylinders in the Innovation Chamber

Each of the Innovation Cylinders corresponds to a model of innovation proposed by a thought leader. We enlist some popular "Innovation Cylinders" for discussion. These are not the only set of Innovation Cylinders possible. The Innovation Chamber has to be continuously maintained by refining or removing existing models of innovation and by adding new models of innovation.

Innovation Chamber can be customized to fit the needs of an enterprise. Although we discuss several cylinders, an enterprise can choose to install any or all of the Innovation Cylinders – past, present and future models of innovation

Any or all of these Innovation Cylinders have only one goal – to identify the next innovation opportunity. The basic value derived by our society is either reduction in some form of pain or enhancement of happiness. Such enhancement of happiness includes creations of new forms of happiness that have not been experienced before. We assume all these innovations are bound within the moral and legal dictates of sovereign states.

Given that the aim of any innovation is to create value for the masses who use it, we name each of these Innovation Cylinders after the type of value created.

4. Conclusion

Innovation Engine is a methodology that was developed based on the framework described by Innovation Cube (Narasimhalu 2005). This methodology can lead to an algorithm that can be routinely used by Innovation Designers for identifying candidates for innovation. This algorithm will be published in a future paper.

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Innovation Stack

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Innovation Stack – choosing innovations for commercialization

Arcot Desai Narasimhalu
School of Information Systems
Singapore Management University

Abstract

This paper describes a method for enterprises to order the innovations of interest according to a number of parameters including their own business strategy and core competencies. The method takes into account aspects such as ability to create entry barriers and complementary assets. Enterprises can now use this method to both filter out innovations that may not be of interest to them and then order the short listed or selected innovations according to their attractiveness.

1. Introduction

A number of authors have addressed different approaches to innovation [1, 2, 3, 4, 7, and 8]. A recent framework for innovation, titled Innovation Cube identified the key drivers, triggers and enablers of successful innovations [5]. This framework identified pain and pleasure as the drivers, technology and market shifts as the triggers and price point and market dominance as the enablers of successful innovations. This was followed by Innovation Engine, an algorithm for generating innovations [6]. Innovation Cube defined a framework while Innovation Engine provided a methodology for identifying new innovation opportunities based on the framework. The third link in this called the Innovation Stack rank orders innovation opportunities in the context of relevance to an organization.

A product or division manager in an organization is often confronted with several innovation opportunities. The manager has to then decide the order in which the different innovations could be addressed. A number of factors such as impact, resources and time to market will contribute to making such a decision. Innovation Stack is an imaginary stack which orders potential innovation opportunities such that the most promising innovation relevant to an organization will be placed on the top of the stack, the next most promising placed second and the least promising and still relevant innovation the last.

This paper presents the Innovation Stack methodology. Section 2 defines Innovation Attractiveness Parameters used in the ranking methodology. Section 3 discusses the relative sensitivities of these parameters. A method for computing the innovation attractiveness scores is presented in section 4. A method for rank ordering the different innovations is presented in section 5. Section 6 provides a summary on Innovation Stack.

2. Innovation Attractiveness Parameters

Innovation Attractiveness Parameters (IAPs) are used to define how attractive an innovation opportunity is to a company. The following is an alphabetical list of innovation attractiveness parameters used in the Innovation Stack.

A. Ability to create Entry Barriers (AEB): An innovation that is not easy to replicate or is able to erect any form of significant entry barrier is to be preferred over those that offer lower entry barriers to the competition. A score ranging from 0 to ∞ is assigned for this parameter. A score of 0 would imply that this innovation is easy to copy and / or cannot erect any form of entry barrier to prevent the competition from moving into the new market rather quickly. A score of ∞ indicates that this is not an easy to copy innovation and / or that extremely high entry barriers can be erected. Innovations with different degree of difficulties will take on score between 1 and ∞.

B. Alignment with Business Strategy (ABS): While there may be many attractive innovations, it is important to check whether an innovation is aligned with the business strategy of the company. For example, a company producing automotives should really not have to worry about innovation opportunities in pharmaceuticals. The alignment of an innovation with business strategy is scored between 0 and 1. A score of 0 would imply that the innovation is orthogonal to the company's business and a score of 1 would mean that it is perfectly aligned with the company's business strategy.

C. Alignment with Core Competencies (ACC): An innovation may be aligned with the business strategy of a company and might also offer robust entry barriers to competition but if the company does not have the requisite core competencies to develop and market the innovation then the chances of commercializing the innovation are pretty low. So, it is best to assess the alignment of core competencies of a company with the innovation opportunity on a scale of 0 to 1, 0 representing total misalignment and 1 representing total alignment. Total alignment would indicate all the core competencies required for developing and marketing the product are available in-house.

D. Assessment of easy availability of Complementary Assets (ACA): Often times an innovation is built using suitable infrastructure or components already available in the market. Let us discuss some examples. Availability of spectrum is important for one to conduct a business as a mobile phone operator. Availability of communication equipment and mobile handsets are also important before one can offer mobile phone service. Spectrum, communication equipment, and mobile handsets are all complementary assets for a company that would like to introduce innovations in the mobile phone service market. The score for ACA should be 1 when the complementary assets are easily available and should be ∞ when the complementary assets are very closely held and protected by a competitor and hence such assets will not be available to the company. The score for ACA will take on a value between 1 and ∞ when the closely held assets can be licensed. The actual value will depend on the difficulty of negotiations and the premium required to obtain a license.

E. Business Value Potential (BVP): While all the above parameters are important, every manager has to be convinced about the business value generation potential of an innovation. Innovations can help either reduce operating costs or can lead to generating new revenues. Innovations contributing to significant revenue growth ought to be preferred over those that save cost of operations. Of course within each of the two categories there is also the relative value that needs to be considered. For example, two different innovations that can bring in different amounts of additional revenue will appeal differently to a manager. The Business Value Potential will take on a score between 1 and ∞. A score of 1 indicates minimal value and a score of ∞ will indicate that there is unlimited business potential realizable from the innovation. The score for BVP will lie between 1 and ∞ if the Business value potential is has some business value. The larger the number the larger the business value. It is very rare to have an innovation with the value of BVP equal to ∞ given that event patent and copyrights are limited by time. One could use a function involving the number of years of right to use and the margin for the product to derive the value of BVP.

F. Cost of acquiring new competencies (CAN): A company without relevant competencies in-house may decide to acquire such competencies from the market place for innovations that offer significant business value potential. The cost of acquiring new competencies will range from 0 to ∞. A value of 0 is assigned when such competencies are available freely and can be acquired easily. The value ∞ is assigned where it is extremely expensive or difficult to acquire the required competency. In reality, the value will lie somewhere in between.

G. Cost of Intellectual Property (CIP): In some cases, the innovation might require licensing intellectual property from a suitable source. The cost of intellectual property may range from 0 to ∞. The cost of intellectual property is 0 when it is freely available. It is ∞ when it is exclusively held, extremely difficult to reengineer and addresses a large market share. Once again actual value will lie in between for most innovations.

H. Market readiness (MR): An important parameter to consider is market readiness. It is important for a manager to understand whether the market is ready to adopt an innovation. There are instances when market is craving for an innovation and in such cases the value will be 1. Other innovations might require a market to be created. It is important to realize that the market is not ready. The lowest value for market readiness is 0 and indicates that the market will never be ready.

3. Discussion on relative sensitivities of the parameters

While one could introduce a number of parameters to determine and order relevance and attractiveness of an innovation, it is important to remember that not all the parameters might impact the selection and ordering strategy equally well.

The sensitivity of the parameters with respect to a market will be dependent on the business objectives of a company. This is a topic for elaboration in a separate paper and hence is not discussed here. An ordered list of IAPs is given below.

A. Alignment with Business Strategy (ABS)
B. Business Value Potential (BVP)
C. Ability to create Entry Barriers (AEB)
D. Market readiness (MR)
E. Assessment of easy availability of Complementary Assets (ACA)
F. Alignment with Core Competencies (ACC)
G. Cost of Intellectual Property (CIP)
H. Cost of acquiring new competencies (CAN)

A company can choose to assign different weights to each of the IAPs based on either actual or perceived importance to the commercialization of an innovation. Different companies will choose different weights depending on their perception of importance of the parameters in their context. Therein lies an important aspect of innovation management.

Weights for all the eight IAPs will be assumed to be same for the purpose of this paper. If they are same, then without any loss of generality we can assign a value of 1 to all of them.

4. Computing Innovation Attractiveness Scores

Innovation Attractiveness Score (IAS) is used to determine the relative levels of attractiveness offered by different innovations. Let us consider 'n' innovations competing for investments.

The Innovation Attractiveness Score for i^{th} IAP is then a function of the eight IAPS and their weights. A sample function is given below. One can derive more than one function by using different combinations of the innovation attractiveness parameters.

$$IAS_i = (((W_{BVP} * BVP_i * W_{ABS} * ABS_i * W_{ACA} * ACA_i * W_{ACC} * ACC_i) – ((W_{CAN} * CAN_i) + (W_{CIP} * CIP_i))) * W_{AEB} * AEB_i * W_{MR} * MR_i), i = 1 \text{ to } n \qquad \text{------------ (1)}$$

It is important to understand the function presented above. Business Value Potential, Alignment with Business Strategy, easy access to complementary assets, and availability of Core Competence are all complementary parameters and reinforce each other. On the other hand, Cost of Acquiring New Competencies and Cost of Intellectual Properties work against attractiveness and hence are dealt separately as adding negative value to the score. While the combination of these two sets results in an intermediate score, it is the ability to erect entry barriers and the readiness of markets that determine the real attractiveness of an innovation.

The theoretical IAS values for any IAP using the above equation will span from $-\infty$ to $+\infty$. Actual values will lie across a much smaller range.

The above equation is only one possible means of combining the parameters and their weights to arrive at Innovation Attractiveness Scores for the different parameters.

Innovation Attractiveness Scores for two innovations such as MP3 player and a MRI machine for a consumer electronics company are shown in Table 1. Let us assume that the weights for all the parameters are all one. The values chosen are representative and actual values will require very detailed computations.

Table1: Computation of Innovation attractiveness scores for two sample innovations.

Parameters	MP3	MRI
BVP	15	30
ABS	1	0
ACA	1	0
ACC	10	20
CAN	100	60
CIP	0	200
AEB	50	500
MR	1	1
IAS	**1350**	**-55,000**

Clearly MP3 player as an innovation is attractive to this company in comparison to MRI innovation. Once again, these values are given as examples and not are not actual values.

5. Ordering Innovations for adoption

The ordering of innovations can be split into two steps. The first step is used to eliminate innovations that are not attractive at all and the second step is used to order innovations according to their desirability and match with an organization's execution capacity. These two steps are combined in the following algorithm.

Begin

Sort (i, IAS_i) such that the value of IAS in the jth place is higher than value of IAS_i in the (j-1)th place.

Remove all (i, IAS_i) whose IAS_i value is below a predetermined threshold

End

Clearly all innovations with a negative value of IAS will be of no interest to a company. Thus, zero is the minimum threshold one could use to filter out the innovation of no interest. In practice very few companies will pursue innovations that do not result in significant gains. Exceptions are those innovations that might be pursued for strategic reasons such as the need to have a token market presence in a product line. In all other cases, the company should additionally decide a positive valued threshold that can be used to skim off less attractive innovations.

A company should focus on the innovation that is at the top of the sorted list. This would be the most attractive innovation for the department, division or the company. The next innovation on the sorted list would be next most attractive. One could go down the list till all the innovations are addressed or stop when the resources available for new product development is consumed.

MP3 player based innovation will be selected if we apply the above algorithm to the two examples. The MRI based innovation opportunity will not even be selected for consideration given its negative value.

The innovation stack could be used either at a department level, a divisional level or even at the corporate level. Corporate program offices could use the innovation stack as a methodology for deciding which innovations should be supported. In the case of submissions from multiple divisions, there may have to be a slight modification to the algorithm to bring in an element of equitable distribution of resources across multiple divisions.

Alternatively a company could take an options based approach when all the innovations proposed by a division are all really well below the list of innovations that can be supported. In such instances such a division can be funded a nominal sum of money to investigate how they could refine the proposed innovation to make it more compelling from a business perspective. Such an approach will ensure that the enthusiasm from any one division is not doused and will stimulate and encourage the division to consider much more meaningful innovations in the future.

6. Summary

This paper proposes a method called Innovation Stack to prioritize innovations for the purposes of funding and commercialization. The Innovation Stack completes the new innovation methodology that consists of Innovation Cube as a framework and Innovation Engine as a method for identifying possible innovations.

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Section 2: Service Innovation

Service Innovation Opportunity Identification

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A Method for identifying Service Innovation Opportunities

Arcot Desai Narasimhalu*

Singapore Management University, 81 Victoria Street, Singapore 188065
E-mail: desai@smu.edu.sg

Abstract: Service Innovation has been gaining increased attention and importance since the recent promotion of Service Science Management and Engineering framework by IBM. There have been numerous attempts at understanding service innovations in the past. Many of these research efforts have focussed on service innovations at the point in time when a service is rendered. This paper highlights the need for service innovations to consider a customer's requirements before, during and after a service is to be provided. The paper recommends a methodology to identify and prioritize service innovations. The proposed methodology was inspired by studies related to Blue Ocean Strategy framework and builds on the Innovation Cube Framework.

Keywords: Service Innovation; Value Drivers; Business Process; Identifying innovation opportunities; Innovation Cube; Blue Ocean Strategy.

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1 Background and Introduction

Service industry continues to play a major role in the gross domestic product (GDP) of many nations and happens to contribute as much as 80 % of the GDP of first world nations. There have been several studies related to services in general [1, 3, 4, 5, and 8] and service innovation in particular [2, 6, 7, 10, 14, 15, 16 and 17]. There have been recent attempts at defining service systems and engineering [9, 13 and 18]. All these studies have clearly highlighted the need for the research community to seriously engage themselves towards furthering the understanding and creation of service innovations.

Chan Kim and Renee Mauborgne had in their studies leading up to the definition of Blue Ocean Strategy [11] referred to a case study relating to cinema industry in Brussels. This was Kinepolis which transformed declining Cinema industry into a sunrise industry by understanding and responding to customer behaviour. The Kinepolis case study clearly established the need to consider the needs and wants of customers before, during and after a specific service.

Narasimhalu had enumerated the attributes of successful innovations in his paper on Innovation Cube [12]. The paper identified pains suffered by a large community of customers to be a driver of successful innovations. It also described pleasures or the desire for enhanced experiences as another driver of successful innovations. Pains correspond more to the needs and "Pleasures" correspond more to customers' wants.

This paper presents a three step methodology for identifying Service Innovation Opportunities that is inspired by Kinepolis example and built using the Innovation Cube. The first step, described in section 2, presents the Service Design Matrix and discusses the elements that are represented in the matrix. Section 3 presents a discussion on the value drivers for the customers of a service. The methodology for identifying service innovation opportunities is presented in Section 4. Section 5 provides a summary and lists areas for future research.

2 Service Design Matrix

The template of the proposed Service Design Matrix (SDM) is presented in Figure 1.

The columns capture the workflow elements. There are three sets of columns in the SDM representing the temporal value chain or the process of a service. The first set of columns B_1, …, B_b capture the links in the value chain before a customer is serviced. Each link corresponds to an activity. The second set of columns D_1, …, D_d capture the links in the value chain when a customer is experiencing the service. The third set of columns A1, …, A_a capture the links in the value chain after a consumer has experienced the service. Each of the links is temporally ordered, i.e. B1 happens before B2, and B2 happens before B3. Also all the Bs happen before Ds and all the Ds happen before the As. We shall refer to the Bs as the "Before" value sub-chain, the Ds as the "During" value sub-chain and the As as the "After" value sub-chain. Each value sub-chain could consist of several activities. B1 to Bb are examples of activities under the value sub-chain "Before." The following example illustrates the discussion.

Table 1 Service Design Matrix Template

		Temporal Value Chain / Process →								
		Before			During			After		
		B_1	…	B_b	D_1	…	D_d	A_1		A_a
Value Drivers	V1									
	V2									
	V3									
	V4									
	V5									
	V6									
	V7									
	V8									
	V9									

When a person wants to go to a cinema to view a movie, the first thing he or she might do is to find out information about the different movies currently playing, their timings and possibly reviews by movie critics. This results in a browsing activity. A customer may choose to browse either off-line using advertisements in newspapers or browse on-line using any of the aggregated service providers or the portals of cinema operators.

The next thing this customer may wish to do is purchase a ticket either on line or at the counter. On the day of the movie itself, the customer might drive to the movie theatre and look for a parking spot. If we assume these three successive activities to be representative of a movie viewer, then we would end up defining three columns in the "Before" value sub-chain for the following three activities.

B_1 – Browsing for a movie
B_2 – Purchasing tickets
B_3 – Parking

The "Before" value sub-chain will be $B_1 \rightarrow B_2 \rightarrow B_3$.

A service innovation designer should follow a similar exercise in defining the entire temporal value chain / process for the service being examined. Possible value sub-chains and their activities for 'During' and 'After' value sub-chains of the movie viewing process are given below.

D_1 – Preview forthcoming movies in the hall

D_2 – Enjoy comfortable seats
D_3 – Enjoy good audiovisuals

The "During" value sub-chain will be $D_1 \rightarrow D_2 \rightarrow D_3$.

A_1 – Buy tickets for the next movie
A_2 – Participate in a lucky draw for those submitting reviews
A_3 – Drive home from parking lot

The "After" value sub-chain will be $A_1 \rightarrow A_2 \rightarrow A_3$

Notice that the order in which two activities appear within a value sub-chain may easily be reversed without affecting the overall outcome of a sub-chain. For example, one might purchase tickets at home and park at the cinema theatre or park first and then buy the ticket from the counter. So, the elements within a sub-chain are only partially ordered. A service innovation may contain one or more of the activities in the three value sub-chains.

3 Value Drivers for a service customer

Value drivers that a customer would pay for are discussed in this section. The following are an example of the value drivers of a typical movie watching customer.

V_1 – Ability to purchase tickets in advance.
V_2 – Ability to choose the seats in the movie hall.
V_3 – Plenty of parking.
V_4 – Comfortable seats.
V_5 – High quality audiovisual experience.
V_6 – Baby sitting facilities.
V_7 – Short waiting time for purchase of tickets.
V_8 – Short waiting time for the beginning of the movie.
V_9 – Dining facilities after the movie.
V_{10} – Planning for the next movie.

The next step is to link the value drivers to the three value sub-chains as shown in Table 2. Each of the value drivers can be translated into an activity in a value sub-chain.

Table 2 Assigning value drivers to the different parts of a value chain

Value driver	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9	V_{10}
Sub-chains	B	B	B	D	D	B	B	B	A	B/A

This arrangement leads to clarity with regard to the part of the temporal value chain that each of the value drivers are to be considered.

At this stage it is important to get customer input on the relative importance each of the value drivers. This could be done using either a qualitative method or a quantitative weighting method. Both approaches are represented in Tables 3, 4 and 5.

Qualitative weighting scheme

One option for qualitative weights could be the following two values – M for Must have and G for Good to have. Table 3 shows an instance of the qualitative weights for the ten value drivers using the two values. This weighting method is labelled weighting scheme A.

Table 3 An example of qualitative weights for the value drivers

Value driver	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9	V_{10}
Weights	G	M	M	G	M	M	G	M	G	G

Quantitative weighting schemes

Quantitative weights could use a range of values, for example 1 to 10. A weight of 1 could be used to indicate that the value driver is the least important and a weight of 10 could be used to indicate that the value driver is the most important. Again, the weighting scheme can be so designed such that every value driver is required to have a unique weight or there could be allowance for more than one value driver having the same weight. We illustrate the two schemes using Tables 4 and 5.

Table 4 shows an example of value drivers with unique weights. In this scheme a case there have to be as many weights as the number of value drivers. This scheme also results in strict prioritization of value drivers. This weighting method is referred to as weighting scheme B.

Table 4 An example of unique quantitative weights for each of the value drivers

Value driver	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9	V_{10}
Weights	6	4	1	3	2	7	10	5	8	9

Table 5 shows an example of value drivers that can take repeatable weights. The range of weights designed for such a scheme can be less than, equal to or higher than the number of value drivers. In other words, this scheme is the most flexible of the three schemes described in this section. This weighting method is labelled weighting scheme C. The example in the following table uses the range of weights shown below:

5 – Most highly valuable
4 – Highly valuable
3 – Valuable
2 – Moderately valuable
1 – Least valuable

Table 5 An example of repeatable quantitative weights for the value drivers

Value driver	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9	V_{10}
Weights	5	5	5	5	5	3	3	2	2	1

Each of the three weighting methods should be used under a different circumstance. The first method is to be used when the value drivers are to be organized into two groups without any concern for the relative importance of the value drivers within each of the two categories. Such a method would generally be used by an innovation designer when there is some flexibility in the budget. The second method is best used when there is a fixed budget and a strict prioritization is desired. The second method gives the innovation designer a simple means of determining how best to utilize a fixed budget. The last method is simply a refinement of the first method wherein there is more than one category. So, an innovation designer can choose first to address the value drivers that are considered most important first and then address the next most important group of value drivers and so on until the budget is exhausted.

The weights can be derived either through a survey or through observation. A survey would list the different value drivers perceived to be important to the customers and ask them to rank the importance of the different value drivers using one of the three weighting schemes. It would be good to allow real time use of their inputs. Survey responses will have to be taken with a pinch of salt given that not all respondents may know what they really want.

A preferred method of deriving the weights is through impressions. In the impression based method customers' behaviour is closely watched and the different challenges faced by the customers are documented. Each challenge then becomes a value driver. The weight is derived by a function derived from the intensity of the challenge and the number of customers facing the challenge. This method allows continuous monitoring and refinement and is thus better reliable in comparison to one time surveys.

Pain and craving for pleasure or enhanced experience that were identified as innovation drivers in [12] can be used to derive the weights. Pains and Pleasures will be the value drivers for service innovations. The more acute a pain the higher can be the weight for that value driver. The greater the craving for an enhanced experience, then higher the weight for that value driver. Given that society often values the solutions for its pains more than the solutions for its craving for enhanced experience, it is natural that the weights for most pains will be higher than the weights for most pleasures.

4 Methodology for identifying Service Innovation Opportunity

The method to identify the service innovation opportunity is very straightforward once the value chain of a service, its sub-chains and value drivers are identified. The method would depend on the weighting scheme chosen. This section first presents definitions used in the service innovation opportunity identification method and then describes the three methods of determining the service innovation opportunity.

Definitions

S – Sum of money available for the design and development of the service innovation
$C(V_i)$ – Cost of design and development of Value Driver $_i$

Method A

Method A uses the Weighting Scheme A. The first step is to identify relative priorities among the value drivers across the three value sub-chains given that the weighting scheme relies on binary values G (Good to have) and M (Must have). In the above example, those activities in the "During" value sub-chain can be said to be more important relative to the activities in the other two value sub-chains. Therefore, the activities in the "During" value sub-chain can be assigned a priority relative to the activities in the other two value sub-chains. Next, consider the activities in the "Before" value sub-chain relative to the activities in the "After" value sub-chain. It can again be inferred in the current example that the activities in the "Before" sub-chain will carry higher importance relative to the activities in the "After" sub-chain and hence deserve a higher priority.

Establishing the relative importance amongst the value drivers is important given that the sum of money available for the design and development of the different activities in the service innovation might not be adequate even for all the activities carrying the M (Must Have) weight. So, in each of the two categories, M and G, the activities in the "During" value sub-chain will carry the highest priority followed by those in the "Before" and "After" value sub-chains.

This specific temporal ordering may be unique to this example and should not be assumed to apply to all service innovations. The following procedure will identify the activities in the value chain that offer customers the highest value for a given budget.

Additional definitions relevant to method A

S* - Sum of money available for the service innovation.
L – List of activities for consideration
L1 – List of activities selected for service innovation.

```
Start
    Initialize L1 to null.
    S* = S

    Populate L with all the activities with weight M in the value sub-chain "During"
    Repeat
      Select the first / next activity j in L
      If S* > C(Vj) then  Add j to L1; Remove j from L; Compute S* = S* - C(Vj)
    Until all activities in L have been considered.
```



```
Populate L with all the activities with weight M in the value sub-chain “Before”
Repeat
  Select the first / next activity j in L
  If S* > C(Vj) then  Add j to L1; Remove j from L; Compute S* = S* - C(Vj)
Until all activities in L have been considered.

Populate L with all the activities with weight M in the value sub-chain “After”
Repeat
  Select the first / next activity j in L
  If S* > C(Vj) then  Add j to L1; Remove j from L; Compute S* = S* - C(Vj)
Until all activities in L have been considered.

Populate L with all the activities with weight G in the value sub-chain “During”
Repeat
  Select the first / next activity j in L
  If S* > C(Vj) then  Add j to L1; Remove j from L; Compute S* = S* - C(Vj)
Until all activities in L have been considered.

Populate L with all the activities with weight G in the value sub-chain “Before”
Repeat
  Select the first / next activity j in L
  If S* > C(Vj) then  Add j to L1; Remove j from L; Compute S* = S* - C(Vj)
Until all activities in L have been considered.

Populate L with all the activities with weight G in the value sub-chain “After”
Repeat
  Select the first / next activity j in L
  If S* > C(Vj) then  Add j to L1; Remove j from L; Compute S* = S* - C(Vj)
Until all activities in L have been considered.


End
```

All the activities in L1 are selected for service innovation. Those activities not included will not be considered. The service innovation design should then proceed with the selected activities.

Method B

Method B uses the Weighting Scheme B. Additional definitions used in Method B and the procedure for Method B are described below.

Definitions

S* - Sum of money available for the service innovation.
L – List of activities in the decreasing order of value to the customer
L1 – List of activities selected for service innovation.

Start

```
    Populate L with all the activities in the value chain
    Initialize L1 to null.
    S* = S
    Repeat
      Select highest weighted activity j from L.
      If S* > C(Vj) then  Add j to L1; Remove j from L; Compute S* = S* - C(Vj)
    Until all activities in L have been considered.
```

End

The list L1 will contain all the activities to be included in the service innovation.

Method C

Method C uses the Weighting Scheme C. It combines aspects of Methods A and B to present another alternative. The definitions used and the procedure for Method C are described below.

S* - Sum of money available for the service innovation.
L – List of activities in the decreasing order of value to the customer
L1 – List of activities selected for service innovation.

Start

```
    Populate L with all the activities in the value chain
```

**** Modify the weights of the activities****
Select values for X and Y such that 1 > X > Y.

Repeat
Consider the first / next activity in L.
If the activity belongs to the "During" value sub-chain add X to its weight.
If the activity belongs to the "Before" value sub-chain add Y to its weight.
Until all activities in L have been considered.

Sort activities in L in the decreasing order of weights

Initialize L1 to null.
S* = S

Repeat
Select highest weighted activity j from L.
If S* > C(Vj) then Add j to L1; Remove j from L; Compute S* = S* - C(Vj)
Until all activities in L have been considered.

End

The list L1 will contain all the activities to be included in the service innovation.

An Example

Methods A, B and C produce a list L1 of activities from across the three value-sub-chains of the service under consideration. Clearly not all the activities in the value chain might qualify for service innovation. A discussion using the following values for the example discussed above will provide some clarity. The sub-chains that the activities belong to, their weights and the cost of design and development are shown in Table 6.

Table 6 A sample set of values for the example discussed earlier

Value driver	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9	V_{10}
Sub-chains	B	B	B	D	D	B	B	B	A	B/A
Weights	5	5	5	5	5	3	3	2	2	1
Cost of design and development	4	2	15	10	10	5	4	4	10	2

($100,000s)										

The weighting scheme used in this example is C and the cost is shown in hundreds of thousands of dollars. Assume the budget allocated for this service innovation is 3 million dollars. Assume the value of X = 0.6 and the value of Y = 0.3. The modified set of weights is shown in Table 7.

Table 7 Modified weights for the activities in the value chain.

Value driver	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9	V_{10}
Weights	5.3	5.3	5.3	5.6	5.6	3.3	3.3	2.3	2	1.3

Method C will select activities V4, V5, V1, V2 and V7 in that order. The process is shown in Table 8.

Table 8 Illustration of the working of Method C for the example

Value driver	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9	V_{10}
Sub-chains	B	B	B	D	D	B	B	B	A	B/A
Modified Weights	5.3	5.3	5.3	5.6	5.6	3.3	3.3	2.3	2	1.3
Cost of design and development ($100,000s)	4	2	15	10	10	5	4	4	10	2
Order chosen	3	4		1	2		5			
Remaining money ($ 100,000s)	6	4		20	10		0			

It is important to note that, although customers might want a number of improvements to any given service, budgetary limitations will only allow for the improvement of selected processes. The proposed method helps identify the set of innovations of highest interest to customers within a given budget.

5 Summary and discussions

This paper is perhaps the first to explicitly highlight the longitudinal property of service innovations along the temporal dimension. It also recognizes the possibility that different value sub-chains can have explicit or implicit priorities over the others. In other words, the paper reveals the need for an order amongst the different value sub-chains. The paper suggests three different weighting schemes and proposes corresponding methods for identifying the activities that ought to be selected for innovation / improvement. It also recommends the circumstances under which each of the weighting schemes apply. The paper uses a simple example to illustrate how the method can be used to identify activities that form a service innovation within a given budget.

The method reported in this paper is a heuristic that many practitioners can use it. While the method reported in this paper is a step in the right direction in designing service innovations, there is room to consider other aspects such as the extent of control to be shared between service innovation providers and their consumers. An example would be seat assignment in a restaurant. Although airlines have long ceded control of seat choices to their customers, restaurants have been rather slow in adopting such a practice. A method for designing service innovations using the selected is now in progress and will be reported in an appropriate forum in the near future. A discussion on deriving weights for value drivers arising out of innovation drivers, pain and pleasure, was discussed towards the end of section 3. A method for deriving such weights for pains and pleasures is also under consideration and will be reported in the near future. They can be collectively a handy tool kit for service innovation designers.

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Designing the Dynamics of Service Innovations

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A Method for Designing the Dynamics of Service Innovation

Arcot Desai Narasimhalu

Singapore Management University, 81 Victoria Street, Singapore 188065.
E-mail: desai@smu.edu.sg

Abstract: There is no serious tool available to design service innovations even as it is gaining in important and attention from the academic and industrial worlds. This paper presents a tool that is specifically developed to help service innovators plan and design their innovations.

Keywords: Service; innovation; design; supplier; customer, supply chain; unit cost; innovation attributes.

1 Introduction and Background

Service Innovation has been gaining attention from academia and industry in the recent years. IBM has been, in the last few years, spearheading the movement to define a framework for service innovation under the able leadership of Jim Spohrer [3]. Industrial Engineering researchers and practitioners have been the early drivers of service innovation related research and practice as much as the researchers and practitioners in Applied Mathematics and Electrical Engineering were the early drivers of Computer Science and Information Technology.

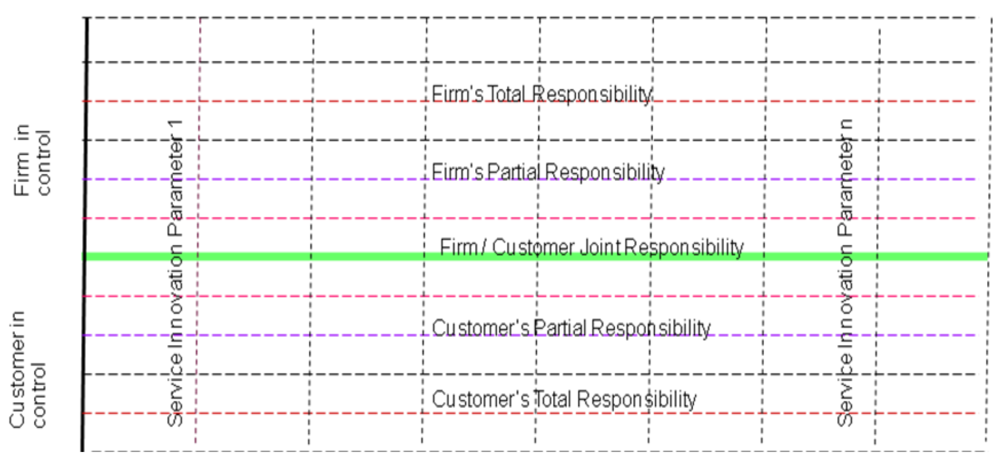
A number of clear differences separate service innovations from product innovations. A main differentiated feature of service innovations as acknowledged by the practitioners of is the short life cycles. Services generally have backstage and front stage [4]. Innovations in the back stages are generally better protected than those in the front stage and visible. Narasimhalu introduced a method for identifying service innovation opportunities [2]. While that was a good beginning, there is still no tool for designing the dynamics of service innovations. This paper presents a tool that addresses the dynamics of designing service innovations in both the front and back stages.

The tool for designing the dynamics of service innovations is called Service innovation Design (SD) Tool. This tool consists of a Service Innovation Design Canvas (SIDC) and Service innovation Value Curve (SVC). SC is defined in section 2, SVC is defined in section 3 and an example of using these two is presented in section 4. Section 5 summarizes the SD tool and its use.

2 Service Innovation Design Canvas

Figure 1 presents a Service Innovation Design Canvas that binds customers with a firm. This canvas has two sections – the first section called "Customer in control" (CIC) and the second called "Firm in control," (FIC). The CIC part is above the midline and the FIC is below the midline. The midline represents the situation where the responsibility and control is jointly owned and exercised by both the customer and the firm or labelled "Both in Control," (BIC).

Figure 1 Service Innovation Design Canvas representing the dynamics of Customer-Firm relationship.



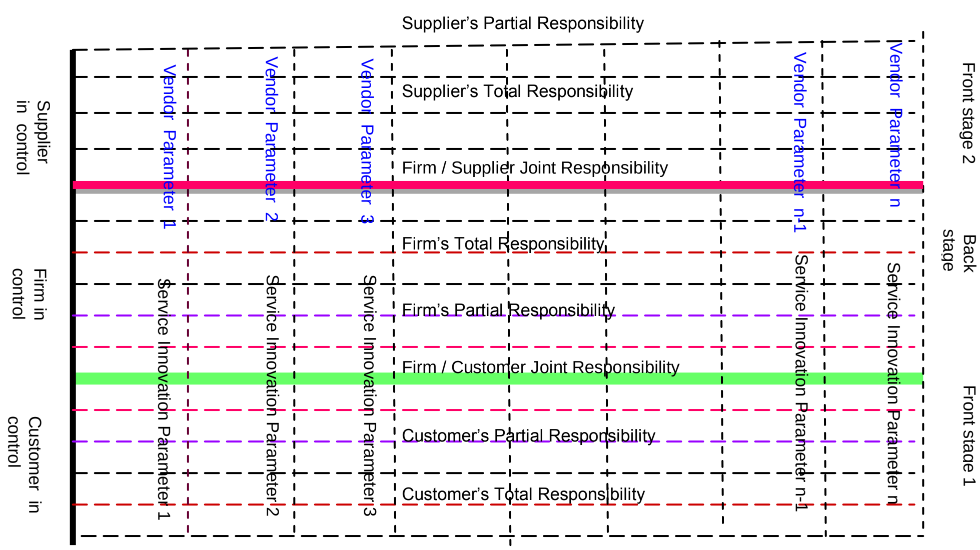
The CIC section corresponds to the front stage. Any innovation in this space will be visible to both the customers and competitors of the firm. The FIC section corresponds to the back stage. Any innovation in the backstage is invisible to a firm's customers and competition.

The horizontal lines define the controlling party and the extent of control. The horizontal line in the middle represents the situation when both a firm and its customers have equal responsibility in making decisions about a Service Innovation Parameter. The horizontal line labelled Customer's partial responsibility in a CIC section represents the situation when a customer has more control than a firm. The horizontal line labelled Firm's partial responsibility in FIC section represents the situation when a firm has more control than its customers.

Each vertical line represents one Service innovation Parameter (SP). A SP is defined to be a feature of the service provided by the firm. It is important that SPs are decided with the customers' perspectives in mind. A service innovation designer can choose any number of Service Innovation Parameters of interest to the customers of a service firm.

A Supplier Augmented Service Innovation Design Canvas (SASIDC) as shown in Figure 2 can be used when a firm believes that its service innovation decisions are dependent on their supply chains as well. This can also be called the Sandwich model since the firm is sandwiched between its customers and suppliers.

Figure 2 Service Innovation Design Canvas for representing the dynamics of Customer-Firm-Supplier relationships.



The SASIDC has a third section that represents the supplier's responsibility and control and this section is called "Supplier In Control" (SIC) section. Supplier's Total Responsibility and Supplier's Partial Responsibility horizontal lines have been designed to be symmetrical with the relevant horizontal responsibility lines of the supplier. Also, notice the two front stages in this canvas – Front Stage 1 between the firm and its customers and Front Stage 2 between the firm and the supplier. The motivation for the introduction of SIC is to ensure that the SIP design is consistent with the service provider's supply chain constraints. This will become obvious when an example is discussed in section 4.

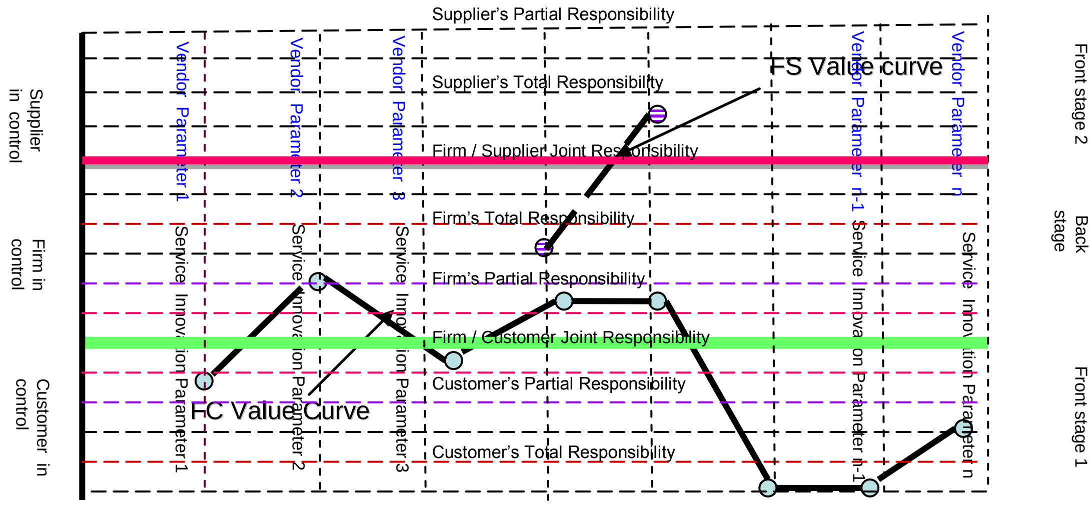
The Service Innovation Parameters will apply across the Backstage and Front Stage 1 and will be used to define the relevant value curves. The Vendor Parameters will apply across the Backstage and Front Stage 2. These will represent the supplies that a firm will need in order to fulfil the service innovations it offers to its customers.

3 Service Innovation Value Curve

This section introduces the concept of Service Innovation Value Curve (SVC). An SVC is similar to the Value Curve used in Blue Ocean Strategy [1] and is yet different. It is used to represent the amount of control to be retained by a firm or to be given to either a customer or a supplier. It represents a specific value given to either a customer or a supplier- Control.

A Service Innovation Design Canvas will have at least one Firm-Customer (FC) Value Curve and one Firm-Supplier (FS) Value Curve. When a firm segments its services to meet the needs of more than one type of customer then there will be more than one FC Value Curve – one FC Value Curve for each customer segment. When a firm gets its supplies from more than one vendor, then there will be a FS Value Curve for each of the vendors. Figure 3 shows a sample Service Innovation Design Canvas with one FC Value Curve and one FS Value Curve. Service Innovation Parameter can also be referred to as FC parameter and Vendor Parameter can be referred to as FS parameter.

Figure 3 A sample SC with one FC and one FS Value curve



Such a Service Innovation Design Canvas and Value Curves can ensure that a service provider is able to represent the controls that they wish to offer their customers and vendors and ensure that there are no incompatibilities between the values.

4 An example

Figure 4 presents the Service Innovation Design Canvas and an FC and an FS value curve each for the customer and supplier using a Food and Beverage service provider such as a restaurant as an example.

Let the Service Innovation Parameters chosen by the restaurant be:

- Ambience
- Cuisine
- Seating
- Dishes
- Beverages
- Payment Mode
- Splitting Bills
- Custom Order

The restaurant can choose to retain control of all these parameters or share the controls with their customers.

Service Innovation Parameters in turn determine the Vendor parameters. Let us consider two examples in this case.

- Dishes → Groceries
- Beverages → Ingredients for Beverages

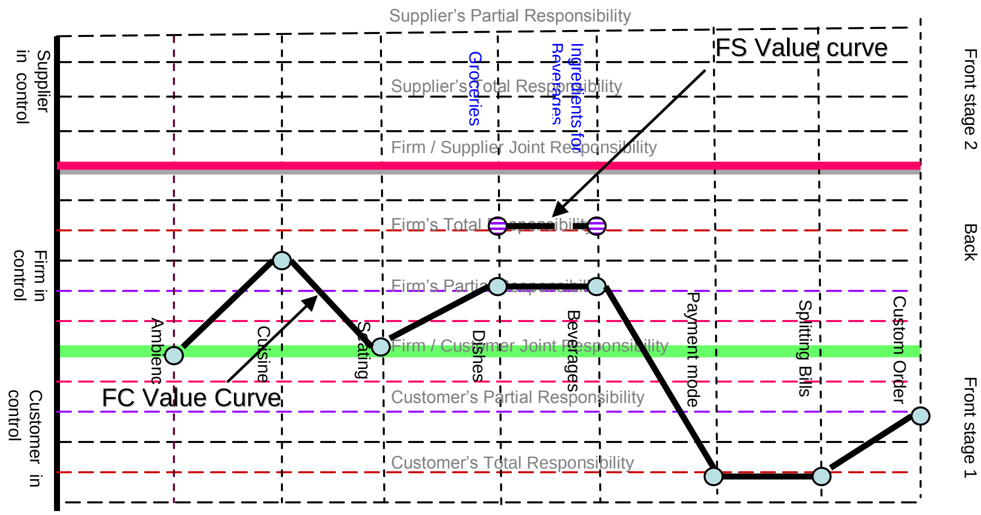
A sample Supplier Augmented Service Innovation Design Canvas representing the above Service Innovation Parameters and the Vendor Parameters is presented in Figure 4.

The FC and FS value curves represented in this canvas can be interpreted as follows.

From the FC value curve, note that the firm has decided to jointly decide with its customers, the ambience for the restaurant and the seat reservations. This might mean that some seats may be assigned at the discretion of the restaurant operator while the others could be listed on a web for the customers to choose. It has decided that it shall exercise total control over the cuisine. The restaurant has further decided that it will take inputs regarding the dishes it should prepare and the beverages it should serve. It has further decided to let the customers decide on the payment modes and whether and how to split the bill. It will give some inputs to customers who wish to order custom dishes but will defer the final decision to them.

From the FS value curve note that the firm will have the final say with respect to what groceries it will order from the vendor and also the ingredients it will need for making its beverages. This situation will hold when there is an assured supply of groceries and the ingredients for the beverages from multiple suppliers and hence the restaurant is able to keep total control.

Figure 4 An SASIDC with an FC Value Curve and FS Value curve in alignment



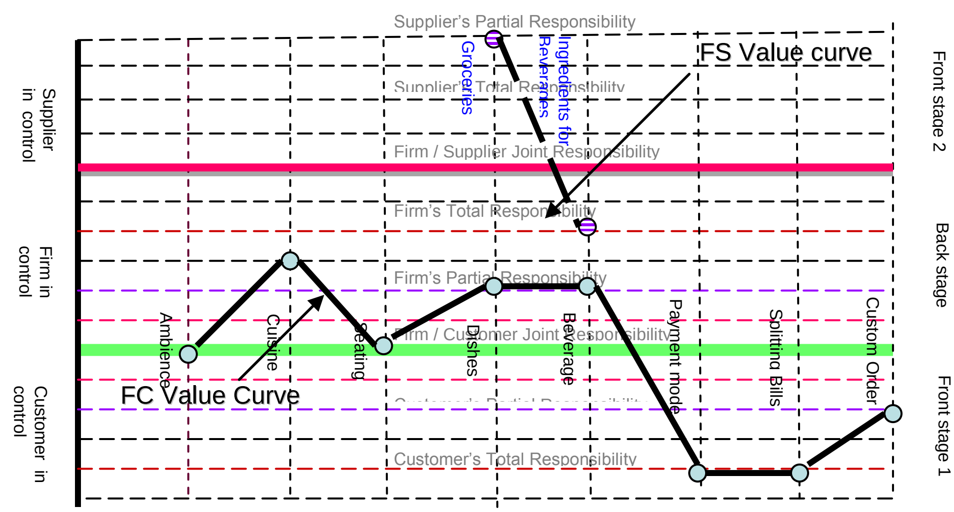
There are situations when a restaurant has not control over some of the supplies. The Service Innovation Design Canvas in Figure 5 presents such a situation. In this Service Innovation Design Canvas, the supplier holds partial control / responsibility over the groceries. This could very well reflect a sea food restaurant which serves only catch of the day from their local seas. In this situation the restaurant operator could be assured of all the groceries except the fish being available as per the restaurant's requirements. However, the fish supply is entirely in the control of the fishermen who supply the restaurant with the catch of the day. It would be difficult to expect such a restaurant to serve a particular fish given that the supply of that fish cannot be guaranteed everyday.

The example shows how a Supplier Augmented Service Innovation Design Curve can be used to identify whether a control can be shared with or totally retained by a customer, a firm or its suppliers. The example shown in Figure 5 is simple one. A firm can establish a vertical line for every Vendor Parameter to distinguish the different levels of control that different vendors will or will not offer.

Although we use the word responsibility through out the canvas, it should be realized that the word responsibility actually translates into control. If a firm is totally responsible for a service innovation, it then controls that innovation totally. If a firm is partially responsible for a service innovation, it could let the customers choose some of the service innovation offerings and it can choose the rest. When a firm has a joint responsibility then it makes the decisions jointly and in agreement with the customers.

In a similar vein, when a supplier is in partial control, the firm can get some of its supplies as per its request and the other supplies will be subject to the vendor's terms and control. When a vendor is in total control, then a firm has not choice but to accept what the vendor will offer. These situations arise when a vendor is a monopoly in a market. When a vendor has joint responsibility then there is a negotiated agreement between the vendor and the firm on the nature and quantity of supplies.

Figure 5 An SC with a FC and a FS that are misaligned



5 Summary

This paper has presented a tool consisting of a (Supplier Augmented) Service Innovation Design Canvas and a family of value curves each for the Firm-Customer interactions and Firm-Supplier interactions. The process of signing the service offerings and validating the offering with respect to supply constraints in itself is the method built around the tool. This tool and the accompanying method are novel and are hopefully used extensively for designing the dynamics of the service innovations.

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Section 3: Commercializing Innovations

A Framework for Technology Transfer

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A Framework for Technology Transfer

Abstract:

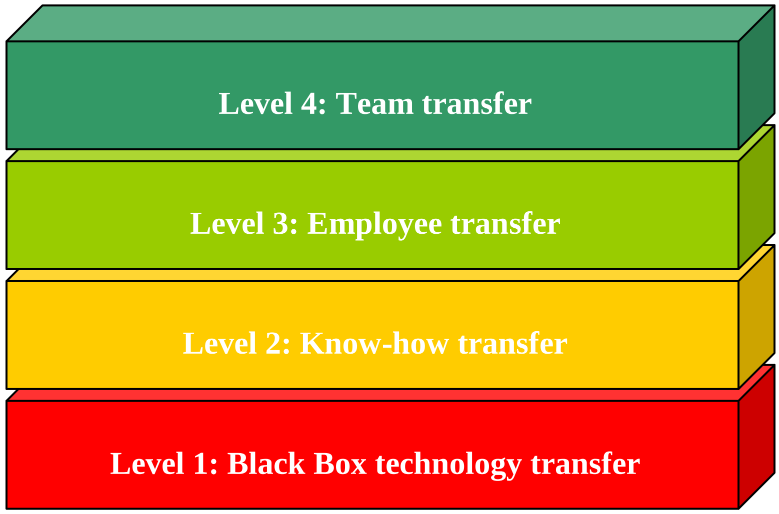
Technology transfer is often perceived to be mere transfer of intellectual property (IP). There are more than one means of transferring technology. While the most commonly experienced transfer is the transfer of the IP alone, it is not the best means of transferring technology in all cases. IP such as trademark and copyrighted material can easily be transferred in this manner. However, that is the lowest level of technology transfer possible. The next higher level of technology transfer is the ability to handover know-how and technology from the originating team to the receiving team. This involves having the creator(s) of technology innovation working with a team from the recipient side until there is a sufficient handover. Transfer of software works best in this manner. This level is followed by the next higher form wherein a person or the team creating the intellectual property is transferred over to the licensee company. This would certainly be of immense value in situations where a trade secret is being transferred. Excellent examples are the transfer of complex technologies that define new vistas in space and defense related leading and bleeding edge applications. The best form of technology transfer is when a team or the entire organization and the culture of that team or organization is transferred over. Most challenges are experienced and most failures are met in such transfers. The paper will illustrate some examples from experience working in a publicly funded research lab.

1. Background

Models for technology transfer are of significant interest to companies that sell or buy intellectual property. There is no significant literature on the best practices for technology transfer processes. This paper defines a multi-level framework for technology transfer (TETRAC) based on hands-on experience over a period of fifteen years. The motivation for proposing this framework is to codify the tacit knowledge acquired during this period into a model that would benefit others.

2. TETRAC framework

TETRAC consists of four levels – Black box technology, know-how, employee and team transfers. The parameters in these transfers and the key components to be considered for valuation purposes are different at each of the four levels.



TETRAC – Four level framework for technology transfer

This framework is derived from fifteen years of technology transfer experience and follows the evolution in the thinking and practice over those years. Each of the levels is described in the following paragraphs.
It is important to understand the reasons behind technology licensing / acquisition through transfers. A large company with deep pockets will license technology only in situations where either it does not have in-house know how or needs the technology in a hurry. If the laggard company has the luxury of time on its side to develop alternative technologies or processes then it will, provided it has the competencies in house. Given that larger companies have the means to recruit teams with competencies to find alternative technologies, time is more of a critical factor than competency. So, such companies would only license technologies in situations where a technology cannot be replaced because of strong intellectual property protection and they have an immediate need to acquire the technology for either offensive or defensive purposes. Offensive acquisitions are for the purposes of release of a new product based on the technology acquired. Defensive acquisitions (especially exclusive) are for the purposes of either preserving / extending the life of their own proprietary technology or for denying the competition access to technology that might allow them to offer products or solutions competing with their own.

Small companies will necessarily be forced to license technologies since they need them for building their products or solutions and are very unlikely to have the competency to develop an alternative solution even if one such exists. So competency and not timing will be the main reason why small companies will be interested in technology licensing.

It is important to recognize this difference since it will have an impact on the valuation of the technology transfer activities. We will discuss each of the four levels with respect to the assets transferred, responsibilities of the licensing and licensee companies, type of transfer and technology transfer pricing model.

2.1. Level 1: Black Box technology transfer

2.1.1. Assets transferred

- Technology / Intellectual Property

Black Box technology transfer happens when the intellectual property is pretty much "thrown over the wall." At this level intellectual property or technology is transferred, often "as is" and sometimes with warranties, to the buyer.

2.1.2. Responsibilities

- Limited warranties

It is the responsibility of the buyer to deconstruct, understand and exploit the intellectual property. The transfer is on an arms length basis where the party transferring the technology agrees to respond to requests for clarifications for a limited period of time. There is no transfer of know-how. This is a case of the transfer of technology in its lowest form.

While there may be warranties for the technology meeting specifications, there are often no agreements on enhancements. If there is an agreement on enhancements it is treated as an additional contract and not as part of the current technology transfer.

2.1.3. Type of transfer

The technology transfer fees are rather low given that such technology transfers are non-exclusive in nature. Several licensees may be given access to the technology and hence the lower licensing costs. The licensee of the technology will have to add value to the technology in order to achieve a competitive market positioning for their products.

Technologies of this nature are generally components that are used to build solutions. They are not usually complete solutions.

2.1.4. Technology transfer pricing model

There are several models for valuing companies as discussed in text books and other literature [1-9]. Models such as Discounted Cash Flow are not appropriate in the case of technology transfer pricing as much as they apply in the case operational businesses that have revenue streams, since technologies by themselves do not bring in revenues. Others have suggested applying "Options" models and Net Present Value models for determining technology transfer pricing. Net Present Value uses discounts expected future value using the cost of capital to determine the present value of technologies. However, there is considerable difficulty in determining the future valuation on an objective and accurate basis. Often times the estimated values are very different from the actual values. Options modeling will be relevant for joint research or collaborative research where companies take a stake in the research by investing a small sum of money in exchange for the results from a larger pool of research money collected from several willing investors.

The approach in the TETRAC framework is more from a bottom up perspective based on the cost of generating a given technology as the base.
The cost of technology transfer at level 1 will be a function of the following factors.

- C – is an index representing the real cost of technology development. This is a dollar figure that is based on the total cost of development including cost of manpower, infrastructure, hardware, software and other overheads.
- IPS[2] – is an index representing the strength of intellectual property protection. This index takes on an empirically determined value between 0.2 and 3 that is used as a weighting factor to account for how well the intellectual property is protected. Note the concern is not about the goodness of an intellectual property or technology is but is really about the strength of the intellectual property protection. The following are suggested weights for the strength of intellectual property index.
    - 0.2 -if there is no or weak intellectual property protection. The lower range is non-zero in recognition of the time it takes to develop an alternative solution.
    - 1 -if the intellectual property protection is sound. That is, there could be other solutions found, however, the current protection is adequate for the licensee to build the proposed product. A protection that is well thought out and may not exclude other equivalent intellectual property solutions is considered to be sound.
    - 2 -if the intellectual property protection is considered to be sound and robust. A technology or intellectual property is said to be robust if no other equivalent intellectual property solutions can be generated. This weighting is considered to be modest and not greedy.
    - 3 -if the intellectual property protection is considered to be sound, robust and comprehensive. An intellectual property protection is considered to be comprehensive when the licensor has secured all possible surrounding intellectual property. In the case of patents, surrounding patents are

[2] The weights given in this instance is one possible set of values. Each institution should decide on the values for weights.

those that could be based on an initial patent by adding new value such that the owner of the initial intellectual property has to acknowledge the desirability of the new additions and is therefore forced to cross-license the original patents in exchange for the later surrounding patents.

- i –is an index representing the number of products for which the technology is relevant. This is a number between 1 and p where p is the maximum number of products in which this technology is deployable. This is a number to be derived by the licensing office of the licensor organization.
- TSi[1] –is an index representing the time sensitivity of the need for technology acquisition. This is a numerical index with a value between 1 and 5 and represents the immediacy of need for the technology for the given product. This number is chosen under the assumption that a technology that is required immediately for global deployment will command a premium of up to 5 times in comparison to less time sensitive requirements. The weight is:
    - 1 -when the technology transferred is for exploratory purposes within the licensee organization.
    - 2 -when the technology transferred is for a medium term product for a selected geography.
    - 3 -when the technology transferred is for a medium term product for all the major geographies with sublicensing rights.
    - 4 -when the technology transferred is for a near term product for a selected geography with sublicensing rights.
    - 5 -when the technology transferred is for a near term product for all the major geographies and the licensee is given sublicensing rights.
- Di – is an index representing the demand for technology license for a given product. This index could take on a value between 1 and n, where n is the number of licensors of the technology for a given product. This could usually be derived from the number of enquiries for licensing.
- MSi[1] – is an index representing the market size for each of the products. This is a number between 1 and 5 and represents the market size in terms of dollar figure. The value of Si is
    - 1 if the market is considered to be small and local.
    - 2 if the market is considered to be medium size and regional.
    - 3 if the market is considered to be medium size and global.
    - 4 if the market is considered to be large and regional.
    - 5 if the market is considered to be large and global.
- Vi – is an index representing the value added by the technology to a given product 'I'. This is a number greater than zero but less than or equal to 1. The lower range of values applies when the value added is marginal and the higher range applies when the value added is crucial or critical to the product. This is an

index that is expected to decay over time in select circumstances such as when more people acquire competency in a given technology.

- Li – is an index representing the number of licenses that the licensor intends to issue for to be used in a given type of product 'I'.

One can now derive a pricing model for the black box technology transfer that is based on the above indexes.

The real cost of the technology development is C.

The technology's value TV, after taking into account the strength of the intellectual property protection is obtained by multiplying the cost by the IP protection strength index and is equal to

$$TV = C * IPS \quad \text{--------------------} \ (1)$$

Technology pricing after factoring in the desired profit margin M, where M is greater than zero would be

$$TP = TV * (1+M) \ \text{--------------------} \ (2)$$

The margin would determine the expected profit from the technology licensing. It will also be determined by whether the competency or expertise required to generate the technology is commonly available or not commonly available. In some cases, the expertise might be rare in early days and might over time become commonly available thus resulting in lower margins. M is also proportional to Di. Higher the demand for the technology and fewer the competing technologies, higher will be the value for M. This index for margin is the sum of margins Mi for each of the products.
Now one can calculate the margin M_i for a given product to be

$$Mi = TSi * MSi * Di * Vi \ \text{---------} \ (3)$$

Given that the highest values for $TS_{i,}$ $MS_{i,}$ V_i and S_i are 5, 5, n and 1, the maximum value of M_i will be 25n.
The combined margin M for all products generated out of a single technology can then be calculated to be

$$M = \sum_{i=1}^{p} Mi \quad \text{----------------------} \ (4)$$

for all products 1 to p using the technology.

A simplistic licensing model for a unit license is to first determine expected revenue ERi from each of the products.

Given that the same technology will be licensed across several products, one can amortize the technology development costs across all the ‘p’ products. The amortized cost of a technology for a product i is denoted as ACi.

$$ACi = C (L_i / \sum_{i=1}^{p} L_i) \quad \text{------------------- (5)}$$

TTP1i, Total Technology Transfer Price or Expected Revenue ERi for a product i at level 1 is

$$= ACi * Mi \text{ ---------------------------- (6)}$$

We will use TTPki to indicate total technology transfer price at Level k for product i.

$SLTTP1_i$ = Single Licensee Technology Transfer Price at Level 1 would be

$$= TTPi / Li \text{ ---- (7)}$$

Total Expected Revenue from a technology at level 1 can be summed up as

$$TER1 = \sum_{i=1}^{p} TTPi \text{ ------------- (8)}$$

We use TERk to denote the Total expected revenue from a technology at a level k transfer.

One can modify the above Single Licensee Technology Transfer Pricing depending on additional factors such as the diminishing value of successive licenses over different time slices.

The value of technologies decays over time either because of loss of intellectual property protection or because of the emergence of competing or better technology alternatives. We know that technology transfers take place in time slices. There generally is no obvious competitive advantage across all those licensees obtaining licenses within the same time slice. This time slice might typically be the time it takes to develop a product using the licensed technology. This is true only if all licensees have near about equal capability to create the product and compete for the market share in about the same time frame.

However, a licensee obtaining technology in a subsequent time slice will find it difficult to compete against already established players in the market place. Hence such a licensee will not be willing to pay the same licensing fee as did the previous licensees.

The technology transfer pricing in the later time slices will have to be lower than that charged in the earlier time slices.

A technology licensor should anticipate such diminishing returns over different time slices and hence may choose to introduce weights for different licensing time slices accordingly. If for example, the licensor expects to license a given technology to 12 different licensees in three time slices then he might adopt a weighting factor that reflects the diminishing value of the technology over each of the time slices.

As an example, if a licensor feels that the technology will be licensed equally across the three time slices, i.e. four licensees each and that the value of the technology will still be relatively high at the end of the three time slices, then the licensor could multiply the Single License Technology Transfer Price listed in equation 7 by 1.1 for those licensing in the first time slice, maintain the initial value for those licensing in the second time slice and apply a weighting factor of 0.9 for those obtaining licenses in the third time slice.

On the other hand, if a technology is considered to be highly perishable then the licensor could adopt a much more aggressive weighting factor such as 1.5 for those licensing in the first time slice, and 0.5 for those licensing in the third time slice. There are many possible weighting models depending on the rate of decay of the value of a given technology and the granularity of time slices.

We can generalize this discussion by using a perishability weighting factor Pj as a multiplier for time slice j.

So, one can define the resulting Single License Technology Transfer Price for time slice j to be

SLTTPkij = SLTTPki * Pj ------------------------ (9)

A representative example of this model for technology transfer pricing is presented in Figure 1.

Video Compression Technology[3]

	Index	Value	Digital Video Disks	Digital Cameras	Multimedia PCs	Video Phones
Development costs CT		500,000				
IPS - Intellectual Property Strength	1					
Number of products for which the technology is relevant	4					
TSi - Timing Sensitivity			5	5	3	1
DPi - Demand (no of license requests) for technology license for each of the products			200	20	4	2
MSi - Market size for each of the products			5	5	3	1
Vi - Value added for a given product			1	1	0.5	0.8
Li - No. of licenses licensor is considering awarding			100	10	2	2
TV - Technology's value after taking into account the strength of intellectual property protection		500,000				
Mp - Margin for each product			400	200	10.5	1.6
Total margin		80,000				
Total number of licensees		114				
ACi - Amortized capital for each product			$438,596.49	$43,859.65	$8,771.93	$8,771.93
TTP1i Technology Transfer Price for ith product at Level 1			$175,438,596.49	$8,771,929.82	$92,105.26	$14,035.09
SLTTP1i Single License Technology Transfer price for ith product at Level 1			$1,754,385.96	$877,192.98	$46,052.63	$7,017.54
TER - Total Expected Revenue			$184,316,666.67			
j, Number of time slices planned for technology licensing for each product			4	2	1	1

[3] All numbers used in this table are fictitious. Total expected revenues and other figures will vary depending on the values assigned to timing sensitivity, prospective demand, market size, value added and number of licenses. There is no correct set of figures recommended. All figures are purposes of illustration only.

P1 - Perishability factor for time slice 1			1.5	1.2	1	1
P2- Perishability factor for time slice 2			1.2	0.8		
P3 - Perishability factor for time slice 3			0.8			
P4 - Perishability factor for time slice 4			0.5			
SLTTP1 time slice 1			$2,631,578.95	$1,052,631.58	$46,052.63	$7,017.54
SLTTP1 time slice 2			$2,105,263.16	$701,754.39		
SLTTP1 time slice 3			$1,403,508.77			
SLTTP1 time slice 4			$877,192.98			

Figure 1. A Sample Technology Transfer Pricing example at level 1

2.2. Level 2: Know-how transfer

2.2.1. Assets transferred

- Technology
- Process
- Know-how

Know-how transfer takes place wherein there is transfer of technology plus transfer of processes. Engineering related technology transfers often involve a license to the patents – process or design as the case may be. Science related technology transfers generally involve training on the process in addition to a license to the patents.

2.2.2. Responsibilities

Transfer of know-how requires the licensor of the technology to assign a team to work with a team designated by the licensee to walk the licensee's team through the design, assumptions, and constraints of the technology being transferred. Discussions would include process and know-how related matters. The hand over period could be from a few days to a few months depending on the complexity of the technology being transferred.

2.2.3. Type of transfer

Such technology transfers are often non-exclusive in nature. The licenses for technology transfer are often bounded by geography or time or both. The technology transfer fees are often substantially higher than in Level 1 transfer since there would be a limited number of transfers given the limited bandwidth available to train the licensee's team on the know-how. Usually the licensor's team has limited bandwidth for transfer and the training is often carried out individually in order to preserve the confidentiality agreements between the licensor and the licensee.

2.2.4. Technology Transfer Pricing Model

The technology transfer price at level 2 could be determined as per the following equation,

> TTP2i = SLTTP1i + Cost of the handholding price + Opportunity cost for the team engaged in handholding being redirected from other engagements.

2.3. Level 3: Employee Transfer

2.3.1. Assets transferred

- Technology
- Process
- Know-how
- One or more employees of the technology development team

At level 3, key personnel from the technology development team are part of the transfer along with the know-how and technologies transferred.

2.3.2. Responsibilities

This type of technology transfer may not have provisions for training on know-how transfer given that a member of the technology development team will bring along the process know-how when he or she crosses over to the licensee. Warranties will also be much more limited since the transfer of human capital brings with it direct and indirect know- how about technologies licensed. Direct know-how refers to the know-how brought along by those individuals transferred. Indirect know-how refers to the know-how that could be obtained by those who crossed over from the part of the team that did not cross over. The licensor is expected to ensure that the employee(s) transferred over is fully trained on the process and know-how.

2.3.3. Nature of transfer

At level 3, technology transfer is often exclusive. Some times, such exclusivity might be limited by geography with provision for future rights for other geographies. At other times the exclusivity is limited by time frames. The number of such licenses will be limited given that there would be a finite sized team that would have developed the technology and that not all of members of the team might be willing to cross over to the licensees.

2.3.4. Technology transfer pricing model

When personnel are transferred over one needs to put a price on the personnel transferred in terms of opportunity cost for the future developments that they might have created had they continued to stay on in their licensor organization. We could call this transfer price for the personnel and this could be similar in nature to the transfer prices negotiated in National Basketball Association in the USA or the English Premier League in the UK.

Transfer price can be a simple extrapolation of the monetized value of the current contributions of the person, extrapolated based on expected average improvement in contributions over time, normalized to net present value using cost of capital. Let us take an example for our discussion purposes.

Let us assume that an engineer gets transferred along with the technology. Let us assume that he is a member of a four member team that created technology whose cumulative net total pricing TP is 4 million dollars. Let us assume that his contribution is determined to be about 15 % of the team's total contribution were to be 1. This would imply that his contributions were worth about 600,000 dollars.

Now, let us assume that the person would have stayed on for a period of 6 more years during which the person's contribution (in terms of value added) would have increased by 15 % every two years. This would be under the assumption that it would take two years to produce the next technology and that the person would continue to be a part of a successful team that would come up with another useful product.

This would put his contributions at the end of six years to approximately 912,500 dollars. One could introduce a certainty discount factor of 0.8 to allow for the possibility that the person might not continue to perform at the expected level but a notch below. This would then translate into roughly 730,000 dollars.

One could use this example to come up with a model for a transfer fee for each of the employees transferred.

- ETF – Employee Transfer Fee
- TER – Total Expected Revenue from the technology
- VCF – Value Contribution Factor assigned as a percentage of value contributed by the person to the development of technology.
- PEF - Productivity Enhancement Factor is a percentage assigned towards the increase in value generation / productivity from the employee for a given product development cycle.
- NPDC – Number of product development cycles the employee is expected to contribute to during the average expected stay with the company.
- CDF – Certainty Discount Factor is defined as the probability that the employee concerned will be able to contribute to the development of a technology with similar likelihood of success. This number is normally very small given that most employees will suffer from burn out after an intense and successful technology development and transfer and hence will not be able to perform at the same level of intensity and success. Also, when employees are separated from the original team the chemistry between them is lost thus resulting in the probability of the transferred employee contributing to the development of a similarly successful product in the new setting being significantly reduced.

$$ETF = TER * VCF * (PEF)^{NPDC} * CDF \quad \text{----------------} (9)$$

The technology transfer price at this level would be

$$TTP3 = SLTTP1i + ETF \quad \text{-----------------} (10)$$

Figure 2 gives a sample valuation for a team made up of four employees in a successful technology development team.

Employee Transfer Fee for the team that developed the video compression technologies[4]

		John	Jim	Mary	Sue	
VCF - Value Contribution Factor		0.2	0.25	0.3	0.25	

[4] The valuations for employee transfer fee are highly sensitive to the values assigned to VCF, TER, PEF, CDF and NPDC. The numbers used here are for illustrative purposes only. Please notice that the values used for CDF are really low. This is closer to reality for reasons explained in the main text.

TER - Total Expected Revenue	$184,316,666.67					
PEF - Productivity Enhancement Factor		0.2	0.05	0.1	0.3	
NPDC - Number of Product development Cycles		4	3	2	3	
CDF - Certainty Discount Factor		0.02	0.01	0.015	0.02	
Employee Transfer Fee for John	$1,528,796.16					
Employee Transfer Fee for Jim	$533,423.95					
Employee Transfer Fee for Mary	$1,003,604.25					
Employee Transfer Fee for Sue	$2,024,718.58					

Figure 2. A sample Employee Transfer Fee calculation exercise.

2.4. Level 4: Team Transfer

2.4.1. Assets transferred

- Technology
- Process
- Know-how
- Entire (or the core) technology development team

At level 4, the entire team that created the technology crosses over to the licensee with the technology, process, know-how and culture, all packaged together.

2.4.2. Responsibilities

The responsibility of the licensor is to ensure that all members of the technology development team move over with full commitment to the licensee organization.

2.4.3. Nature of transfer

Level 4 type of transfer would imply that there is technology and know-how assignment and not mere transfer. This is the highest level of transfer possible.

2.4.4. Technology transfer pricing model

In the case of Level 4 type of technology transfer one has to include the technology transfer pricing plus all of the employee transfer pricing as well. There will be two possible scenarios. The first scenario will be when no technology has been transferred to any licensee. The second scenario will be when technology has been transferred to a few licensees. Of course, there can be a further variation of second scenario wherein some members of the technology development team might have been transferred to the licensee along with the technology. We will call it scenario three. We shall analyze the technology transfer pricing for each of the three scenarios below.

Scenario 1: Before any technology transfer has taken place

TTP4.1, the Technology Transfer Pricing for scenario 1 would be

$= ETR + \sum ETF$ for all employees

Scenario 2: After technology has been transferred to say m licensees

TTP4.2, the Technology Transfer Pricing for scenario 2 would be

$$= TTP4.1 - D \sum_{1}^{m} \text{All license revenues from m previous technology transfers.}$$

Where D is a weighting factor greater than 1 to account for the fact that some licensees have access to the technology and hence may end up being competitors.

Scenario 3: After technology has been transferred to say m licensees and l (l<m) employees have been transferred to other licensees as per level 3.

TTP4.3, the Technology Transfer Pricing for scenario 3 would be

$$= TTP4.1 - D \sum_{1}^{m-l} \text{All technology transfer revenues from m previous level 1 and 2 technology transfers} - \sum \text{All technology transfer revenues from l previous level 3 technology transfers}$$

3. Summary

This paper has presented a four level framework for technology transfer. At each level, the assets transferred, the responsibility of the licensor organization, the nature of transfer and the technology transfer price model have been discussed. These have been derived from experience and should by no means be interpreted to comprehensive and complete. It would be nice if technology transfer pricing data were available in public domain so that the weights for these models could be derived using empirical data. Given the confidential nature of such information, it will be difficult to derive the weights that reflect practice across multiple deals from several organizations. That should not prevent individual organizations from using this or a similar framework and to generate weights that are relevant to them for their own use.

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Bridging Units and Business incubation in a Technology Research Lab

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BRIDGING UNITS AND BUSINESS INCUBATION IN A TECHNOLOGY RESEARCH LAB.

Arcot Desai Narasimhalu
School of Information Systems
Singapore Management University

ABSTRACT

This paper describes a new model of incubation practices at Singapore's Kent Ridge Digital Labs from 1998 till 2002. The model deviates from previously known models where by research institutions including institutions of higher learning license their technologies to companies or entrepreneurs who wished to either productize the technology or start a new company using the technology. The model was successfully applied towards the creation of more than fifteen start ups. These start ups attracted significant investments from venture capitalists from Singapore and elsewhere. Several of these companies are still in business.

1. BACKGROUND

The characteristics of entrepreneurs have been researched extensively in (Brockhaus 1982; Carland, Hoy, Boulton & Carland 1984; Delmar & Davidsson 2000; Gasse 1986; Herron & Sapienza 1992; Kets de Vries 1996; Reynolds 1997; Stevenson, Roberts, Grousbeck 1989; Venkatapathy 1986; Welsh & White 1981; Winslow & Solomon 1987).

Entrepreneurship has also been very well researched in (Ahmed 1985; Cunningham & Lischeron 1991; Gartner 1985; Gartner, Shaver, Carter, Reynolds 2004; Green, Brush & Brown 1997; Hodgetts & Kuratko 2001; Jolly, Lahuhta & Jeannet 1992; Kuratko & Hodgetts 1995; Kuratko, Hornsby, Naffziger 1997; Manning, Birley & Norbun 1989; Schumpeter 1965; Sexton & Bowman-Upton 1991; Timmons 1999).

There have been studies on technology based entrepreneurship in (Cooper 1973; Cooper 1986).

There have been extensive studies on government supported entrepreneurship in different countries and regions of the world (Abdullah 1999; Broehl 1982; Co 2004; Diochon, Menzies, Gasse 2005; DTI 2000; Lerner & Avrahami 1999; Malach-Pines, Dvir & Sadeh 2004; Mitchell 2004; Monk 1991; Naude, Havenga 2005; Nicholls-Nixon 2002; Sardar, Ghosh & Rosa 1997; Shanklin, & Ryans 1999; Thomas 1994).

Some findings on entrepreneurship in enterprises have been reported in (Lippit 1987; Loane, McNaughton & Bell 2004; MacMillan & George 1985; Shetty 2004).

Theory building in Entrepreneurship has been reported in Bygrave 1993.

Research on international entrepreneurship has been reported in (Etemad 2004; Etemad & Lee 2003; Fontes & Coombs 1997; Karagozoglu & Lindell 1998; McDougall 1989; McDougall & Oviatt 1996; McDougall & Oviatt 2000; Oviatt & McDougall 1995; Welsh 1992).

However, none of these research publications have addressed the experiences of transforming an academically inclined research lab into a business generator. This paper discusses such a transformation.

The rest of section 1 introduces Kent Ridge Digital Labs, a publicly funded research lab in Singapore and the motivation for setting up Bridging Units. Section 2 introduces Bridging Units and addresses a range of issues ranging from qualification to become a bridging unit to lessons learnt. Section 3 summarizes and concludes the findings.

Kent Ridge Digital Labs (KRDL) was set up in 1998 as software driven Information Technology research lab funded by the government of Singapore. KRDL was the coming together of two previously well established information technology research labs – Institute of Systems Science (ISS) and Information Technology Institute (ITI). ISS was well known for its ability to produce world class technologies. ITI was well known for developing innovative solutions using mature technologies. The Government of Singapore felt that the combined institute can become a powerhouse at developing innovative solutions using new technologies. This was also the time when the government of Singapore was promoting Technopreneurship on a national scale through its National Science and Technology Board.

KRDL was creating world class technologies. However, it was experiencing difficulties in translating these technology developments into industrial impact. There were at least four reasons for this gap. The first was that the Singapore companies had difficulty using technologies from a research lab. Second, even the setting up of licensing units was not enough to convince companies to adopt technologies. Third, technology transfer was much more than licensing of software or patents. Fourth, the Dot Com bubble was attracting the best of KRDL's brains away from the lab and this would lead to a hollowing effect. These issues are discussed in some detail in the rest of this section.

1.1. Industry Response to Licensing

In the mid 90's Singaporean companies were generally very comfortable building solutions using proven technologies developed elsewhere in the world. KRDL was creating very good technologies that were world class but could not get the local companies to adopt their technologies and solutions. Companies in Singapore were not used to adopting emerging technologies, especially those developed in Singapore by her research laboratories.

The following are three key reasons why Singapore companies did not adopt the technologies developed by local research labs:

- Lack of past experience in adopting such technologies / solutions.
- The significant gap between the research prototype and industry strength product.
- The lack of clarity on whether the respective research lab will continue to maintain and enhance the technology / solution.

1.2. Licensing Units

KRDL had set up licensing units to ensure that there was planned support for a technology or solution if it were to be licensed by a company. This was an effort to convince the early adopters of its technologies and solutions that there will be a concerted effort in providing a after sales support for all the technologies licensed. There was limited success with this mechanism. An example was the IPSEC technology that was transferred to CET, a subsidiary of Singapore Technologies. This went on to become a new company called Digisafe. Another example was the suite of information security technologies licensed to Computer Associates.

Every licensing unit had one member from the team that created the technology / solution earmarked for servicing the licensees' needs. It was difficult to have one full time equivalent (FTE) of a scientist or an engineer wait for either a technology to be licensed or once a technology has been licensed to wait for customer requests for maintenance and enhancement. Further, almost always the person earmarked for the licensing unit did not have answers to all the questions raised by a licensee.

This resulted in the person earmarked for the licensing unit of a technology to be deployed in some other project with the provision of getting him or her respond to a licensee's request for maintenance and support. Often times this person would be assigned to be a member of a new technology / solution team that was different from the team that had created the technology or solution that was licensed. This created further problems since the priority of the person rested more with the current project rather than the technology or solution whose development was considered complete. Hence the licensing unit concept was found to not to be sustainable.

1.3. Technology Transfer through Licensing

Some of the early experiences in licensing technologies threw up several issues that had to be managed.

The first licensee of the technology would almost always demand some form of preferential treatment. Often times this would mean exclusivity of some form – time, geography, or other forms. The value of a technology would fall significantly once exclusivity was granted to a licensee. Often times, the first licensee would end up being the only licensee. This resulted in not being able to create a multiplier effect out of a single technology.

The transfer of software or patents was not sufficient for successful technology adoption. Often the licensing company did not have the know-how to exploit the licensed technology. It was common to see the licensees adopt an inferior technology that had been well packaged and walk away from the technology licensed from the lab. Even claw-back agreements did not help given that the IT world was very dynamic and the lead time available for seeding a product and scaling it up was lost.

The amount of time spent by KRDL researchers and engineers in handholding the licensees was significant. The designated licensing unit person's attention was always torn between the need to service the licensee to his satisfaction and the drive to contribute to the challenges faced by his new team.

1.4. Dot Com Bubble's Impact

Mid to late 1990s was also the time when the dot com bubble was building up. Even untested ideas were attracting significant venture funding. Some of the companies were listed within a year of their formation thereby creating wealth for its founders. Many researchers were tempted to leave the research lab and set up their own companies. This mood was certainly promising to erode the human capital built up over the years.

KRDL had to create a mechanism for the top talent to benefit from their technology creations even while remaining rooted to the organization while foregoing what seemed to be the lucrative alternative of raising easily available funds to start up a business. Sure, not many of the startups were going to survive but many were tempted with the possibility of a quick public listing and instant wealth accumulation in the process.

Some of the KRDL employees were genuinely interested in building companies using the technologies they had created. They were passionate about creating sustainable companies that can create new jobs for Singaporeans. Such passion had to be recognized and managed.

KRDL had built up its human capital over the previous ten to fifteen years. The cost and time involved in replenishing such lost talent would be enormous. Further, all the previous investment into building up this pool of talented researchers would be lost if it was not dealt with immediately.

KRDL found the Technopreneurship movement promoted by the Singapore government to be an excellent vehicle for addressing all the four issues described above. Transforming the combination of world class technologies with significant market potential and KRDL employees who were passionate about creating companies that could generate employment for Singaporeans appeared to be excellent way forward. KRDL visited several venture capital organizations, read up on several best practices and chose to set up Bridging units as a mechanism for translating its technologies and human capital into promising businesses.

2. BRIDGING UNITS

KRDL established "bridging units" to translate promising technologies into companies that can develop, maintain and enhance products using the technologies created in the labs. These were called Bridging Units since they were a "Bridge" between the technology oriented labs and the markets. These units were "businesses in the making". Bridging Units managed the transition better than if the technical teams were to transition directly into a company.

These were significantly different from incubators of those times. There were two popular types of incubators during the height of the Dot Com era. The first was usually run by a well known and successful entrepreneur. A good example of this was the IdeaLab. These incubators had some in house expertise on IP, Marketing and other aspects and seed money from the successful entrepreneur. The second type of incubators was essentially real estate offered in exchange for some equity in the company. There were of course a variety of other incubators that fell in between these two extremes.

Bridging units were very different from incubators. They were housed within a research lab and had continued access to the wealth of technological expertise in different parts of the research lab. They were provided seed funding by the research lab and were provided significant infrastructure, marketing, and fund raising support by the lab.

2.1. Qualification

A technology development team wishing to become a bridging unit had to satisfy the following criteria.

- Leading edge technology

It was important that young startup companies coming out of a research lab had strong technology portfolio. A technology was considered leading edge if it was 10 times better than any of the existing solutions for the same problem. There were occasions when the '10 x' requirement was relaxed given the apparent immediate market opportunities. Several technologies easily met '10 x' requirement given that they attempted solve a novel problem or approach solving an existing problem in a unique manner.

- Strength of Intellectual Property

It was important that young companies had a "Window of Protection". This would be lead time that it can enjoy before the competition comes snapping at its heels. It was generally preferred that there be either one strong patent or a suite of patents that were collectively strong in order to defend the markets of interest to the company. The stronger a patent or a collection of patents, the longer would be the competitive advantage enjoyed by the company. Teams can highlight the patents that they would like to file even if they have not done so. The invention disclosure would then be the basis for evaluating the strength of their Intellectual Property.

- Significant Market size

It was important for the team to ensure that their company is addressing a large enough market.

- Market timing

It was important that there was either an immediate or a near term emerging need for the proposed product or service. It would be futile to offer the product or service either too late or too early.

- Passionate team

It was very important that there was a team consisting of either all or a significant number of the technology developers willing and able to start up a company. It was also important that they were very passionate about starting a company that they were willing to quit their comfortable research and development jobs and move over to the new company.

- No Return Policy

The members of the team who wanted to form a “Bridging Unit” were told that they will not be allowed to return to the lab. This was to ensure that they gave their utmost attention to the success of the bridging unit. Anything less would have seen members beating a hasty retreat into the comforts of the lab when faced with the very first challenge.

Teams that satisfied the above criteria were encouraged to apply for a transition from a R&D team to a Bridging Unit.

2.2. Funding Model

Most projects in KRDL were planned for two years. A few of these projects would request for additional funding of up to six months for winding down the project and archiving all the resources. This was needed in order to ensure that all the resources required for licensing the technologies were in place. Teams could not anticipate this request and plan ahead for such request given that not all the R&D teams would have come up with compelling new technologies. This was in line with the nature of R&D projects.

The funds for the Bridging units were drawn from the core R&D funds allocated to KRDL by the National Science and Technology Board. There were no additional special funds set aside for Bridging Units. In most cases, the technology development team that wished to be converted to a Bridging Unit would make such a request well within their project funding cycle. This resulted in the funds already ear marked for the team to be redirected for Bridging Unit purposes.

The size of funding ranged from 200,000 Singapore dollars to 500,000 Singapore dollars depending on the size of the team and the timing of the Bridging Unit formation relative to the project life cycle. The larger the team and the earlier they are able to come up with a compelling technology and a credible plan for a Bridging Unit the larger the funding.

2.3. The Transition

KRDL was a research lab funded by the government of Singapore. Therefore it followed civil service recommended procedures for purchasing, travel, and hiring manpower. These processes were well defined with sufficient checks and balances built in. These checks and balances also resulted in delays in acquiring resources or planning travel. The Bridging units needed the freedom to plan their own travel, hire additional manpower and acquire resources on a timely manner. Their needs were always almost on an urgent basis. It was therefore important to give them the autonomy for responsibly spending the money within some guidelines.

When a team was deemed to be ready to transition into a Bridging Unit, they were physically moved to the ground floor of the building in a space meant for such teams. This was a very important step since it was important for the mindset of the members in the Bridging units that they were no longer part of the research lab.

Every Bridging Unit was given a separate working space and share several common resources. These included support for marketing, fund raising and information resources required for creating a successful new business.

The Bridging Units continued to have access to technical expertise available in the lab. Such expertise could be availed from the members of the technology development team who chose not to move across to the Bridging Unit or from any other part of the lab. This was a very significant and unique feature of the Bridging Units.

2.4. Deliverables

All bridging units were given a period of six months to accomplish the following:

- Productize the prototype developed in the lab

  Almost all technology development teams focused on developing proof of concept prototypes. Most of these prototypes were stress tested and were often brittle. Many of them had poor user interfaces. Bridging unit was the place for the team to reengineer their development to be a rugged product that will do well when deployed at customer sites.

- Draw up a sound business plan

Technology teams were mostly made up of engineers and scientists. These talented technical experts often had no clue about how to position their products in the real market place. They were handheld in developing business plans that can attract investments from angel investors and venture capitalists.

- Secure angel investor where needed

Some of the products attracted interest from angel investors when they were show cased in different forums. Some Bridging Units benefited by inputs from angel investors who were businessmen in the markets of interest.

- Identify the management team

Most of the Bridging Units were made up of technical talent. Very few of them had anyone with any prior start up experience or business experience. It was important for a start up to identify the proper management team so that they can get better valuations from the venture capitalists as well as ensure transition from the early adopters to mass marketing and growth.

- Secure early adopters

It was almost always important to secure the attention of the early adopters in order to find the first few sales and deployment of the products. Most teams were aware of the technology adoption life cycle as described by Geoffrey Moore and were prepared to develop “whole products” to the satisfaction of their customers. This required a significant shift in their mind set. Their previous approach was to develop a technology and throw it over the wall for someone to make a product and deploy it to the satisfaction of the customers. It was certainly important for the Bridging Units to understand that the early adopters required more than technologies. These early customers certainly needed complete solutions. And the Bridging Units had to deliver these complete solutions.

- Raise Series A funds

It was important for the bridging units to raise funds so that they can be spun-off into companies. The teams were used to making technical presentations, which were attuned to academic and other technical audiences. The pitches to the venture capitalists had to be different. These presentations had to be market oriented, focusing on market size, product differentiation, sustainable competitive advantage and erecting entry barriers. All these were words not in the vocabulary of the scientists and engineers. They had to be coached and trained in such presentations.

2.5. Graduation

A Bridging Unit graduated when it attracted Series 'A' funding from investors. Investors could be venture capitalists or corporate investors. Some of the investors were also business angels. The investments from business angels were usually not large enough for the bridging unit to graduate. It was often necessary for a Bridging Unit to secure funding sufficient to get to their next milestone. This would normally be between twelve and eighteen months.

Bridging Units were encouraged to secure multiyear performance / milestone based funding commitments from its investors. This would certainly ensure that the company did not have to worry about further rounds of funding. The founders were however, rightfully concerned about "selling out too much too soon for too little." Although KRDL's management team advised the Bridging Units on how much money would be required for a "safe" graduation, the final decision of how much funding to secure was left to the founders.

2.6. Innovations

There were at least three innovations in the setting up of Bridging Units. These were:

- Share holding structure

Bridging Units were set up with the following unique share holding structure.

  - Founders – thirty percent
  - KRDL – thirty percent
  - Key employees – ten percent
  - Investors – thirty percent

Founders were defined to be those members from the original technology team who decided to burn their bridges with the research lab and concentrate all their energies on growing a new company.

KRDL was a publicly funded company that was redirecting a considerable sum of research and development money towards the seed stage investment in each Bridging Unit. The general market rate for seed stage funding was ten percent of a company for anywhere between investments of Singapore dollars 100,000 to 200,000. Hence, a thirty percent of the equity in a Bridging Unit was in line with the market practice. Such holding also ensured potential returns for public funds. This structure simplified the discussions between the Bridging Units and their investors. The Bridging Units would basically negotiate the post-money valuation for the company and the investors had to inject thirty percent of the post money valuation. This model greatly simplified the discussions during the fund raising stage.

Key employees were defined to be the CEO, VP of Marketing and VP of Engineering of the company to be formed out of the Bridging Unit.
Investors were defined to be any one of the following:

- Business Angels
- Venture Capitalists
- Private Equity
- Institutional investors

Although Private Equity was included, it was highly unlikely that they would come in at the early stages of a new company formation.

- Incentives for contributors

Founding teams of several Bridging Units did not have the full complement of the original technology development teams. Some members of the technology development team preferred to remain as researchers. These members had to be rewarded for their contributions. The founding team was required to reward such members out of the thirty percent equity set aside for founders. The reward would depend on the extent and nature of the contribution by each of the individuals who decided to stay behind in the research lab.

Bridging units were started in response to the strong market pull for good technopreneurs. The senior managers of KRDL were definitely not spared by the market pull. Some of them were beginning to be attracted to the easy availability of a reasonable sum of money to start a company. There was a possibility that KRDL would lose its top talent including very experienced managers. These managers were given a very small incentive to remain with the organization and contribute towards helping create more Bridging Units that would attract venture funding. They received a very very small sliver of the thirty percent equity set aside for KRDL.

This was equivalent to private sector's practice of rewarding its top managers' performance with its stock options. A publicly funded research lab in Singapore was adopting this best practice to stem the outflow of its top talent.

- Prequalification methodology

Some of the early Bridging Units were a result of unbridled exuberance arising out of the Dot Com bubble. The need for a proper methodology to help the technology teams to define a Bridging Unit attractive to the investors became very evident within the first few months of operations. Hence, a team titled "Portfolio Planning" was set up to help the technology teams aspiring to become Bridging Units to prepare themselves for the qualification. The most important area that they needed help was to find the market sweet spot that best matched their technology. KRDL was a technology generator and very few of its technical leaders had marketing experience.

The Portfolio Planning Team comprised of the following members:

  - Head of the Portfolio Planning Team
  - Key technology experts
  - Business Development Management personnel
  - IP Management personnel

Technology teams aspiring to become Bridging Units were required to answer the following three simple questions.

- Why would anyone want our product or Service and Why from us?

The first part of this question ensured that the team would be focused on target customer's needs. This was important in the context of a technology development lab. The second part of the question was inserted to make the team members think about the sustainable competitive advantage that their company offered and also to think about the type of entry barriers that they needed to erect in order to have a reasonable lead time to establish themselves as a viable company.

- How much will they pay and how will they pay?

The first part this question was designed to get the teams to think about proper pricing strategy. They needed to ensure that the pricing was commensurate with the value created by their solution. This part of the question also required them to think through the cost of goods, manufacturing, distribution, and marketing. The second part of the question forced the teams to think through the collection of money from the customers. It is very important that Bridging Units thought through this important but often neglected aspect of building a new business.

- How many will pay and how often will they pay?

The first part of the third question required the team to think through the issues related to market size. The second part got them to think about recurring revenues from existing customers.

2.7. Success Stories

KRDL developed several bridging units during from 1998 -2000. The name, a short description and the current status of each of the bridging units are listed below.

A. BigontheNet

Technology Transferred: BigontheNet used natural language processing technologies created at KRDL.

Market Addressed: The initial markets addressed were related IP management. This Bridging Unit created an application called SurfIP which is an Intellectual Property Information System for patent attorneys, researchers and inventors developed and maintained by the Intellectual Property Office of Singapore.

Status: Trade sale to Hong Kong based Azeus Systems Holdings Limited

Website: www.bigonthenet.com

B. BuzzCity Pte Ltd.

Technology Transferred: Information Retrieval Technologies developed at the Information Technology Institute.

Market Addressed: Initial markets addressed were web based information extraction, filtering and distribution. The focus later changed to building mobile phone SMS (Simple Messaging Systems) based communities. The transition was swift and very successful. This was an excellent example of a company responding to emerging market opportunities.

Status: Operational Company.

Website: www.buzzcity.com

C. CommonTown

Technology Transferred: Multimedia based community building software.

Market Addressed: Initially started off as a company offering on-line retail stores in virtual towns and is now offering technology solutions that drive business value.

Status: Operational Company.

Website: www.commontown.com

D. GeneticXchange Inc.

Technology Transferred: Data Integration

Market Addressed: Integrated biological data sources that are geographically distributed, complex and heterogeneous in data types and structures, and are constantly changing for Drug Discovery and Bioinformatics.

Status: Operational Company

Website: www.geneticxchange.com

E. Horizon.iExpress

Technology Transferred: Application, File and process migration.

Market Addressed: Education and Entertainment.

Status: Absorbed into the parent company.

F. Hotcard:

Technology Transferred: Image scanning and recognition technology for portable devices. Small Footprint Optical Character Recognition for portable devices.

Market Addressed: Mobile Phone and PDAs

Status: Operational Company

Website: www.hotcardtech.com

G. Logipolis

Technology Transferred: Vehicle routing algorithms

Market Addressed: Logistics and Supply Chain

Status: Operational Company

Website: www.logipolis.com

H. Mustard Technology

Technology Transferred: Multiethnic Name morphology

Market Addressed: Retail – on-line catalogues

Status: Not operational

I. Muvee Technologies

Technology Transferred: Automatic Video Editing

Market Addressed: Entertainment – Amateur video editing.

Status: Operational Company

Website: www.muvee.com

J. NanoStorage

Technology Transferred: Error correction algorithms for high density storage systems.

Market Addressed: Non volatile storage for PCs and electronic appliances.

Status: Not operational

K. Newstakes

Technology Transferred: Video indexing technologies

Market Addressed: Real time News transmission to PDAs and other handheld devices

Status: Not operational

L. Nexusedge

Technology Transferred: J2EE based client side application framework.

Market Addressed: Enterprise application solutions and services.

Status: Operational Company

Website: www.nexusedge.com

M. PixAround

Technology Transferred: Imaging and graphics technology

Market Addressed: Web based real estate and travel and tours.

Status: Operational Company

Website: www.pixaround.com

N. Private Express

Technology Transferred: Information integration across CD-ROMs and browsers. Later, secure enterprise application solutions.

Market Addressed: Enterprise

Status: Not operational

O. ThirdVoice

Technology Transferred: Virtual Post-it note

Market Addressed: Customer Relations

Status: Not operational

P. Transparity

Technology Transferred: Information Security

Market Addressed: Enterprise Applications.

Status: Operational Company under a new name.

Website: www.transparity.com

Q. Trustcopy Pte Ltd

Technology Transferred: Optical marks for document verification

Market Addressed: Document Image storage and retrieval systems.

Status: Operational Company

Website: www.trustcopy.com

R. Vislog

Technology Transferred: Vehicle Number Plate Recognition

Market Addressed: Access control systems

Status: Operating as a subsidiary of a larger Singapore company

Website: www.vislog.com

S. Volume Interactions

Technology Transferred: 3D Image Visualization and Interaction

Market Addressed: Healthcare

Status: Trade Sale to an Italian multinational

Website: www.volumeinteractions.com

T. WholeTree.com

Technology Transferred: Multilingual input, storage and retrieval

Market Addressed: Multilingual processing

Status: Not operational.

2.8. Challenges faced

There were several challenges faced by the Bridging Units when they were spun off as companies. Some of them are discussed below.

- Emotional Bonds

Some staff who formed the management of the Bridging Unit found it difficult to give up their positions to more experienced professional managers with the right track record for the growth phase of their company. This caused some delays in the companies' ability to scale.

- Early Stage Investors

Some early stage investors were savvy businessmen who provided good inputs and strategic directions to the companies. There were other early stage investors who did not do enough due diligence and hence the companies under their direction faltered.

- Early Adopters

Singapore companies were used to buying mature technologies from reputable companies. As a result, even leading edge solutions from startup companies were viewed with apprehension. There were, rightfully, concerns about whether these companies would continue to exist beyond the short term. All large corporations of today started small. These companies would not have grown big if everyone had viewed them with the same reservation. It just shows that startup companies had to find the right markets that were receptive to innovations from small companies.

- Experienced Management Teams

One of the major challenges faced by the Bridging Units was finding the right management talent. Most of the management in Singapore was from the service sector. There was managerial talent available in the engineering product category. However, there was a dearth of management talent in IT software product category. This proved to be a significant hurdle in the expansion plans of companies that decided to operate out of Singapore. Those companies that located their operations out of Singapore found that the price they had to pay for even second and third tier management from the markets of interest to the company were pretty high given the Dot Com bubble.

- Hands-off policy

Given that KRDL was a research lab, it was required to operate at arm's length with all its Bridging Units and those that lead to start up companies. As a result, KRDL could not actively participate in helping grow the company although it had significant equity in its companies.

- Small Sized Domestic Market

Singapore was a leading adopter of mature IT solutions. Hence, it could be expected to be also an aggressive adopter of new IT solutions. However, given the small size of the markets in Singapore, most companies and individuals had to take conservative positions. News of failure spread very fast and a person deemed to have made an error would probably have very few options to exercise the learning from his experience.

- Bounded by Technology

KRDL was a technology development lab. As a result, it could only engage in creating Bridging Units and startup companies using home grown technologies. This was an opportunity cost that the lab had to pay. This resulted in many interesting process oriented customer need fulfilling opportunities had to be let go.

2.9. Lessons Learnt

There were several lesson learnt from the experience in creating the above Bridging Units and hence the startup companies. These are listed below.

- Customer Value

Early Bridging units and the resulting startup companies did not focus very much on the value their products offered to their customers. They had nifty technologies and solutions that were popular. One of them, Thirdvoice, was hated by a large community of existing companies. There was a website created called "Say No to Third Voice." Some of these solutions were given very high profile by respected magazines such as Forbes, Fortune and Red Herring. Even then, those that did not overcome the adoption hurdles flailed and failed eventually.

Value created for the customer was critically scrutinized for the Bridging Units that were created later. These could be the reason why more of them are still surviving and some even growing well.

- Entry Barrier

It was also clear that the Bridging Units had to erect significant barriers to entry. The cultures in Singapore and elsewhere were very different. While hardworking groups in Singapore's research lab were clocking twelve hour days, their counterparts in the Silicon Valley were burning midnight oil. Thus, it was very difficult to compete based on time to develop and market. Significant barriers to entry included IP protection, strategic and exclusive business partnerships, and finally marquee name early adopters along the lines specified in "Inside the Tornado".

- Sustainable competitive advantage

While many of the Bridging Units started off with good vision, technology strength and customer focused, the markets were not always static. Unexpected surfacing of submerged competition, new start ups trying to offer similar capabilities and alternative technologies offering same solutions were some examples of threats to the Bridging Units that spun off as companies. In addition, markets would shift based on new regulations or deregulations, technologies or processes.

The only sustainable competitive advantage that these Bridging Units could enjoy was their will to continuously innovate new solutions that responded to emerging market opportunities. They had to exercise enough care since they had to time the market correctly. Even solutions offering outstanding customer value that are ahead of the curve found themselves orphaned.

- Locating the start up

This was a major decision item. Locating where the markets and key investor were was considered important. The Bridging Units had to balance this with the willingness and ability of their key founding members desire to live in Singapore. There were instances where some Bridging Units were considered to be strategic enough so that Singapore investors wanted them to remain in Singapore although the local market was very small.

- Investors

Another key lesson learnt was about investors. Some of the early deals involved significant sums of money from investors who could not add value to the Bridging Units and their resulting start ups. Some others accepted corporate investments and had to accommodate requests from their investors that were limiting their growth opportunities. Corporate investments generally gave a higher valuation for the Bridging Units. However, they often came with strings attached.

In a few cases, some investors requested establishing an additional presence close to them. This resulted in extra burn rate for these companies and in some cases contributed to their difficulty in spending their money optimally. IT was clear accepting “smart money” from non-corporate sources was preferred when possible.

3.0. SUMMARY AND CONCLUSIONS

The Bridging Unit concept that was defined and managed by KRDL produced more than several promising young companies that went on to attract more than US 50 million from venture capitalists from Singapore and elsewhere. The implementation resulted in innovations on share holder’s structure, incentive for contributors and prequalification methodology. The encouragement for entrepreneurial pursuits backed up by management commitment changed KRDL’s culture significantly. In 2002, KRDL was well on its way to refining its Bridging Unit model to create stronger and more successful companies. This model proves government support aligned with management commitment towards helping passionate scientists and engineers start new companies to see their technologies create significant impact in the markets was a success. Some of the early exuberance aided by the Dot Com bubble that threatened to hollow out the research lab did result in some less than desirable companies. The learning involved in transforming an academic research lab into a business creation entity was both enriching and rewarding.

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A Method for MonetizingTechnology Innovations

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A Method for Monetizing Technology Innovations

Arcot Desai Narasimhalu
Singapore Management University
desai@smu.edu.sg

Abstract: Technology innovations from most universities and research institutes are generally created with no clear path to commercialization in mind. This is largely due to the culture in academic institutions and research institutes whose mission it is to explore the creation of innovations that promise long term benefits. This culture of academic freedom leads to a stockpile of technology innovations at their technology transfer offices (TTOs). These offices are often in a dilemma on how best to monetize the technology innovations that are in their custody.

While there have been many social science research methodology based studies on this subject under the broad umbrella of "Technology Management", there is still no method available to help TTOs manage the commercialization of their IP better. A clearly articulated method for translation of technology innovations into business innovations will certainly help move accumulated IP at the TTOs to the markets. Such a method should help identify the best commercial application of technology innovations.

This paper is based on action or practice research. This approach uses empirical data and experiential observations derived from several years of commercialization experience to derive and define a method.

The method will present a framework for capturing the properties of technology innovations. A heuristic algorithm is used to achieve a prioritized list of business innovations that can be generated from a set of technology innovations. The paper will use an example to illustrate the method.

An early version of the algorithm is being used in a course on technopreneurship. This exercise is expected to both validate and refine the method presented in the paper.

Keywords: Technology innovation, Business Innovation, Technology Transfer Office, Commercialization, Optimal.

1. Introduction

From time to time one observes that a technology innovation that was created for one market gets adopted in a different and unexpected market on a wider scale. An example is the steam engine. Steam engine was first envisioned for stationary use - pumping water from a coal mine to the surface by Thomas Savery in 1698 based on Denis Papin's Digester or pressure cooker of 1679 (innovators.about.com). It however had the maximum impact in mobile use – various forms of locomotives.

The above example shows that a technology innovation can be used to create more than one business innovation. A challenge often faced by the inventor or the organization managing technology innovations is to figure out the best strategy for monetizing their suite of technology innovations. There are several proprietary practices and these are often ad-hoc and not disclosed to the world at large as best or preferred practices. This paper will describe an approach to understanding the properties of value drivers that customers desire, the properties exhibited by technology innovations and use these set of properties to derive a method for selecting the best means of monetizing technology innovations.

Section 2 of this paper presents a literature review. Section 3 presents the proposed method and Section 4 contains discussions and conclusions.

2. Literature Review

There have been a number of studies related to innovation (Abernathy and Utterback (1978), Kelly and Kranzber (1978), Leifer, Colarelli and Peters (2000), Schumpeter (1934, 1939, 1942), Trott (1998), Utterback (1994), Van de Ven (1999) and von Hippel (1978)). These papers have looked at different aspects of innovation. They have been followed by innovation models as described in Rothwell (1992) and presented in Table 1. In the last decade there have been several methodologies to identify innovation opportunities (Christensen (1997), Kim and Mauborgne (2005), La Salle (2002, 2006) and Narasimhalu (2005)) and some of them are listed in Table 2.

Table 1: Different Innovation models

Year	Innovation Model
1950s / 60s	Technology Push Model
1970s	Market Pull Model
1980s	Coupling Model
1980s/ 90s	Interactive Model

2000s	Network Model

Table 2: Recent work in Innovation identification methodologies

Year	Innovation Methodology
1997	Disruptive Innovation
1997	Value Innovation
2002	Thinking Matrix
2005	Innovation Cube
2006	La Salle Innovation Matrix

All of the above studies have contributed significantly towards advancing the understanding, identification and management of innovation opportunities. However, none of them has critically examined the properties that technology innovations share with value drivers considered to be important to customers. This paper fills this void by presenting a property based approach towards finding the best means of realizing value from a set of technology innovations.

3. The Proposed Method

This section first presents the definitions used in the proposed method. The proposed method matches the properties of technology innovations with the properties of business innovations to arrive at a suggested means of monetizing technology innovations. A sample list of properties of technology innovations is presented in section 3.2. The value drivers of innovations and their properties are discussed in section 3.3. Section 3.4 introduces TechVal matrix that is used to identify the path to monetizing technology innovations in section 3.5. This section also discusses the proposed method using an example.

3.1. Definitions

This section provides definitions for terms used in the paper.

Addressable market – is defined to be the product of the number of estimated customers times the price they are willing to pay for the business innovation. This number is an estimate.

Business Innovation – is defined to be a product, solution, application, platform, service or any other process which meets either the explicit or the implicit demands of the customers in a given market. Business innovations are often built using technology innovations. Some business innovations use technology innovations. Other business innovations are built on existing or mature technologies to address a new market opportunity.

Innovation Drivers - are either the pains or the demand for enhanced experience (also called pleasure) by a group of customers. Innovation drivers define the opportunities for creating successful business innovations. An Innovation Driver may lead to one or more Business Innovations. An example can be body ache. This is a pain and hence an innovation driver. This can result in a foot massaging equipment, a business innovation. It could also result in a separate neck massaging equipment, another business innovation. There could also be a back massager, a third business innovation. All these three may get integrated into a total massaging solution, a fourth business innovation.

Innovation Triggers – are defined to be market shifts and / or a technology shifts that creates opportunities for successful business innovations. Regulations or deregulations are good examples of market shifts. Emergence of new group of users for a product is another example of a market shift. Market shifts can be represented as Innovation Rules or Innovation Chains (Narasimhalu (2005)). Multi-touch technology is an example of a technology shift. A technology shift can result in the creation of one or more successful business innovations. Universal Serial Bus or USB is a great example of a technology shift that resulted in several business innovations including Thumb drives ™.

Innovation Rule / Chain - is a representation of observed phenomenon on how a market or a business innovation evolves over time. Computers were first created for Defence applications and later lead to the creation of main frames, mini computers, personal computers, lap tops and now personal digital assistants or PDAs. This evolution can be captured as an Innovation Chain (Narasimhalu 2005)). An innovation chain with a single link is called an innovation rule. Each link in an Innovation Chain defines a new market opportunity. A business innovation that currently addresses an enterprise market is most likely to shift to a consumer market or vice versa when the required technology shift takes place.

Technology Innovation – is defined to be a new technology that provides an improvement over one or more existing technologies. Examples of improvements could be either reduced cost or increased functionality. Technology innovations will be a means for creating new value for customers.

Value Drivers – are defined to be the properties of business innovations that address innovation drivers. For example, if the pain of standing in long queues at a cashier's register is an innovation driver, faster transaction processing is the corresponding value driver. Either a larger number of service stations or a new solution to speed up the ringing in the purchases and completing the payment will be the corresponding business innovations. The first alternative will be a service innovation and the second alternative will be a product innovation. Service innovations may not always require innovations in technology.

3.2. Properties of technology innovations

The following are a sample set of categories of properties of technology innovations. A technology innovation could have one or more properties from across different categories. Every organization should continually maintain a list of properties for its technology innovations. These properties will be used in the method to monetize technology innovations.

Functional properties
- TF1: Cost reduction
- TF2: Increased productivity
- TF3: Faster processing
- TF4: Increased display quality
- TF5: Reduced size
- TF6: Increased power

Emotional properties
- TE1: Improved look and feel
- TE2: Ease of use
- TE3: Substitute for animal testing
- TE4: Environment friendliness
- TE5: Choice of colours

Communal properties
- TC1: Personal improvement
- TC2: Interpersonal communications
- TC3: Intercommunity communications
- TC4: Intra-enterprise communications
- TC5: Groupware

These three categories are examples. There can certainly be more than these three categories. The examples given under each of the categories are by no means exhaustive. A firm or an organization should develop a customized list of categories and subcategories of properties of technology innovations in its custody.

The first step is to derive a mapping between technologies and their properties.

Each property of a technology innovation is labelled TXn where T stands for technology innovation; X is a unique letter indicating the category the property belongs to and n is a unique number assigned to the property. The sample properties listed above get labelled TF1 through TF6, TE1 through TE5 and TC1 through TC5.

Table 3 is an example using the property categories of technology innovations defined above. T1 through Tn are the technologies under consideration. A technology innovation can have one or more properties. The contents of the table are for the purposes of illustration only and do not represent real technologies.

Table 3: Mapping between technology innovations and their properties.

	Technologies												
	T1	**T2**	**T3**	**T4**	**…**	**…**	**…**	**…**	**…**	**…**	**…**	**Tn-1**	**Tn**
Properties	TF1	TE1	TF3	TC1								TC1	TC1
	TE3	TE2	TF4	TF4								TC2	TE2
	TC4	TE3	TF5	TE3								TC3	TF5
	TC5	TE4	TF6									TC4	TF6

3.3. Value drivers or properties of business innovations

Recall value drivers are the properties of business innovations that customers will be willing to pay for. Every organization should develop its value driver categories and the value drivers under each of the categories to represent the emerging market demands. These market demands and could be generated using Innovation Rules or Innovation Chains or any other means. Each of the value drivers should be labelled VXn where V stands for value created; X is a unique letter representing the Value Driver category and n is a unique number representing a property within each subcategory. Table 4 shows an example of the link between innovation drivers and corresponding value drivers.

Table 4: Value drivers or properties demanded by Innovation Drivers.

Value Driver Category	Innovation Driver Category	Value Driver 1	Value Driver 2
Functional	Long waiting times	Faster processing times (VF1)	Increased service capacity (VF2)
	Not affordable	Cheaper product / service (VF3)	Low cost components (VF4)
	Too bulky to carry	Miniaturization (VF5)	Consolidation of components into one (VF6)
	Need the product / service anytime anywhere	Mobile connectivity (VF7)	Miniaturization (**VF8**)
	Difficult to use	Better user interface (VF9)	Simplified interface (VF10)
	Too complex	Reduced feature set (VF11)	
Emotional	Better quality TV viewing experience	Larger screen size (VE1)	Higher resolution (VE2)
	More comfortable seating in cinemas	Bigger seats (VE3)	Reclining seats (VE4)
	Better product design	Improved look and feel (VE5)	
	Better entertainment	Improved audiovisual experience (VE6)	Improved programming (VE7)
	Be more presentable	Burn fat (VE8)	Accessories (VE9)
Communal	Simultaneous audio visual communication with several people	High quality multiple video stream transmission (VC1)	Managing multiple sessions within a window (VC2)
	Easy group discussion	More than one display for a laptop (VC3)	
	Multiplayer entertainment	Middleware to support multiple players (VC4)	Middleware to support multiple games (VC5)

It is important to note that the categories for properties of technology innovations can be different from the categories for value drivers. Value drivers for two different innovation drivers may be same, for example VF5 and VF8. Not all value drivers will require a technology based solution. The value driver VE3 bigger seats, does not require any new technology. Again, the value driver VF2 requires increased capacity provisioning and not new technologies. Some of the value drivers will of course require the use of technology innovations with matching properties.

3.4. TechVal Matrix

There are two key principles used in developing this method.

Key principle 1: The properties demanded by a value driver may be fulfilled by the properties of one or more technology innovations that collectively satisfy the requirements at the lowest cost.

Key principle 2: A technology innovation can satisfy more than one property demanded by one or more value drivers.

Let the cost of technology innovation Ti be CTi.

Let the Addressable market for a Business Innovation be A(Bi). A business innovation might be made up of several value drivers V1, V2, …, V_k.

Let Rj, be estimated revenue from the sale of one unit of 'j'th business innovation. Rj can be defined as:

Rj = Sum (RXi), where RXi is the estimated revenue for providing value driver VXi.

The revenue for a value driver will be proportional to the demand for it. If a demand for a value driver is high then the revenue or the money a customer is willing to pay will be correspondingly high.

A(Bi) can be calculated using a formula such as the one shown below. If Ni is the estimated unit sales of 'i'th business innovation, then the addressable market of the 'i'th business innovation can be derived as,

A(Bi) = Ni x Ri

TechVal Matrix represents Innovation Drivers (IDi), their corresponding Value Drivers (VXn), Technology innovations (Tj) and their properties (TXm) as shown in Table 5.

Table 5: TechVal matrix for the properties discussed in sections 3 and 4

Innovation Drivers	Value Drivers	RXi	N	A(Bi)	Technology innovations and their Properties							
					Tech 1		Tech 2			Tech 3		Tech 4
					CT1		CT2			CT3		CT4
					TF1	TF2	TC1	TC2	TC3	TF5	TF6	TE3
ID1	VF1	RF1	N1	A1	X							
	VE1	RE1										X
ID2	VF3	RF3	N2	A2								
ID3	VC2	RC2	N3	A3				X				
	VF5	RF5									X	
	VE3	RE3										
ID4	VF7	RF7	N4	A4							X	

An 'X' placed in any of the cells of a TechVal matrix indicates a match between the property of a technology innovation and a value driver.

3.5. Method for monetizing technology innovations

TechVal matrix certainly helps match properties of technology innovations with the properties with value drivers and forms the building block of the proposed method.

3.5.1. The Method

1. Identify the technology innovations under consideration.
2. Define the categories for representing the properties of technology innovations.
3. List the properties of each of the technology innovations.
4. Generate a list of known Innovation Drivers. For the sake of simplicity assume each innovation driver leads to one business innovation.
5. Forecast the sales estimates of quantities of each of the Innovation Drivers.
6. Derive a list of Value Drivers for each of the Innovation Drivers.
7. Estimate the monetary value of each of the Value Drivers.
8. Project the sales forecast for each of the Business Innovations.

9. Determine the addressable market size for each of the value drivers (optional if needed).
10. Calculate the addressable markets of each Business Innovation / Innovation Driver.
11. Construct TechVal matrix for the set of chosen Innovation Drivers and Technology innovations.
12. Select the Value Driver with the (next) largest addressable market. Identify sets of technology innovations whose properties match the property demanded by the Value Driver.
13. Pick the set of technology innovations which cost the least while still satisfying the needs of Innovation drivers.
14. Iterate steps 12 and 13 until all Value Drivers have been considered.

The technology innovations whose properties match the properties of the value drivers and are the least cost would be selected through this method. If a technology innovation is picked only for one value driver and the addressable market for that value driver is very large then it may be best to build a company around this technology innovation. If a technology innovation is picked against multiple value drivers, it is likely to be a natural candidate for licensing.

3.5.2. An Example

The following steps illustrated the use of the method with the aid of an example.

1. Identify the technology innovations under consideration.

   T1 – MP3 Coder / Decoder
   T2 – USB Disks
   T3 – High resolution LCD displays
   T4 – Light weight security protocols

2. Define the categories for representing the properties of technology innovations.

   Communal

   TC1 – Easy sharing of content
   TC2 – Portable content

   Emotional

TE1 – Sharper picture viewing
TE2 – Privacy and Security

Functional

TF1 – Digitized music
TF2 – New standard adopted by many
TF3 – Increased storage capacity
TF4 – Better viewing in smaller formats

3. List the properties of each of the technology innovations.

T1 – TF1, TF2
T2 – TC1, TC2, TF3
T3 – TE1, TF4
T4 – TE2

4. Generate a list of known Innovation Drivers. For the sake of simplicity assume each innovation driver leads to one business innovation.

ID1 – Cannot listen to music when I want where I want
ID2 – No displays on portable devices
ID3 – Limited functions on mobile phones
ID4 – Do not want others to access my portable data

5. Forecast the sales estimates of quantities of each of the Innovation Drivers.

ID1 – 10; ID2 – 50; ID3 – 40; ID4 - 50

6. Derive a list of Value Drivers for each of the Innovation Drivers.

Value Drivers for ID1

VF1 – Portable music player
VE1 – Prefer graphics matching the music

Value Drivers for ID2

VF2 – Displays on small devices

Value Drivers for ID3

VC1 – High resolution screens to support good quality video conference
VF3 – Removable storage
VE2 – Listen to different music collections

Value Drivers for ID4

VF4 – Secure my portable data

7. Estimate the monetary value of each of the Value Drivers.

   RXi – The price customers are willing to pay for the value driver. The numbers are in dollars and for illustrative purposes only. Monetary values of the different value drivers are listed below.

   Functional value drivers

   VF1 – 10 dollars
   VF2 – 10 dollars
   VF3 – 20 dollars
   VF4 – 50 dollars

   Emotional value drivers

   VE1 – 10 dollars
   VE2 – 10 dollars

   Communal value drivers

   VC1 – 30 dollars

8. Forecast the sales for each of the business innovations.

   Ni – Estimated number of units of a business innovation sold in millions.

   Estimated numbers of 10 million MP3 players and 40 million mobile phones are for illustrative purposes only.

   BI1 corresponds to ID1and is meant for MP3 players only – 10 million

BI2 corresponds to ID2 and is meant for mobile phones and MP3 players – 50 million
BI3 corresponds to ID3 and is meant for mobile phones only – 40 million
BI4 corresponds to ID4 and is meant for mobile phones and MP3 players – 50 million

9. Calculate the addressable markets of each Business Innovation / Innovation Driver.

   Business Innovation Bi is in response to Innovation Driver IDi.

   A(Bi) – Addressable market in millions of dollars. This value is derived from estimated numbers and the price the customers are willing to pay for a given value driver. The value for each Innovation Driver is determined by the sum of the products of the price customers are expected to pay for a value driver times the market size in terms of the number of units sold. The sum is only for the value drivers satisfied by the suite of technologies. If a given suite of technologies do not meet the needs of a value driver then the product of its value times the estimated market size should not be included in the calculations.

   A(B1) = (RF1 + RE1) N1 = (10+10) x 10 = 200 million dollars.

   A(B2) = RF2 x N2 = 10 x 50 = 500 million dollars.

   A(B3) = (RC1 + RF3 + RE2) x N3 = (30+20+10) x 40 = 2400 million dollars.

   A(B4) = RF4 x N4 = 50 x 50 = 2500 million dollars

10. Construct TechVal matrix for the set of chosen Innovation Drivers and Technology innovations.

    See Table 6.

    Table 6: Techval Matrix for the example

Inno-vation Drivers	Value Drivers	RXi $	Ni	A(Bi)	Technology innovations and their Properties			
					T1 MP3 coder / decoder	T2 USB disks	T3 High resolution LCD	T4 Light weight security

										displays		protocols
					CT1=10		CT2=10			CT3=20		CT4=30
					TF1	TF2	TC1	TC2	TF3	TE1	TF4	TE2
ID1	VF1	10	10	200								
	VE1	10										
ID2	VF2	10	50	500								
	VC1	30										
ID3	VF3	20	40	2400								
	VE2	10										
ID4	VF4	50	50	2500								

11. Select the Value Driver with the (next) largest addressable market. Identify sets of technology innovations whose properties match the property demanded by the Value Driver. See Table 7.

Table 7: TechVal matrix for the examples with matches identified.

Inno-vation Drivers	Value Drivers	RXi $	Ni	A(Bi)	Technology innovations and their Properties							
					T1 MP3 coder / decoder		T2 USB disks			T3 High resolution LCD displays		T4 Light weight security protocols
					CT1=10		CT2=10			CT3=20		CT4=30
					TF1	TF2	TC1	TC2	TF3	TE1	TF4	TE2
ID1	VF1	10	10	200	X	X	X	X	X			
	VE1	10								X		
ID2	VF2	10	50	500							X	
	VC1	30								X	X	
ID3	VF3	20	40	2400				X				
	VE2	10						X	X			
ID4	VF4	50	50	2500				X				X

– ID4 has the largest addressable market.
– ID3 has the next largest addressable market.
– ID2 has the next largest addressable market.
– ID1 has the next largest addressable market.

12. Pick the set of technology innovations which cost the least while still satisfying the needs of the innovation drivers.

    CTi – cost of technologies. They will come into play when more than one technology satisfies the value drivers.

– Only one set of technologies T2 and T4 has a property match. Select them.
– Only one set of technologies T2 and T3 has a property match. Select them.
– Only one set of technology T3 has a property match. Select it.
– Only one set of technologies T1 and T2 has a property match. Select them.

13. Iterate steps 11 and 12 until all Value Drivers have been considered.

Notes:

1. T4 is used in only one innovation driver and has the largest revenue potential and is hence perhaps a serious candidate for spin-off.
2. T1 is used in only one innovation driver ID1 and does not have a large enough revenue potential and is hence better licensed.
3. T2 and T3 are used by more than one innovation drivers and hence are candidates for licensing.

4. Discussions and Conclusions

This paper identified the challenges faced by owners of technology innovations in deciding the best means of monetizing their technology innovations. It suggested that monetizing technology innovations is perhaps best carried out through a matching of properties of the technology innovations with value drivers or properties demanded by a business innovation. The paper defined TechVal matrix as a means of organizing the properties of technology innovations and value drivers. It described a method for determining the best means of monetizing technology innovations based on the extent of demand and the addressable market size. The paper also presented some examples of technology innovations that were originally created for one market being much more successful in other markets.

This method is perhaps the first to use a property based approach to plan the path to monetizing technology innovations. The method proposed is still work in progress and needs to be rigorously tested in real situations by those responsible for monetizing technology innovations. Feedback from such exercises will certainly help refine the method.

The proposed method is only a beginning in matching technology innovations' properties with the value drivers and there is room for further research. For example, the proposed method assumes that a technology innovation fully satisfies a value driver of a business innovation. This assumption may not indeed be true in many cases. One can design a method that can offer solutions where a technology innovation can only either partially or almost fully satisfy a value driver. A method that addresses partial matches is a research in progress and will be repeated in a future publication.

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Section 4: Innovation Management

A Research Capability Maturity Model for Managing Technology Innovations

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RECAMM: A Research Capability Maturity Model for Managing Technological

Innovations

Abstract:

Companies, private and publicly funded research institutions have been engaged in research projects and research programs. This paper describes a research capability maturity model for managing technological innovations. The insights for this proposal were derived from studying a variety of research organizations for managing technological innovations in a publicly funded research institute in Singapore. The model was implemented over a period of time with different degrees of success at Kent Ridge Digital Labs, Singapore. The suggested maturity model has five layers – Ad-Hoc, Directed, Managed, Optimized, and Outsourced. Every research organization is likely to operate in any one of these five levels. The first fours levels can easily be managed entirely within an organization. The transition from the fourth to the fifth level is indeed very challenging and requires establishing the right framework for collaboration. The paper will describe the relationship between an organization's researchers and the research partners and the issues that become important at each of these levels. Some research organizations may have technology innovation directed research projects that operate across all the five levels. The paper will discuss the nature of technology innovation projects that lend themselves best to each of the five levels.

1. Background

Universities, publicly funded national and state research laboratories, and corporate research laboratories constantly wrestle with issues related to managing their research programs that produce technological innovations. We share some experiences gathered over a period of eighteen years while the author was at the Institute of Systems Science / Kent Ridge Digital Labs in Singapore[5]. During this period the publicly funded IT software research lab was engaged in collaborative research with multinational corporations such as Ericsson, Siemens, Hewlett Packard, Apple, National Semiconductors, Fujitsu, IBM and several Singapore companies. It is the richness of observations derived from structuring these research collaborations combined with the experience of managing different types of internal market oriented applied technology

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[5] Kent Ridge Digital labs has since been merged with the Institute for Communications Research and the merged entity is named Institute for Infocomm Research. Information about this merged entity can be found at www.i2r.a-star.edu.sg

driven research projects that provided the inspiration for developing the RECAMM research capability maturity model.

2. The motivation for a research capability maturity model

Managing technology research projects leading to technological innovations are one of the most challenging management tasks in the world, simply because it is an exercise often aimed at inventing some shape or form of the future. The players involved in the process are highly qualified high achievers who often come bundled with high egos.

University based research where individual professors are largely free to pursue research of individual interest is at one end of the technology management spectrum. At the other end of the spectrum lies targeted research carried out by businesses in response to a market need. Needless to say, management of research would be different for these two purposes.

Research and development for technology management is interpreted and managed differently by different organizations. They types of research departments of Physics and Biology would carry out in universities will be too early stage to worry about intellectual property protection. On the other hand any research carried out with a target product or service in mind will need to be managed with intellectual property protection in mind. The need to be concerned about intellectual property protection becomes more acute as a project migrates from the research to the development phase, especially into product development stage.

A research capability mature model will provide organizations with a framework that they could use for both benchmarking their current research management efforts and to decide on where they should position their research management efforts in the future.

3. The RECAMM

We recognize all technology innovations are the results of research projects. Hence in all the following discussions we treat management of research projects as equivalent to management of technological innovations.

RECAMM has five levels of research capability maturity. The first level is called Ad-Hoc given that there is no control of any kind. The second level is called Directed since the research projects managed at this level are typically in response to a need. The third level is called Managed given that the research projects have very clearly articulated accountability. The fourth level is called Optimized and generally reflects situations where a portfolio based approach is taken. The fifth level is called outsourced and this is when a third party is engaged to carry out research on behalf of an organization.

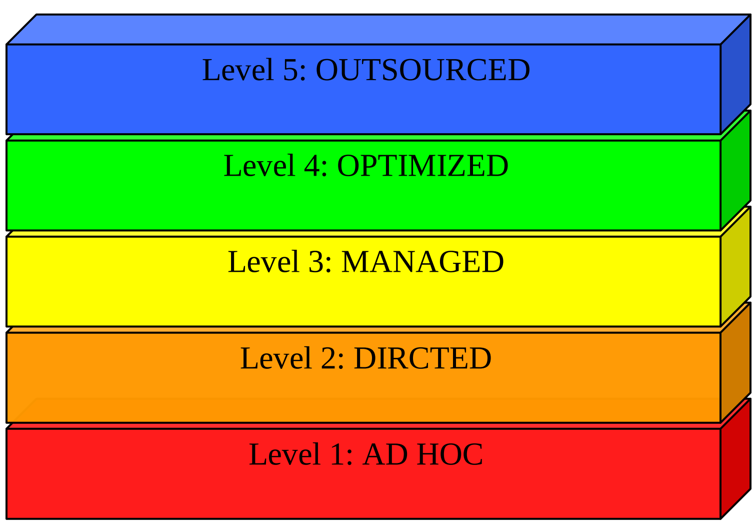
Level 1: Ad-hoc research

The lowest level of the RECAMM is ad-hoc research. An organization operating at this level of research management will allow research projects to be proposed based on the interests of individual researchers. Results from such projects are freely disseminated.

Individual researchers in corporate and other research labs, Professors and students belonging to the academic departments of most universities operate at this level. In fact, professors would often wince at the very thought of another entity controlling the nature and direction of research they pursue.

Many research organizations in publicly funded or corporate research labs are very likely to operate at this level in the early years of their existence. There are no direct Key Performance Indicators (KPIs) for the research outcomes since the research is ad-hoc.

The research outcomes from efforts positioned at this level are very unlikely to have any major commercial impact. As a result, any entity operating at this level generally has no major concerns about protecting any form intellectual property. University and other researchers freely explore and seek out research collaborations with similar minded organizations and individuals.



Five Layers of the Research Capability Model RECAMM

Level 1 of research management works well for the management of exploratory and embryonic research. Such projects usually involve one or two researchers or a combination of senior and junior researchers. Junior researchers will include research students in universities or research students on internships at corporate and other research labs.

The research results from such projects are often too early stage to have any significant market impact. Hence there is really no need to institute any IP management procedures for organizations, projects or entities operating at this level.

Level 2: Directed Research

The second level of RECAMM is Directed research. Organizations, projects or individuals operating at this level carry out research in accordance to the requirements specified by a sponsor in return for some funding arrangements. Such call for proposals often specify broad areas of interest as opposed to specific deliverables. Examples of such broad areas are Nanotechnology, Pervasive computing and Grid computing. The deliverables from such research efforts are often proposed by those who apply for such directed research grants.

Some examples of directed research are the NIH and NSF funded research in the US and their counterparts in other parts of the world. Such projects may generally not have any restrictions on the freedom to disseminate the research results. Quite often the research outcomes are first submitted to the sponsors before being disseminated through other channels.

Directed research is carried out in universities through research programmes or research centers. Smaller scale directed research is generally structured as research programmes. Larger scale directed research efforts are structured as research centers. Examples of research centers are the Robotics Lab and CyLab in Carnegie Mellon University. There are several federally funded research centers of excellence set up in different universities across the United States using this model. These are typically funded for a limited period of time. Also, the researchers are almost all from the university, albeit from multiple departments and schools.

Directed research in publicly funded research labs are typically aimed at training manpower needed for a specific knowledge intensive industry. The Key Performance Indicators (KPI) for such research is the number of people trained from the program and the secondary performance indicator is the quality of publications.

Directed research in corporate research labs are often used for competency building. It may also be used for the purposes of positioning – i.e. sending a message to the world that the company has interest in the topic and is therefore perhaps exploring product development opportunities.

The teams engaged in directed research are usually of significant size. Research programs can easily have a dozen or two researchers while research centers can have several dozens of researchers distributed across multiple research programs.

Directed research at universities and publicly funded research labs generally focus on post embryonic and emerging technology innovations oriented research. Such research programmes and centers often offer freedom of collaboration and the license to freely disseminate the results. However, almost all of the members of the directed research teams often come from within a university or a research lab. At best, the team might consist of a mix of researchers from the university departments and publicly funded research labs. It is rare for such projects to involve researchers from other organizations given that university administrations are often reluctant to share the funds they helped raise with third parties unless absolutely necessary. Even the directed research efforts within corporate research labs often enjoy quite a bit of freedom of collaboration and dissemination. They seek out academic partners in order to get to the cutting edge innovations and do so through funding relevant research projects.

Directed research teams in corporate research labs are generally made up of a mix of experienced and junior researchers from multiple disciplines. They are largely made up of researchers from the same organization with occasional consultants or short term visitors. These visitors could be students from universities of post doctorates.

Given the considerable latitude for collaboration and freedom for dissemination of research results, there is really not much need for instituting intellectual property management processes. It might be useful for ask the researchers to voluntarily articulate the likely impact of the research results on different industry verticals. Such exercises are often rare and the impact if at all identified is aligned with the specifications by the sponsor.

Level 3: Managed Research

Managed research is very focused and is often disguised as advanced technology development in corporate research and development labs. Such research is generally product oriented and is pursued rather intensely with clear deliverables and time frames. The research is often a result of an early stage study that involved competitive intelligence and patent and other IP searches. Quite often companies study (potential competitors') positioning with respect to the topic of interest. Competitive intelligence reports from market news are used to determine (lack of) interest from potential competitors. Diligent analysis of the patents is carried out in order to identify white spaces that are ready for "occupation and exploitation". Such analysis is often a prerequisite before a proposal for managed research is submitted for approval. In such cases, a serious study is carried out to understand the possibility of creating surrounding intellectual property or replacement intellectual property. Surrounding intellectual property identifies new intellectual property that restricts the value of existing intellectual property by the competitors often rendering the existing intellectual property irrelevant. This is achieved through some form of value addition(s) to the existing intellectual property resulting in new products of greater value to the customers.

Universities and publicly funded research labs rarely engage in such managed research. Even when they do so, they rarely carry out such research with a view towards licensing the know-how. Therefore, all discussions in the rest of this section will be directed towards corporate research and development projects.

Corporate research and development groups, especially the development oriented research groups operate using the managed research model.

Managed research teams are usually made up of researchers, engineers, product managers and marketing personnel. The teams are of considerable size and on occasions can be few hundred in strength. Consultants are brought in as needed and are given only the needed information. Consultants are rarely aware of the detailed or complete research project plans. They are given to understand that slice of the project that needs their inputs and the rest of the project is treated as a black box.

Given the serious market driven nature of managed research, such teams rarely engage in collaborations of any kind. When they collaborate with other companies, it would be on the basis of quid pro quo, i.e. joint development or exchange of intellectual property. Researchers from universities and publicly funded research labs are engaged as consultants with necessary non-disclosures and intellectual property assignment forms duly completed and signed.

Most of the results from managed research projects will not be freely disseminated until product plans are clear and products are announced. Most information is disseminated on a need to know basis and often under the cloak of a non-disclosure agreement.

Information flows freely upwards in an organization and very little information flows laterally or downwards.

Serious measures are required to be instituted for the timely registration, protection and management of intellectual property of all forms. Such intellectual property management measures might include filing a suite of patents as opposed to single patents. Such suite of patents might be to thwart the possibility of a competitor surrounding the initial intellectual property with incremental intellectual property that is value adding. Several rounds of discussions might ensue to decide which of the surrounding incremental intellectual property needs to be protected and which of them could be let go. Significant resources and efforts would be expended on ensuring that each of the patents individually and all the patents in the suite collectively ensure a robust intellectual property positioning for the company.

Level 4: Optimized Research

Optimized research is often carried out at the corporate research and development organizations. Very rarely would there be an attempt at deploying optimized research strategies either in academic departments of universities or publicly funded research labs. The exception to this might be the case of some National labs that would like to make some limited investments in serendipitous innovations.

Optimized research will take a portfolio based approach and will be a combination of the ad-hoc, directed and managed research strategies. In other words, organizations will decide on different amounts to be invested into each of the three types of innovations. This will naturally follow their long term, medium term and near term interests.

For research of long term interest, organizations will typically adopt the ad-hoc research strategy. They may even fund individual researchers to carry out research in a topic of interest to the company. For research of interest in the medium term they might partly or wholly fund research programs or centers of interest. National or regional organizations will invest in the setting up and total funding of research centers. Companies in most cases will fund complete innovation programmes of interest to them at third party sites or co-fund large collaborative innovation programmes just to hedge. For research of immediate interest the companies will generally fund their internal innovation teams.

In the case of large national funding agencies almost all of their funding will be directed at long and medium term innovation. Their interest will be to invest in multiple teams since it would be difficult to forecast which of the teams will produce the desired results. Whilst such organizations might use track records of research teams for determining funding decisions and funding levels, they will often be wary of excluding dark horses that might spring a surprise.

Optimized research strategy is a mixture of individual strategies at levels 1, 2 and 3. Hence the freedom to collaborate and the freedom to disseminate the research outcomes will be determined by the types of research funding. Similarly the treatment of intellectual property will also be determined by the nature of research project – long term, medium term and near term.

Teams managing optimized research are small and often operate on lines similar to the fund of funds in the venture capital industry. They fund the different types of innovation programs through different funding channels. An example might be for a company to set up a university relations group to fund ad-hoc and directed research and the internal research management group to fund managed innovation projects.

Level 5: Outsourced Research

By outsourced research we refer to organizations that provide no support for any form of internal innovations. The development of Apache web server is one such example. IBM allowed several hundreds of university based researchers to contribute to the development of Apache server. These are organizations that have decided to pursue an options model where in they retain the option of working with the best of breed in any area at a given moment. They are aware of the harsh reality that researchers often desire to remain in their pet areas of interest even when the market opportunities have moved on. These organizations have realized that to change the interests of individual researchers working in their research labs is harder than to outsource the research to the best team out there in universities and publicly funded research labs. They also realize that the gap between research and commercialization is big enough that it is cheaper and less challenging to outsource all their early stage innovation projects.

Outsourced research is also pursued as a strategy when an organization is very clear that its strategy is on developing new products and services internally while outsourcing innovation efforts, especially the non-product development oriented research. One of the major proponents of outsourced research is Intel. Intel has been very clear that it will not set up a corporate R&D lab. It had significant investments into engineering related resources but shied away from setting up a research lab.

Clearly, universities and publicly funded research institutes do not out source research. The will normally be the beneficiaries of outsourced research. Outsourced research as a strategy is practiced only by companies or large national organizations such as Department of Defense.

Organizations that outsource all their research would have understood the dynamics of the research world very well. They will have understood that any given topic is researched by armies of researchers across the globe and such research is rarely followed up by any serious attempt at productizing and that all such research is theirs for the picking at the right price. They would rather wait and cherry pick the right results and perhaps hire the most promising research team as consultants from among the many different research teams that are in the rat race to create a desired innovation. The second key understanding that they would have gained is that being ready to activate product design and development teams once promising innovation is identified is significantly more important than carrying out such innovations in house.

Outsourced research is often managed by lean teams. These teams are often a bridge between the corporate product divisions and external research teams. Universities and publicly funded research institutions have been the recipients of outsourced research funds for long and medium term research. A somewhat simple example of outsourced research is the Original Design Makers / Manufacturers or also known as ODMs. Outsourced research is the model adopted when a company's strength lies elsewhere – product engineering, manufacturing, distribution, customer relations. Another example of outsourced research is industrial design. A third example of outsourced research is customer profiling / market research.

The intellectual property generated from such research almost always belongs to the company sponsoring the research. The entity undertaking such research certainly enriches its researchers in the know-how and competency but has no rights for dissemination of the results, collaboration freedom or the rights to the intellectual property generated from the research.

Above discussions are summarized in the table given below.

Research Capability Maturity Level	Prevalence in University based research labs	Prevalence in corporate research and development labs	Time sensitivity	Degree of freedom for external collaborations	Degree of freedom for Dissemination of research outcomes	Control of intellectual property issues
Ad-hoc	High	Low	Long term	High	High	Poor
Directed	Sparse	Medium	Medium term	Medium	High	Weak
Managed	Rare	High	Near term	Low / Limited	Low / Zero	Strong
Optimized	None	High	Mix	Mixed	Mixed	Mix
Outsourced	None	High	Near term	High	Zero	Strong

4. RECAMM in action at Institute of Systems Science / Kent aRidge Digital Labs

Institute of Systems Science started off in Level 1 in the year 1985. It had an early taste of directed research in 1987 when Singapore Telecoms commissioned a directed project on Teleview. Teleview was a project to build Internet based applications on existing Plain Old Telephone Lines (POTS). In mid 1990s Institute of Systems Science and Apple entered directed joint research collaboration aimed at developing solutions for handling Chinese on computers. Between 1995 and 1998 Institute of Systems Science carried out outsourced innovation for Hewlett Packard on information security related solutions, with Siemens on Dynamic Policy based Mobile IP solutions and with Fujitsu on the development of a SGML database management system as a component of their Active Information Sharing System initiative. All these are examples of outsourced research. In 1998 Institute of Systems Science was merged with Information Technology Institute to set up a market focused entity that was named Kent Ridge Digital Labs (KRDL). KRDL adopted both Level 3 and Level 4 approaches. It had joint research projects with other research entities such as TNO of Holland and CNRS of France. At the same time it defined managed research projects that were market oriented resulting in the creation of twenty technology based start ups. These start ups went on to raise a total of S$ 120 million from venture capitalists and corporate investors. Twelve of these companies are still in existence despite the tough market conditions following the Dot Com debacle starting 1999 and the tough economic situation and apathy to technology based companies and emerging IT solutions that followed. As observed, KRDL itself did not outsource any R&D to third parties.

5. Making the transition from one to the next level

As mentioned in the beginning of the paper most organizations start with ad-hoc research in their early stage of existence.

Academic departments in universities will remain by and large in level 1. Publicly funded research labs and corporate research labs will make an effort to transition into higher levels.

The following table suggests steps for transitioning to higher levels.

Transition	**Definition of Research areas / Topics**	**Policy on Collaboration**	**Policy on Intellectual property**	**Policy on dissemination**
Ad-Hoc to Directed	Announce general areas of interest and invite proposals against such areas only	Identify selected partners for collaboration	Establish a lightweight intellectual property watch to capture the occasional and rare opportunity.	Sensitize researchers on voluntary disclosures of results that they consider might be worth protecting.
Directed to Managed	Identify the specific product or solution opportunity. Assemble a team to create the desired outcomes. Require competitive intelligence and patent analysis to be carried out as part of the project proposal.	Seek collaboration in exceptional cases when absolutely needed. Use consultants otherwise.	Require that all research teams submit invention disclosures. Institute close scrutiny of all aspects of IP for every research project. Institute processes for IP protection.	Approval for external publication is to be obtained explicitly.

Managed to Optimized	Establish a portfolio management decision framework. Set aside contingencies for unexpected new research opportunities.	Establish relevant collaboration policies for each of the types of research projects – Ad Hoc, Directed, Managed and Outsourced.	Establish multi-tiered IP management policies and processes to address all types of research projects.	Establish multi-tiered publication policies and processes to address all types of projects.
Optimized to Outsourced	Establish clear monitoring policy and processes for tracking all research topics and teams of interests.	All business partnerships are on outsourcing based. Collaborations to be pursued only as an exception.	All IP arising out of outsourced research to be owned by the sponsoring company.	All publications relating to research to be vetted by the sponsoring company before dissemination decision is made.

6. Summary

The paper presents a framework for managing research projects resulting in technological innovations. The paper defines each of the five levels of the framework. It also outlines recommended policy and management issues for transitioning from one level to the next. We hope that this framework would inspire organizations to examine their current practices and make necessary changes. We also hope that practitioners and researchers of research and technology management will come forward to continuously refine this framework towards a sophisticated standard model that could be adopted across multiple industry verticals.

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A Maturity Model for Innovation Management

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A Maturity Model for Innovation Management

Arcot Desai Narasimhalu
Singapore Management University

Abstract

Continuous innovation is the only mantra for the sustenance and sustained business leadership in any industry. Mighty companies have come to naught because they failed to understand the importance of continuous innovation. There is a major shift in innovation management practices. Even the most competitive companies are beginning to realize that new innovations are increasingly complex and that there is a need to establish collaborative platforms within and beyond organizational boundaries. We believe that innovation management ought to be a major research and practice discipline that addresses the issues related to creating and managing an innovative culture and environments within organizations. This paper proposes a maturity model for innovation management and goes on to encapsulate the practices in open innovation management.

1. Introduction

Many organizations have treated innovation as the exclusive rights of a selected few in the company. The generally accepted practice was for a strategy or planning unit that is located in the headquarters to be the innovation brains of the company. This group was deemed to know what is good for the company and hence would be able to prescribe the way forward. This was alright when the innovation development cycles were relatively long and the competition was not as fierce. As the world gets flatter and the educational levels of different continents move northwards it becomes imperative that companies make the best use of all the bright minds scattered around the globe. This is the major driving force for the open innovation movement.

Open innovation is not entirely new. Computer Science and Information Technology communities have witnessed many open innovation projects that have been very successful, albeit with limited market dominance. Examples abound - Linux is an often cited as a classical example of open innovation. There have been other earlier attempts such as GNU software that also had their own degrees of success.

A maturity model for innovation management is first presented in section 2. This is followed by discussions on models of open innovations as observed in the industry.

2. Maturity model for Innovation Management

Many organizations were born out of some form of innovation. However, very soon they end up spending all their energies focusing on the competition and none or very little on innovations. It is easy for enlightened organizations to understand the need for process innovations to remove the inefficiencies within and thus reduce the operating costs. Fewer organizations realize the potential for increasing their business leadership by producing a continuous stream of innovations. 3M has been known to be a leader in embracing the concept of continuous innovation. It had allowed its employees to take 15 % of their time off to address new possibilities. Proctor and Gamble has recently developed the concept of Connect and Develop. Several companies that started with good innovations stagnate as Small and Medium Enterprises because they lose their appetite for continuous innovations. Google is a great example of a company that has strived to continuously innovate new products and service offerings. It is in this context it might be timely for us to define a maturity model for innovation management and share some insights into how companies could move from one level of maturity to the next in this model. We will describe the maturity model in section 2.1 and provide minimum measures required to move from one level to the next in section 2.2 and alert the readers to some challenges when it comes to managing the tension between creativity and efficiency in section 2.3.

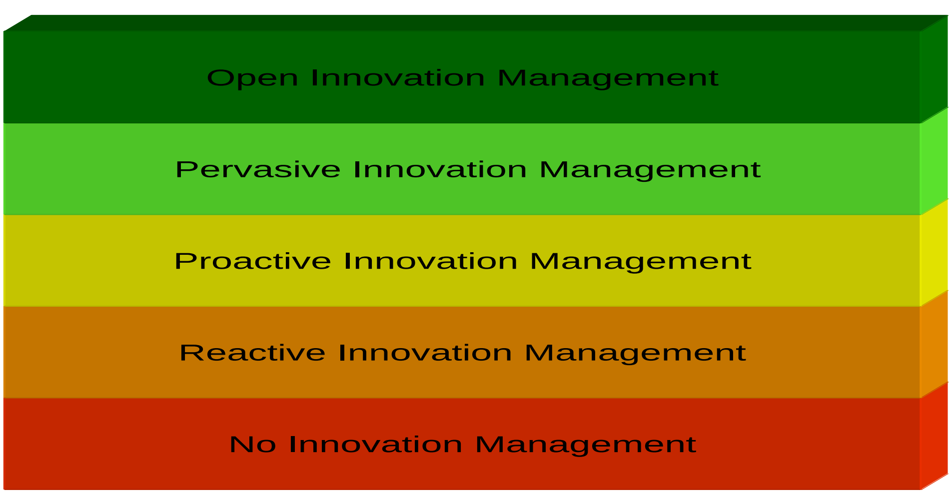


Figure 1: A Maturity Model for Innovation Management

2.1. Description of the Innovation Management Maturity Model

In this section we describe each of the layers of the proposed Innovation Management Maturity Model. Figure 1 presents a visual representation of MIM, a Maturity model for Innovation Management.

The first (lowest) layer of MIM represents companies with no explicit innovation management processes. This does not imply that a company at that level does not produce innovations. It is more likely that innovations are created in an ad-hoc fashion, i.e. when someone's light bulb is turned on. We call this the NIM layer.

The next level of innovation management is what is generally called reactive innovation management. A company positioned at this level often responds to innovations from competitors. Innovation committees are formed in response to a competitor's new product or service innovation and the company scrambles to respond with its own innovations. Such innovation committees are generally made up of top management and marketing departments. These are generally centralized ad-hoc groups that are disbanded after the response to a competition. This would correspond to the Red Ocean Strategy alluded to by Kim and Mauborgne [1]. The focus remains on the competition and a lot of innovation management energy is spent on fire fighting type of responses. We call this the RIM layer.

The third level of innovation management is proactive. Such a company plans ahead for innovations in the coming quarters and years and has a well established innovation trajectory for new products and services. They also ensure a mechanism for steady stream of innovations. Innovation management is internalized among all the heads of business and support divisions and is seen to be an important strategy towards achieving the vision and growth of the company. The project and program offices consider innovation as a desirable parameter to be explicitly addressed by business proposals. Companies operating at this level could use the Blue Ocean Strategy [1], Disruptive Innovation [2], Innovation Engine [3], or any other innovation management strategies as a common paradigm that all business and support division heads understand and practice on a regular basis. One would know that the company is in level three when more than 80 % of their business and support division heads identify continuous innovation as the basis for business efficiency and growth. We call this the PIM layer.

A company is said to be in the fourth level of innovation management if the internalization of innovation is pervasive. This suggests that almost every employee is trained in innovation methodology of one kind or another and is aware that their company's existence and growth is directly dependent on continued innovation. There should also be a very clear innovation culture that is established within the organization. Employees in such companies will talk about innovation every day and all day. 3M is a company that is an exemplar of this category. It allowed each employee to take 15 % of his or her time off to explore new ideas. This requires more than giving them time. There has to be requisite support as well. Apple and Google are other examples of companies that provide the culture and environment for creating an innovation movement across all of the company. Toyota is another example of a company that empowered every person in the company including those in the assembly line to think about innovations big and small that will help the company progress and grow at a steady pace. One would know that a company has achieved level four innovation management when every employee's voice related to innovation is heard, respected and responded to. Such companies take great pains to explain to its employees reasons for not adopting some of the suggested innovations. We call this layer the WIM layer, W standing for whole organization empowered for innovation.

The following quote from 3M's website captures the spirit of innovation at 3M [4]

"Much of 3M's rich culture comes from the principles that William L. McKnight, former President and Chairman of the Board, set forth. McKnight believed "management that is destructively critical when mistakes are made kills initiative. It's essential that we have many people with initiative if we are to continue to grow." It is this growth that continues to make 3M a leader in the 21st century."

Toyota's innovation methodology is centered on the concept of "Innovation Factory" [5]. The company implements about one million new and creative ideas every year. The list of innovations are remarkable – Camry, Lexus, Prius, Scion, Rav4 and more. Matthew E. May, a senior University of Toyota advisor describes the term "Elegant Solution" which is about "finding the 'aha' solution to a problem with the greatest parsimony of effort and expense." He shows how at Toyota, you get elegance from creativity, simplicity, intelligence, subtlety, economy, and quality. One of the guiding principles for Innovation at Toyota is defined by the definition "Innovation is trying to figure out a way to do something better than it's ever been done before." The guiding principles used by Toyota are the art of ingenuity, the relentless pursuit of perfection and the rhythm of fit.

A necessary condition for a company to be in the fifth level of innovation management is only when it has achieved a pervasive innovation culture and has established a major innovation movement across all of its employees. It has to further ensure that there are support structures in place for open innovation. This merits some discussion. Often times employees in companies tend to collaborate with external partners on an ad-hoc basis. That type of support while good is not sufficient. There should be well thought out processes that encourage the employees of the company to seek our collaborations from outside of the company as needed. This would also require policies related to IP sharing or reward for external collaborators and such policies ought to be known to all employees who are directly involved with innovation related activities. Further, these practices and policies ought to be followed very religiously by the top management. Only then will the others believe in the policies. As we all know talk is cheap and action is difficult and when the top management "walk the talk" then the rest of the company will believe in the policies. Proctor and Gamble appears to be on the right track with their new innovation management model called "Connect and Develop". We call this layer the OIM layer

The following extract from describes the Connect and Develop approach [6].

"For generations, Procter & Gamble generated most of its phenomenal growth by innovating from within--building global research facilities and hiring the best talent in the world. Back when companies were smaller and the world was less competitive, that model worked just fine. But in 2000, newly appointed CEO A.G. Lafley saw that P&G couldn't meet its growth objectives by spending greater and greater amounts on R&D for smaller and smaller payoffs. So he dispensed with the company's age-old "invent it ourselves" approach to innovation and instead embraced a "connect and develop" model. By identifying promising ideas throughout the world and applying its own capabilities to them, P&G realized it could create better and cheaper products, faster. Now, the company collaborates with suppliers, competitors, scientists, entrepreneurs, and others (that's the connect part), systematically scouring the world for proven technologies, packages, and products that P&G can improve, scale up, and market (in other words, develop), either on its own or in partnership with other companies. Thanks partly to this connect-and-develop approach, R&D productivity at Procter & Gamble has increased by nearly 60%. In the past two years, P&G launched more than 100 new products for which some aspect of development came from outside the company. Among P&G's most successful connect-and-develop products to hit the market are Olay Regenerist, Swiffer Dusters, the Crest SpinBrush, and the Mr. Clean Magic Eraser. Most companies are still clinging to a bricks-and-mortar R&D infrastructure and to the idea that their innovation must principally reside within their own four walls. Until they realize that the innovation landscape has changed and acknowledge that their current model is unsustainable, top-line growth will elude them."

It is important to understand that not all companies need to be in the highest levels. Some companies produce products for third parties. Examples are

2.2. Measures required to move up the maturity framework

In this section we will list the minimum set of policies and processes that need to be instituted for a company to move up from one level to the next.

2.2.1. Moving up from NIM layer to RIM layer

RIM layer minimally requires the formation of ad-hoc teams to address the competition in the markets. Hence the following minimal set of policies and processes become very important for a company planning to operate at the RIM layer.

- Policies relating to
  - Triggers for constituting a response team
  - Composition of the response team
    - Situations that would need hiring external consultants
    - Departments that need to represented
  - Training of response team members
    - Innovation methodologies
    - SWOT analysis
    - Competitive Intelligence
  - Terms of reference to the response team
    - Response planning time frame
    - Risk (due to the competitor's move) assessment
    - Guidelines for recommendations
    - Choice of leadership for the response team

- Processes relating to

  - Composition of the response team
    - Situations that would need hiring external consultants
    - Departments that need to represented
  - Training of response team members
    - Innovation methodologies
    - SWOT analysis
    - Competitive Intelligence
  - Key issues related to the response
    - Response planning time frame

        - Risk (due to the competitor's move) assessment and management
        - Guidelines for assessment, selection and implementation of recommendations
        - Appointment of response team leader

2.2.2. Moving up from RIM layer to PIM layer

The transition from RIM to PIM layers is not easy but still manageable. There is a permanent function within a company that is made responsible for innovation management (IM). This team has corporate planning responsibilities and will work with various product and service divisions and their representatives from product management and marketing departments. This function is often labeled as Process and Innovation Department. The minimal policies and processes required to move from a RIM layer to PIM layer is listed below.

- Policies relating to
    - Composition of the IM Steering committee
        - CxOs' role in the steering committee
        - Situations that would need hiring external consultants
        - Departments that need to represented in the steering committee
    - Training of IM team members
        - Innovation methodologies
        - SWOT analysis
        - Competitive Intelligence
    - Terms of reference to the IM team
        - Planning time frame
        - Innovation related risk assessment and Management
        - Scope of Innovation
            - Process innovation
            - Product innovation
            - Service innovation
            - Keeping the lights on innovations
            - Transformational innovations
            - Growth oriented innovations
        - Choice of leadership for the IM team

- Processes relating to
    - Composition of the IM Steering Committee

        - Situations that would need hiring external consultants
        - Departments that need to represented
    - Training of IM team members
        - Innovation methodologies
        - SWOT analysis
        - Competitive Intelligence
    - Key issues related to the IM planning
        - Planning horizon
        - Innovation related Risk assessment and management
        - Assessment, selection and implementation of recommendations
        - Appointment of IM team leader

2.2.3. Moving up from PIM layer to WIM layer

The transition from PIM layer to WIM layer is much more challenging. An organization desirous of operating at the WIM layer has to redefine the innovation culture across the entire company. It should also establish a means of promoting, facilitating, recognizing and rewarding innovations.

- Policies relating to

    - Evangelizing Innovation
        - CxOs' and Division Heads' role in the Promotion
        - Engagement of corporate and division level evangelists
        - Benchmarking the impact from the innovation related evangelism
    - Training of new and current employees on
        - Innovation methodologies
        - SWOT analysis
        - Competitive Intelligence
        - Measuring effectiveness of broad based training
    - Establishing a culture and support structure for innovation
        - Defining the culture
            - Walking the talk
            - Rewarding the successes
            - Forgiving the failures
            - Identification and promotion of exemplars
        - Risk (of abuse) assessment and Management
        - Establishing a Support structure
            - Schemes for pursuing innovations
            - Resources required for pursuing innovations

        - Visibility for innovations

- Processes relating to

    - Innovation evangelism
        - Promotion
        - Assessment
        - Refinement
    - Training of employees
        - Nature of training
        - Effectiveness of training
        - Results attributable to training
    - Key measures relating to Innovation
        - Percentage of employees participating
        - Number of innovation proposals per capita
        - Percentage of high quality proposals accepted and supported
        - Quality of responses from the management for those innovations not pursued
        - Percentage of new products developed per year
        - New revenue earning arising out of innovations
        - Operational and other cost savings due to innovations
        - Improvement in employee morale due to support for innovations

2.2.4. Moving up from WIM layer to OIM layer

Moving up from WIM and OIM layer is another giant step that a few companies make successfully. This transition is perhaps the hardest of all. It requires a change in mindset and a realization that the benefits for the company will be much more by efficiently managing open innovation. Open innovation does not necessarily imply that a company would lose control over the innovation process. A classic example of open innovation would be companies sponsoring research pursued in universities. Such sponsorships bring with them new and creative results and the opportunity to recruit those who can generate these new ideas.

- Policies relating to

    - Economic
        - Funding
        - Technology licensing
    - Human capital related issues

    - New Hires (and “No Hire” policies)
    - Consulting engagements
  - IP issues
    - IP sharing
    - IP acquisition

- Processes relating to

  - Funding open innovation
  - Sharing of costs for open innovation
  - Identifying Talents for Hire
  - Hiring talents
  - IP enhancement, acquisition and retention strategy
  - Know-how acquisition and retention

A question often asked is whether every company needs to operate at the highest level of innovation management maturity. The answer is an emphatic NO. The level to operate will depend on a number of factors related to a company such as the industry it operates, the strategy of the company, the operating philosophy of the company and the culture of the company. A company that is focused on efficiency need not operate at the highest level of maturity for instance.

2.3. Creativity vs Efficiency

One of the key challenges faced by companies is how to balance efficiency with creativity. Every organization has to remove inefficiencies of various kinds in order to excel in its operations thereby resulting in efficient use of capital. Process oriented methodologies such as Six Sigma [7] clearly help achieve process efficiencies. Efficiencies are best achieved when employees follow rules and procedures. Creativity cannot be rule driven and hence any introduction of methodologies for process efficiencies have to be carefully positioned to co-operate with methodologies that promote creativity and innovation.

3M once considered world’s most innovative company introduced Six Sigma in 2000 under the leadership of James McNerney [8]. The company embraced DMAIC and DFSS and found operating margins improving from 17 % in 2001 to 23 % in 2005 [8].

"Invention is by its very nature a disorderly process," said 3M’s current CEO George Buckley. "You can't put a Six Sigma process into that area and say, well; I'm getting behind on invention, so I'm going to schedule myself for three good ideas on

Wednesday and two on Friday. That's not how creativity works." He also said, "You cannot create in that atmosphere of confinement or sameness," Buckley says. "Perhaps one of the mistakes that we made as a company—it's one of the dangers of Six Sigma—is that when you value sameness more than you value creativity, I think you potentially undermine the heart and soul of a company like 3M." [8]

The lessons from 3 M are very stark. Innovation managers will have to work with process owners and C level executives to understand how to strike a health balance between efficiency and creativity. Anything less can only sound the bells for the beginning of the end of the company's innovation record and hence the long term sustenance.

The symptoms are very clear. When a company announces awards only for operational efficiency and has no means of recognition for innovations then it is time for a company to take a look at its positioning with respect to innovation management.

3. The many faces of Open Innovation Management

One of the hardest to manage aspects of innovation is open innovation and hence it merits a separate discussion in this paper. Let us recall the definition of open innovation by Henry Chesbrough, Wim, V. and West, J. [9]

"Open innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively. [This paradigm] assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology."

One part of the definition that could be rewritten is the last three words. It would have been better for Chesbrough to position Open innovation to advance their business and not just technology, given that the chasm between technology innovation and business innovation which really bring home the revenue is very wide and deep.

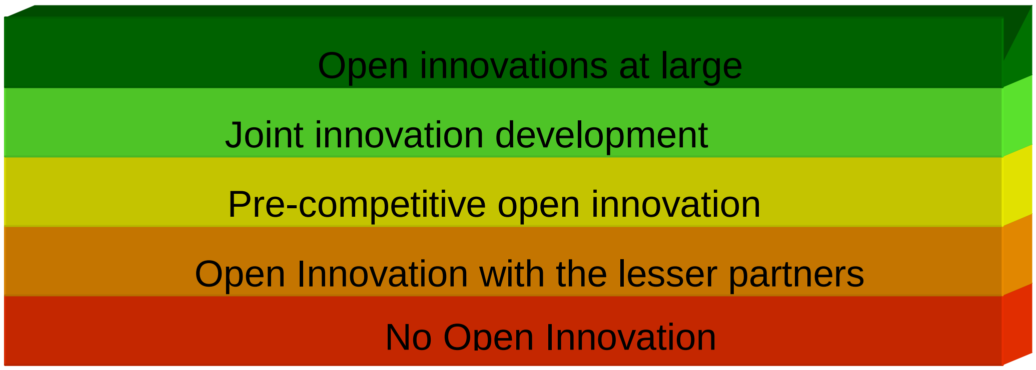
Open innovation is not new. ISO, IEEE, ITU, WWW and several such organizations have been developing standards that can be adopted by the industry. In some cases, those using the standards have had to pay a nominal fee whereas in the other cases they could use some of the standards free of cost. Open Source is a well known movement in computer software and the Open group has been addressing issues relating to the architecture, Enterprise Management, Identity Management Platform and Real-time and embedded systems security. The following statements from the two respective groups merit reproduction for the sake of the readers.

> Open source is a development method for software that harnesses the power of distributed peer review and transparency of process. The promise of open source is better quality, higher reliability, more flexibility, lower cost, and an end to predatory vendor lock-in.
>
> The Open Source Initiative (OSI) is a non-profit corporation formed to educate about and advocate for the benefits of open source and to build bridges among different constituencies in the open-source community.
>
> One of our most important activities is as a standards body, maintaining the Open Source Definition for the good of the community. The Open Source Initiative Approved License trademark and program creates a nexus of trust around which developers, users, corporations and governments can organize open-source cooperation. [10]
>
> The Open Group is a vendor-neutral and technology-neutral consortium, whose vision of Boundaryless Information Flow™ will enable access to integrated information, within and among enterprises, based on open standards and global interoperability. [11]

More recently, there has been a significant movement aimed at addressing the information security threats. A group of companies have come together to establish the Trusted Computing Platform. This group is called the Trusted Computing Group [12] and its home page defines its mission as given below.

> Trusted Computing Group members develop and promote open, vendor-neutral, industry standard specifications for trusted computing building blocks and software interfaces across multiple platforms. [12]

Such industry driver collaborative standards development efforts are one of the forms of the open innovation. The diagram presented below represents the different types of open innovation. Note this is not a maturity model. Companies can use the different approaches for different parts or projects of their organizations.



3.1. Models of open innovation

There are several possible models of open innovation and we will describe five such positions a company could take.

3.1.1. No open innovation

Some companies take the position that their innovation management strategy would require the hiring of experts in a given business innovations into the company rather than practice open innovation. This is normally true of smaller companies that do not have the muscle to translate the results from open innovation into revenues as fast as larger companies with deeper pockets could.

3.1.2. Open innovation with lesser partners

There are many models of open innovation with lesser partners.

One example is the collaborative research projects between companies and universities and research institutes [13]. In this model, companies normally invest a certain amount of money into a research program or project. The university that is the recipient of this largesse typically gives the company the first right of refusal for licensing the technology on favorable terms if it is a research project and simply on favorable licensing terms if it is a research program. This is necessitated based on the fact research programs require larger funding that has to be collected from more than one company and hence the difficulty in giving the first right of refusal to any one company. Of course, if an entire research program is funded by one company then the company is often extended the first right of refusal. A major benefit derived by the company is the right to recruit the brains behind the innovation. The universities are often capable of developing interesting inventions and sometimes good technology innovations. However, they are generally incapable of translating such inventions and innovations into good revenue bearing business innovations. It is therefore important for the companies sponsoring the research to be able to hire the brains behind the innovation to develop the product or service innovation stemming from the research results.

The second type of open innovation with lesser partners is when a large company partners a smaller company of niche skills to develop an innovation. The relationship between the smaller company and the large company is a research or innovation consulting and contract. The smaller company with niche skills is required to assign the results of the joint innovation exercise to the larger company that pretty much funds the costs of the project. In very rare cases, where the lesser company has very unique capabilities then they could negotiate a continued revenue stream from the innovation they develop albeit for a small license fee. This type of situation is generally rare although possible. An example is Apple and Symbol Systems (a maker of barcode scanners) working together to develop a mobile cash register for use in Apple Stores.

A third type of open innovation with lesser partners is when a large company engages venture capitalists to develop a new solution outside of the company. There is often an agreement between the venture capitalist and the investor company (the only limited partner for such a venture fund), to build the company and the product or service solution to an agreed upon quality for a predetermined valuation. This approach can be interpreted as an outsourcing of the operational load and risks associated with the development of a new innovation.

3.1.3. Pre-competitive open innovations

There have been and will continue to be many instances of pre-competitive alliances for creating innovations. The early examples were directed towards creating standards. However there have recently been efforts directed at creating early ideas relating to innovations through collaborations involving present and future competitors. A great example is the creation of Trusted Computing Platform [12] which aims to develop secure personal computer platforms that would resist attacks from hackers. This effort brings together arch rivals such as Intel and AMD, Microsoft and Sun Microsystems and Lenovo and Hewlett-Packard. Similar efforts abound in Nano and Biotechnologies.

Another example of pre-competitive research in innovations is the coming together of companies within a country context. For example, Israel has set up a consortium of companies to address the emerging opportunities in 4G telecom industry. The consortium is called Remon and has Alvarion, Cellcom, Rafael, Celletra, Schema, Runcom Technologies, Comsys Mobile and Paragon Communications as its members.

Another example of precompetitive open innovations is the concept of industry specific consortia. Taiwan's ITRI and Japan's METI are drivers and catalysts of such consortia for open innovations. The US tried a similar concept for semiconductor technology innovations when they feared a dominance of the industry by Japanese and Korean companies. They set up Semiconductor Manufacturing Technology, Inc. (SEMATECH) as a consortium of members to address continuous improvements in innovations, compressing product cycles, establishing relationship with suppliers while strengthening the core capabilities. This was a part of the Microelectronics and Computer Technology Corporation (MCC) set up by thirteen companies including Control Data, Motorola, Advanced Micro Devices, Allied, Digital Equipment, Harris, Honeywell, Martin Marietta, Mostek, National Semiconductor, NCR, RCA, and Sperry. MCC was headed by Bobby Inman, formerly the Director of National Security Agency of the United States. More examples of joint ventures in innovations and related discussions can be found in [14].

3.1.4. Joint innovation development

In some instances two companies come together to develop a new innovation. An example is the development of the Itanium processor. The processor is meant for enterprise level servers and high performance computing. The architecture was initially developed at Hewlett Packard. However, the final innovation was a joint development involving both Hewlett Packard and Intel. This is an excellent example of two companies coming together to make a new product.

Another example of joint innovation development involves the setting up of a joint venture for producing a specific set of new products. A classic example in the recent times is the case of Sony Ericsson. This was established in 2001 by both Sony Corporation and Ericsson to produce innovations in mobile phones. The objective was to combine Sony's consumer electronics expertise with Ericsson's finesse in communication sector. It is today the most profitable phone maker behind Nokia.

3.1.5. Open Innovations at large

The final model we discuss in open innovation is to go beyond open innovation by a single company. This is often an effort to create new industries where the focus in not just on innovation but on the entire value chain starting from technology innovations leading to business innovations all the way to reaching the consumers or enterprise customers.

Such collaborations often take place either when a new industry is about to be created or when an existing industry is under dire threat from competition and needs rejuvenation. In either case, the effort is not limited to creating innovations but extends to marketing, distribution, supply chain and finally support.

Another example of collaboration beyond open innovation is the government to government agreements to set up collaborations across industries in two countries. An example is the setting up of the Singapore-Israel Industrial R&D Foundation in 1997. This foundation promoted, supported and facilitated joint industrial activities between Singaporean and Israeli high-tech companies. The objective was to identify partners who would work across the two countries to identify, develop and commercialize innovations. This foundation was supported by the Economic Development Board of Singapore and the Office of the Chief Scientist of the Ministry of Industry and Trade of the Israeli government.

3.2 Usage of the different open innovation models

The different open innovation models prove to be useful under different circumstances.

The open innovation with lesser partners such as universities is most useful in exploratory and undirected search for innovations. The open innovation for smaller companies who are niche players are best pursued either when such expertise in not available in house or when the cost of employing in-house expertise cannot be justified. Open innovation using venture capitalists is best deployed when a company wishes to pursue a new product or service innovation opportunity is sensed addressing a market that is different from what the parent company is current engaged in.

Pre-competitive open innovations resulting in standardization is often employed when there is a compelling need for interoperability is most often seen in the consumer space. We also saw a sector focused pre-competitive innovation open innovation model is often deployed within a country to grow a new industry or to address an emerging opportunity within a current industry. A third type of pre-competitive open innovation is pursued when nations suspect that their leadership in a particular industry is under great threat.

Joint innovation development is used when two companies want to collaborate to address the development of either a single innovation or a family of innovation. In an extreme situation this might take the form of a joint venture.

Open innovation at large happens at the birth of a new industry or across two small nations wanting to collaborate across multiple industries.

4. Summary

This paper should not be interpreted to be a systematic study using social science research methods. We have tried to crystallize our experience and observations in innovation management including open innovation management trends over a thirty year horizon using some examples. It is an attempt to focus the thoughts of the readers on various models available for them to use. We hope that the paper will help some readers in deciding what models best suit their organizations.

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Management of Technology deployed in Service Innovations

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Management of Technology deployed in Service Innovations

Arcot Desai Narasimhalu
Singapore Management University

Abstract

Services form a major portion of the GDP of several nations, especially that of the first world nations. These nations also experience high cost of providing services of different kinds. This has resulted in the displacement of non-customer facing services to countries that can offer them at lower prices. Nations have to be concerned about sustaining their economies even as such off-shoring of services continue to grow. It is therefore important to understand how countries can create those service innovations that will help them retain the growth trajectory of their economies.

We believe that the different types of service innovations need different approaches to the use of technologies. This paper will review related work, introduce a new perspective on service innovation and identify how technologies can be managed to create optimal value from service innovations.

I. Introduction

Several researchers have addressed the issues related to services and service innovations [1-5, 7-9, 11-27, and 29-39]. Some have approached service innovation from an Operations Research point of view [6, 10] and yet others have addressed it from co-creation perspective [2, 4].

We have come to accept goods and services as two distinct non overlapping sets of offerings in the commercial world. This is partly due to the practice by nations to broadly classify their GDP into Agriculture, Goods and Services. There have been early attempts to provide classification of service innovations based on goods and services [25, 26 and 30]. While this is a good beginning, we require a deeper understanding of services and how technologies are used in services. We record our definitions and observations related to service innovations in section II. We follow this up with discussions on related work and a new perspective on service innovations in section III. Section IV presents a technology management framework for service innovations. Section V will examine the link between business strategy and technology management for service innovations. Section VI will discuss the technology demand identification for service innovations. Section VII summarizes the discussions in this paper.

II. Definitions and Observations

In this section we will first define the concepts we use in this paper and then list a set of observations.

Definitions

Products: Can be either goods or services

Goods: Goods are tangible products.

Hard-Goods: Examples of hard-goods are pencils, washing machines, toys and computers. Hard-Goods are visible. They can be touched and felt.

Soft-Goods: Examples of soft-goods are information, media, financial products such as loan and insurance. Soft goods cannot be touched or physically felt. One might touch and feel the containers that hold the soft-goods but not the soft-goods themselves.

Consumables goods: These are goods such as food and stationary.

Services: Services are intangible products.

Services are also referred to as service products.

Service Cost Management: refers to managing the costs incurred in the creation and offering of service products.

Service Value Management: refers to managing the creation and realization of value of services from a customer's perspective.

Service Point – refers to the physical space or point where a service is provided.

Observations

Observation 1: Some firms offer both Goods and Services in the same transaction. Examples are dine-in restaurants and retail stores.

Observation 2: Customers can differentiate between the Quality of Goods and Quality of Services provided by a firm.

Observation 3: User expectations of service quality for hard and soft goods are different.

Observation 4: Firms that traditionally produced goods only are now also now creating new revenue streams using service as a business model (See Figure 1). In some instances a larger percentage of the net profits of companies producing goods will come from accompanying services.

Observation 5: Firms producing hard goods will increasingly embed services into their offerings in order to ensure a second stream of revenues based on the utility model of business.

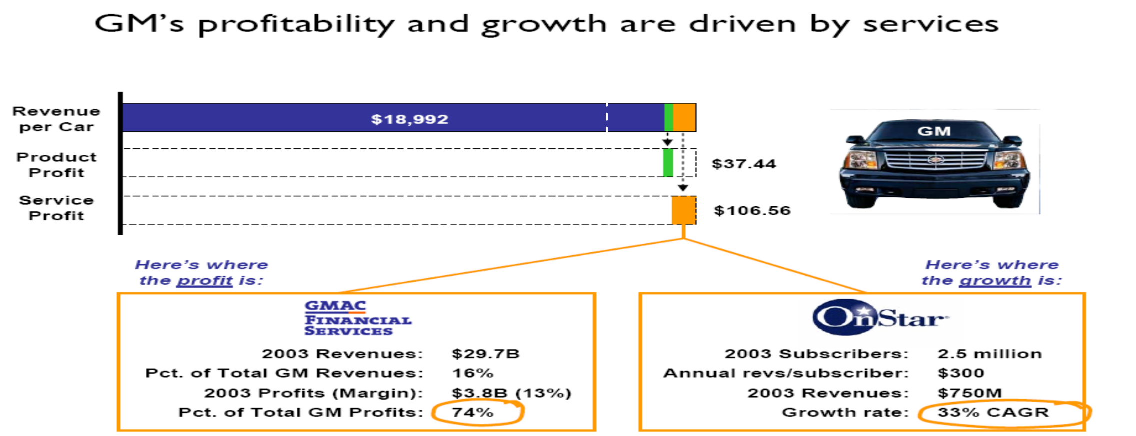

Fig 1. GM as an example of a firm producing goods that has also entered the service offerings.[6]

III. Related work

Several people have studied the classification of Services. James Teboul [35] listed services into three major categories - business oriented, consumer oriented and personal services. He defined services across other dimensions such as services offered within an organization, business services offered to other businesses, marketed services, distributive services, and non-marketed services.

Leonard L. Berry and his colleagues looked at classification of services from a different perspective [2]. They chose separability and core, as the two dimensions for classifying services. They define inseparable services as those where the service provider and service consumer needed to be co-located or needed to have face to face interaction and separable services as those where they need not have to meet. They also labeled those services that helped transport goods, either hard or soft, as delivery and the rest as core.

We believe that services will also have be classified based on the location where the services are provided. For example, a dine-in restaurant serving Pizza will provide its services at its location where as a Pizza delivery company will provide the services at the customer's location.

Table 1: A new perspective on service innovations

Location	Services related to		
	Hard-goods	Soft-goods	Service Products

[6] Reproduced from From PeerInsight, Jeneanne Rae and Tim Ogilvie

@Provider's location	Retail Stores	Cinemas	Hospital based healthcare.
@Consumer's location	Maintenance of washers and dryers	Netflix	Home based healthcare

The above classification provides the framework for our discussions on technology management for service innovations. Service innovations can be created to support hard-goods, soft-goods or service products.

IV. Technology Management Framework for Service Innovations.

In this section we examine how investments in technologies for producing service innovations can be managed. Figure 2 lists the key considerations for the Management of Technologies for Service Innovations.

<table>
<tr><td colspan="3">BUSINESS STRATEGY

The type of business Strategy adopted – Revenue Growth, Profit Maximization, Operational Efficiency, Product leadership or Customer Intimacy</td></tr>
<tr><td>TECHNOLOGY PRINCIPLES

Guidelines on a firm's principles with respect to technology positioning and technology adoption.</td><td>SERVICE ARCHITECTURE

Business architecture for the services offered.</td><td>SERVICE SOURCING PRINCIPLES

The guiding principles on when to outsource or offshore the development and delivery of service innovations. These principles will guide the technology investment decisions.</td></tr>
<tr><td>TECHNOLOGY INFRASTRUCTURE

This refers to the technology architecture and the infrastructure needed to develop and deliver Service Innovations.</td><td>SERVICE PRODUCT PORTFOLIO

The number and type of Service Products that are currently under development or being offered.</td><td>BUSINESS RULES ON TECHNOLOGY INVESTMENT PRIORITIES

Decision on whether to focus on Service Value Management or Service Cost Management.</td></tr>
</table>

Figure 2: Technology Management Framework for Service Innovations

It is important for any firm to first define its business strategy. Different business strategies will lead to different sets of guidelines for technology principles, business rules for technology investment priorities, technology infrastructure and Service sourcing principles. These interrelationships will be discussed in section V.

Technology principles will include investments a firm will make into the different type of technologies, the type of technology infrastructure it will set up and the firm's positioning with respect to emerging technologies – whether to adopt early, be amongst the early majority or be content being one amongst the late majorities.

The Service Product Portfolio will enumerate the number of service products that are currently being offered and the number of service innovations that are under development. The number of products and the stages at which they are in a product lifecycle will determine the demand for different types of technologies.

V. Business Strategy as a driver for technology management of service innovations

In this section we will discuss the interrelationship between business strategies, technology principles, buy build decisions, technology infrastructure, service sourcing, and business rules for technology investment priorities. Service innovations have shorter life cycle. Hence, it is important to realize that technology selection should match the short life cycles of service innovations. What this really means is that there is not much time to experiment with emerging technologies. Firms will be forced to use mature technologies for creating service innovations.

Technology Classification

Technologies can be classified into Strategic, High Potential, Key Operational and Support as shown in Figure 3. Firms will choose technologies that match their business strategy.

STRATEGIC	HIGH POTENTIAL
Technologies that are critical to sustaining future business strategy	Technologies that may be important in achieving future success
Technologies on which the organization depends for immediate success	Technologies that are valuable but not critical for immediate success
KEY OPERATIONAL	**SUPPORT**

Figure 3: Classification of technologies based on the use for business strategies

Business Strategy Classification

Firms often choose one or more of the following as their business strategy.

- Revenue Growth

  Firms using this business strategy will invest in technologies that will enable creation of new revenue streams and / or growing the current revenue streams. They will deploy technologies in the ideation, innovation, design and development of new products and in extending the sales of the current products.
- Profit Maximization

  Firms pursuing this business strategy will invest in technologies that will improve operational efficiencies and increase revenue growth. They will deploy technologies to achieve both revenue growth and operational efficiencies.
- Operational Efficiency

  Firms interested in operational efficiencies will invest in technologies that will reduce operating expenditure. The focus will be technologies that eliminate inefficiencies and improve productivity.
- Product leadership

  Firms keen on establishing product leadership will deploy technologies that help create bells and whistles required to achieve product leadership.
- Customer Intimacy

  Those firms that value customer intimacy dearly will invest in Customer Relationship Management technologies.

Technology principles

The relative importance of the four different types of technologies to the different business strategies is listed in Table 2.

Table 2: Technology dependencies for different business strategies

Type of Business Strategy	Types of Technologies			
	Strategic	**High Potential**	**Key Operational**	**Support**
Revenue Growth	Must have	Good to have	Not relevant	Good to have
Profit Maximization	Must have	Not relevant	Must have	Good to have
Operational Efficiency	Not relevant	Not relevant	Must have	Good to have
Product Leadership	Must have	Good to have	Must have	Good to have
Customer Intimacy	Good to have	Not relevant	Must have	Good to have

Table 3 presents a relationship between business strategy and technology principles (positioning, buy Vs build), business rules for technology investments priorities, service Sourcing and Technology infrastructure. Firms pursuing different business strategies could adopt the corresponding choices for implementing service innovations.

Table 3: Business Strategy Technology Strategy nexus

Type of Business Strategy	Business Strategy influence on Technology Strategies				
	Technology Positioning	**Buy / Build Strategy**	**Business rules for technology investment priorities**	**Service Sourcing**	**Technology infrastructure**
Revenue Growth	Early majority	Buy	Strategic	Channel partnership	Extend assets
Profit Maximization	Late majority	Buy and Build	Strategic and Key Operational	Channel partnership and manufacturing outsourcing	Extend assets Optimize asset utilization

Operational Efficiency	Late majority	Buy	Key Operational	Manufacturing outsourcing	Optimize asset utilization
Product Leadership	Early adopter	Build and Buy	Strategic and Key Operational	In-house	Establish agile and extensible infrastructure
Customer Intimacy	Early adopter	Build	Key Operational	In-house	Emphasize firm wide CRM adoption

Service Sourcing Principles

Given the globalization trends, it is important that firms' make the best uses of resources available from around the world. This is especially so in the context of service innovations. An important distinction between product and service innovation is that the lifecycle of service innovations is shorter. Hence, firms do not have the luxury of building competencies before they create their service innovations. This requires firms to make considerable use of external service providers where they do not have either the core competencies or sufficient internal capacity. Table 4 lists an illustrative example of a typical firm's potential dependence on external service providers.

Table 4: A typical firm's dependency on external service providers

	In-house services	**Business to business services**	**Marketed Services**	**Non Marketed Services**	**Distributive services**	**Personal Services**
Ideation	x					
Research	x	x				
Pilot	x	x				
Design	x	x				
IP Management	x	x	x			
Development	x	x	x			
Marketing	x	x	x			x
Manufacturing	x	x			x	
Testing& Assembly	x	x	x			
Packaging	x	x	x			
Distribution		x			x	
Sales / Service		x			x	

After sales support	x					x

VI Technology demand identification for service innovation lifecycle

Table 1 introduced a new perspective to service innovations – the location where it is offered, providers' location or customer's location. Section II introduced the concept of Service Value Management and Service Cost Management. Some of the Technology investments will be for internal service products or processes which typically will be reengineering in nature. Other investments will be for service innovations visible to the external world, both customers and competitors. Table 5 provides a technology strategy for both SVM and SCM.

Table 5. Technology Management Strategy for SVM and SCM

	Service Value Management	Service Cost Management
Internal service products (typically reengineering).	Technology support for redesigning existing business processes that create Service Value.	Technology support for Quality and Innovation Teams
Visible service products	Technology support for creating a continuous stream of Service Innovations	Technology support for cost down products – moving towards self-service

While service innovations might be either for internal or external purposes, it is important to understand the different types of technology demands that such innovations create. Following types of technologies would be used during the service innovation development lifecycle. It is important to study the technology demands at different stages.

Technologies for Analytics: Examples are technologies used for Business Analytics, Technology Intelligence, Market Intelligence and Competitive Intelligence.
Technologies for Synthesis: Examples are technologies for supporting the design phase of a product development.
Technologies for Communications: This includes Email, Fax and other technologies commonly used for communications.
Technologies for Transaction Processing: This includes E-Commerce, Point-of- Sales and similar technologies. Some component technologies such as data base management will also qualify as a technology supporting transaction processing.

Technologies for Business Transformation: These are technologies that completely change the nature of conducting business. Examples are Mobile technologies and Automatic Teller Machines.
Technologies for Compliance: These are technologies that are introduced because a regulator specifies them. Some examples are risk management technologies related to Basel-2 and SOX.

Table 3 shows the typical importance of the finer grained technologies at the different stages of a service innovation's product life cycle. We refer to the stages ideation to development as Product development phase and the rest as Post-product development phase.

Table 3: An illustration of the role of technology in a goods and services providing organization

	Functions in product development life cycle					
Stages in Product development life cycle	**Technologies for Analysis**	**Technologies for Synthesis**	**Technologies for Communication**	**Technologies for Transaction processing**	**Technologies for business Transformation**	**Technologies required for Compliance to standards and regulations**
Ideation	Extremely important	Extremely important	Moderately important	Not important	Moderately important	Marginally important
Research	Extremely important	Extremely important	Moderately important	Not important	Not important	Not important
Pilot	Not important	Extremely important	Moderately important	Not important	Not important	Not important
Design	Not important	Extremely important	Extremely important	Not important	Not important	Extremely important
IP Management	Extremely important	Extremely important	Extremely important	Not important	Not important	Extremely Important
Development	Not important	Extremely important	Extremely important	Not important	Not important	Important
Marketing	Extremely important	Moderately important	Extremely important	Very important	Moderately important	Marginally important
Manufacturing	Not important	Not important	Very important	Very important	Moderately important	Extremely important
Testing& Assembly	Very important	Marginally important	Marginally important	Very important	Not important	Extremely important
Packaging	Not important	Not important	Marginally important	Very important	Not important	Not important
Distribution	Very important	Extremely important	Extremely important	Extremely important	Moderately important	Not important
Sales / Service	Extremely important	Moderately important	Extremely important	Extremely important	Marginally important	Not important

After sales support	Extremely important	Extremely important	Very important	Extremely important	Not important	Not important

The above table is for illustrative purposes only. Each firm has to decide the relative importance of different technologies to different stages of its service innovation's life cycle. It can then derive quantitative measures by replacing the qualitative descriptors using values such as suggested below.

- Extremely important – 5
- Very important – 4
- Important – 3
- Moderately important – 2
- Marginally important – 1
- Not important – 0

Table 4: Quantitative version of Table 3.

	Functions in product development life cycle						
Stages in Product development life cycle	**Technologies for Analysis**	**Technologies for Synthesis**	**Technologies for Communications**	**Technologies for Transaction processing**	**Technologies for business Transformation**	**Technologies required for Compliance to standards and regulations**	
Ideation	**5**	**5**	**2**	**0**	**2**	**1**	**15**
Research	**5**	**5**	**2**	**0**	**0**	**0**	**12**
Pilot	**0**	**5**	**2**	**0**	**0**	**0**	**7**
Design	**0**	**5**	**5**	**0**	**0**	**5**	**15**
IP Management	**5**	**5**	**5**	**0**	**0**	**5**	**20**
Development	**0**	**5**	**5**	**0**	**0**	**1**	**11**
Marketing	**5**	**2**	**5**	**4**	**5**	**1**	**22**
Manufacturing	**0**	**0**	**4**	**4**	**2**	**5**	**15**
Testing& Assembly	**4**	**1**	**1**	**4**	**0**	**5**	**15**
Packaging	**0**	**0**	**1**	**4**	**0**	**0**	**5**

Distribution	**4**	**5**	**5**	**5**	**2**	**0**	**21**
Sales / Service	**5**	**2**	**5**	**5**	**1**	**0**	**18**
After sales support	**5**	**5**	**4**	**5**	**0**	**0**	**19**
Total	**38**	**45**	**46**	**31**	**12**	**23**	**195**

Column totals can be used to infer the relative importance of a technology across all stages of a service innovation's life cycle. Row totals can be used to identify relative importance of all technologies for the different stages of a service innovation's life cycle.

In this example, an examination of columns totals shows that technologies for Analysis, synthesis and communication are very critical to service innovation product development in comparison with the rest. This would imply that the firm needs to prioritize its technology investments in these areas. An examination of the rows totals reveals that the technology support is most needed for the Marketing, Distribution, IP management, and "After sales support" and Sales stages of a product development. This observation will certainly influence the timing of the technology investments in a service innovation's development life cycle.

A firm has to aggregate all the requirements for its service innovations, present and those under development, to derive a complete picture of its technology demand.

The X axis represents the two stages in the service innovation life cycle. The Y axis represents the nature of the technology. Circles represent the innovations where the service is rendered at the provider's location. Such innovations require less support for mobile applications. Circles represent technology required to primarily support in-situ service. Squares represent the innovations where the service is rendered at the consumer's location. These innovations require more support for mobile applications. Therefore, squares can be interpreted as technology required to support mobile services. Green color is used to represent innovations of the type Service Value Management while red color is used to represent innovations that address Service Cost Management. The size of a square or a circle represents the relative importance of that technology.

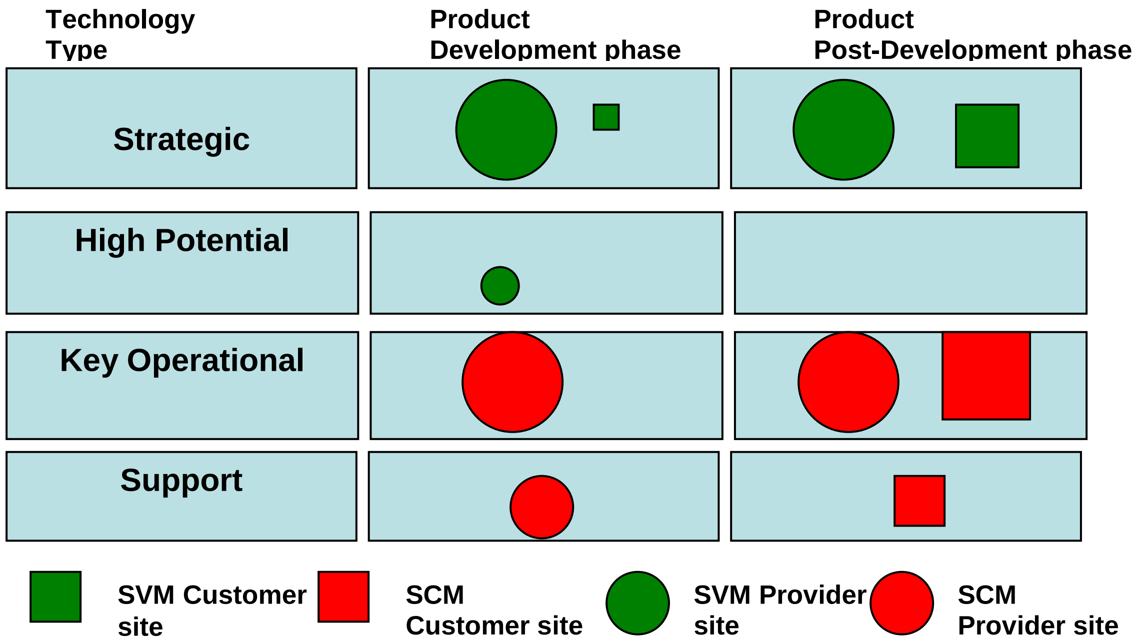

Fig. 4. Relative merits of technologies for different types of service innovations.

A very important feature of service innovation is that many visible service products are susceptible to easy replication by competitors. The internal process innovations are less visible and are known to give service companies longer protection for their service product leadership in comparison to visible service products. This leads us to an interesting position with respect to technology management for service innovations. Firms are able to derive longer competitive advantage from internal innovations. Firm's should develop a battery of visible service innovations that can be released in quick succession without confusing the market.

VII Summary

This paper introduces a new perspective, service location, on service innovations. This is followed by a technology management framework for managing service innovations. The paper then analyses use of technologies in the different stages of a service innovation's life cycle. We hope to validate the framework by conducting follow on studies.

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Designing the next innovation using Value Curve

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Designing the Value Curve for your next innovation

Arcot Desai Narasimhalu
School of Information Systems
Singapore Management University

Abstract

This paper introduces an additional feature to the Strategy Canvas and Value Curve that will make innovation designers more effective. The new feature is to let the innovators carry out the designs of their new innovations taking into account both the cost of improving the quality of a parameter that the users value highly and the savings accrued from the drop in provisioning for parameters that users place less emphasis in an innovation.

1. Introduction

Several authors have provided insights into useful innovation methodologies [1, 2, 4, 5, and 6]. Among these, Blue Ocean Strategy [4] provides Value Curve on a Strategy Canvas as a tool for designing new innovations. A Value Curve represents the different levels at which the value drivers for a given representation are positioned. For example, while it might be desirable to have the highest quality of bed in a hotel, a one star hotel may provide only a bed of medium quality. An Innovation Designer has to determine which of the customer focused features or value drivers in a Value Curve need to be repositioned and also whether to introduce new value drivers or even drop some existing ones. This Strategy Canvas and Value Curve tool can be more effective if it can be augmented with a feature that allows an innovation designer to determine the optimal positioning of a value driver taking the available money into consideration.

It is important that an Innovation Designer be empowered with design methods that will help determine optimal positioning of the value drivers of an innovation. Such methods should include a means of determining the priority of different value drivers based on the cost sensitivity of the value drivers.

Every Innovation Designer will almost always has to work within limited budgets while aspiring to maximize customer experience with a given product or service. An analytical method that can help optimize the design of an innovation within budget constraints will certainly be a useful augmentation to Strategy Canvas based Value Curve tool.

This paper outlines an analytical model based innovation design method that can be used to optimize the overall value of an innovation with respect to customer specified priorities and cost sensitivities of value drivers. Section 2 introduces a discussion on value drivers in designing an innovation. Section 3 presents a model for determining the value delivered by an innovation to a customer. Section 4 presents a sample design of an innovation. The method described in this paper is summarized in section 5.

2. Innovation Value Drivers in Strategy Canvas and Value Curve

Fig. 1 shown below represents the strategy canvas and value curve for a new class of business hotels discussed by Chan Kim and Renee Maugborne under the "Focus what the customers value", in an article titled "How to leapfrog the competition" [3]. The business hotel has been cited by the authors as an example of a new innovation under the Blue Ocean Strategy. The study involved a European hotel chain Accor that created a new class of hotels called Formule 1 for business travelers. The X axis of the strategy curve lists the value drivers considered to be of interest to the customers. The Y axis represents the positioning of each value driver. The picture without the lines is called a Strategy Canvass and the lines are referred to as Value Curves. The dashed line represents the characteristics of a one star hotel. The dotted line represents the value drivers of a two star hotel.

The Innovation Designers responsible for designing the new chain of hotels observed the customer behavior at the one star and two star hotels. It turned out these were typically businessmen who would come into the hotel mainly for a good night's sleep. Since most of them were mobile, either because they drove or their business partners would pick them up, they did not care much regarding eating facilities, lounge or the architectural aesthetics. On the other hand they were quite particular about having a good quality bed, good hygiene and lower room noise, all these to be available at a low price.

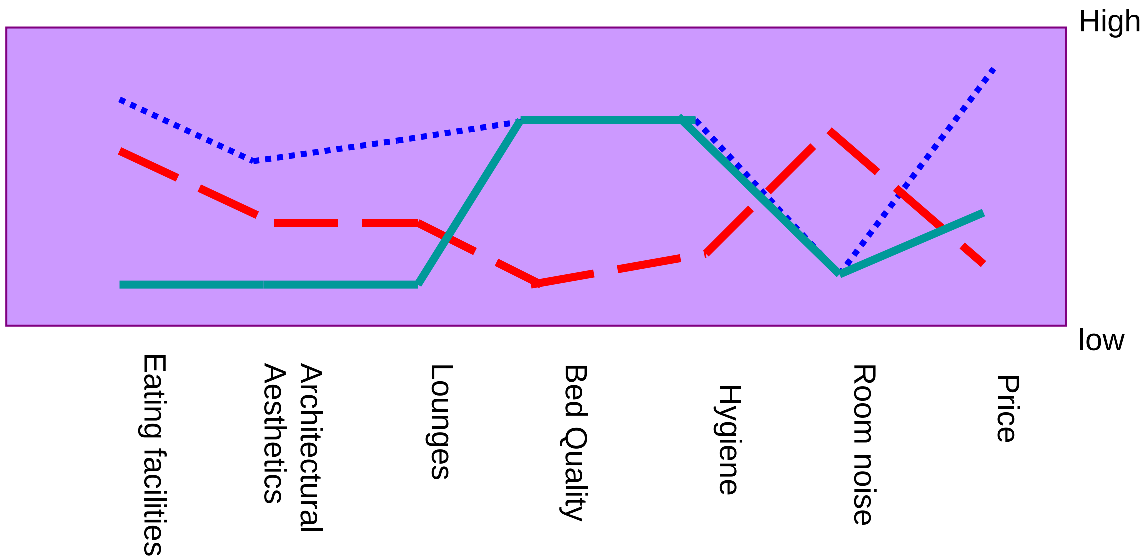

Fig. 1 Strategy Canvas and value curve for Formule 1

3. Modeling the value delivered to customers

It is clear that price is a dependent variable or value driver. For example, Price will increase if the investment in aesthetics is increased and should decrease if the investment in aesthetics is decreased. So, in reality we have only six value drivers to manipulate and the value of price gets altered based on the values assigned to each of the six independent value drivers.

The solid line is an example of the design of a new innovation. While the design of this new type of hotel is achieved by moving the curve for each of the customer centric value drivers, the resulting savings in cost or the additional investment required is not immediately apparent. It would be nice to build this into the Strategy Canvas and Value Curve such that the change in positions of value drivers in a value curve will show the corresponding increase or decrease in investments required. This requires an analytical model to be developed and bound to the value curves.

The following is the description of an analytical model for representing the value of investments in the value drivers of an innovation.

Let there be 'n' customer centric value drivers that characterize an innovation. In the example given above there are six independent value drivers. Table1 lists these value drivers.

Table 1: Value drivers and costs incurred or savings expected per unit change.

Value driver number	**Value driver**	**Weight**	**Current level CLi**	**Desired level DLi**	**Incremental cost for unit increase Ci**	**Savings from unit decrease Si**
1	Eating facilities	0	2	0	200	100
2	Architectural Aesthetics	0	3	0	500	300
3	Lounges	0	2	0	1000	500
4	Bed quality	4	3	5	700	300
5	Hygiene	4	4	5	300	150
6	Room Noise	5	3	5	500	200

Let C_i be the cost for increasing positioning of the ith value driver by one unit. For example, consider restaurant as a value driver of a hotel. Different countries use different symbols to represent the quality of a restaurant. Let us assume the number of forks represent the quality of a restaurant. The quality of a restaurant is considered to be better the higher the number of forks. So, if a hotel at present has a restaurant rated one fork and would like to improve the quality to two forks, there would be a corresponding increase in costs for setting up the infrastructure for the higher quality restaurant. The amount of money required for the upgrading of the restaurant would be represented as C_1.

Let S_i be the savings obtained by reducing the value of ith value driver by one unit. Notice that S_i may not be the same as C_i. For example, if a hotel offered a two fork rated restaurant and wanted to downgrade it to a one fork rated restaurant it may not bother to modify all parts of the infrastructure. It may rework some parts and let the rest remain. Hence S_i for a value driver i will almost always be less than or equal to C_i.

Innovation Designers quite often conduct focused group studies to understand those aspects of an innovative product or service that the potential customers value and by how much. This translated into weighting of the value drivers of an innovation. Higher weighting indicates that more customers prefer the value driver. Let W_i represent the weight that a customer assigns to a value driver. The weights will almost always be on a predefined scale. Let the minimum value of such a weight scale be 1 and the maximum value j. Weights are often described on a five point or a ten point scale. The variable j will take on a value of 5 in the former case and 10 in the latter case.

When ith value driver's position has been bumped up by one then C_i will take on a positive value and S_i will take on the value zero. When the ith value driver's position has been dropped by one then C_i will take on the value zero and S_i will take on a positive value.

Table 1 lists the weights assigned by customers to the different value drivers, the current level and the desired level of the value drivers and the cost incurred or savings derived by adjusting each value driver one notch up or down. The table assumes that all value drivers can be positioned at six levels, 0 to 5. It also records the weight placed by customers on each of the value drivers. A weight of 0 would imply that the value driver is of least consequence with respect to the new innovation and a weight of 5 would indicate that the said value driver is of utmost importance to the customer.

The effective cost of a new innovation can then be defined to be the net of all additional costs of upgrading some value drivers minus sum of savings resulting from downgrading other value drivers.

Effective cost of new innovation = $|\sum Si + Ci|$ for all i = 1 to n. This cost should be less than equal to the budget available for the required changes.

An innovation is only as good as the value it creates for the customer. It is therefore important to address the value to customer by using the relative importance placed by the customer on each of the value drivers.

So, if the budget for the new innovation is limited, then an Innovation Designer has to prioritizing the choices of value drivers that needed to be upgraded. If the additional money available is X dollars, the total money available will be the sum of additional money available and the savings accumulated from downgrading or removing the value drivers less valued by the customer. It is clear from the above table that value drivers 1 (Eating Facilities), 2 (Architectural Aesthetics) and 2 (lounges) are at levels higher than those desired by customers.

The total savings from dropping these can be computed as TS = $\sum (CLi - DLi) * Si$ for i = 1 to 3.

The total budget now available for making the changes desired by the customers would be TB = X + TS. The key decision will be one of how to distribute the available funds across the different value drivers selected for upgrading. There are many possible approaches towards distributing these funds. The following are two of the possible methods used for distributing the additional funds available.

Method 1

One approach would be to allocate funds to the value driver with the highest weight first. This would imply that sufficient funds are allocated for moving up this value driver all the way up to the desired level. The next value driver selected for fund allocation could be the one with the next highest weight. Once again sufficient funds can be allocated to this value driver to move it all the way up to the desired level. This process can go on until all the available funds are exhausted. Where more than one value driver carries the same weight, the one with lower unit upgrade cost can be considered first followed by the remaining value drivers assigned the same weighting.

Method 2

Another approach is to distribute the funds equitably to each of the value drivers considered for upgrade. In the above example, value drivers 4 (Bed quality), 5 (Hygiene) and 6 (Room Noise) require consideration for upgrades. This will ensure moving up all the value drivers if possible and not starving any of them. This approach can be considered to be a fairer spread across all the value drivers.

4. An example

Table 1 contains all the information required for the design of a new hotel. Let additional budget available be zero dollars. This would imply all the improvements have to come from the savings. The savings from dropping value drivers 1 to 3 to the desired level will result in a savings of 1600 dollars. This is the money available for making improvements.

The total budget required to meet all the customer specified improvements can be computed as follows:

a. Improving Room Noise from level 3 to level 5 will require 1000 dollars.
b. Improving Bed Quality from level 3 to level 5 will require 1400 dollars.
c. Improving Hygiene from level 4 to level 5 will require 300 dollars.

Total budget required is the sum of these three expenses which amounts to 2700 dollars. Obviously all the required improvements cannot be achieved within the available budget. One of the two methods suggested above can be used to design the value drivers for the new hotel.

Design using method 1:

The feature that is considered to be most important to the customer is Room Noise. This requires 1000 dollars. The money left after committing to this upgrading will be 600 dollars. There is not enough money to spend on Bed Quality. Hence 300 dollars can be spent on improving Hygiene. This leaves a remainder of 300 dollars that cannot be used to improve Bed Quality.

Design using method 2:

One unit of improvement in each of the value drivers will require a total of 1500 dollars. While Room Noise that is given the highest weight by the customers is not brought up to the desired level, there is uniform improvement across the board. There is a left over money of 100 dollars which cannot be used to upgrade any of the value drivers.

5. Summary

This paper proposes a useful tool that adds allows innovation designers to use the Strategy Canvas and Value Curve proposed in the Blue Ocean strategy more effectively. It addresses "how or by how much" in addition to the "what" addressed by the value curve. Integrating the model effectively with the Strategy Canvas and Value Curve will give innovation designers tremendous real time visualization of the impacts of their design on their budgets. A real time display that indicates the remaining money after a change in value curve will be of tremendous value to Innovation Designers.

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Section 5: Case Study

Crossing the Chasm: The XID Story

Published in the proceedings of 2006 PICMET conference, Turkey, Istanbul

Crossing the Chasm: The XID Technologies Story

Abstract:

XID Technologies was founded as a biometrics startup company using a disruptive face recognition technology. The technology innovation came from Kent Ridge Digital Labs, a publicly funded software research laboratory. Face recognition is the least intrusive and harmless among the various biometric solutions available in the market. The basic approach to human face recognition was to identify a robust feature set that was unique enough to differentiate amongst the many millions of human faces that the system was required to verify. The technology innovation used by XID technologies framed the problem differently and overcame the challenges posed by poor lighting and tilted or rotated heads.

XID Technologies licensed the basic technology from Exploit Technologies Private Ltd., Singapore and developed a pilot application that was in an undiscovered market. This new and yet undiscovered niche market gave the young company a protection from those with competing technology solutions who were busy focusing on the well known markets. Once its solutions were accepted, XID technologies was emboldened to explore developing its own technologies in related spaces. It has now several parallel products under development even as its main offering is being brought to market by some of the large solution integrators. The paper will discuss the transition of XID technologies from a young one product start up to its present position as a technology and new solution generator.

Crossing the Chasm: The XID Technologies Story

1. Background

XID Technologies was built initially around a face processing technology developed at the Kent Ridge Digital Labs[7] (KRDL), Singapore by Dr. Roberto Mariani. KRDL was an IT software research lab funded by National Science and Technology Board of Singapore Government and focused on IT software related research.

KRDL was founded in 1998 as a result of a merger between the Institute of Systems Science and Information Technology Institute, both IT focused applied research institutes, the former focusing on the creation of innovative technologies and the latter focusing on the development of innovative applications. KRDL had interest in several real life applications one of which was biometrics. KRDL had several research collaborations. One such major collaboration was with the Real World Partnership Program (RWCP) that was established by the Japanese government's Ministry of International Trade and Industry[8]. Biometrics was also one of the topics of interest to RWCP.

Around the year 2000 KRDL applied itself to creating technologies that would create a 10 X impact. 10 X would imply that technology development teams would strive to produce technologies that were better than existing solutions by at least one order in magnitude. KRDL rightly believed that this new vision will help promote out of box thinking and result in redirecting its researchers' focus away from sustaining innovations to creating disruptive technology innovations.

This new vision was aligned with KRDL's desire to position itself as the incubation engine for information technology based new business creation in Singapore. A list of companies created using KRDL's proprietary technology can be found at http://www.i2r.a-star.edu.sg/index.php?page=Spin_Offs&anchor=87:84

KRDL's research group developing biometric solutions for RWCP took a fresh approach towards solving the face recognition problem. Where most companies focused on

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[7] Kent Ridge Digital Lab has merged with other labs in the last two years and is presently renamed as Institute for Infocomm Research or I2R. See www.i2r.a-star.edu.sg for more information about this institute.
[8] Ministry of International Trade and Industry has since been renamed as Ministry of External Trade and industy. From MITI to METI.

identifying a feature set from a face and compared it to the feature sets of stored collections of faces to find a match, the 10 X drive by KRDL lead to adopting face synthesis based approach to face recognition research. Dr. Mariani was the main inventor of this face synthesis technology. This technology allowed for recognizing human faces more accurately under different lighting conditions and with different degrees of tilt much better than competing face recognition solutions using conventional feature set based technologies.

2. Crossing the Chasm

Crossing the Chasm is a model for marketing and selling high-tech products to mainstream customers and was introduced by Geoffrey A. Moore through a book by the same title that was published by Harper Business first in hardcover in 1991 and later in 1999 and 2002. The model basically presents historical evidence on how high technologies that often fell into a chasm used a bowling alley model based strategy to help climb out of the pits on its way to reaching the masses. The following diagram captures the Crossing the Chasm and the model that followed – Inside the Tornado. The diagram shown in Figure 1 is called Technology Adoption Life Cycle and represents the evolution of high technology from early market, into a Chasm and from there through a Bowling Alley strategy into a Tornado followed by Main Street and finishing by end of life.

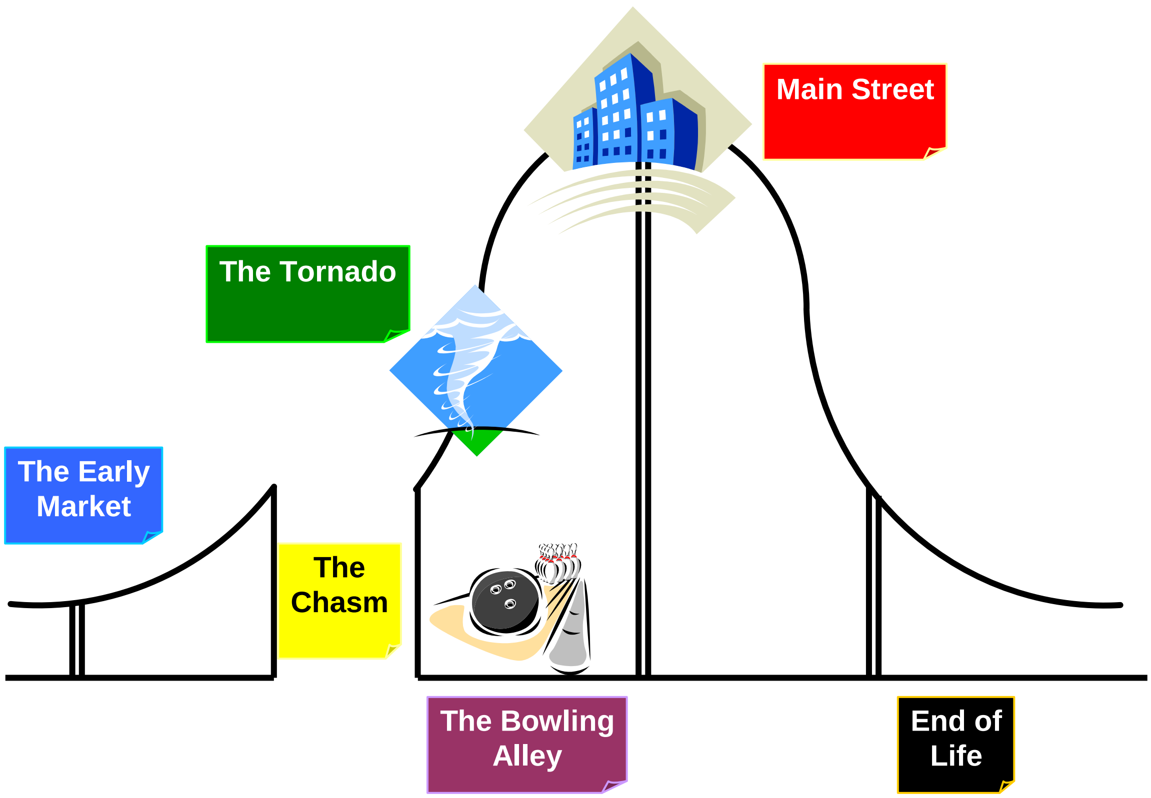

Figure 1: Crossing the Chasm using the Bowling Alley Strategy as a part of technology adoption life cycle curve.

The purpose of this paper is not to explain this model but to show how XID managed to cross the Chasm in its bid to bring its innovate high technology to the mass market. We will assume that the readers are familiar with this model or they are directed to the book listed in [1] for getting a comprehensive understanding of this model.

3. XIDTechnologies

XID Technologies was set up on 22nd December 2002. The company managed to license the face synthesis technology from KRDL through the commercialization company called Exploit Technologies Private Limited , http://www.exploit-tech.com on 15th April 2003.

XID technologies early focus was to help build applications to demonstrate the power of their disruptive recognition technologies. The technology innovation developed at KRDL was initially benchmarked by Hitachi against all the then available commercial face recognition solutions and found to be the most robust. XID technologies was fortunate to have Sharp Electronics work them from its inception to help develop proof of concept solutions. These early solutions were showcased at the CARTES trade exhibition held in France in 2003 and 2004. These solutions were also exhibited in Singapore, India, Philippines, Malaysia and Thailand through a collaboration with SUN Microsystems.

XID Technologies face recognition through face synthesis was considered to be an innovative technology. It bagged a prize at the Defense Technology Prize 2002 Awards ceremony organized by the Ministry of Defense in Singapore. It also won an award at the Asian Innovation Awards 2003 event. It was a nominee for the World Technology Award 2004.

XID Technologies in the mean time was getting attention from several organizations sourcing for biometrics solutions in general and face recognition technology platform in particular. Although fingerprint recognition technology based biometric solutions were considered to be mature they suffered from taboos. For example, only criminals and foreigners were fingerprinted in countries such as Japan. Further, Fingerprint based solutions were considered to be intrusive since it required subjects to voluntarily submit their finger prints for verification purposes. This was considered to be intrusive by many potential users of biometric solutions. The search for alternatives to finger print based biometric solutions resulted in face recognition rising up to the challenge as a non-intrusive substitute. This was also post 9/11 and several organizations were in search for robust access control solutions. So there was in general a great demand for biometrics based access control from different market segments.

More information about XID technologies can be found from its website http://www.xidtech.com/

4. XID Crossing the Chasm

XID technologies had a portfolio of market positioning options to choose from, as shown in Figure 2, for entering the commercial world. XID technologies chose access control market as the head pin for its bowling alley strategy. This market offered multiple application deployment opportunities, although the overall market size was smaller than other opportunities. However, as per experiences with disruptive innovations, it was better to start in a market that was attracting less attention than those well established highly competitive markets. It was therefore of paramount importance to choose application deployment opportunities in the access control market that were not well addressed.

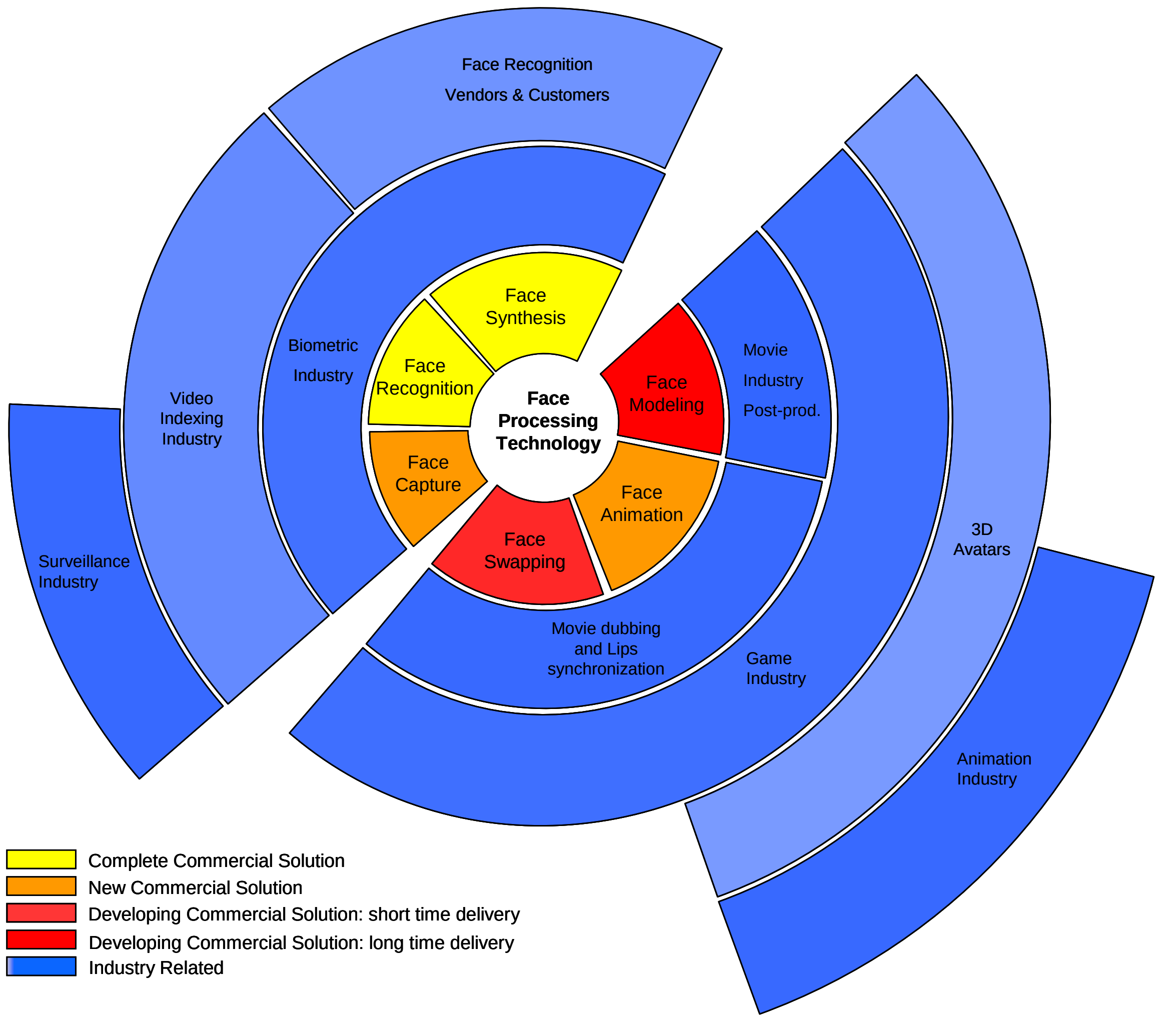

Figure 2. Portfolio of options for XID technologies.

Figure 3 provides a list of application deployment areas that XID could have addressed.

Markets such as airport security control including biometric passport were the prime target for established biometric solution companies with less robust access control solutions. XID had to therefore identify a series of early deployment opportunities either too small for those big players or neglected by the big players since they were too focused on existing and popular market opportunities.

XID's intellectual asset was its Predictive Face Synthesis algorithm (See Figure 4). It had to identify several application development scenarios as well as rapid market penetration Strategies.

Smart ID Documents	Immigration - Passport, Visa & Boarding Pass; National ID Cards, Driving Licenses, Health Cards ....
Identity Theft Prevention	Banking - ATM Computer and Internet
Access Management (White & Blue Collar)	Manufacturing & Processing Plants Petrochemical & Nuclear Sites Healthcare Human Resource Management Workers Dormitories & Construction Sites
Mobile Authentication Device	Telecom Industry (access to premium content) Law Enforcement

Figure 3. Access control application opportunities XID had to choose from.

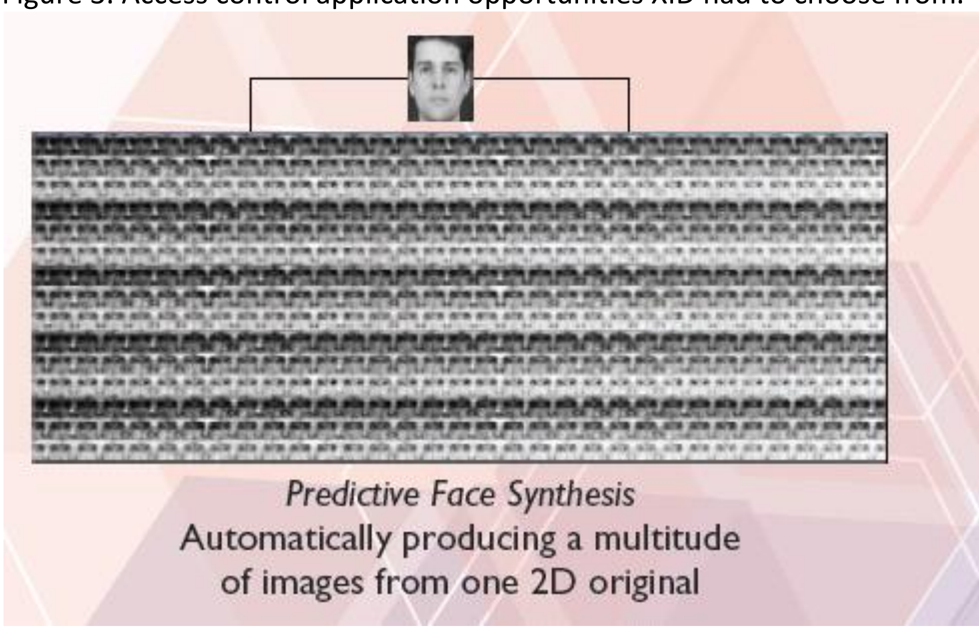

Figure 4. An example of the multitude of faces generated from one two dimensional face by XID's Predictive Face Synthesis algorithm.

4.1. Market development strategies

While starting small, XID had to also think through its vision for addressing future market opportunities as well. As a startup it could not do everything itself and hence had to draw up a strategy for rapid expansion into the different markets.

XID identified the following paths for rapid exploring different market positioning.

4.1.1 Packaged Solutions

XID's packaged solution offering was targeted at small scale users who would require well tested and robust readymade solutions that could "plug and play". XID developed access control devices using combined hardware and software solutions as a product to address this market. This market was further split into in-situ and mobile requirements. In-situ requirements would address installation of such devices in buildings and campuses whereas mobile solutions would be required in temporary work sites that require access control. Figure 5 shows an access control device developed to address the in-situ market where as Figure 6 presents a mobile kiosk using the same access control solution.

Figure 5: An XID Access control Device developed for in – situ building installation

Figure 6: An XID Mobile Kiosk product for access control

4.1.2 Large Scale Project Licenses

Very large technology suppliers preferred to integrate XID's products into their own integrated solutions. Hence XID established a program to work with such partners in their bid to win large scale national and industrial contracts through competitive bidding. Establishing a few large reference sites was critical to acceptance of XID solutions for large scale applications. This approach would allow XID to become a business partner of large system integrators.

4.1.3 OEM Software License

Some vendors preferred to embed XID's core technology into their own products. XID would then become a OEM software licensor to such product developers. This would allow XID to deploy its software in applications that it cannot itself address.

4.1.4 Add-on Software Licenses

Some vendors serviced legacy systems. These typically involved upgrading of software on previously installed hardware. This would allow XID to partner existing solution providers who might have been once considered their competitors.

4.1.5 Vertical Businesses

XID also realized that the Predictive Face Synthesis could be applied to solutions outside of the access control applications. XID was willing to help young companies exploring the adoption of XID's core technologies in other domains by giving them the licenses to XID's technologies in lieu of stakes in their companies. Taking equity positions instead of cash encouraged the new companies to use XID's core technologies, given that both XID and these startup companies did not have a healthy cash flow.

4.2. Building XID technology based solutions

Once XID had identified its market development plans, it had to develop different types of applications and Software Development Kits that could be licensed to the different business partners. The following sections describe the different applications developed by XID.

4.2.1. XID SmartID

XID developed a Face recognition engine called XID SmartID from XID's award winning technologies that formed the core engine for all of XID's verification systems and solutions.

At the heart of XID SmartID is a technology known as *Predictive Face Synthesis* and it is this algorithm that assures robust performance even in uncontrolled, outdoor environments. XID SMartID overcomes the problems associated with conventional systems that are sensitive to nuances such a changes in lighting conditions, facial rotations and the addition of glasses or beards.

XID SmartID uses memory cards and smart cards to store an individuals' ID. XID recognized the need to develop an embedded version of SmartID for use in Smartcards, Mobile phones, PDAs and access controllers. XID has developed an embedded version of its face recognition engine for such purposes.

4.2.2. XID Workwear for access control to buildings, worksite and other residential quarters.

XID WorkWear, a patent pending product, used XID's core technology to secure access and prevent security breaches within a facility such as a factory or a worksite without the need for smart cards.

The ground breaking XID WorkWear product was developed to provide two factor authentication of individuals by combining XID's core face recognition technologies with simple tags. These tags contained no electronic components. The tags were easy to generate and could be printed simply and quickly on standard paper even at temporary locations such as exhibition registration counters. The tags could also be sewn on to a uniform for long term use such as in factories. XID WorkWear offered a highly scalable, cost effective, efficient solution.

XID's biometric security system offered a highly secure method of authenticating every person that entered a building. Most biometric based security solutions were directed only towards indoor, white collar scenarios. Yet blue collar environments perhaps had an even greater need for security. For example, the magnitude of damages incurred by a petrochemical plant or a nuclear site can be enormous because a corrupt employee had traded his or her identity with a malicious infiltrator.

Intrusive, contact based biometric security systems such as fingerprint recognition based solutions have often failed in such environments. XID has developed and deployed Workwear and other XID technology based security systems that cater specifically to blue collar environments. These systems can also be used for access control for white collar workforce.

4.2.3. Visitor registration

Singapore and other countries in the ASEAN region suffered significant economic losses when SARS (Severe Acute Respiratory Syndrome) hit these countries in February 2003. . SARS symptoms surfaced only a few days after an individual was infected. However, those who had visited such individuals might have unwittingly contracted the disease in the mean time. When a person was found to have contracted SARS, it became important to identify all visitors to the buildings in which the person was housed and actively investigate the possibility that they might have been infected as well. Healthcare organizations were affected the most in such situations because they serviced infected persons who might have passed on the disease to unsuspecting visitors. They and all other organizations were required to keep track of visitors to their facilities in order to efficiently trace and manage potential infections. XID's technology was piloted for such visitor registrations. Visitors were issued with XID tags and they were registered using these tags every time they visited a facility. Bird Flu is expected to become global pandemic any time soon. XID is well positioned to deploy its solutions quickly in such a situation.

Furthermore, XID significantly accelerated the registration process required for patients and visitors, thus providing time and cost savings to the healthcare organization whilst ensuring speedy, simple, secure access for patients and visitors alike.

4.2.4. Border control

International travel poses possibly one of the greatest threats to the security of a nation. People are able to fly from one country to another faster than ever before and identity theft and the fraudulent misuse of passports are on the rise. Biometrics based solutions offer a secure method of verifying the identity of every traveler. Specifically, biometric data embedded in a passport could be automatically verified against the live data of a person at an immigration counter or immigration check point.

XID participated in biometric standardization in partnership with companies such as SHARP Electronics and leading biometric vendor IRIS Corporation, in order to remain at the forefront of border control technologies and solutions.

4.2.5. Computer login

Passwords are the main means of identification used to log users into computers. The weaknesses of the password login are obvious. Users often

- used the same password for multiple applications
- write their passwords on scraps of paper to be found next to their computers.
- shared their passwords with friends and colleagues to allow for temporary access but then forget to change the password afterwards

XID combined its previously developed two factor authentication system and a monitoring system to address this problem. A registered user can login to a computer using the two factor authorization system. The monitoring system captures user's face every few seconds for verification. The keyboard is frozen and the screen is blacked out when the user leaves the computer for longer than a predetermined interval of time. The user has to be re-authenticated for continued use of the computer.

4.2.6. Automatic Teller Machine authentication

XID has developed an ATM verification system that authenticates each transaction at every machine using the face recognition engine. This solution ensures that an ATM card is non-transferable and therefore cannot be used by anyone other than the owner.

The solution requires the person initiating a transaction to look at a camera embedded into the ATM kiosk. The user's face id is stored in the ATM card. The ATM machine verifies that the person at the ATM terminal is indeed the one who owned the ATM card.

4.3. XID's Business Partners

XID's primary interest is to get its technology and application solutions widely adopted and deployed in the shortest possible time. This is only feasible through establishing partnerships with existing businesses. XID has set up partnerships with system integrators, resellers and OEMs.

4.3.1. System Integrators

XID works closely with system integrators for small to large scale deployments in a variety of environments and scenarios; from national level projects to localized corporate projects. XID trains all of its partners and jointly executes the first project for each vertical to ensure complete knowledge transfer to the partner's team. XID's strategy to pursue open architecture and standards allows easy integration of its solutions / products with the solutions of its business partners.

4.3.2. Resellers

XID seeks partnerships with value-added resellers to define country and vertical specific applications. Resellers are selected based on territorial reach and market coverage, customer base and sales force strength. Resellers are provided with sales kits including demonstration software and are assisted by XID's team in all aspects of the technology, operations, integration and sales and marketing.

4.3.3. OEM

XID works with OEMs to build specific system solutions that meet their customer needs. XID carries out customized design and development of a variety of face recognition enabled products for its OEM customers.

4.3.4. Some of XID's Partners.

XID has or is exploring business relations with the partners listed below. It is continuously exploring the possibilities of establishing business relationships with other vendors interested in adopting, promoting and deploying its technologies.

A4vision
Accenture
Aquatelgna
Atlas G.A
Barcode Technology Inc.

Intel Agents LLC
Integrated Decision Systems
IRIS Corporation
Logos
Miltrade technologies

Biometric Soluzioni per l'indentificazione	RFID Technologies
Blue Force	Sagem Morpho Inc.
CISCO Security	Sharp Electronics
CM Sistem	Sun Microsystems
Comat	Thakral Corporation Ltd.
Cyber Extruder	Thales
Digital Embrace	Tonson Technologies
Hitachi	Tyco
IMCI Technologies	Unisys
UPEK	Wincor | Nixdorf

4.3. Testimonials

Many of the business partners have been very impressed with XID's solutions. The following three are examples of some of these testimonials.

"Having good partners with unique and innovative technologies is key to SHARP Electronics Singapore strategy for meeting the growing demand of highly integrated electronic devices with intelligent software. XID's solid technologies and dynamic team are what we cherish and highly value."

Mr. Toshifumi Nakai, Director, SHARP Electronics Singapore

"With more than 20 years of experience working with best of breed partners to deliver proven solutions to customers, Sun Microsystems is constantly building successful partnerships with companies providing leading edge technologies. XID offers innovative face recognition technologies and we are confident of a long, fruitful partnership."

Mr. Lionel Lim, Vice President & Managing Director, Asia South, Sun Microsystems

"Our experience was referenced by ICAO for defining a new standard for electronic passport and allowed us to identify two new biometric requirements, the iris scan and the facial recognition. In our quest for a common Multimodel Biometrics Platform, we have recognised XID as the preferred complimentary facial recognition technology provider."

Mr. Lee Seng Hoong, Sales & Marketing Director, IRIS Corporation Berhad

5. Lessons learned

Developing good technology is only the beginning. Establishing good business and market development strategies and business partnerships are absolutely essential, for the growth phase of a company.

Getting investors who believe in the team and the solutions is even more critical. XID is presently raising funds from outside of Singapore for three good reasons. Firstly, investors are interested in investing in companies addressing large markets. These large markets addressed by XID are certainly outside of Singapore. Investors like to invest in companies closer to them so that they can help the companies by meeting them on a regular basis. These two are almost universally true for investors' interests in young start ups with management they are not familiar with. The third factor is the nature of venture capital community in Singapore. Most of the VCs in Singapore are late stage investors, typically prepared for mezzanine round for new companies and often for growing well established companies through private equity capital. Hence, it is important to identify larger markets that have sufficient number of early stage VCs who have had experience helping grow start ups into large companies.

6. Going forward

XID started with access control as the initial markets that it will explore. XID has since acquired and developed other technologies that will fuel its growth beyond recognition based opportunities. It is currently exploring growth in animation based industry. Several companies including Sony Corporation have expressed interest in this new direction.

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Re-engineering XID

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Re-engineering XID Technologies – From Enterprise to Consumer Markets

Arcot Desai Narasimhalu
School of Information Systems
Singapore Management University

Abstract

Several studies have addressed the process of taking ideas to markets but few have shared the experiences of start up companies that have reexamined their product strategies and repositioned their products and services for better revenues and profits. This paper reports the efforts related to repositioning of XID technologies, a start up company, into new markets while continuing to exploit its core technical competencies.

1. Introduction

A number of authors have written about innovation methodologies [1, 2, 4, 5, and 6]. Some authors have written about managing the process from ideas to commercialization [3 and 7]. They deal with topics such as the process of technology commercialization, identifying valuable opportunities, incubating to define commercializability, understanding customer adoption, promoting adoption, mobilizing complementary assets for delivery and appropriating the returns to innovation. However, little has been written about how startup companies facing market challenges are reengineered or repositioned to offer products that use the same technological competencies but offer different products aimed at newer markets. This paper is about reengineering a startup company by repurposing its core competencies for new markets.

XID technologies (XID for short) is a startup company (http://www.xidtech.com) set up in 2003 using face synthesis technology developed at Kent Ridge Digital Labs. XID is a technology leader amongst biometric system vendors offering face recognition based solutions. Their award winning face synthesis technology differentiated them from the rest of the pack. A paper on building the XID's business was reported in 2006 [5].

Section 2 of this paper explains the challenges faced by XID when it operated in the biometrics markets using face identification as the core technology. The approach to reengineering XID is discussed in section 3. Section 4 presents a summary of the new opportunities now available to XID. The summary of the experiences is described in section 5.

2. Challenges faced

Several high technology companies such as XID start up with a perceived market opportunity. Market forces channel their products and services into directions that they may not have initially thought about. XID faced the following challenges despite possessing multiple and market relevant product offerings.

XID was selling biometric solutions using face synthesis as the differentiator. Biometrics is often perceived to be a large market. On closer examination one realizes that the markets while big are highly fragmented across geographies. Biometrics market is also crowded. There are several alternative technologies including finger print, hand print, retina, and voice recognition that meet the requirements of the biometrics markets.

Markets serviced by biometrics have seen several false starts, unkept promises and marketing hype. Hence the trust customers placed on biometric solutions is relatively low. Further, given so many alternative types of biometric technologies, customers are often confused about the choices that they had to make. Elaborate experiments are required to assess the relative merits of not only the offerings within a specific type of biometric technology but across all alternative types of biometric technologies. This made the markets certainly confused.

The largest customer base for biometrics is government organizations whether at county, state or national level. These organizations often take long time to make decisions. This surely results in several rounds of meetings starting from request for information all the way to demos supporting tenders. This results in long selling cycles for biometrics solution vendors.

Government organizations often work with prequalified vendors. This is due to the sensitive nature of the projects handled by them. They require trustworthy and proven vendors. Hence it is very difficult for a relatively young company with no previous dealings with government organizations to gain their trust and confidence even if the company has the best solution for their requirements. Thus the entry barriers faced by new biometric start ups are relatively high.

A government organization uses a biometric solution it acquired for a relatively long period of time. They do not replace such solutions with alternative technology very frequently within relatively short time periods. This assures a biometric vendor continued maintenance revenue once their product is used by a government function.

Biometric solution is a small part of a generally larger access control solutions. Hence biometric vendors face the challenge of having to work with business partners who are large solution providers or system integrators for getting their solution to be adopted by customers. While they need to work through the system integrators, it is not the system integrators who decide on what biometric solutions to use. The biometric vendors will need to convince both the ultimate customers and the system integration business partners to accept their solution. As is often the case, several system integrators compete for business when government tenders are released. It is very rare that all system integrators competing for a tender use the same bioinformatics solution. And, the decision to select a system integrator depends on a number of factors including the quality of the proposed biometric solution. So, even the vendor providing the best biometric solution is not guaranteed to be selected if the overall solution proposed by its system integration business partner does not find favor from the government organization. So, the sales of biometric solution vendors are not only dependent heavily on their business partners but also are not in control of the outcomes despite having the best solution for the market.

All these challenges were faced by XID technologies as well. Team XID decided to take a step back and ask themselves whether to continue to focus on the award winning biometric solutions that they had so fondly developed and promoted.

3. Reengineering XID

It is the agility of the founding team of a business that will determine whether a company can repurpose itself in a new market with much greater promise. It is important to realize that companies need to continue to leverage on their core competencies even as they prepare to transform themselves. Team XID's core competency was in the general area of image processing and in the specific area of face processing. They had technology that allowed them to both analyze and synthesize a face. Any change in product offerings had to leverage that core competency.

The first decision that the team made was to refocus their products for the consumer space. The time to market and the selling cycles are significantly shorter than those for enterprise products if they could find a sweet spot in the consumer markets. The challenge will be in identifying the product offerings that would position XID Technologies in a strong consumer space.

XID's core product was changed from a face analysis engine to a face replacement engine. This new engine essentially reused many of the underlying modules developed for the earlier products and required minimal additional modules. Once face replacement was identified as a core technology the challenge then was to identify the applications in consumer space that were compelling. XID first re-branded this new technology as XID Face Media technology.

Team XID decided to apply Face Media technologies to three broad markets. The first one was directed towards consumers who would like to see photorealistic face animation that can alter expressions accompanied with complementary artifacts and environments. The second market would be industrial face replacement applications. The third market identified was web 2.0, gaming and mobile environments.

Fig. 1 is an example of how expressions can be introduced into different types of pictures (Painting, Photo, Caricature and Line Drawing) using the Face Media Technologies. Another example is the video ring tone application as shown in Fig. 2.

Industrial applications of Face Media technologies abound across many markets. Examples are postproductions for movie and television industries.

Clearly there was significant opportunity for Team XID to generate a suite of products and services for consumer, mobile and industrial applications. Some examples are personalization of players in games, advertisements using face replacement technologies, personalized avatars and video ring tones, personalization of Karaokes, personalized greeting cards and personalized emoticons. In fact, some of the applications suited the emerging Web 2.0 markets very well.

It was now up to Team XID to prioritize the products according the market size and opportunities. Clearly the range of products had global appeal and Asia was the number one market for some of the applications such as personalized games and mobile applications. XID Technologies was now poised for a rapid take-off in the consumer space.

It was also refreshing that the Singapore's Infocomm Development Authority bestowed the 2006 National award for the most outstanding product or service to XID in October 2006. This was closely followed by the Asian Innovative Product Award given to XID's Face Media Technologies. XID's Face Media technology was also among those short listed for the World Technology Award 2006 held in San Francisco in November 2006.

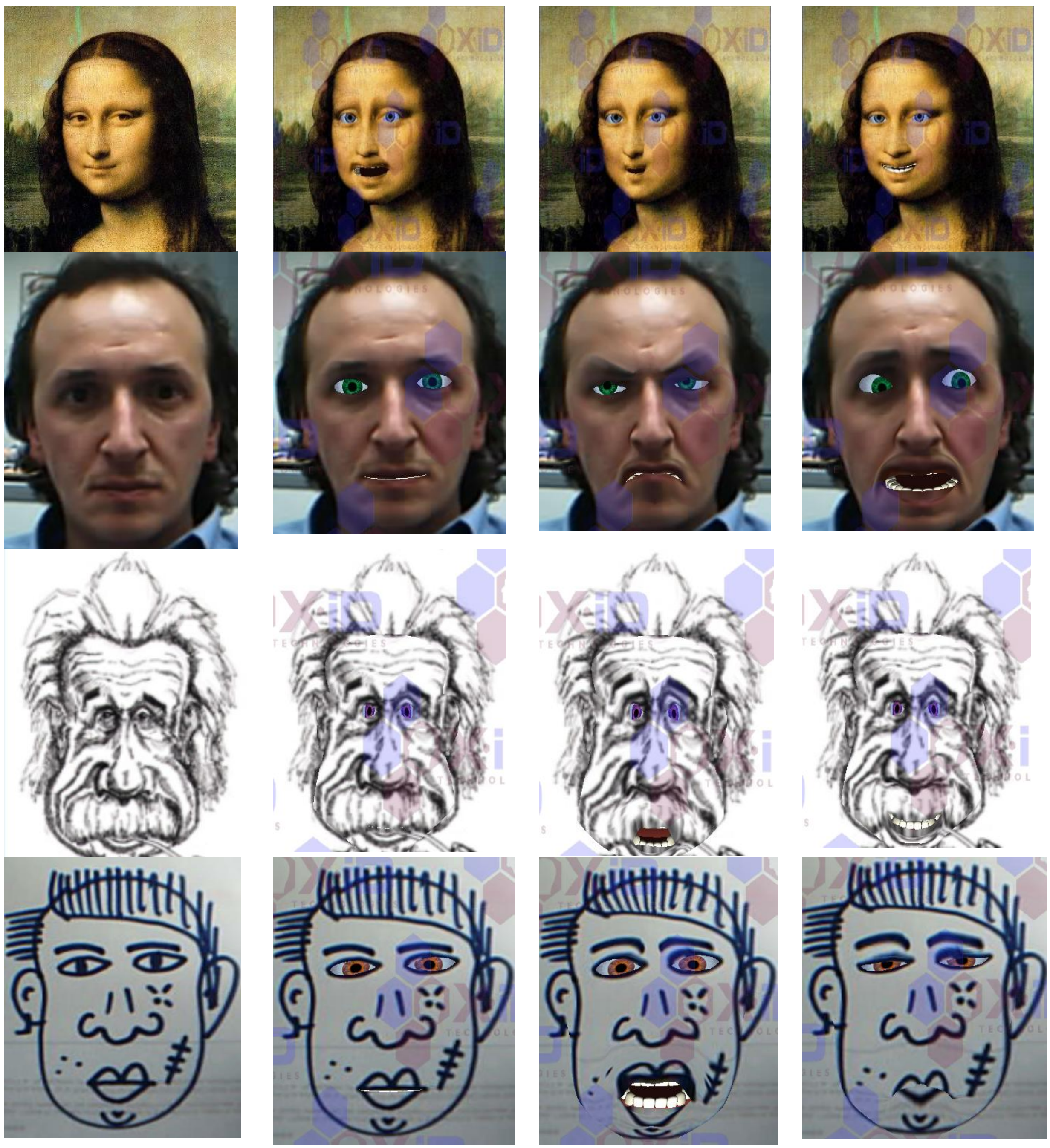

Fig. 1 Animations of different types of images using XID's Face Media Technology.

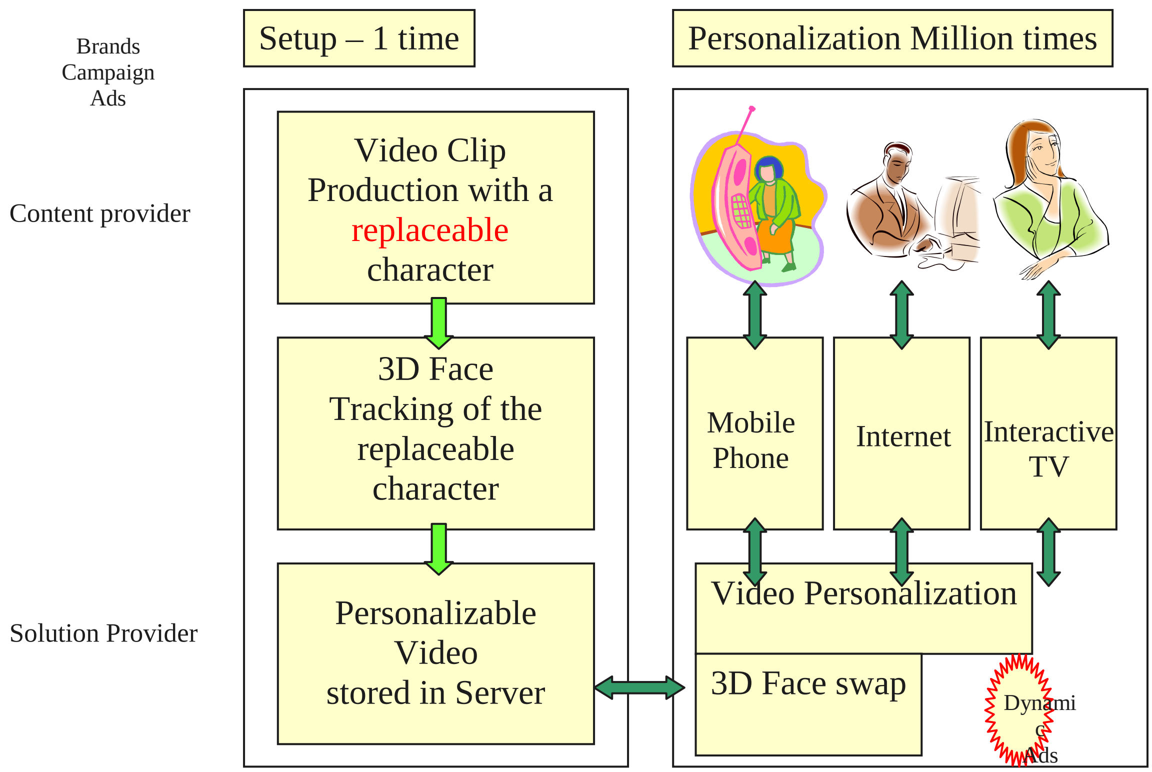

Fig. 2 A system for generating video ring tones.

4. New opportunities

The reengineered XID Technologies now finds itself in the enviable position of multiple suitors expressing a desire to invest in the company. Team XID has the option of deciding whether it needs investments and if so who would be the strategic investor for them.

They also needed to identify a mechanism for rapidly executing the different market opportunities in order to thwart the possibilities of copy cats occupying areas not served by XID technologies in the near term. Some of the opportunities are:

- ❑ Billion dollar markets across video games, post production of videos and movies, and mobile applications that can use the XID Face Media Technology. The video games market alone is worth 18 Billion dollars and Asia Pacific is the largest opportunity for this markets.
- ❑ 3D Avatar Personalization market is another opportunity. This could span a number of applications including the possibility of personalizing emoticons.
- ❑ Singapore is setting up MEDIA 21, a bold effort to create a sizable Interactive Digital Media industry. XID's technology fits some of the areas promoted by MEDIA 21.

There are many possible revenue streams for the XID Face Media Technologies. One of the revenue streams will by selling accessories for Avatars. New and upgraded accessories can be released at regular intervals. The revenue can be either from the consumers or from the sponsors of the accessories. Choice of accessories can reflect user preferences and hence the possibility of sponsorship from accessory manufacturers. Examples are the choice of eye-glasses and other accessories. The companies that market such accessories can use information on customer preferences for positioning their products.

5. Summary

This paper illustrates how a company can remain agile and nimble in sensing new market opportunities and revise its product offerings using its core technology competencies in response to market feedback. The important lesson learnt is to move away from markets with long selling cycles and to repurpose the core competencies to address attractive consumer markets. We hope that reengineering of XID would be a great inspiration to others facing challenges similar to what XID was facing previously.

6. Acknowledgments

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