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Innovation Engine

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Abstract: This paper describes a meta-model for innovation using an automobile engine as a metaphor.
This innovation meta-model is used to manage a collection of innovation models. We develop an algorithm to identify innovations with potential for success using this meta-model. This meta-model can be used by corporations and individuals to identify plausible innovations at any given point in time.

Keywords: Innovation; Innovation Methodology; Innovation Management; Meta-model; Innovation Cylinder; Innovation Chamber; Innovation Chain.

1 Introduction

Schumpeter is recognized as the pioneer in investigating the role of financial and technical innovations in a firm [1]. His later works expanded his theories on entrepreneurship and growth [2, 3]. In these works Schumpeter introduced the concept of "Gales of creative destruction" as the foundation for innovations. These works were soon succeeded by study of successful industrial innovations using two companies as an example [4], a critical review of technology innovation [5] and related articles [6, 7].

There were also articles on Radical innovation [8], Innovator's Dilemma [9], Blue Ocean Strategy [10] and Innovation Cube [11]. Perspectives on innovation and learning [12] and managing product innovation [12, 13] enriched the earlier literature. Additional research was also reported relating to industrial innovation [14, 15, 16], firm level innovation issues [17, 18 and 19] and Innovation Management related [20, 21]. The rising interest in innovation led to a Handbook on innovation [22].

While the different innovation models explain why innovations work there is no clear algorithm or method for identifying possible innovations. The best effort has been by the Value Innovation model presented by the Blue Ocean Strategy where there are some operators defined to modify a value curve drawn on a corresponding strategy canvas. The six paths to innovation described by the authors is again recording their observations and does not provide a step by step approach towards generating possible innovations.

This paper describes Innovation Engine a meta-model for innovations using the Innovation Cube as the framework. The paper uses an auto-engine as a proxy to describe the Innovation Engine (InEng, for short) given that it is easy to understand abstract ideas using real world proxies,. It goes on to define concepts parts of the Innovation Engine such as Innovation Cylinder, Innovation Rule, and Innovation Chain. It describes how InEng can be used to configure a customized set of innovation models that are of interest to a company or an inventor.

The paper makes a distinction between promising innovations, good innovations and successful innovations. Promising innovations are identified using the “Drivers” dimension of the Innovation Cube. Promising innovations are reduced to good innovations using the “Triggers” dimension of the Innovation Cube. Good innovations can be further trimmed to produce successful innovations using the “Enablers” dimension of the Innovation Cube.

The paper defines a preliminary algorithm for generating promising and good innovations. The algorithm does not address the transition from good to successful innovations given that this transition is a direct result of the execution capability of an innovator or an innovative organization.

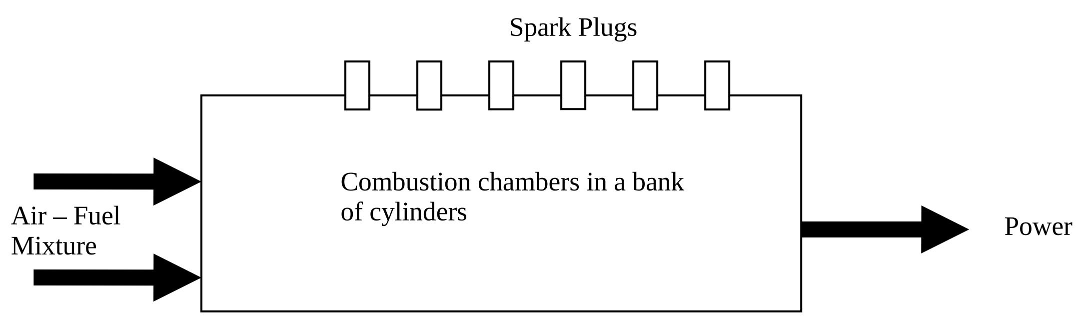
The InEng meta-model is described in section 2. Innovation Bank that consists of all the innovation models represented in InEng is discussed in some detail in section 3. Section 4 introduces some examples of Innovation Cylinders, Innovation Rules and Innovation Chains. Section 5 presents a preliminary innovation algorithm that uses the InEng meta-model. Conclusions and Summary are presented in Section 6.

2 InEng Meta-model

Innovation Cube introduced the drivers of successful innovations Pain:Pleasure, the triggers of successful innovations Market-Shift:Technology-Shift and the enablers of successful innovations Price:Speed as its three dimensions.

The InEng meta-model has parallels to the automobile engine. A simple block schematic of an automobile engine is presented in Figure 1. The Air-Fuel mix enters the combustion chambers of 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 the resulting motion is then translated into power in automobiles.

Figure 1 Block Schematic of an Auto Engine



Innnovation Drivers in InEng correspond to the Air-Fuel mixture of an auto engine. Pain and Pleasure or craving for enhanced experience corresponds to the air-fuel mixture pumped into an auto engine. It is the pain suffered by a large community in this world or the craving for enhanced experience by a sizable community that identify promising innovations.

Innovation Triggers in InEng correspond to the spark plugs of an auto engine. It is a market shift and / or a technology shift that converts a promising innovations into a good innovations.

Innovation Bank corresponds to a bank of cylinders in an auto engine. Innovators or Innovative organizations can configure an Innovation Bank of their choice. An Innovation Bank is made up of selected innovation models. Each innovation model (labelled an Innovation Cylinder or an Innovation Rule or an Innovation Chain) corresponds to a cylinder in an auto engine.

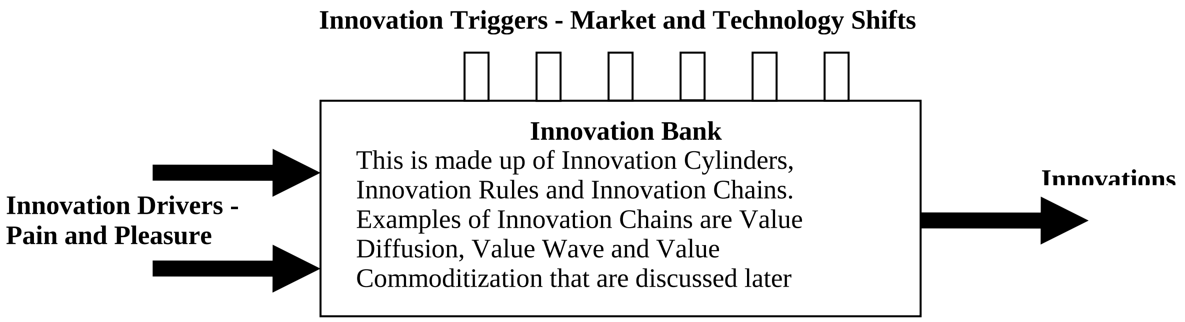
Innovations produced by InEng corresponds to the the power produced from an auto engine.

The process of reviewing and refining innovation models corresponds to the engine oil of an auto engine.

Although we do not use it in the preliminary algorithm, it is the Innovation Enablers that correspond to the gear train of an automobile. They either speed up or slow down the market adoption of good innovations.

A model of InEng using an automobile engine metaphor is presented in Figure 2.

Figure 2 Block Schematic of an Innovation Engine



2.1 The Air-Fuel mixture of InEng

Just as Air-Fuel mixture powers an auto engine so does the desire for reduced pain or the craving for increased pleasure identify promising innovations.

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.

Innovations that do not address significant reduction in pain or do not contribute to significant increase in happiness will face a slower adoption rate and will require significant marketing budgets. Adoption rate will be high and marketing costs will be relatively lower when either the reduction in pain or enhancement in happiness offered by an innovation is significant.

The intensity of the pent up demand for reduction in pain or increase in pleasure corresponds to the degree of compression of the air-fuel mixture in an auto engine. The greater the intensity, the easier an innovation will be accepted by the markets.

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 in some form or shape of pain.

Identifying the correct pains and pleasures will identify promising innovations.

2.2 The spark plugs of InEng

Just as the spark plugs ignite the compressed air-fuel mixture in an auto engine, so do market shifts and technology discontinuities ignite or trigger the creation of good innovations.

Successful innovations have been observed to be triggered either when the required technology and/or the market shifts fall in place. For example, it was the availability of Internet, and the Web browsers as technology shifts and the increased computer literacy of the world population as the market shift that resulted in successful search engine innovations.

The higher the intensity of demand for reduction in pain or the increase in happiness the easier the technology and market shifts will trigger successful innovations. Where the intensity is low then the shifts in markets and technologies may have smaller effects on the success of an innovation.

The following are some examples of broad technology discontinuities or shifts that triggered successful innovations.

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

The following are examples of finer grained technology discontinuities

- USB port in computers
- Miniature camera technology
- Internet Browsers
- MP3 technology

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 finer grained market shifts.

- Mobile phone based Internet Services in Japan
- Success of broadband multimedia services in Korea
- Mushrooming cable TV services in India
- Demand for SMS based services in Singapore and Phillipines

The correct market and technology shifts will advance promising innovations into good innovations.

2.3 The gear train of InEng

Just as a gear train either speed up or slow down an automobile, correct pricing and speed of fulfilment either accelerate or arrest the market dominance of a successful innovation.

Product pricing and speed of delivery of the product to the markets of interest were identified as the enablers of innovation in Innovation Cube. Even good innovations may not be accepted by markets if they are not properly priced and not quickly delivered to the customers. Justly priced innovations are easily adopted by the markets.

Good innovations that are fuelled by compelling drivers and switched on by the right triggers can still stall if they are priced either too high or too low. Good innovations priced too high will attract only a few buyers. They will remain niche products and services. On the contrary, markets may mistakenly ignore good innovations that are priced too low. Markets often associate low priced goods with low value and hence low price for a good innovation may lead to undesired market response.

When a good innovation is introduced at the right price point the market demand spirals into a tornado. The company marketing such an innovation should be ready to fulfil the demand. Imitators and substitutes emerge if the entire market demand is not met within a reasonable period of time. The original innovation may take a backseat when powerful competitors unleash substitutes to fulfil the unmet demands of the market. Hence the volume and velocity of demand has to be matched by the availability of innovative product or service.

When good innovations turn into successful innovations when they are priced appropriately and the company offering the innovation is able handle the market demand adequately.

2.4 Innovation Bank of InEng

Innovation Bank is to an innovation engine what the bank of cylinders are to an auto engine. Just as an auto engine has several cylinders, an innovation engine will consists of several Innovation Cylinders. Each Innovation Cylinder represents an innovation model. Each innovation model may contain one or more Innovation Rules. Innovation Rules that have multiple links are called Innovation Chains. Examples of Innovation Cylinders, Rules and Chains are presented in the next section.

The number or the type of innovation models represented in InEng is not limited. New models or Innovation Rules or Innovation Cylinders can be added to the InEng and existing models can be replaced, enhanced or retired. Such an extensible approach allows for the continuous "tuning" of the InEng.

Innovators are the pistons of innovation or "Innovation Pistons". It is their untiring efforts that translate the opportunities for innovation into actual successful innovations. The friction between pistons and cylinders result in wear and tear in an automobile engine. Analogously, innovators might find working with certain innovation models do not always result in successful innovations. Good lubricants are required to ensure the longevity of piston rings. Review, refinement of existing models of innovation and the creation of new versions of existing innovation models is the "Innovation Oil" that is required to lubricate the "Innovation Cylinders".

3 Innovation Cylinders of InEng

InEng can be customized to fit the needs of an enterprise. Although we have developed several Innovation Rules or chains, an enterprise can choose to install any combination of them – past, present and future models of innovation. Recall each of the Innovation Cylinders has only one goal – to represent a rule or Innovation Chain that will lead to next innovation opportunities.

Recall each of the Innovation Cylinders corresponds to a model of innovation. We discuss some sample Innovation Cylinders in this section. Every Innovation Rule / Chain may not yield new innovations every time it is used. It will yield results only when the predicated conditions are satisfied. Each Innovation Cylinder has to be continuously maintained by refining the innovation model it represents. Over time some Innovation Cylinders may be retired and other Innovation Cylinders introduced.

Given that the aim of any innovation is to create value for the masses that use it, we name each of these Innovation Cylinders after the type of value created. While we have identified seventeen Innovation Rules, we list four sample Innovation Rules in the following sections. All the seventeen rules will be described in a forthcoming publication.

3.1 Value Diffusion

The Value Diffusion Cylinder can generate innovations that move from use in large firms to those meant for use by consumers. An example is the photocopier. Value Diffusion exploits the well known historical evidence that any basic idea takes about nineteen years to reach the masses. In many cases the basic idea would have been created in response to a special purpose needs such as those from the Ministry of Defence or Space Travel. Such value created is diffused across multiple levels or phases catering to different kinds of users before reaching the masses.

Let us take the example of computers. They were initially created to address the needs of the Department of Defence. Once a system was developed for their needs, the innovation made inroads into corporate head quarters for the purposes of centralized Management and Executive Information Systems as a mainframe computer. IBM and the BUNCH (Burroughs, Univac, NCR, CDC and Honeywell) were the leaders in this game.

The preoccupation of the central Electronic Data Processing and later Management Information Systems groups with the requirement of the corporate headquarters led to the starvation of department level computing needs. This gave rise to the birth of the minicomputer. The minicomputer empowered the division / department level employees at a company with access to computing. Digital Equipment Corporation, Sun Microsystems, Hewlett Packard and Apollo Computers were the leaders in this market.

Individual employees then started craving for computing for their own personal needs, albeit initially for scientific computing. This gave rise to the birth of the personal computer. IBM, Apple and Compaq were the early leaders in this game.

When hundreds of thousands of employees discovered personal computing, they wished that the computers were portable. These gave rise to laptops and note books. Toshiba, IBM and Dell were the early leaders in this game.

Over time, personal computers and notebooks have become more of a communication tool than a computing tool for consumers. The demand for small sized portable devices such as Personal Digital Assistants became evident when such a transition took place. Palm and O2 were the early leaders in the game.

Thus the value for users (computing, communications and organizing in this case) diffused from special users to Enterprise level applications to Departmental or Divisional level applications to use by individuals in companies and finally to the consumers at large. This can be represented as an Innovation Rule or an Innovation Chain.

Such an Innovation Chain is called the Value Diffusion chain since it diffuses the value of an innovation across different user groups finally ending up empowering the individual consumers.

Special → Enterprise → Division → Employee → Consumer

Each and every product innovation does not have to start with special applications and work its way down this cycle. Some innovations can start from the middle of the cycle and work their way down Value Diffusion chain. Where it stops depends on the level of pain experienced by that group of potential users. If the pain at some level is not acute enough, then the innovation pauses at the previous state for a while before continuing the journey of diffusion. In most cases, the innovation diffuses down to the consumer level over time no matter where in the Innovation Chain it originates.

One could argue that innovations can flow in the reverse direction – i.e. from a consumer to a corporate. This flow should be defined as an independent Innovation Chain.

3.2 Value Wave

The Value Wave cylinder can generate innovations that provide the next level of value add to the users of current innovations.

Let us continue our discussions about computers. Needless to say no man is an island in this world. When computers were used for corporate applications, they could exist in isolation. When minicomputers were created, they had to talk to the central main frames and this created the need for a new innovation called computer networks. These were often hub and spoke connectivity models - one central office computer was connected to each of the departmental computers. The departmental computers may have more than one link connecting them to the central systems for the sake of reliability. However, the departmental computers often did not talk to each other directly. This worked well for a while given that the number of departmental computers connected to the central computer was small. It is when personal computer market bloomed, the demand for new forms of computer networks emerged. It turned out that Local Area Networks were needed to help connect the computers within a department. This was followed by innovations that connected Wide Area Networks and Local Area Networks.

The need for innovating application software that connected groups of people was apparent once computer networks had matured. Computer networking was succeeded by groupware as the next wave of innovation. Such groupware connected people across departments in a company and across companies in general. Examples of groupware in the corporate world were Word processing, Electronic Mail and Spreadsheets. Examples of groupware in the consumer markets were ICQ and web browsers. Web browsers essentially consumerized FTP (File Transfer Protocol). What was once the envied tool used by sophisticated computer users was now available for all consumers to benefit from.

Once the Groupware wave generated benefit to the masses, there arose a need for some central sites that were the computing equivalent of telephone exchanges of the world. Except, these exchanges would be called Information Service Providers and they would not only send and receive mail to and from users connected to different service providers, but would also host information services that were relevant to the local community of users.

As the types of service providers proliferated, the need for someone to provide an aggregation service to these service providers became a reality. It was with this view Jamcracker was started [1]. The aggregation services will surely be followed by other innovations.

To generalize this observation, one could say that innovations come in waves each one forming the platform or the infrastructure upon which the next ones are built. A concrete example in the Internet world is the following set of Value Waves.

Computers → Computer networks → Groupware → Service Providers → SP tool makers → . . .

There will be similar Value Wave chains in other industries. A good way of generalizing this Innovation Chain is shown below.

Value Proposition 1 (VP1) → Value Proposition 2 using VP 1 as its infrastructure → … → Value Proposition (n+1) using VP (n) as its infrastructure.

3.3 Value Commoditization

The Value Commodization Cylinder generates innovations that are based on modularizing hitherto monolithicly built products.

When new products are developed they follow a cycle. The products are initially developed based on proprietary technologies. At this stage the product is designed as a monolithic whole. Then one of the following two things usually happens.

As the market size for such products increases in size, the original developers of proprietary technology are usually unable to cope with the increased manufacturing capacity demanded by the increase in sales. They therefore decide to engage third party manufacturers to meet the increase in the demand for their products.

Or the competitive forces tend to drive the margins down thereby forcing the market leaders to outsource the manufacturing to third parties in cheaper manufacturing countries.

In either case, this results in the monolithic product being divided into well defined modules or components. Opportunities for creating module level innovations emerge once the interfaces connecting the modules or subsystems are standardized. This results in setting up of new companies that can respond to this new opportunity to build subsystems at a lower cost. We call this cost down subcomponent based innovations Value Commoditization. The Innovation Cylinder that fires this innovation is called Value Commoditization Cylinder. Value Commoditization Innovation Cylinder is represented in the following Innovation Rule.

Monolithic products based on proprietary technologies → modularized components that are cost down.

3.4. Value Migration

Value Migration Cylinder generates innovations that travel across value propositions beginning from function, robustness, cost and after sales service.

When new innovations are first introduced as products, they normally focus on a well defined function that meets the value proposition offered by the product. The early stage is generally focussed on cost or other factors and usually has products that are not very robust.

When there are enough customers interested in the innovation, they demand that the products be robust or rugged. When the number of customers further increases, competition sets in to service the additional unmet demand given that no one company is well prepared to meet all the demand that is unleashed when a product becomes very popular. The innovation focus transitions to bringing the cost of a product down as the competition sets in. When the cost is brought down sufficiently, the focus shifts to after sales support.

This chain of events is called a Value Migration Cylinder of innovation. When a product is first introduced it can open up innovation opportunities related to robustness. When a robust product is available there appear innovation opportunities related to lowering the price of the product. When a low priced robust product is available in the market there are innovations opportunities related to after sales service. What customers view as value migrates from function, to robustness, to price and finally to after-sales service. This Innovation Cylinder is represented in the Innovation Chain shown below.

Function → Robustness → Cost → After Sales Service

5 A preliminary algorithm based on InEng

It is now time to examine how the InEng and the set of Innovation Cylinders / Chains / Rules it supports can be used by an inventor or a firm. A "candidate innovation" refers to an innovation that is under consideration or evaluation.

In the past, ideation exercises where often run without setting the context for such exercises. Those gathered were either asked to name candidate innovations by a facilitator and then the items thus collected short listed either by that group or by the planning group of the company. The result was a collection of ideas most of which did not make sense for the company. One had to examine these ideas very carefully in order to identify one or two gems.

InEng can be profitably used by companies to generate list of promising innovations in a proper context. Listed below is a preliminary algorithm that can be used by firms or individuals for the ideation exercises. This algorithm uses only the Innovation Drivers and Innovation Triggers. Some of the initial studies using fifteen students in a class on "IT and Business Innovations" yielded excellent candidates for innovation. This algorithm needs to be tested by multiple groups of people and refined based on the input before being widely deployed.

Algorithm InEng_One

Initialization

First configure the desired InEng. This would require examining the set of Innovation Chains / Rules and deciding which of them ought to be included in your Innovation Engine. Initialise the Pain:Pleasure, Promising Innovations and Good Innovations stack. Set them all to empty.

a. Identify major pains or pleasures. Develop a stack called "Pain:Pleasure stack" that lists in decreasing order the most significant pain suffered by or the most significant happiness desired by the largest group.
b. Generate a list of recent technology shifts. Call this Technology list. Include technology shifts that are currently in play. Resist the temptation of including broad technology areas such as Wireless. Be as narrow and as

recent as possible. Also, ensure that this technology will be stable over the next 3 years.

c. Generate a list of recent market shifts. Call this Market list.

Generating promising innovations

d. Consider the highest (or next highest) pain or pleasure from the Pain:Pleasure stack.
e. Consider each of the Innovation Chains. Generate candidates for innovations, if any. Add this to Promising Innovations Stack.
f. Repeat steps d and e until you have considered all the Innovation Chains and Rules in the InEng configured by you / your company.
g. Reorder the Pain:Pleasure stack if necessary such that the most promising / compelling innovation is on top and the least promising innovation should be at the bottom. Each of the items in this stack is a candidate for innovation. Call them candidate innovations.

Filter by market shifts

h. Consider the (next) most promising candidate innovation.
i. Consider whether there are likely to be any adoption hurdles. If there are adoption hurdles then skip this candidate innovation and go back to step h.
j. If there are no adoption hurdles examine whether any market shifts from the market shift list might derail this candidate innovation.
k. If there are no threats from any of the list of market shifts and if any of the market shifts is likely to promote the need for this candidate innovatio then add this innovation to the "Good Innovations Stack". Repeat steps h through k until all the candidate innovations in the Promising Innovations stack have been considered.

Filter by technology shifts

l. For each of the candidate innovations in the Good Innovations stack examine the technology needed to realize it.
m. Examine the list of technology shifts to determine whether the required technology shift is in play.
n. Retain this candidate innovation in the list if the required technology shifts are in play. Remove the candidate innovation if the require technologies is not ready.
o. Go to step l until all the candidate innovations in the Good Innovations list have been considered.
p. The good innovations list consists of candidate innovations that are ready for exploitation. You now have to decide whether or not you wish to pursue marketing any of these innovations.

This algorithm will produce a list of good innovations. However, not every individual or company will be able to develop and successfully market each of these innovations. An individual or a company can use the steps described in the Innovation Stack [23] to decide on the innovations that can be easily developed and marketed.

5 Summary

Innovation Engine or InEng meta-model, derived from Innovation Cube is described in this paper. This model consists of Innovation Drivers, Innovation Triggers and Innovation Enablers. The Innovation Drivers and Triggers are explained using an auto engine analogy. Candidate innovations are filtered to form promising and good innovations. The paper presents a preliminary algorithm for generating good innovations.

References and Notes

Note 1 – Jamcracker was started by K.B. Chandrasekhar as a means of offering ASPs a one stop service for mixing and matching the different enterprise software that they would want to access. It eliminated the hassle faced by them in negotiating independently with each of the enterprise software package vendors. It has since evolved. See the following website for more information - http://technorati.com/tag/jamcracker

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