DETERMINING AND MEASURING PRODUCT NOVELTY TO ASCERTAIN INNOVATION IN PRODUCT DEVELOPMENT CYCLE

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Abstract

Rapid Product development forms the backbone of today's industry. Substantial increase in competition compels design firms to develop new products at an increasingly rapid pace. This situation pressurizes engineering teams to develop better products and at the same time develop products faster [Eppinger, et al., 1994]. Continuous innovation is a key factor to enable a company to generate profit on a continued basis, through the introduction of new products in the market – a prime intention for Product Life Cycle Management. A central goal of product development is to create products that are sufficiently novel and useful.

This research focuses on the determination of novelty of engineering products. Determination of novelty is important for ascertaining the newness of a product, to decide on the patentability of the design, to compare designers' capability of solving problems and to ascertain the potential market of a product. Few attempts at measuring novelty is available in

literature, [Saunders, 2002; Chakrabarti and Khadilkar, 2003; Shah and Hernandez, 2003], but more in-depth research is required for assessing degree of novelty of products.

This research aims to determine the novelty of a product by enabling a person to determine the degree of novelty in a product. A measure of novelty has been developed by which the degree of 'novelty' of products can be ascertained. An empirical study has been conducted to determine the validity of this method for determining the 'novelty' of the products.

Key words: Novelty, Innovation

1 INTRODUCTION

During product development, creative solutions can give a product advantage over other competing products. Creative products can therefore be used to increase the price of the products and to get a larger market share [Stig Ottosson, 1995]. Without creative problem solving, products will be traditional, without a creative edge, which can cause loses on the market place [Larry et al., 1988]. A substantial part of the future income for a company will come from new products; thus, companies should introduce new products continuously in order to sustain in this competitive market and make profit. [Rozenberg & Eekels,1991]. Thus, substantial increase in competition compels design firms to develop new products at an increasingly rapid pace. This situation pressurizes engineering teams to develop better products and at the same time develop products faster [Eppinger, et al., 1994]. Creativity is the core ingredient of innovation and it enhances the possibility of generating superior products. Continuous innovation is a key factor to enable a company to generate profit on a

continued basis, through the introduction of new products in the market – a prime intention for Product Life Cycle Management.

'Product design', in which the idea of a product is conceived and embodied, costs are committed and other qualities like manufacturability etc. determined, is the crucial stage for any product in its entire life cycle. Generation of product concepts takes place in the initial phases of design where, innovation, the key for the generation of products thus satisfying the needs of the society, occurs. Miles & Moore [1994] mentions that compared to the overall cost of a scheme, the design cost are a relatively small part; and yet they have a fundamental bearing on the overall costs, durability, serviceability and utility of the product. Good products are the result of good design. A central goal of product development is to create products that are sufficiently novel and useful. Thus, in the modern age we come across many so called 'new' products arising out of product development by various companies; this creates the requirement for identification of good products from the chafe, enabling us to recognize the good products and also identify better inventors/ designers.

The essential element that separates a product from any of its predecessors is its 'novelty'. Identification of novelty is important for the following reasons:

1. To identify products that are more creative.
2. To determine the creativity of designers in order to recognize or recruit them.
3. To select a better product from similar products.
4. To assess the patentability of a recently generated product.

Again, in the day-to-day life we come across many products manufactured by several companies that are quite similar to each other (like pens, speakers etc.); and it might be

difficult for us to identify which product is novel, since the difference among these products may be very small. Thus, apart from identifying novel products, this work also aims to ascertain the qualitative degree of novelty viz. very high, high, medium and low degree of novelty. Next section deals with the tem 'novelty' in greater detail.

The inspiration of this work came from the following observations:

1. While going through Altshuller's work, the inventor of TRIZ methodology [Terninko et al., 2000], it is noticed that there are many levels of innovative products i.e. conventional inventions (32%), small invention (45 %), substantial invention inside technology (4%), Invention outside technology (4%) and discovery (1%) as found by Altshuller. Hence we feel that if products are different from each other in terms of the level of innovation, and since it is known that innovation requires 'novelty', it follows that the products should also differ from each other in terms of the relative degree of novelty. Even though in all these above cases the patented idea is novel, the level of novelty must be different. The products or ideas that fall under 'invention outside the technology' should be more novel than that of those falling in the first category that is 'conventional invention'. The current approaches to assess novelty seem inadequate to honour this distinction.

2. One more observation is that, for similar products like pens, scientific calculators etc., any latest product might come with only 2-3 new functions and so this latest product should be taken as a novel product. Again there are products like new medicines for curing life-threatening diseases such as cancer or AIDS for the first time in history – definitely a novel solution. In both the cases the most recent products are novel, but

the degree of novelty of the products mentioned in the second case is much higher than in the first case. So, novelty detection alone will not be able to differentiate between them - the degree of novelty should also be established.

2 UNDERSTANDING NOVELTY

'New' is something that has been recently created. 'Novel' products are those that are new to the entire human race.

'Novelty' encompasses both new and original. Novelty is 'not resembling something formerly known' [Sternberg and Todd, 1999]. Novelty may also be defined with reference, either to the previous ideas of the individual concerned, or to the whole of human history. The former definition concerns P-creativity (P for Psychological), the latter H-creativity (H for Historical). H-creativity pre-supposes P-creativity, for if someone has a historically novel idea, then it must be new to the person as well as to others [Boden, 1999]. Thus a 'new' product can be termed as 'new' (this should not be confused with our general notion of 'new product' as something that is recently introduced or manufactured or used for the first time), when it comes through p-creativity. Later this product must be checked with all other available products in that category to assess its absolute novelty. Generation of novel products requires H-creativity.

For novelty detection the common characteristics of products could be compared and differences among these characteristics should indicate whether the new product is novel or not as compared to the old products that perform the same or similar task or function. On the

other hand, if a new product fulfils a need for the first time in the history, the product must be taken as novel.

Identification of a 'novel' product is difficult since we are not aware of all the products available in all the countries. A database containing the names and characteristics of all the products in all domains from each country would be an ideal database that would have enabled one to assess with greater ease the novelty of a newly generated product. Absence of such a search system compels us to depend upon the knowledge base of the experts in that domain to which the newly generated product belongs. Amabile [1996] suggests using a few experts to assess the novelty of a new product. If the product is completely new to them and also satisfies some form of need for the society, then the product can be taken as novel. It is imperative that to assess the novelty of a product, one should know both the time line of similar inventions (the sequence of invention of products belonging to the same category – in terms of the domain and functionality) and the characteristics of the previous similar products belonging to the same product line.

As incremental innovations take place more often than radical innovations, the number of products which are slight improvements over their predecessors are many in numbers, making assessment of novelty of these products hard. The methodology as discussed here deals with a process by which both an expert and a novice designer can assess the novelty with its degree, of a new product, by comparing the new product with the old ones.

The objectives of this paper are:

1. To develop a method to assess the novelty of a product.

2. To improve the same method to help assess the degree of novelty of a product.
3. To evaluate this methodology (initial evaluation).

3 DEVELOPMENT OF A METHODOLOGY TO ASSESS THE NOVELTY OF A NEWLY GENERATED PRODUCT

To judge and compare various products it will be useful to compare the characteristics of the products. So, any methodology which breaks a product into its characteristic components should be suitable for comparing products. The widely used model in this regard is the Function, Behaviour and Structure (FBS) model. Many researchers [Chandrasekaran, 1994; Qian & Gero, 1996; Umeda et al., 1996; Goel, 1997; Deng, 2002; Chakrabarti, 2001] have developed definitions and methodology for determining the FBS of products. Extensive work conducted on FBS models illustrates that FBS is a good way of classifying the characteristics of products. The definitions of function, behaviour and structure, derived from the above-mentioned references, as taken for this work are as follows:

- *Function:* Descriptions of what a system does – what is intentional and at a higher level of abstraction.

- *Behaviour:* Descriptions of what a system does, generally non intentional and at a lower level of abstraction. It can be taken as the way by which the function is achieved.

- *Structure:* Structure is described by the elements and interfaces of which the system and its immediate interacting environment are made.

Since novel products are those that are new (recently generated) and original (appearing for the first time in human history); it is implicit that if the function(s) of a new product are different from all other available products, then the new product should be very highly novel product – the need that it fulfils was not previously fulfilled by any other available products at that time, else the product may or may not have been novel. Some examples of highly novel products are (when introduced for the first time): television- to broadcast video and audio data over long distances without any physical connection between the sender and the receiver; camera (pin hole)- to capture image for future use, similarly multi-utility systems such as X-ray machines or drugs such as penicillin are also highly novel products.

Next, if the new product structure matches with that of any other product then the new product cannot be novel, else it should be taken as novel (see the initial steps of the novelty detection method in Fig.2).

The above method should help us identify novel products, but it will not enable us to assess the degree novelty of products, which is required to distinguish among similar products as opposed to individual radical innovations. Thus, a more comprehensive FBS model should be used. In a comparatively recent study [Chakrabarti et al., 2005] the product characteristics (of an FBS model) have been subdivided into seven elementary constructs. We found that this model can be employed to assess relative degree of novelty of products. The seven elementary constructs are:

Parts: A set of physical components and interfaces constituting the system and its environment of interaction.

State: The attributes and values of attributes that define the properties of a given system at a given instant of time during its operation.

Organ: The structural context necessary for a physical effect to be activated.

Physical effect: The laws of nature governing change.

Input: The energy, information or material requirements for a physical effect to be activated; interpretation of energy/material parameters of a change of state in the context of an organ.