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Innovation: From Data and Knowledge

Innovation enables organizations to effectively compete (Christensen 1997). The need to understand innovation has resulted in renewed interest among research and corporate communities.

Though numerous innovation studies have been published, the literature on innovation is filled with myths and inconclusive research findings. Innovation is often discussed based on experiences specific to a particular case study. For example, innovation undertakings at companies such as 3M and Apple Computer have been broadly studied. However, it is not known to what degree these findings would produce similar results in other corporations.

Some companies have followed conventional thinking for too long (Garvin and Levesque 2006). Most widely cited examples include Microsoft's reluctance to embrace the concept of open-source software; Polaroid's slow progress on digital cameras; GM's and Ford's lack of enthusiasm for hybrid cars, improvements in fuel economy, and failure to embrace the common platform concept; and media companies overlooking blogs.

What is Innovation?

Innovation is an iterative process aimed at the creation of new products, processes, knowledge or services by use of new or existing scientific knowledge. Some use the terms "technology-based innovation" or "technological innovation" to emphasize the role of technology.

Innovation Level

The level of innovation varies from incremental to radical.

Incremental innovation often follows a more systematic development process. This could begin with an idea generated in a Research and Development project, or provided by marketing for the existing products to better meet customers' needs. Incremental innovations usually do not open new markets; however, they are the core of business activities (Garcia and Calantone 2002).

Radical innovation, referred also as discontinuous, disruptive, landmarking and groundbreaking, involves a fundamental tech-

nological breakthrough or causes drastic changes in the market place (Gopalakrishnan and Damanpour 1997). For example, music-playing devices were not uncommon before the launch of Apple iPod; however, factors such as the iPod's intriguing design, multifunctional capability and successful bundling with iTunes contributed to its overall success. It is also said that radical innovation constitutes only a small percentage of all innovations and therefore it cannot be addressed by the routine corporate management practices structured for common product improvement (Reid and Brentani 2004).

Product, Process and Business Innovation

Product innovation is concerned with the introduction of new goods that differ from the ones existing in the market. Process innovation is the creation and modification of methods to improve the existing process (including the business process). The direct sales model introduced by Dell Corporation is a clear example of process innovation that has become the company's core strength. It began with an attempt to eliminate the lengthy and costly selling process, which impacted the total product price. While many computer manufacturers concentrated on enterprise integration, Dell decided to outsource many non-competitive tasks. Buying experience, affordable pricing and excellent customer support have satisfied the customer needs, and the PC business has been changed.

From a requirements-driven standpoint, the idea of product innovation can often be traced back to the deficiency of certain product functions. If the product design is modular, it is much easier for a company to improve or redesign such functions. The innovation produced from mapping product functions into customer requirements is generally incremental. Higher level innovation often addresses customer requirements other than function and form.

Besides innovation, by incorporating new functions, e.g., a copy machine plus digitizer plus fax plus email, other approaches are possible:

- Incorporating inventions into existing designs
- Integrating inventions
- Extending inventions
- Impacting the environment, e.g., marketing

Innovation Drivers

The traditional view of the innovation process is based on the technology-push approach — a linear model emphasizing the advancements in science and technology as a sole event triggering the creation of a new design. The process is initiated by a technological breakthrough and followed by a series of developments. This view is criticized as neglecting the influence of customers.

Companies use various means to reach out to customers to incorporate their needs into the product development process. Many researchers have suggested that companies use an incorrect approach and incorrect measurements when consulting with customers. Ulwick (2002) pointed out that companies should not expect solutions to be offered by potential customers; rather, they should ask them about the desired product’s characteristics. He argued that customers may only know what they have experienced and may have a limited frame of reference when suggesting innovative ideas. In addition, companies that link their products too closely to their customers may end up creating incremental innovation. Veryzer (2005) emphasized the need for caution with customer input, and pointed out the importance of discontinuous product development, e.g., the customer’s input should be introduced later in the project. Christensen (1997) stated that customers may emphasize the product’s functionality to too great a degree. For example, many customers buy milkshakes based on the drink’s thickness and strong flavor. The milkshake is thus competing with the “functionality” of such complementary products as sandwiches, soft drinks and salads! Without understanding this phenomenon, fast food companies may develop a product that is completely at odds with what the customers actually want.

The Need for Requirements-driven Innovation

Recognizing customer requirements as derived from product and service has been widely practiced by successful corporations. Traditionally, requirements have been managed by marketing departments. Conventional marketing techniques such as questionnaires, focus groups or interviews are widely used. In the digital world, customer opinions are recorded on blogs, social network forums and other digital media. Using digital media to generate useful information about customer requirements is of paramount importance. Google’s business model is based on matching advertisements with targeted audiences. More recent social network internet sites, such as MySpace or YouTube, follow Google’s model by sending the right information to the right people.

Sources of Requirements

In the past two decades, the design of products and services has been largely driven by customers. After all, the customer buys a product or uses a service. The “customer-as-the-king” model was preceded by the “engineer-as-the-king” (often designer) model, in which technical experts made the decisions for the customer. The customer was expected to accept the offered product or service.

Both models of eliciting requirements have focused on the product and service functions. Product innovation calls for additional requirements, making it worthy of the label “innovative product.” The sources of innovation-fostering requirements are much wider and they include:

- Customers. The information from the customers should be collected over the product’s life-cycle rather than during a limited time frame. Processing that information and blending it with other sources of data and information could be the ultimate key to the success of the designed product.
- Domain experts. Though the importance of the voice of the engineer in forming requirements has been marginalized in the last few decades, it needs to be brought back and expanded when innovating. It is true that a customer is the one who ultimately pays for the product; however, he may not be aware of the possibilities that a new technology or a product/process combination may offer. A technologist may generate innovative features of a product.
- Legacy materials. All kinds of standard and digital libraries could be searched in the quest of innovation. The search would involve hypotheses, theories, innovation rules, and information about inventors and innovators. Data-mining algorithms could create previously unseen value in fusing data and information from various sources.
- Product life-cycle data. A product leaves a data trail over its life cycle. This is in addition to the information provided by the customers or experts before and after the product has entered the market. The volume of data collected can be large, e.g., imagine a database of cockpit and maintenance data collected over the useful life of an airplane. The product’s lifetime data can deliver valuable knowledge leading to requirements spurring innovation.

People are fascinated with inventions and innovations. In fact, progress and development across civilizations have been fueled by human inventiveness. An analysis of certain historical information, e.g., studying inventors or the discovery of commonality among invention processes, could lead to the creation of a body of innovation knowledge. (See Figure 1.)

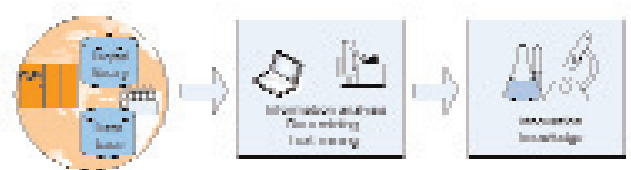


Figure 1: Discovery of innovation knowledge principles through data and text mining of legacy libraries.

A product creates a data trail at every phase of its life cycle, as illustrated in Figure 2. Some of the data serves the existing product while other data is stored for future use.

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Various analyses could be performed on the data collected over the product's life cycle, including extraction of innovation fostering requirements. The locally extracted requirements could be integrated in an innovation-inspiring list or a tree. (See Figure 2.)

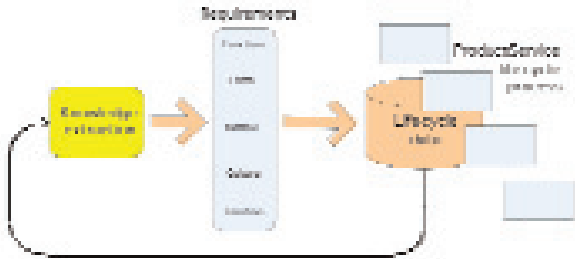


Figure 2: Extraction of innovation knowledge and requirements from the data collected over the product/service life cycle.

The integration of users and stakeholders into product and service development has been validated in a number of industries. For example, Procter & Gamble has opened its product development processes to key stakeholders, which has improved acceptance of their products. Their innovation success rate has doubled in two years, while the R&D expenditure has decreased by 3.4% (Huston and Sakkab 2006).

Despite the success with the customer-driven development process Huston and Sakkab (2006) have a few words of caution,

namely:

- Do not assume that customer-generated ideas can be implemented as originally presented. Additional development is usually needed.
- Do not underestimate the internal resources required.
- The ideas should be supported by the senior management, including the CEO.

As every innovation should lead to market success, any development process has to target the right requirements. With the abundance of data in the cyber world, new ways to acquire and analyze data are needed. The collected data and requirements are refined and analyzed by a group of tools and people to advance innovation.

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