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NEW PRODUCT DEVELOPMENT AND CURRENT TRENDS IN INNOVATION MANAGEMENT

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1. Introduction

You can ask why designers should be interested in innovation management. In this paper we would like to give you some reasons.

It is generally accepted that innovation is one of the driving forces of the economy and without it no company can remain competitive. However, innovation is a complex process and it can be successful only if all its facets – scientific and technological progress, research and development, design, production, process management, marketing and the whole business model - are properly linked together. Innovation is an ***opportunity*** for something new, different. The complexity of innovation is reflected in the definition given in the OECD Frascati manual:

> *"Technological innovations are defined as new products and processes and major technological modifications to products and processes. An innovation is considered performed if it is introduced to the market (**product innovation**) or implemented in the production process (**process innovation**). Innovation includes many research, technological, organizational, financial and commercial activities."*

New product development is one of the initial phases of the innovation cycle. As follows from previous considerations, the innovation can be successful if already at this stage it is focused on the market success; the new or modified product should deliver added value to the customer. Designers usually well understand this facet of the innovation process – the product innovation.

We could all agree that the technological excellence is necessary for the innovation's success. However, often it is not sufficient. Technical skills must be combined with business and managerial ones. Moreover, with the growing competition, the time to market is often critical. Lead times in any part of the innovation process – including design process - should be as short as possible. As products are getting more complex, you need to combine many disciplines and efficiently work in teams. It means that the design process itself has to be innovated. Many technological developments, namely information and communication technologies, can support design process innovation. On the other hand, if you design a new machine, it can initiate substantial process innovations in companies where it will be used.

In the following parts of this paper we attempt to give a brief account of some recent developments in the theory of innovation management. The concept of disruptive innovation introduced in works of C.M.Christensen, is summarised in section 2. Section 3 focuses on

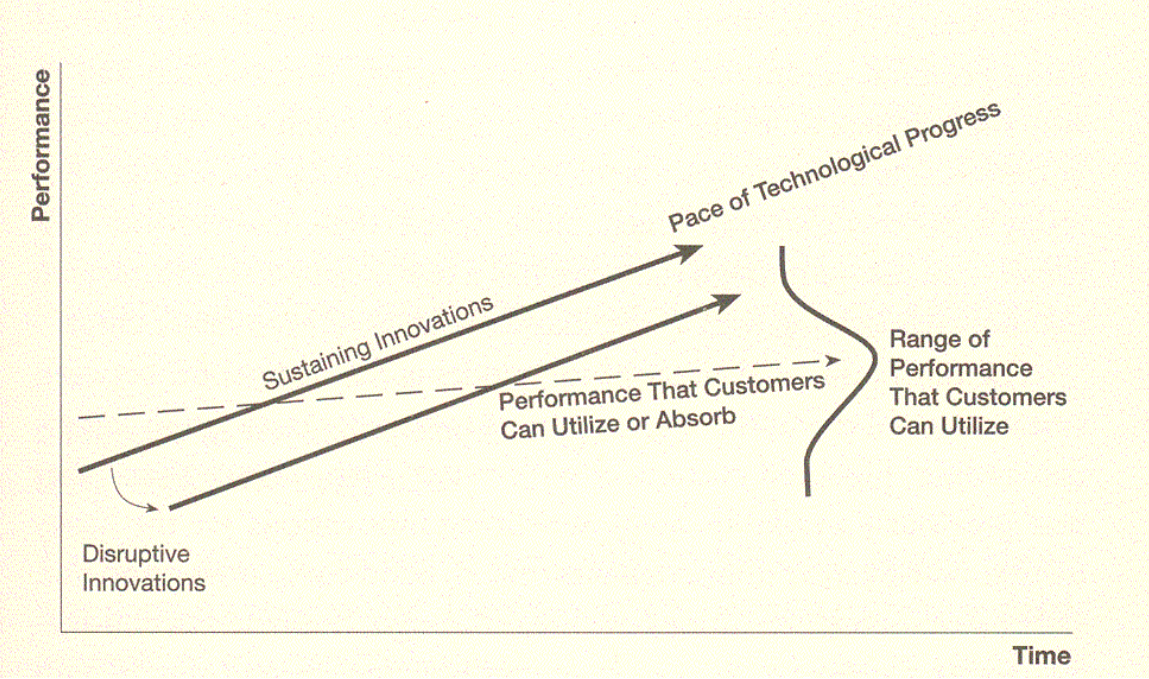
the open innovation, introduced by H. Chesbrough. In the last section we try to suggest how to apply those new research results to the new product development and design.

2. Disruptive innovation

Based on his research in the industry of hard disk drives, Christensen in his book [Christensen 1997] introduced the concept of disruptive innovation and showed that even the best managed companies, focused on their best customers and most profitable markets, often fail in competition with far less technologically sophisticated products.

While ***sustaining innovation*** focus on better product that can be sold with greater margin, ***disruptive innovation*** brings to the market simpler, more convenient, cheaper product that at the beginning appeals to new or unattractive customers. But then the improvement cycle begins and the originally inferior technology improves enough to satisfy the needs of more demanding customers. Industry leaders, with their processes designed and tuned to satisfy the high-end customers, are often unable to respond to disruptive entrants and lose their positions.

This process is well illustrated in Figure 1:



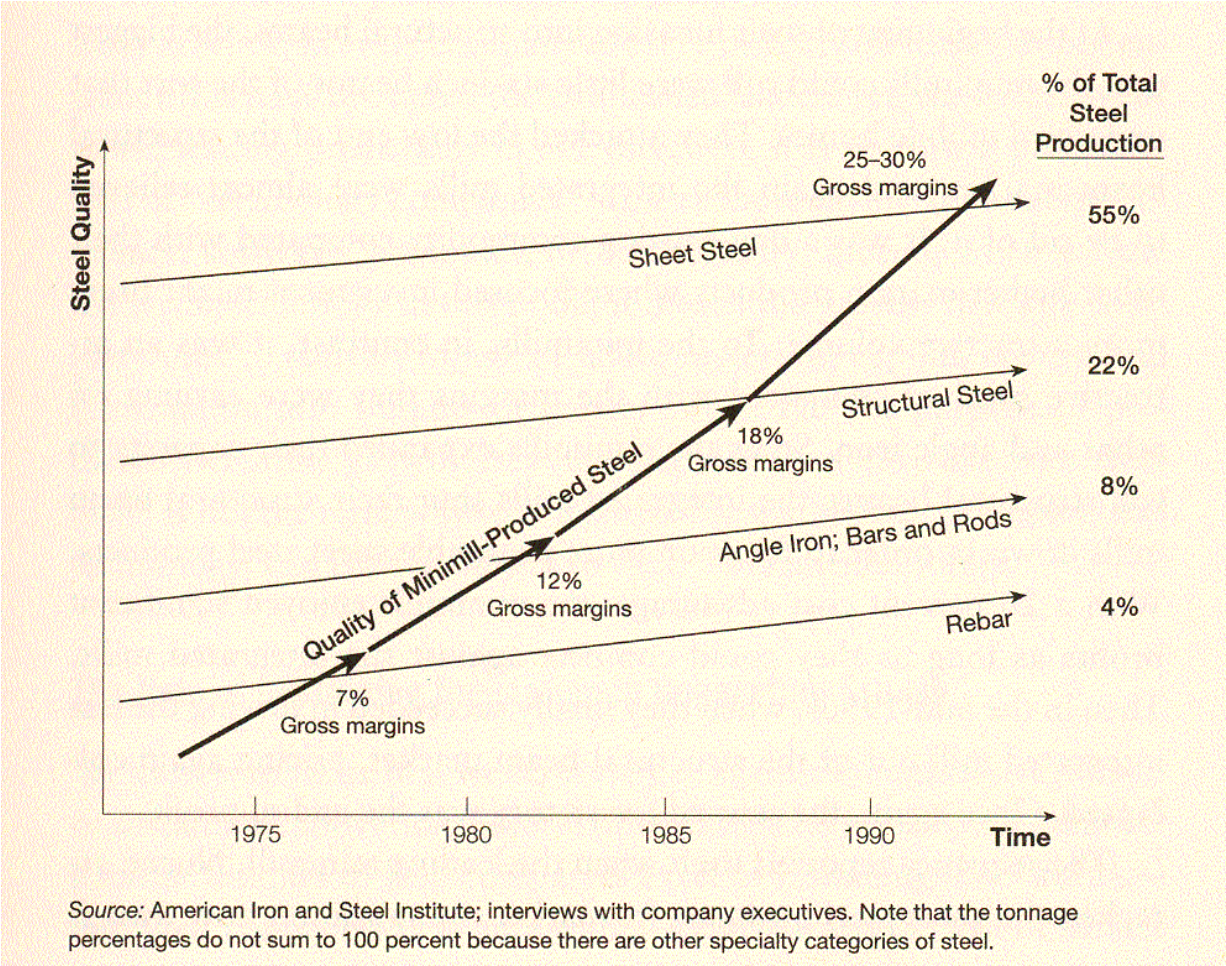
Source: [Christensen 2003, p.33]

Figure 1: The disruptive innovation model

The concept of disruptive innovation is closely linked to the market absorption capacity: at each market there is the speed of change that can be absorbed by the customers. The suppliers innovate their products to satisfy their best customers. However, the technological progress is usually faster than the capacity of customers to employ it.

As industry leaders are motivated to succeed at the best, highly profitable markets, they too often welcome new entrants, serving low-end customers. However, due to the technological progress, trajectory of disruptive innovation in time intersects the trajectory of performance demanded by high-end customers. And then it is often too late for established companies; as they are not prepared to defend their markets, they lose customers and their market share rapidly decreases.

This process is excellently illustrated by the case of minimills – see Figure 2. Notice gross margins and market shares of individual types of steel products.



Source: American Iron and Steel Institute; interviews with company executives. Note that the tonnage percentages do not sum to 100 percent because there are other specialty categories of steel.

Source: [Christensen 2003, p.37]

Figure 2: The Up-market Migration of Steel Minimills

At the successive steps of the process, integrated mills were quite happy that minimills took from them the burden of low profit, low market share business – until it was too late.

The story similar to that of hard disk drives industry and steel minimills was repeated in other industries: hydraulic excavators disrupted cable shovels, discount stores disrupted traditional retail chains.

As Christensen says, „*Moving up the trajectory into successively higher-margin tiers of the market and shedding less-profitable products at the low end is something that all good managers must do.*“ [Christensen 2003, p. 43]. And that is the innovator’s dilemma – each company prepares its own disruption. However, it is also the start of the innovator’s solution: the company has to be prepared to disrupt itself, before anybody else does it.

The theory distinguishes two types of disruption:

- New market disruption: products compete with non-consumption. They are more affordable and simpler to use by new users (PC, transistor radio, desk copiers). And, as has been shown beforehand, as their performance improves, they become good enough for the mainstream market with all the consequences.
- Low-end disruption focuses on the low end of the mainstream market (minimills, discount retail stores, Korean car makers).

Whenever you start thinking about a new product development, you should try to identify the new product’s disruptive potential.

To be disruptive at the new market, there has to be sufficient number of less skilled or less affluent people who can own and use the technology that was formerly available only to more skilled or more affluent people, possibly only in centralized, inconvenient location.

The product can be suitable for a low-end disruption, if there are customers happy to purchase a cheaper product with less (but good enough) performance and if it is possible to create a business model making money at lower price per unit sold.

3. Open innovation

As H.Chesbrough shows in [Chesbrough 2003], the paradigm of innovation has significantly changed in recent decades. The leading principle of the closed innovation, typical for the most of the twentieth century, says that successful innovation requires control. The company must hire the best and the most clever people to outsmart its competitors; it must generate its own ideas, bring them to market first and carefully control the intellectual property, so that the competitors can't profit from our ideas. For most of the twentieth century this model worked well

However, this logic of innovation has been challenged by the growing mobility of highly experienced and skilled people. Growing number of new firms commercialize external research and successfully compete with large, established companies. Time to market is getting ever shorter and customers are more knowledgeable and more demanding. Open innovation assumes that companies use external as well as internal ideas and both external and internal ways to market, and that internal ideas can be taken to the market through external channels to generate additional value.

The principles of closed and open innovation are summarized in the following table:

Closed Innovation Principle	**Open Innovation Principle**
The smartest people in our industry work for us	Not all the smart people work for us. We need to work with smart people inside and outside our company
To profit from R&D, we must discover it, develop it, and ship it ourselves	External R&D can create significant value; internal R&D is needed to claim some portion of that value
If we develop it ourselves, we will get it to market first	We don't have to originate the R&D to profit from it
The company that gets an innovation to market first will win	Building a better business model is better than getting to market first
If we create the most and the best ideas in the industry, we will win	If we make the best use of internal and external ideas, we will win
We should control our intellectual property (IP), so that our competitors don't profit from our ideas	We should profit from others´ use of our IP, and we should buy others´ IP whenever it advances our own business model
Examples of industries: nuclear reactors, mainframe computers	Examples of industries: PC, movies
Largely internal ideas	Many external ideas
Low workforce mobility	High workforce mobility
Little venture capital (VC)	Active venture capital (VC)
Few, weak start-ups	Numerous start-ups
Universities unimportant	Universities important

Source: [Chesbrough 2003, p. xxvi, xxviii]

Table 1: Contrasting Principles of Closed and Open Innovation

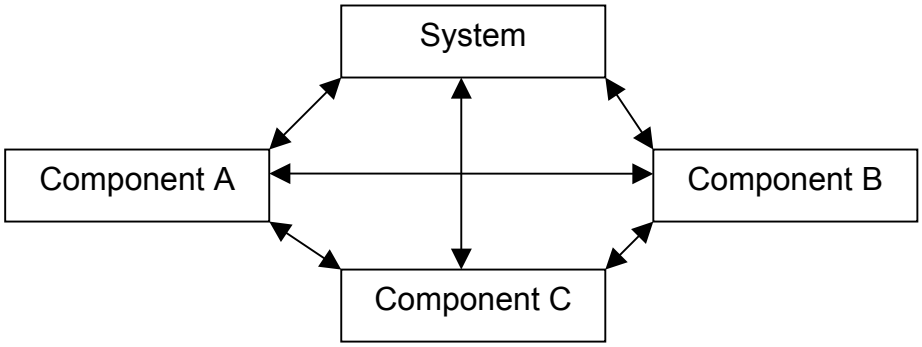
Many industries are in transition between the two paradigms and we recommend you to try to find what is the position of your company.

The term business model is often used, but often not clearly defined. In [Chesbrough 2003, p. 64] we can find the working definition, based on the following functions of a business model:

1. To articulate the *value proposition*, i.e. the value created for users by the product based on the technology
2. To identify a *market segment*, i.e. the users to whom the technology is useful and the purpose for which it will be used
3. To define the structure of the *value chain*, which is required to create and distribute the product. Creating value is necessary, but not sufficient to profit; the ability to claim value depends on the balance of forces between the firm, its customers, suppliers and competitors, but also on the presence of complementary assets as manufacturing, distribution, etc. needed to support the firm's position in this chain
4. To specify the revenue generation mechanism(s) and estimate the *cost structure* and *target margins* of the product
5. To describe the position of the firm within the *value network* linking suppliers and customers, including identification of potential complementary firms and competitors
6. To formulate the *competitive strategy* by which the innovative company will gain and hold advantage over rivals.

On several case studies Chesbrough illustrates that innovation can be successful only if the process of technological development is accompanied by the development of the business model.

A critical role in the new product development plays the definition of the product architecture, i.e. a hierarchy of connections between disparate functions within a system. In an early stage of a product development, there are many possible ways how to combine components; the greater the number of components, the greater the number of their possible interconnections. Often there may be no obvious best way to proceed. To coordinate the complexities and resolve the ambiguities, it is necessary to develop deep expertise in many areas. Possible interdependencies between the system's parts are shown in Figure 3: components A, B, and C constitute the system and they all interrelate – changing one component requires changes in all other parts of the system, because the relationships between the parts are not clearly understood. Such an architecture can be best managed through internal processes.

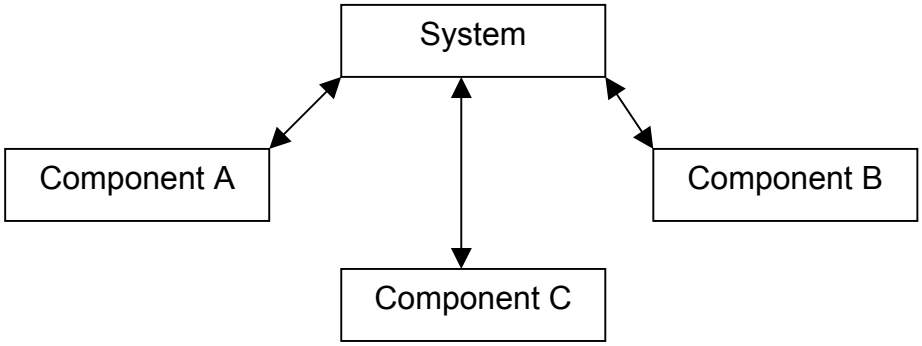


Source: [Chesbrough 2003, p. 60]

Figure 3: An Interdependent Architecture

Over time, as the technology matures, interdependencies become clearer and better manageable. In a modular architecture, components A, B, or C could change without causing any change in other components. The modular design enables to assemble system more easily, from "plug and play" components whose interfaces are well understood. The modular architecture makes it easy for many companies to innovate components without worrying

about possible impact on other parts of the system. Open innovation firms must be prepared to shift their approach: deep vertical integration becomes a millstone around a company's neck. Company must open itself horizontally by participating in the complex supply chains. This approach often opens new markets and requires mastering of so-called *co-opetion*, combination of co-operation and competition.



Source: [Chesbrough 2003, p. 61]

Figure 4: A Modular Architecture

4. Implications for new product development

The above mentioned paradigm shifts in innovation management have direct implications for the new product development and design. Moreover, extended circle of company stakeholders, often including customers, NGOs, local and regional governments and many others, demand new products that are not only of superior quality, but also environmentally friendly, aesthetically appealing, etc. – briefly speaking designed for X, where X can be quite large and multi-faceted set. After-sale service plays an increasing role – and brings increased turnover and profit.

All these requirements can be rarely met by even the most able, skilled designer working alone. Therefore designers must be trained to work in multidisciplinary teams covering many aspects of the new product. In [Vacek 1999] we summarize some requirements to new engineers, which are applicable also to new designers. We say that "*The engineers of tomorrow must be able to solve problems that have not been even formulated during their studies";* life-long learning becomes necessary.

Paradigms of disruptive and open innovations imply that companies must look for unsatisfied needs, new ways of delivering value to their customers, create new business models for new products. Technological excellence of new products is the necessary, but not the sufficient condition for their market success. Technological and business intelligence becomes extremely important – you must know what is happening in relatively diverse disciplines, anticipate potential disruptions and use them as an opportunity, otherwise they can become threats. On the other hand, the company must competently work with its intellectual property and – if it cannot be used internally – to create spin-offs or to license it to external companies.

While advances in manufacturing in the past 25 years have been largely driven by information technology, computer tools, automation, and advanced work practices, unit processes that transform materials into products have advanced only incrementally. Mechanical or structural parts and products still require partitioning of processes by functions. New, emerging technologies, as nanotechnology, biotechnology, and direct materials deposition present new challenges to research, development and design. Comprehensive survey of the use of four converging technologies - nanotechnology, biotechnology, information technology and cognitive science - for improving human performance is given in [Roco 2002].

Concurrency can shorten the time between the conception of a product and its realization. However, current systems often lack flexibility and the ability to respond to rapid market change. The barriers can be eliminated by enabling technologies focused on:

- Systems Modeling Capability
- Modular and Adaptable Design Methodologies
- Adaptable Processes and Equipment
- New Materials and Processes

All above mentioned processes open new ways to cooperation between universities and industry that can be advantageous for both sides. In the open innovation mode, universities can bring to companies new innovation impulses and, with their good access to information resources, can play an important role as centres of knowledge networks and information and knowledge brokers. On the other hand, the feedback from companies and from the market can bring new impulses to universities.

Unfortunately, many knowledge-based processes were undermined at the very beginning of transformation of the Czech economy, as industrial R&D and centres of economic and technical information often were among the first victims of sometimes not very well-reasoned restructuralisation processes. Only recently the policy makers realized the important role of strategic planning in the market economy. We can only hope that the policies will be transformed in actions.

Acknowledgement

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