TEACHING "NEW PRODUCT MANAGEMENT" FOR INCREMENTAL AND RADICAL INNOVATION

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ABSTRACT
In educational collaborative design projects with industry, the nature of innovative activity has shifted from radical to incremental product change. This article claims that at least user and monetary value creation in New Product Development (NPD) projects can be achieved through competitive design solutions demonstrating better "Style" and "Technology". In terms of educational planning initiatives, both, radical (Ansoff's Product-Market matrix) as well as incremental (3-D Positioning Maps) innovation methods and tools should be taught to design students. However, awareness should be created among these students that "Diversification" (= Radical Innovation) on its own is not the only generic growth strategy to gain significant competitive advantage. Focusing on *"Development of new products for existing markets"* or *"Creation of new markets for existing products"* as generic growth strategies in combination with a design strategy targeted at the "Upper Right Quadrant" of Cagan and Vogel's positioning map can also lead to a significant value creation for companies.

Keywords: Value creation, incremental innovation, radical innovation, new product management

1   INTRODUCTION
Within the context of integrated product development, the level of innovative success, leading to competitive advantage in formulating an effective product strategy and a design goal is highly dependent on how thorough and effective "Product Planning and Goal Finding" processes were carried out in the Fuzzy-Front-End of Innovation. Although many new-products professionals may harbour hopes of developing "the next big thing" in their respective industries, most product development efforts focus on incremental innovations. Accordingly, most research on New Product Development (NPD) processes focus on the development of evolutionary products [1]. However, an attempt has been made to answer certain fundamental questions by professionals seeking insights into the means for achieving breakthrough innovations. These questions are:
- Does the NPD process for radical / discontinuous differ from the process for incremental / continuous innovation with respect to value creation for firms?
- Once differences in NPD processes has been identified, how can then design students and companies be made aware of on how these differences affect and distinguish front-end innovation activities .

2   DIFFERENT PERSPECTIVES ON INNOVATION
Many authors have written about the different perspectives that firms have on innovation to determine their level of "radicalness". Utterback and Abernathy claim that the relative focus of innovation changes as the firm matures, underscoring its fluid nature with respect the firm and the environment in which it operates [2]. Crawford discussed three levels of innovation, pioneering adaptation and imitation [3]. Likewise, it is suggested that the degree of technological change represented by a product is the most useful way to classify development projects [4]. Lee and Na distinguished between "incrementally improving innovativeness" and "radical innovativeness, while explicitly excluding commercial performance as a basis for classifying innovations [5] Christensen distinguishes between two fundamental types of innovation, *sustaining* innovation, which continues to improve existing product functionality for existing customers and markets, and *disruptive* innovation, which provides a different set of functions which are likely to appeal to a very different segment of the market [6]. Existing firms and their customers are likely to undervalue or ignore disruptive innovations, as these

are likely to appear inferior to existing technologies in terms of measures of benefit and performance [7].

From a methodological and enquiry perspective three types of innovation approaches can be distinguished. These are User-Centred, Design-driven and Context-based innovation approaches.

Significant efforts in recent literature studies concentrated into investigating a specific approach to design usually referred to as *user-centred design* [8, 9]. This approach implies that product development should start from a deep analysis of user needs. In practice, researchers spend time in the field observing customers and their environment to acquire an in-depth understanding of customer's lifestyles and cultures as a basis for better understanding their needs and problems [10].

Unlike user-centred design processes, design-driven innovation is hardly based on formal roles and methods such as ethnographic research. However, this type of innovation plays a crucial role in the innovation strategy of design intensive firms, but still remained largely unexplored [11]. Its processes are hard to detect when one applies the typical methods of scientific investigation in product development, such as analyses of phases, organizational structures, or problem-solving tools [12]. In this case, Design-driven innovation may be considered as a manifestation of a *reconstructionist* [13] or *social-constructionist* [14] view of the market, where the market is not "given" a priori, but is the result of an interaction between consumers and firms. Hereby, users need to understand the radically new language and message, to find new connections to their socio-cultural context, and to explore new symbolic values and patterns of interaction with the product. In other words, radical innovations of meaning solicit profound changes in socio-cultural regimes in the same way as radical technological innovations, which solicit profound changes in technological regimes [15].

In terms of context-based innovation, the user-product relationship is not something that takes place in isolation, but is part of a larger context, consisting of all kinds of factors. Examples of factors are social patterns, technological possibilities, and cultural expressions, that affect the way people perceive, use, experience, respond and relate to products[16].According to Hekkert and Van Dijk, these factors can be classified as "trends" and "principles". Trends are developments, which change over time, such as behaviour, values and preferences, whereas principles refer to immutable laws or general patterns that can be found in human beings or nature [17]. When refocusing on user-product relationships within (environmental), a systems thinking approach comes into the picture. This systems thinking approach is based on the understanding that a set of interconnected entities, comprising people, processes and technologies, which are dynamic in their behaviour and have a purpose or reason for existence [18]. From an innovation management perspective, systems thinking have surfaced in different net work theories and are likely to be associated with different environmental contingencies and types of innovation. For example, complex products have to interface with the products and services of other vendors, and it is in the interest of all organizations to share knowledge in order to ensure compatibility. In such cases an 'open' network is most appropriate. In contrast, a 'closed' network seeks to control standards by economies of scale and proprietary standards in order to lock-in customers and other organizations in the network [19].
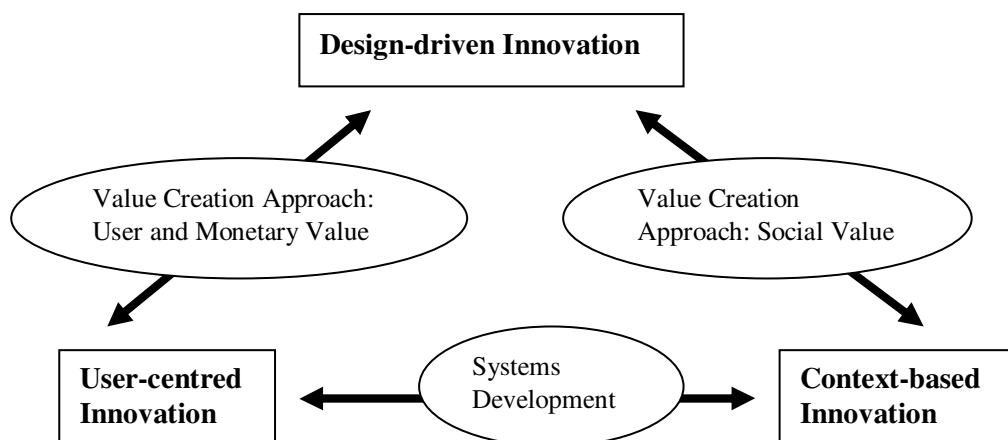

Figure 1. Relationship between different types of innovation approaches, value creation and systems development

The three types of innovation approaches; User-centred, Design-driven and Context-based innovation, have initiated a common platform in the search for innovative products and services (see figure 1).

Whether the objectives are radical or incremental, benefiting the receiver (customer / user) or provider (firm), the overall aim is some form of "Value Creation". Hereby, value creation and systems approaches function as the glue between the three innovation approaches.

3   THE CONCEPT OF VALUE CREATION IN PRODUCTS AND SERVICES

In their investigation of what it takes to create breakthrough products, Cagan and Vogel concluded that one of the key attributes that distinguishes breakthrough products from their closest followers is the significant value they provide for users [20]. Taking it one step further, the more value in a product, the higher price people are willing to pay, with the price increasing more rapidly than the costs, resulting in a profit margin, significantly higher for higher valued products. After all, as Drucker has pointed out, *"customers pay only for what is of use to them and gives them value"* [21].

Boztepe has categorised user value according to utility, social significance, emotional and spiritual value [22]. Utility value refers to the utilitarian consequences of a product. Social significance value refers to the socially oriented benefits attained through ownership of and experience with a product. Emotional value refers to the affective benefits of a product for people who interact with it. Similarly, Sanders and Simons identified 3 types of values related to co-creation, which are inextricably linked. These values are monetary, use /experience and societal [23]. Driven by context- and situation-specific experiences, value changes as cultural values and norms, and external contextual factors change [24].

4   INNOVATION AND VALUE CREATION MODELS

As the global environment is continuously changing, organizations and businesses are compelled to permanently seek the most efficient models to maximize their innovation management efforts in terms of product, process and service. Hereby, most innovation models are based on a continuum from evolutionary or "continuous" to revolutionary or "discontinuous" [1].

Within the context of diversification strategies, three models will be discussed below.

Ansoff's Product- Market matrix is frequently used to position generic innovation strategies through new methods and paradigms [25], which efficiently serve existing and new markets with new and/or modified products as well as services. In his matrix, the most ambitious aim for companies is diversification, which is a radical innovation strategy targeted towards developing *new products* for *new markets*.

Veryzer discusses innovation from a "Technological Capability" and "Product Capability" dimension perspective [1]. In this context, radical innovation involves advanced capabilities that do not exist in current products and cannot be achieved through extension of existing technology. However, from a design perspective, commercially discontinuous innovation, whereby "Technological Capability" is considered the same is also very relevant in determining value creation.
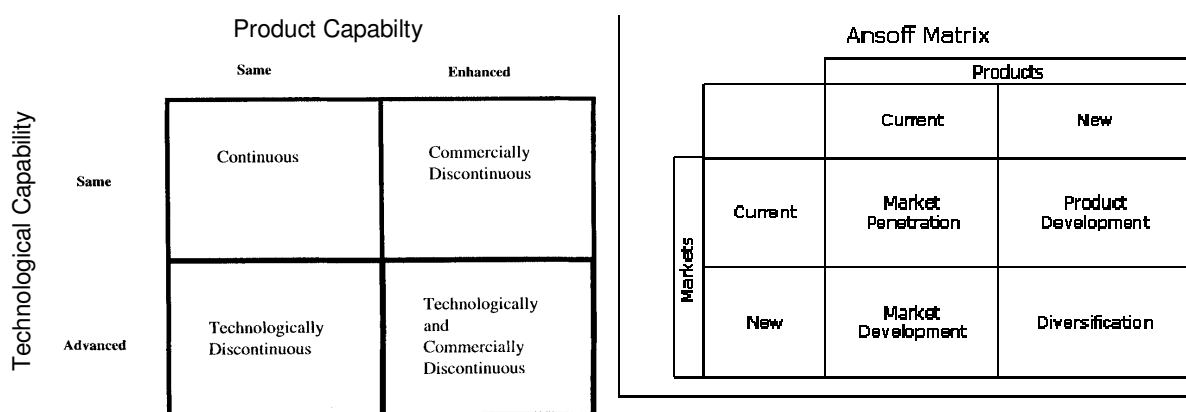

Figure 2. Ansoff´s Product-Market matrix [25] and Veryzer´s Technological and Product Capability Mapping [1]

Cagan and Vogel stresses that market penetration strategies should be within the context of value creation. Referenced to improved "Style" and "Technology", it has been argued that consumers are willing to pay a higher price for product purchases, which connect with their own personal values *(see figures 3A and 3B)* [20]. As visualised in figure 3A, the more value in a product, the higher price

people are willing to pay, with the price increasing more rapidly than the costs, resulting in a profit margin, significantly higher for higher valued products.
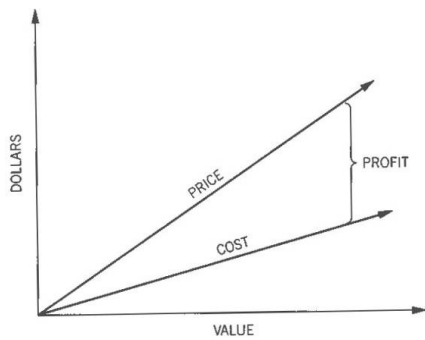

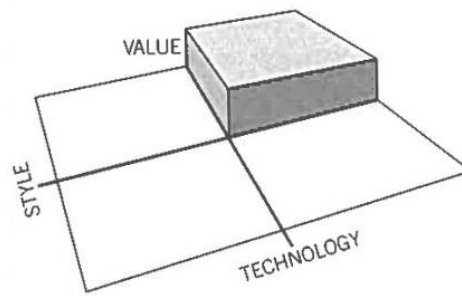*Figure 3A. Price and Cost versus Value – Profit increases with added value [20]*

Figure 3B. Value creation positioned according to New Style and New Technology [20]

With respect to the three innovation and value creation models, this paper argues that collaborative product planning projects with industry, conducted within an educational setting, seldom lead to diversification as contextualised by Ansoff's four generic growth strategies [25]. Main reasons are:

- Companies are generally introspective in their innovation selection criteria, rejecting possibilities for radical product change and failing to respond to significant market shifts.
- Existing firms and their customers are likely to undervalue or ignore disruptive innovations, as these are likely to appear inferior to existing technologies in terms of measures of benefit and performance.
- Industrial collaborators do not confide in students being able to identify these significant market shifts and propose radical innovations
- Executors lack experience to propose radical innovative concepts within the short project timeframe, as exemplified in a 1st year M.Sc. studio design project.

5   IMPLICATIONS FOR DESIGN EDUCATION

The role of industrial design in the product development process has changed and extended. It is not simply about emphasising form giving, drawing and model making. As design educators are not able to predict the possibilities of technology, it is necessary to emphasize the design process based on the inquiry approach and continuous learning of new knowledge and skills for design students in order for them to adapt to these changes. According to Schön, due to the rapid development of technology, 50% of what we teach today will be out-of-date in five years [26].

Within the context of teaching NPD, Yen and Wei claims that incremental innovation and radical innovation requires different design knowledge. To achieve incremental innovation more emphasis is to be placed on basic operation & skills, whereas for radical innovation visionary capabilities should be stressed more upon [27].

However, based on the analysis of 9 strategic design projects, this article showed that visionary capabilities were also important and relevant in generating incremental innovations. In these 9 projects 1st year M.Sc. Design students acted in groups of 2 or 3 as consultants and were required to formulate a product planning strategy as well as materialise the strategy into a product and / or service. In 5 of the 9 projects, a "New Product – Existing Market" strategy was targeted, whereas 2 projects aimed at creating a "New market for Existing Products and Technologies". Two (2) companies adopted a "natural" diversification strategy, as they were contract manufacturers and did not have experience in developing their own products. However design goals were determined through discussions among company management and design students, driven by a conjecture – analytical design approach *(figure 4A)*.

From a "Design Strategy" and "Value Creation" perspective, students were capable to propose product and service variations / extensions, which may enhance a company's competitiveness. This has been achieved through innovative design concepts challenging new technologies and style (= ergonomics and form) and by positioning products and services in the "Upper Left and Right Quadrant" of the 3-D

"Style" versus "Technology" positioning map as described by Cagan and Vogel [20] *(figure 4B).* The positioning map aligns with Veryzer's Technological and Product Capability Mapping [1], emphasising technologically or commercially discontinuous innovation or a combination of both.

New Market	• Sweets • Social Game Play	• Multi- functional Outdoor Fire Place • Load-Crosser	
Existing Market		• Heating Systems for the Future • Energy Control Systems for the Future • Monitoring Fish health • New Thinking in Bridge Design • Bridge and Identity	
	Existing Product	New Product	

Figure 4A. Positioning of Strategic Design Projects on Product-Market matrix

STYLE	**HIGH**	• Sweets • Social Game Play • Multi- functional Outdoor Fire Place • Load-Crosser • Monitoring Fish health • New Thinking in Bridge Design *(Current and near-future concepts)* • Bridge and Identity *(Current and near-future concepts)*	• Heating Systems for the Future • Energy Control Systems for the Future • New Thinking in Bridge Design *(Mid.- and far-future concepts)* • Bridge and Identity *(Mid.- and far-future concepts)*
	LOW		
		LOW	HIGH
		TECHNOLOGY	

Figure 4B. Positioning of Strategic Design Projects on Cagan and Vogel´s Positioning Map

A deeper analysis of strategic design reports, complemented with interviews with students has surfaced the following limitations and opportunities in teaching NPD:

- Nature, history and (short-term) pragmatic attitudes of some of the companies have favoured incremental innovation above radical innovation
- Most of the companies have unconsciously influenced the students to focus on the "new product / existing market" or "existing product / new market" strategies
- This led to a "design strategy" approach towards innovation, whereby the development of "Style" and / or "Technology" in the design of products and services was emphasised to create value
- Although in some cases a radical product idea is *"in the making",* very aggressive time frames for the projects as well as the lack of experience among students to frame and communicate, did not provide a convincing atmosphere for the company to pursue diversification.
- On the contrary, companies, who aimed for diversification in their generic growth strategies may not always end up with a complementary "high valued" design outcome, as illustrated through the "Multi-functional Outdoor Fire Place" and "Load Crosser" projects.

From an educational planning perspective, learning experiences showed that Front-End of Innovation (FEI) methods and tools should be taught to students in conjunction with Ansoff's Product-Market matrix [25], as well as the 3-D Positioning Maps [20]. This will then lead to the following thinking approaches:

- Diversification on its own is not the only generic growth strategy to gain significant competitive advantage
- Focusing on "Development of new products for existing markets" or "Creation of new markets for existing products" as generic growth strategies in combination with a design strategy targeted at the "Upper Right Quadrant" of Cagan and Vogel´s positioning map can also lead to a significant value creation for companies.

6 CONCLUSION

In support of an industry dominant design attitude, whereby the nature of innovative activity has shifted from radical to incremental product change, collaborating with students on strategic design projects does not compromise significant value creation. Developing competitive and radical design solutions aimed at the "Upper Right Quadrant" will then be the new design strategy aim in industry collaborative design projects.

REFERENCES

[1]   Veryzer, R.W. Discontinuous Innovation and the New Product Development Process. *Journal of Product Innovation Management*, 15 pp 304 – 321, Elsevier Science Inc. New York (1998)

[2] Utterback, J.M. and Abernathy, W.J. A dynamic model of process and product innovation. *Omega* 3: pp.639-656. (1975)

[3] Crawford, C.M. *New Product Management*, 4th Edition. Boston. Richard D. Irwin, Inc. (1994)

[4] Wheelwright, S.C. and Clark, K.B. *Revolutioning Product Development*. New York: The Free Press, (1992)

[5] Lee, M. and Na, D. Determinants of technical success in product development when innovative radicalness is considered. *Journal of Product Innovation Management*, 11: pp 62-68 (1994)

[6] Christensen, C. *Innovators Dilemma*. Boston, MA: Harvard Business School Press (1997)..

[7] Tidd, J. Innovation management in context: environment, organization and performance. *International Journal of Management Reviews*. Vol. 3 Issue 3 pp. 169–183. Blackwell Publishers Ltd (2001)

[8] Chayutsahakij, P. and Poggenpohl, S.: User-Centred Innovation: The Interplay between User-Research and Design Innovation. *Proceedings of the European Academy of Management 2nd Annual Conference on Innovative Research in Management (EURAM)*, Stockholm, Sweden (2002).

[9] Veryzer, R. W. and Borja de Mozota, B.: The Impact of User-Oriented Design on New Product Development: An Examination of Fundamental Relationships. *Journal of Product Innovation Management, 22*: 128–143 (2005).

[10] Belliveau, P., A. Griffin, A. and Somermeyer, S.M.: *The PDMA Toolbook for New Product Development*, Wiley, Hoboken (2004).

[11] Verganti, R.: *Design Driven Innovation*. Boston, MA: Harvard Business School Press (2008).

[12] Shane, S.A. and Ulrich, K.T.: Technological Innovation, Product Development, and Entrepreneurship in Management Science. *Management Science 50* (2):133–144 (2004).

13] Kim, W.C. and Mauborgne, R.: Blue Ocean Strategy: From Theory to Practice. *California Management Review 47* (3):105–121 (2005).

[14] Prahalad, C.K. and Ramaswamy, V.: Co-opting Customer Competence. *Harvard Business Review*. January–February, 79–87. (2000).

[15] Geels, F.W.: From Sectoral Systems of Innovation to Socio-Technical Systems. Insights about Dynamics and Change from Sociology and Institutional Theory. *Research Policy 33*: 897–920 (2004).

[16] Hekkert, P. Productive Designing: A Path to Creative Design Solutions, in *Proceedings of the Second European Academy of Design Conference*, Stockholm, (1997) Available Internet: http://www.svid.se/ead.htm.

[17] Hekkert, P. and Van Dijk, M. Designing from context: Foundations and Applications of the ViP approach *In: P. Lloyd and H. Christiaans (Eds.), Designing in Context: Proceedings of Design Thinking Research Symposium 5*. Delft: DUP Science. (2003)

[18] Singleton, W.T., *Man-Machine Systems*, Penguin, London, (1974)

[19] Garud, R. and Kumaraswamy, A. (1993). Changing competitive dynamics in network industries. *Strategic Management Journal*, 14, pp. 351–369.

[20] Cagan, J., and Vogel, C. M.: *Creating breakthrough products: Innovation from product planning to program approval.* Upper Saddle River, NJ: Prentice Hall (2002).

[21] Drucker, P. F.: *The essential Drucker: The best of sixty years of Peter Drucker's ideas on management*. New York: Harper Business (2001).

[22] Boztepe, S.: User Value: Competing Theories and Models. *International Journal of Design*. Vol 1, No 2 online (2007).

[23] Sanders, L. and Simons, G.: A Social Vision for Value Co-creation in Design. *Open Source Business Resource*, December (2009). Available at http://www.osbr.ca/ojs/index.php/osbr/article/view/1012/973

[24] Overby, J. W., Woodruff, R. B., & Gardial, S. F.: The influence of culture upon consumers' desired value perception: A research agenda. *Marketing Theory*, 5(2), pp. 139-163 (2005).

[25] Ansoff, H.I. *Corporate Strategy: An Analytic Approach to Business Policy for Growth and Expansion*. Harmondsworth: Penguin. (1968).

[26] Schön, D.A. *Educating the reflective practitioner*, Jossey-Bass Publishers, London, UK (1988).

[27] Yen, C.C and Wei, H.S. Patterns of the Incremental and Radical Innovation of Design-Driven Enterprises in Singapore. *IASDR 2009* Seoul.