DESIGN, PRODUCT DEVELOPMENT, INNOVATION: ALL THE SAME IN THE END? A SHORT DISCUSSION ON TERMINOLOGY

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Keywords: design research and methodology

1. Introduction

It is widely accepted in academia and industry that new products or services, which are developed on a regular basis, are one of the main factors for sustainable success of companies. Although the fact itself is clear, the terminologies to describe this professional and academic field are manifold. Terms such as design, engineering design, product development, and innovation are used. Some of these terms are common in the business area some are common in the engineering field. The idea for this paper arises from an intensive discussion on the difference in terminology during the Special Interest Group Workshop on Collaborative Innovation at ICED03 in Stockholm. Based on the different terminologies from some exponents of the design science as well as other communities the paper tries to broaden the view on what "design" means and shows some different perceptions of the term between languages (e.g. German and English). In addition to that the paper tries to highlight the accordance and differences between the terms design, product development and innovation. Nonetheless the paper should not be seen as the definite answer to the question proposed in the title but only as a starting point for a discussion.

2. Terminology

2.1 Design, Engineering Design, "Konstruieren"

The Cambridge International Dictionary defines the term "design" as: *"To make or draw plans for something* or *A design is a plan"* and "designing" as *"The art of making plans or drawings for something"* [Dictionary 1995]. Taking this meaning, it seems quite clear that the starting point of the development of the terminology was engineering, first related to buildings then to machines. The people working in the area were later confronted with the fact that design was also used for describing the discipline dealing with the shape, colour and material of objects. The German languages today still attributes this latter meaning to the word "Design". Hence the term engineering design evolved to allow a clearer distinction of the two areas. In German speaking countries the term used was "Konstruieren", which corresponds quite well with the English Term "Engineering Design". The research in the area especially by Pahl and Beitz, e.g. [Pahl and Beitz 1993], also led to the DIN 2221 standard, which gives ideas on how the design process should look like. It incorporates not only a product oriented view of design but also tries to have an eye on issues like competition, costs, deadlines, regulations etc. [VDI Verein Deutscher 1993]. Although DIN 2221 is the standard on "the methodology on developing and designing technical systems and products" in German speaking countries, it does not give a very clear definition on what, to "design" or to "develop" really mean.

In their paper on "Design Typology and Design Organisation" Andreasen et al. describe the following basic elements of design: formulation of the design strategy, the design task, the way to design, the organization chosen for the task, the use of this organisation as well as the actual context and the designer's reaction upon it [Andreasen, Wognum et al. 2002]. Looking at these activities, especially the last one, it seems that there is more to design than just to draw plans for something. Cantemessa in a paper on design research mentioned that the starting point of design was lying in mechanical engineering, but that it has widened in the last years: "The design of products is now being integrated with that of systems and services" [Cantemessa 2001]. A similar observation can be made by looking at the topics of conferences related to the Design Society. These topics have broadened as well, especially in the direction of development of products and most of its related fields.

2.2 Product Development, "Produktentwicklung"

The word "to develop" is defined as "a) to grow or change something into a more advanced form" or "b) to invent or to bring or come into existence" [Dictionary 1995]. This seems to incorporate two things: something radically new and something which has been adopted from an existing product or service.

In a book, which summarizes the results from the German program "Produktion 2000" and the study "Neue Wege zur Produktentwicklung" (new ways to product development), the authors identified several success factors for product development, including customer focus, internal integration, collaboration with manufacturing, quality issues, entrepreneurship of product designers, team orientation, solid basic knowledge and methodology, IT support, collaboration and alliances [Grabowski and al 1997]. All together this enlarges the original view associated with the term "product development" as mentioned in the dictionary.

To get a better picture on what product development covers, the product development and management association (PDMA) published a handbook as well as a toolbook for product designers. The books cover many different aspects of product development. The term product development has more of a business approach than engineering design, as it also incorporates things like market studies and issues like knowledge management, collaboration and others. Nonetheless a clear definition is missing, on what product development means [Rosenau 1996].
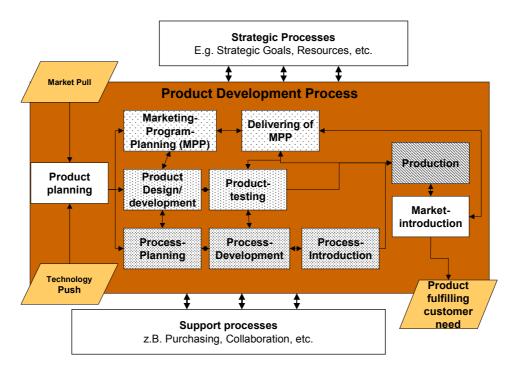

Figure 1. Product Development Process

Robert Cooper takes an interesting point of view. In his book "Product Leadership" he does neither use the term design nor development, he calls his process "new product process" or also "stage gate process". After the phase of ideation – others would probably call this phase invention – he suggests two phases of closer investigation of feasibility and market opportunities. After the decision is made to proceed, the development stage starts: "Here, the actual design and development of the new product takes place, along with some product testing work. Full production and marketing plans are also developed in this potentially lengthy stage" [Cooper 1999].

Summarizing, it can be said that product development is somehow the term for creating an improved or new product and delivering it to the market. Starting points for this process can be a market pull (or customer need) as well as a technology push (Figure 1).

A model with simultaneous phases is usually the standard model in industry. Andreasen for example uses a model quite similar to the one above and calls it "integrated product development": «Product development consists of market research, development, the establishment of production and sales, and ongoing production and sales.» [Andreasen 1987]. Although the last part is usually considered to be part of operations, this view supports the basic ideas on what product development consists of. If the new product is quite radical and also leads to a change of the business model of a company it could be called an innovation.

2.3 Product Innovation

Looking at the innovation area the dictionary gives us a very simple definition: to innovate means "to introduce changes and new ideas" [Dictionary 1995]. Innovation was originally introduced in economic theory, as a term which described renewal or creative destruction This seems to be a very broad and not quite specific definition compared to the previous ones. It is supported by some of the most well known authors in the field, such as Tushman and O'Reilly [Tushman and O'Reilly 1997], who focus on the introduction of change in organisations from a strategic perspective. Innovation can generally be seen as something new: new products, new processes, new distribution networks or new marketing concepts – it goes beyond finding technological solutions. Some authors define innovation by distinguishing the type of newness, e.g. Thomond and Lettice [Thomond and Lettice 2002], who describe innovation as being a continuum ranging from *radical incrementalism* – that delivers significant change to the mainstream market (mostly competence-enhancing) with low environmental turbulence and a low market uncertainty – to *totally disruptive innovations* – that deliver transformational change to the mainstream market and its value attributes (mostly destroying) with high environmental turbulence and a high market uncertainty.
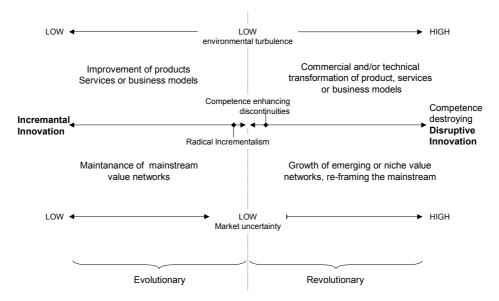

Figure 2. A continuum of innovation [Thomond and Lettice 2002]

3. Synthesis

Looking at the statements in the earlier chapters it seems more than reasonable to argue that there has been a change of meanings over time. Although "design" originates from the "making of a drawing" it is obvious that the meaning of "design" has been enriched over time. In parallel to "design" the term "product development" has evolved describing the generation of products, processes or services. In the last couple of years the term innovation was used in a variety of meanings although the original meaning refers to a more or less radical introduction of changes. The following figure tries to illustrate the differences (Figure 3) and their enhancements.
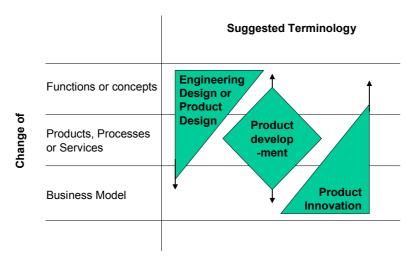

Figure 3. Preliminary distinction of terms

The basis of distinguishing the three terms design, product development and innovation is the question of what has been changed (or improved). In (engineering) design the starting point of the discussion was introducing change to functions and concepts, where as in product development the product is in the focus of attention. Innovation starts from changing business models but is nowadays also used for describing the change of products or even technological concepts. The next part summarizes briefly the implications for research design.

4. Implications for Research Design

The previous discussion on terminology focused on a linguistic differentiation of the three concepts. But what are the differences in respect of the research methodologies used? Three questions have to be discussed: Are there differences between epistemological foundations of research, are there differences in the research methodologies used in the three different areas and what implications for research design does the "closure of the gap" between the disciplines have?

Epistemological foundations differ between and within disciplines. Whereas in natural sciences usually an objective view of the world can be found, it is not that simple in the social sciences, which increasingly influence research questions in innovation, product development and design. One of the main questions is, whether a scientist can really be an objective observer or not. When a researcher applies an objective ontological as well as epistemological view, Positivism and Neopositivism will be the main way to conduct research. If an objective ontology is combined with a subjective epistemological view, Critical Theory as well as Critical Realism and Pragmatism will be applied. The last relevant category is Postmodernism and Conventionalism, where subjective views dominate. As already mentioned, the engineering design area was influenced by a more objective epistemological point, as it is quite close to the natural sciences, whereas product innovation, as defined in section 2, has more influence of social sciences and hence a bigger potential for a more subjective view of the world.
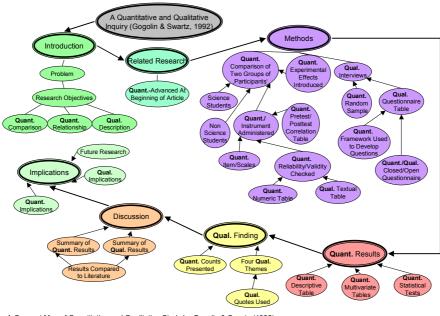
The choice of research methodologies strongly depends on the above described epistemological principles applied by the researcher. A subjective view will lead to methods, which are more

4

qualitative such as case study research, interviews and a narrative description of the findings, whereas an objective view will lead to quantitative methods, such as surveys, hypothesis testing, and a mathematical description of the results. Being aware that this is a simplified view and would not qualify as a detailed description of research methodology, it nonetheless shows that the main differences in research methodology between the three areas – engineering design, product development and innovation – depend on epistemological views rather than on the subject matter of what is improved or changed as described above.

The final question remains: What are the implications for research design as these three areas converge? Probably the question is wrong. It should read more like: Can we overcome the underlying assumptions on how the world is seen? A first spontaneous answers would be: "no" and "this was not the idea of the paper". Nevertheless we want to suggest a solution. A researcher can take different positions – objective and subjective, when looking into a research problem. In such a interdisciplinary approach, the subjective view gets more important as soon as the research topic is more people oriented, whereas a calculation of stiffness will remain an objective task. Applying both views can also broaden the idea of what is happening and helps to find the right questions to ask. Figure 4 shows a possibility to combine the different approaches into one and suggests to triangulate methods.

5. Conclusions

In his book on "Integrated product development" Ehrlenspiel wrote an interesting very first sentence: "This book is about development and design as the core function of product development" [Ehrlenspiel 1995]. It seems quite clear, what he means. The original term "design" ("Konstruktion") has evolved into a much broader meaning. A designer has to become a developer or even innovator. Hence he or she has to take markets as well as issues of business strategy into account. This view is also supported by what the Oxford Thesaurus gives as other meanings for the word "to design": "1) draughtsmen design the structure; plan, draw, draw plans of, sketch, outline, map out, plot, block out, delineate, draft, depict 2) designing clothes / designing schemes in his head; create, invent, originate, think up, conceive, fashion, fabricate, hatch, innovate; inf. dream up."[Kirkpatrick 2000]. The words in the Thesaurus include nearly everything that we today associate with the work designers, product developers or even innovators do. Although all three terms were used in different disciplines, it seems obvious from the few definitions used in this paper that the disciplines have evolved and broadened.

A Concept Map of Quantitative and Qualitative Study by Gogolin & Swartz (1992)
Source: Data from „A Quantitative and Qualitative Inquiry Into the Attitudes Toward Science of Nonscience College Students" by L. Gogolin and F. Swartz, 1992, Journal of Research in Science Teaching, 29.

Figure 4. Example for a combined qualitative and quantitative research process [Creswell 1994]

There are two answers to the question in the title. On the one hand the original meaning of the three terms was different, as each one came from another discipline, on the other hand the meaning of the terms has changed over time and it seems that they have been used in a more similar way in the last years. From the point of view of the authors this is understandable, and the different communities of design, development and innovation should be aware that the gap between them is closing.

References

Andreasen, M. M. (1987), "What is integrated product development?" Integrated Product Development, M. M. Andreasen and L. Hein, Berlin, Springer: 21-28.

Andreasen, M. M., Wognum, N., et al. (2002), "Design Typology and Design Organisation", Design 2002, Dubrovnik, The Design Society.

Cantemessa, M. (2001), "Design Research in Perspective - A Meta-Research on ICED97 and ICED99", 13th International Conference on Engineering Design, Glasgow, Professional Engineering Publishing.

Cooper, R. G. (1999), "Product Leadership", Cambridge, Perseus Books.

Creswell, J. W. (1994), "Research design: Qualitative and quantitative approaches", Thousand Oaks, Sage Publications, Inc.

Dictionary (1995), "Cambridge international dictionary of English", Cambridge, Cambridge University Press.

Ehrlenspiel, K. (1995), "Integrierte Produktentwicklung: Methoden für Prozessorganisation, Produkterstellung und Konstruktion", München, Wien, Hanser.

Grabowski, H. and al, e. (1997), "Neue Wege zur Produktentwicklung", Stuttgart, Dr. Josef Raabe Verlags-GmbH.

Kirkpatrick, B. (2000), "Oxford Thesaurus", Oxford, Oxford University Press.

Pahl, G. and Beitz, W. (1993), "Konstruktionslehre", Berlin, Springer.

Rosenau, M. D., Ed. (1996), "The PDMA Handbook of New Product Development", New York, John Wiley & Sons, Inc.

Thomond, P. and Lettice, F. (2002), "Disruptive Innovation Explored", 9 th IPSE International Conference on Concurrent Engineering: Research and Application, Cranfield University: On-line ressource

Tushman, M. and O'Reilly, C. (1997), "Winning through innovation: a practical guide to leading organizational change and renewal", Boston, Harvard Business School Press.

VDI Verein Deutscher, I. (1993), "Methodik zum Entwerfen und Konstruieren technischer Systeme und Produkte", Düsseldorf, VDI-Gesellschaft Entwicklung Konstruktion Vertrieb

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