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THE ROLE OF DESIGN IN UNIVERSITY INDUCED INDUSTRIAL INNOVATION

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1. Introduction

As performance evaluation is being imposed on universities worldwide, metrics for the effectiveness in both education and research are being developed and implemented. At the same time, many universities add a new dimension to their objectives: That they shall have a positive impact on innovation in industry. At the present there is only a limited understanding of the quantitative nature of 'university induced industry innovation', and a strict metric is not available at the moment. As funds for the universities are getting scarce, there is increasing focus on those, and only those, activities that show up results in the university evaluation. Consequently, individuals and groups are reluctant to involve themselves in industrial innovation, as results generated in this domain do not show up in an evaluation. Thus, universities may find that even if 'university induced industrial innovation' is added to their objectives and formulated as strategies, activities may not be initiated, and results may fail to show up. Thus there is a need of understanding how university induced industry innovation should be measured, and a need of implementing a metric of innovation, alongside the metrics of research and education.

The objective of the paper is to demonstrate the qualitative aspects of how design research and the subsequent dissemination of derived design tools may support industrial innovation. Ultimately, the objective of the current work is to establish a metric for university induced industrial innovation, by which the impact of an individual, a group, a department or a university may be measured.

2. Company / university interaction

2.1 The impact of university research on industry

Several studies have shown that there is a clear impact from university research on innovation in industry, and that "academic researchers and the academic research infrastructure are directly involved in the development of industrial tools, prototypes, products, and production processes" [Arenberg 2003]. It is also indicated that academic research provides long-term, positive impact on industry performance.

There is a clear trend that more and more companies are working according to lean strategies, and that they are moving further into outsourcing, with examples found within nearly all types of company operations. It is therefore conceivable that there will be a growing interest in the company / university interaction.

It should be emphasized that cooperation between industry and academia is not a one-sided deal, where all the benefit is on the part of industry. Even not counting the economic benefit that the university may reap from the encounter, the benefits in the form of and impulses for the initiation of new research is highly contributing to the effectiveness of the university.

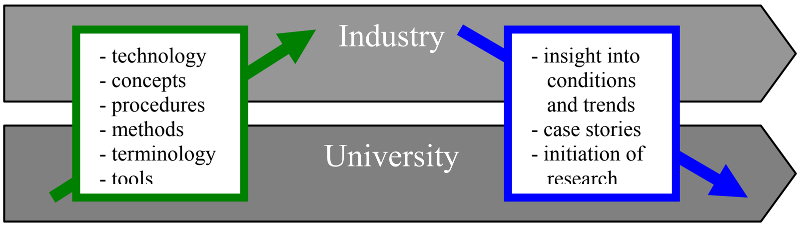

Figure 1. Exchange between industry and university

2.2 How companies and universities interact

There are great differences in how various sectors of the industry cooperate with the universities:

- Different industrial sectors have different environment and may pose different challenges to the universities
- Different industrial sectors may be at different points on the technology and product ripeness curves, consequently with great variations in the need for university cooperation
- Different industrial sectors may call for different research competencies

And, as it is companies, not industries, which cooperates with universities, the individual ability of a company to interact will also influence the cooperation:

- Their expectations of what academic researchers can provide
- Their ability to penetrate ‘the university veil’
- Their ability to manage the interface with the research team
- The nature and complexities of their needs
- Their strategies and their time horizons

Likewise, there are great differences in how well prepared and well suited the universities are for the company / university interaction, with differences in research competencies, in their grip on legal and IPR aspects, in quality of infrastructure, and in their general ability to interface with a company. Basically, there is a difference between the timeframes of industry (short term) and universities (long term) which should be understood and respected [Rosenberg 1994].

2.3 Criteria and indicators of university impact on innovation

The basic criteria of university-induced innovation could be formulated as follows:

- Quality of the innovation induced by the university
- Volume of the innovation induced by the university
- Timeliness of the innovation induced by the university
- Contribution of the innovation to the short and long term survival of the company

However, these criteria are extremely hard to measure directly, so a kind of breaking down into something more concrete and operational of these criteria must be undertaken.

The concept of *indicators* is referred to also in literature that deals with the measuring of academic research [Korhonen 1998]. Indicators are attributes or signals which are in themselves more easily quantifiable and measurable, but who are not directly linked to the corresponding criteria.

Example: Indicators of 'Quality of innovation"

- *Number of consecutive years for which close cooperation ties are held with the same company*
- *Number of participants from industry on annual seminars and workshops*
- *Extend of in-sourcing of research from industry*
- *Revenue gained from sale and licensing of patents and software*
- *Number of enterprises initiated based on university know-how*
- (etc.)

Figure 2. Indicators of quality of innovation induced by a university

At the Technical University of Denmark, DTU, 13 indicators are used to gauge the impact on industrial innovation from a department or a section, as an element in the university's innovation policy.

DTU's 13 indicators for innovation:

- *Number of patents issued to the section*
- *Revenue gained from sale and licensing of patents and software developed by the section*
- *Number of enterprises initiated, based on the know-how developed by the section*
- *Volume of activity in cradle companies in the section*
- *Extend of knowledge and technology transfer via PhD-projects, final year projects (M.Sc) and bachelor projects in the section*
- *Number and extend of deals and contracts with technical public service institutions related to technology transfer, delivered by the section*
- *Number of projects organized as cooperation projects with industry, the extend of in-sourcing of research from industry, etc, and the turnover of these projects in the section*
- *The volume of projects in the section paid for by companies*
- *Turnover in the corresponding sections of the Institute for Product Development, IPU *).*
- *Number of participants in information seminars for industry and partners by the section*
- *Number of companies joining networks and clubs maintained by the section*
- *The sum total of "free" resources gained through partnership deals, clubs, etc, by the section*
- *The volume of post-graduate education for industry delivered by the section.*

**) IPU is DTU's 'on campus' consultancy and development company, currently with 90 full time engineers.*

Figure 3. The 13 indicators used at the DTU to gauge innovation [Pallesen 2004]

It is probably an inherent feature of most indicators that they can be manipulated once it is known that they are being used to assess the effectiveness of an organization. By manipulation is meant that their score could be optimized (often at no or little cost) without actually improving on the score of the corresponding criteria. So, when deciding on what indicators to use one should look for those which cannot be optimized without making at least some real contribution to the related criteria.

3. The role of design

3.1 Transfer of technology vs. design

In the mechanisms of university induced industrial innovation, there are some great differences within the university, between on the one hand sections that deals with technology (based on the natural sciences, and with basically an analysis oriented approach) and on the other hand sections that deals with design (based on cognitive science, and basically an synthesis oriented approach).

Important differences that favor *technology* are that the deliverables are often very concrete and quantifiable, and that technology is likely to generate patents and other IPR, which may be made to generate revenue. One important difference that favors *design* is that where technology is often (if not always) domain specific, applicable only to specific industrial sectors and specific companies, design is applicable over more of the industrial sectors, and is not so very company specific.

Figure 4. 'Technology' competencies and 'design' competencies in the BeoSound1

3.2 Carriers of design-oriented deliverables

Design and design-oriented activities has to do mainly with processes inside one or more heads and therefore the corresponding deliverables tend to be insubstantial. It is consequently an essential question what to choose as carrier when the deliverables are to be transferred into industry. There is a board spectrum of carriers available, where some will accommodate certain deliverables, and not others.

At DTU a changing group of people (stable at 12 – 18 individuals) have for the last 25 years been working solely with active dissemination and implementation to industry of design and design-oriented tools, procedures, and mind-sets. Figure 5 shows a list of some of the carriers and the corresponding deliverables that this group has been developing and using [Hein 1991]. It is an important aspect of these carriers that they may all be considered indicators, and that they are easily quantifiable.

Carriers of design and design-oriented deliverables

- *Books and publications (Systematic and creative idea generation, New Product Search, Integrated Product Development, DFA, DFM, DFEn, ...)*
- *Annual workshops and seminars (Product Development Methodology, Mechatronics Design, ...)*
- *Post-graduate courses: company specific, in-house (On quality, systematic design, design of mechanisms, Integrated Product Development, DFA, DFM, DFEn, ...)*
- *Hands-on design and development projects (design of components, sub-systems, or whole products, either through just a single step, or the whole, of the development process)*
- *Design project facilitation (advise on procedure, methods & tools, creativity, organization, ...)*
- *Advisory to company management (diagnosis on design and development ability, benchmarking, reorganization of design and development department, strategic use of design tools, ...)*

Figure 5. Carriers of design and design-oriented deliverables, as used at DTU

3.3 Special aspect of measuring the impact from design

Design is a very crucial activity within the company, because the outcome of this activity determines how well the product fits into production, quality assurance, logistics, sales, etc., and how well the product is received by the customer. This aspect gives design a very special role in university induced industrial innovation, because there is consequently a very strong multiplication factor imposed on what is transferred and implemented into the company: At DTU we have demonstrated cost saving effects from our DFM projects in industry of literally millions of EUROs per year. Likewise, a bad design of a new product that flaws the image of the company could mean disaster. Whether the company is likely to get the one type of result, or the other, may be hard to judge if there is no previous contact and no record to show. For this reason, companies are not very adventures when choosing partners for design and product development.

This means that there is normally no hard and fast correlation between the cost (in man hours, or EUROs) of the communication / implementation / consultation and the value for the company. The implication of this is, that the *indicators* about to be deployed as part of a university's assessment system will tend to be less adequate for the area of design.

Another aspect, an additional effect, of having design competencies within a university is the role that it plays in "enabling and enhancing science return" [Antonsson 2003], when it brings to the other more technology oriented departments the option of competent design of laboratory and research equipment, who, in their turn, will eventually benefit industrial innovation. An outstanding and contemporary example of this is the design by the Jet Propulsion Laboratory at California University of Technology of the two Mars rovers.

4. Conclusions and Future Work

Currently, many universities are adding a new dimension to their objectives: That they shall have a positive impact on innovation in industry. It seems evident that the ability to measure university induced industrial innovation is a prerequisite for the application of resources and funding in a lean university environment, thus the current need for a metric for 'university induced industry innovation'. At the present there is only a limited understanding of the quantitative nature of this university induced industry innovation, and thus a strict metric cannot be made available at the moment. In this paper it is argued that indicators, and not criteria as such, will provide the initial basis for assessment.

The set of indicators that a university decides upon should also include the type that covers the impact of design. In this paper it has been demonstrated how these design-oriented indicators are readily identified and set up, with an example given from the current set of indicators at the Technical University of Denmark.

However, indicators may provide a poor measurement of the impact of design, because the design activities determines the 'fate' of most of the other operations (stakeholders) in the company, and thus impact may be greater (for better, or for worse) than suggested by the indicators. The theory of dispositions (the understanding of precisely how the design activities influences the stakeholders) may provide a framework for future clarification of actual criteria.

The ultimate objective of the current research is to establish a complete metric for university induced industrial innovation, by which the impact of an individual, a group, a department or a university may be measured, to balance the existing metrics for the effectiveness in education and research that most universities have already implemented.

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