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"MATERIAL DEMO LAB" PROCESS - TRAINING PROCESS FOR BUSINESS MODEL & DESIGN METHODS FOR MATERIAL SCIENTISTS

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Abstract

Up to 70% of all new products are based on new materials and there is considerable scientific and economic potential in combining different material and technology domains in particular. Former research projects have shown that material scientists face several challenges in the later stages of the innovation process, especially in market placement meeting the needs of business customers and other stakeholders. Problems are e.g. too complicated communication of their work, missing understandable business cases, and uninspiring demonstrators. These developing issues could already be prevented in an early TRL level by using and combining product design and business modeling methods.
The paper presents the design of the innovation process of competence acquisition of business model development and design development methods for material scientists. The innovation and training process is designed to overcome the "Valley of Death", i.e., the unsuccessful transfer of research results to the to market maturity. The goal of the process for the material scientists is to a) reflect and structure own competencies b) to make unique selling propositions comprehensible and c) to generate and strengthen impact. In addition, the observed limitations are described, which were observed during the implementation of the process in two test groups composed by scientists from three different institutes and research areas in materials science to further refine the field. The findings are based on a) literature reviews and b) observations during the design, implementation and evaluation of the process.
Part of the core findings is the increased acceptance of the methods applied in the innovation process, if they primarily address technology development. A more challenging acceptance in the field of research communication is the development of commercial business models. During the development and testing of the innovation process, the stages of the Delft Design Guide as one popular handbook in the field. The development phases were used as a guidance and orientation.

Keywords: *Business model development, science communication, prototyping, material science innovation process.*

1. Introduction

Companies are already cooperating and collaborating with partners and customers along the value chain and nowadays in early stages of the innovation process in order to increase the market potential of new products. In fundamental scientific research, especially in research institutions, the development for potential business models and the design are downstream processes that start at later stages of the Technology Readiness Levels (European Commission, 2014). There is considerable scientific and eco-nomic high potential in combining different material and technology domains (BMBF, 2015). To unfold the potential the innovation process in material science needs to be rethought, so that material scientists can make their research and its application understandable in early stages for the industry and targeted users that are not experts in basic research. Within this research project "SIMPROMAT2", which is coordinated by the Leibniz Institute of Polymer Research Dresden and also involves the Fraunhofer Institute for Ceramic Technologies and Systems IKTS, the Leibniz Institute for Materials Research Dresden (IFW), the Fraunhofer Institute for Chemical Technologies (ICT) and the

Fraunhofer Institute for Microstructure of Materials and Systems (IMWS), started in 2019, the Chair of Technical Design at the TU Dresden and the Chair of Business Administration, in particular Marketing and Event Management of the University of Applied Sciences Dresden (FHD) started the conception by designing the training sessions for the participants. The sub-study, which is presented in the paper, is part of the research project SIMPROMAT2 which is funded by the Federal Ministry of Education and Research, the so called Material Demo Lab (MDL). In the so-called MDL, workshops using design and business design methods take place with the material scientists. The focus of the paper is the introduction and presentation of the innovation approach and process.

2. Background

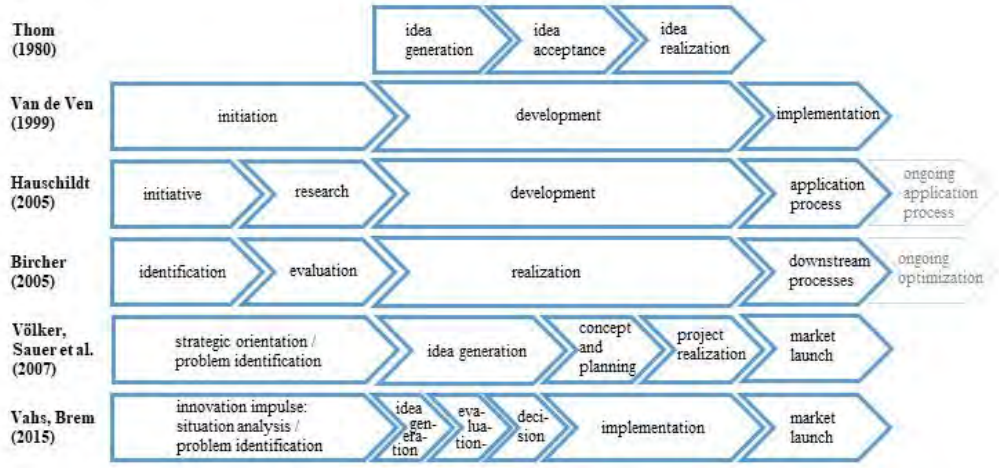
Due to its early position in the value chain and their proximity to basic research, the commercialization of materials research more hampered. Wessner shows that only a few research results reach marketability (Wessner 2005). Between the research performance and market application, according to Markham, there are still steps of concept development, potential transfer and formal development steps must take place (Markham 2002). In theory, these development steps are described as the "valley of death", because only a few research projects successfully pass through these and reach market maturity (Wessner 2005, Livesay 2006, Minshall 2007). To this end, researchers often a lack of experience in the economic field and knowledge about the market itself (Würmseher 2017). The commercialization and transfer of scientific work plays only a strongly subordinate role in the performance evaluation (Markham 2002). Furthermore, the qualification of researchers is often exclusively focused on scientific work with interfaces to other scientific work with interfaces to other scientific and technological disciplines, but does not consider interdisciplinary cooperation with economics, social sciences or social sciences. This type of interdisciplinarity is of great importance in the of commercialization of research results is essential, because it also requires skills of marketing, design, and product manufacturing are also necessary (Eppinger and Ulrich 2015).

The innovation process is sometimes distinguished from the (product) development process. However, in certain literature, all of them are interleaved and combined. Feldhusen equates the innovation process with the product development process (Feldhusen and Grote 2013). Bircher, in contrast, provides a different approach in which the three processes interleaved. According to this, the product development process is embedded in the product development process. This process in turn is a part of the innovation process (Bircher 2005). This paper follows the approach of Birchner and, in addition to innovation, places a strong emphasis on continuing training during these processes.

2.1. Phase models proposed by literature

In the scientific literature, there is a large number of different models of idealized innovation processes and implementation recommendations. The following figure (Figure 1) provides an overview of the models and basic schemes of common innovation processes with the corresponding authors.

Figure 1. Overview of the basic scheme of the innovation process (own representation based on Thom 1980; Van de Ven 1999; Hauschildt 2005; Bircher 2005; Völker et al. 2007; Vahs and Brem 2015)-



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By illustrating the different approaches through a comparison, it shows that the basic content structure of innovation processes differs very little from one another. Nevertheless, all approaches include the following phases: 1. problem analysis 2. generation of ideas 3. evaluation 4. implementation.

2.2. Process design

Innovations can only be successfully implemented with a qualified, structured, transparent and target-oriented innovation process can be successfully implemented. In each phase of the innovation process, further decisions are made with the help of various methods and techniques. These methods transform the innovation process into a training process. These techniques are tailored to the goal of each phase. The chosen methods are taken from the popular Delft Design Guide (Boeijen, 2014). This popular handbook proposes as well the following stages for the process:

1. Discover 2. Define, 3. Develop 4. Implement 5. Convey

The structure of these phases is also consistent with the identified phases described in the basic schemes. In a schematic model, the Material Demo Lab Process would be outlined as follows in Figure 2:

Figure 2. Material Demo Lab process (own representation based on Delft Design Guide (Boeijen, 2014).

This process provides the basis for the innovation and training process.

3. Objectives

The literature highlights the following challenges faced by researchers in general and materials scientists in particular, in achieving a higher degree of innovation and degree of innovation as well as relevance into the market:

1. overcome the "Valley of Death" through the creation of business models (Mesa, Thong, Ranscombe, and Kuys 2019),
2. communicating and conveying understanding to other audiences of their research competencies (BMBF 2019),
3. creating a demonstrator by using product design and business modeling methods in the development of a new technology can mimic its potential for future application in terms of meeting mimic commercial needs (Moultrie 2015).

These identified challenges are to be solved or improved through the process. The core objectives of the process are to introduce methods of economics and technical design for an improved transfer of research results with the help of a technology demonstrator. Materials scientists train and apply beyond their technical methods the knowledge and drive the development of technology demonstrators as boundary objects (Star and Griesemer, 1989) for science communication. The concept of boundary objects, first introduced in 1989 by Susan Leigh Star and James Griesemer, is a very useful theoretical tool that has been adopted by many disciplines. The consideration complex situations through the perspective of boundary objects can help to understand how the various stakeholders involved can work together on a project despite their different and often conflicting interests (Freeman 1984). The single scientist is expected to learn during the process to

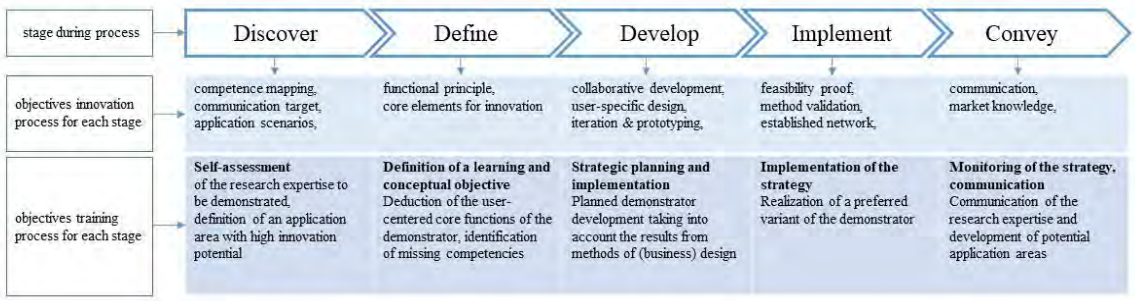
4. reflect and structure own competencies,
5. to make unique selling propositions comprehensible and
6. to generate and strengthen impact (Schöne et al. 2022).

4. Methods and approach

As already described in section 2.1, there are different approaches, but constantly recurring phases in the innovation process: 1. problem analysis 2. generation of ideas 3. evaluation 4. implementation. As the "Material Demo Lab" process is also a training process, methods and techniques of the Delft Design Guide are applied (Boeijen, 2014). This means that these aspects are combined to create the process. As presented in Section 2.2, the "MDL" process for the innovation approach is divided into the following phases: 1. Discover 2. Define 3. Develop 4. Implement 5. Convey

The following overview shows the process with all phases as well as the explanation of the goal of each stage to better explain the training approach.

Figure 3. "Material Demo Lab" Process - Innovation and Training Approach.



5. Discussion and conclusion

The process was already applied in two different test groups, which consisted of material scientists from three different institutes. The observations and findings are the result of these runs. Fundamentally, it could be observed that the material scientists were able to achieve or partially achieve the objectives 4. -6. in both test groups. The objectives 1. - 3. cannot yet be evaluated due to the temporal component of the complex process. By using design and business design methods, the scientists were able to learn new ways of driving product development forward. One of the central observations is the interest in principle in the facilitation techniques and in transdisciplinary collaboration. This can be seen as positive, as the training approach works here. This is inhibited by reticence on the part of the participants, if they are asked to comment or perceive work steps that are outside their professional their professional expertise. The expertise provided in the area of design and business model development provided by the framework program is used only hesitantly. The added value of the methods themselves, which is a part of the whole process, seems difficult to convey. Interest and initiative always increase when the participants' own technical expertise is required in detail, which is closest to their familiar day-to-day business of the participants. There are no behavioral differences between groups, group size, gender, or age. A special point may be the position of the participant. The more strategic responsibility the participant has, the more he understands the importance of the process. However, this hypothesis still needs to evaluated, since two test groups do not allow for certainty. In order to stabilize the process, it is recommended to repeat it as often as possible in different groups as often as possible in order to adapt it in the sense of a continuous improvement.

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