TOOL FOR CREATING A DEFINED TASK AS PREPARATION FOR A TARGET-ORIENTED IDEA GENERATION PROCESS

Herrmann, Thorsten; Binz, Hansgeorg; Roth, Daniel
University of Stuttgart, Germany

Abstract

Knowledge and information concerning a need or a problem are important for the steps of creating solution ideas which lead to the design of successful products. However, this information is often not provided accurately, meaning that an analysis of a need or a problem does not take place properly before starting with the steps of creating potential solution ideas. A tool which will close the information gap has been elaborated and is presented in this paper. This tool functions as a problem analysis which prepares the information needed for the subsequent steps of solution idea creation within the front end of the product development process. In particular, the elaboration of the set of information needed and the way the information is elaborated, stored and transformed or – in other words – how such a problem analysis might take place is presented. As an evaluation step, the presented tool has been partially assessed by a group of experts from the engineering design sector and the applicability, usefulness and comprehensibility are confirmed.

Keywords: Problem analysis, Design process, Organisation of product development, Design management, Innovation

Contact:
Thorsten Herrmann
University of Stuttgart
Institute for Engineering Design and Industrial Design
Germany
thorsten.herrmann@iktd.uni-stuttgart.de

Please cite this paper as:
Surnames, Initials: *Title of paper*. In: Proceedings of the 21st International Conference on Engineering Design (ICED17), Vol. 8: Human Behaviour in Design, Vancouver, Canada, 21.-25.08.2017.

1 INTRODUCTION

Nowadays, there is demand for innovations in nearly every sector of the economy. Innovations have consequently become a major subject of discussion. Several authors mention that innovations of products, processes and business models are necessary in order to gain business success, profit and economic growth (Gassmann and Granig, 2013; Hauschildt and Salomo, 2011; Vahs and Brem, 2015; Zhang and Doll, 2001). Cantamessa and Montagna (2016) present the exaggerated description of innovation as a cure-all to solve problems in society and the economy. All of these statements show that innovations are highly important in our society. This is also emphasized by Vahs and Brem (2015) and leads to the assumption that the management of innovation with a view to generating more – and particularly more constructive – innovations is becoming ever more important. Innovation management should therefore be, and indeed become, an increasingly essential issue in a company's daily work (Herrmann et al., 2016a). However, innovation management processes are often not properly adopted within companies (Herrmann et al., 2016b; Vahs and Brem, 2015). For this reason, many papers exist that analyze problems during the innovation process and give advice by means of new support methods to increase innovative performance. Likewise, the aim of this paper is to present a supporting tool for dealing with problems in innovation management processes, particularly during the front-end. Kim and Wilemon (2002) define the front-end as the sum of all activities starting from the first impulse for an opportunity for a new product or service through to the decision of whether a new idea is evaluated in preparation for more comprehensive product development steps or. The front-end is often considered an important stage for achieving success in development and innovation (Khurana and Rosenthal, 1997; Zhang and Doll, 2001). The product's potential for improvement while incurring minimal modification effort is often higher than in later phases (Krause et al., 2007).

2 PROBLEM STATEMENT, RESEARCH CONTENT AND GOAL

In general, this paper deals with the information concerning a customer's problem, requirement or need as a basic foundation for a new product or the further development of an existing one. In this context, in order to ensure consistent interpretation, the term "product" may describe a product which is tangible, i.e. material, a product which is intangible, i.e. immaterial, or a combination of both (DIN EN ISO 9000, 2009). The term "problem" should additionally describe a customer's problem, need or requirement for a new product as demanded by the product user. At the outset of a product development process – in other words, the front-end phase (Koen et al., 2002) – the relevant literature often suggests idea processes (Messerle et al., 2013), which usually consist of similar steps governing the correct handling of ideas, starting with idea creation, followed by evaluation steps and finally concluded with the selection of the most promising idea (Cooper, 2011; Messerle et al., 2013; Vahs and Brem, 2015). However, the topic of this paper predominantly addresses strategy steps that take place before conventional idea processes and the transfer of the relevant information developed and created in preceding steps. This information can serve as preparation for the initial steps of the aforementioned idea processes, often starting with idea creation. Some literature sources exist which deal with the steps preceding idea processes (Miecznik, 2013; Vahs and Brem, 2015; Verein Deutscher Ingenieure 2220, 1980). Figure 1 gives an overview of the results and milestones within the front-end phase for clarification. Vahs and Brem (2015) mention the development of a strategy as an initial task. The respective company's potential, environment, market trends and alternative action are analyzed at this point. A first business mission should thus be derived after analyzing an initial vision which leads to an innovation strategy (see Figure 1). Based upon this, new future fields or search fields are derived and preliminary opportunities are identified (Khurana and Rosenthal, 1997). Typical tools for this are trend analysis, strategic roadmaps, scenario planning, product portfolios or market research instruments (Koen et al., 2002). After determining future fields, new ideas for a new or further developed product are generated, such as by using creative techniques (Koen et al., 2002). These ideas are evaluated, further elaborated and promising approaches are selected (using portfolio methodologies, for example) and handed forward as detailed plans for new products up to the advanced steps of product development (Messerle et al., 2013; Miecznik, 2013).

As Figure 1 is intended to indicate, problems exist at the interface between the defining steps of strategy determination and idea creation (new product ideas). Designers often have to deal with a large number of ideas during product idea evaluation processes. The ideas of designers who are responsible for idea

creation are often not entirely appropriate for the addressed problem. This means that restrictions, conditions and claims are not appropriately considered. In other words, strategy issues, cost limitations or time restrictions have not been taken into account. In many cases, the communication and transfer of such internal information developed in earlier steps and referring to the companies' strategy development (e.g. target markets and strategy) are not accurate, precise or satisfactory (Khurana and Rosenthal, 1997). Additionally, the overarching character of the problem is not communicated properly. In order to understand the problem, certain information should be communicated to designers (for a detailed list, see state of the art, Section 4.1).

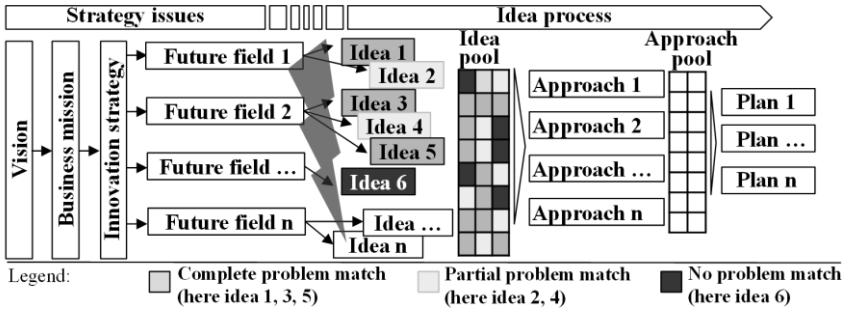

Figure 1. Results in the front-end phase, according to Miecznik (2013)

In order to summarize the problem being considered in this paper, information addressing the need or the problem of a customer and the benefit of a new product or process are often not analyzed properly or provided appropriately to designers before starting idea creation. Usually, documents like a design requirement document, design specifications or design brief do not exist yet in these early phases. So the mentioned gap, generally speaking between product development and preceding required steps for defining strategy issues, is mostly caused by incorrect or missing analysis steps, particularly in the exchange of information (Gerhards, 2002). There is frequently a lack of appropriateness, which represents a weak point in the process sequence and new ideas fail to perceive the real problem. Efficient, structured methods that combine the issues are not usually used. (Schlicksupp, 2004)
However, it is important for the success of innovation to gain a fundamental understanding in order to satisfy the customer's wishes, to solve a current problem or to clarify the company's issue (Khurana and Rosenthal, 1997). Actually, this content-related question was addressed in Herrmann et al. (2016a). The aim of the present paper is to present a mature method for analyzing a problem in order to derive a target-oriented task for subsequent steps of the idea management process and to identify a significant amount of information which describes the problem precisely.The applicability of this tool and the potential to support designers during idea creation by providing specific information will be presented in the form of assessments by students and experts working in the field of product design.

3 METHOD AND STRUCTURE

The Design Research Methodology (DRM) according to Blessing and Chakrabarti (2009) is used as a structural method for this paper. Its general content is based on the following four stages: Research Clarification, Descriptive Study 1, Prescriptive Study and Descriptive Study 2 (Blessing and Chakrabarti, 2009). In this paper, the results of the Research Clarification are analyzed and described in Section 2. The results of the literature research can be found in Section 4, where the state of the art is discussed (Descriptive Study 1). For this purpose, literature sources are analyzed which address the question of which general aspects must be respected for a problem analysis and which information must be considered for a target-oriented task and the preparation of idea creation steps (see Section 4.1 + 4.2). Furthermore, literature recommendations which concern transferring, saving and providing information in a transparent and comprehensible way as the result of a problem analysis will be investigated (see Section 4.3). During the Prescriptive Study, which addresses approaches for improving the current situation, a set of information necessary for idea creation steps based on the literature research is derived and presented (see Section 5.1). This set of information is assessed in a support evaluation by a group of 40 design students (see Section 5.2). These results and proposals for improvement have been used in Descriptive Study 2 to refine the method. The elaborated tool is therefore presented in Section 5.3. Section 6 includes the results of an assessment by 18 industry experts asked about the supporting effect of the tool. Figure 2 shows the elaboration of the method.

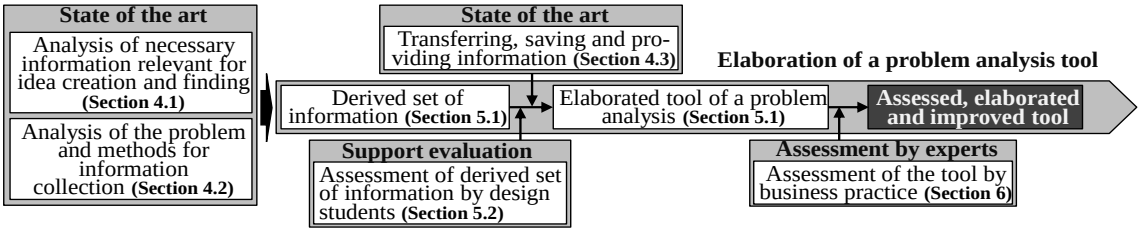

Figure 2. Elaboration and assessment of information

4 STATE OF THE ART

For the analysis of the pertinent literature, three main aspects have been examined: Which information about the problem is necessary for creating and identifying new product ideas (Section 4.1), how this information is developed or found by the designers (Section 4.2) and how this information is stored, provided or transferred for further steps of the idea process (Section 4.3).

4.1 Aspects and information relevant for idea creation and finding

Different kinds of information are useful for product developers and can help designers acting in idea processes, especially during the initial step of idea creation and idea finding. According to Baker et al. (1967), two types of information are required for the majority of ideas in order to generate new ideas: firstly, knowledge concerning a need, problem or opportunity relevant to the company and, secondly, knowledge concerning a method or technique to satisfy needs and problems, as well as how to benefit from the opportunity (Baker et al., 1967). Piller (Ciupek, 2015) gives advice that designers need to have enough information on the problem or respective customer's needs because the focus on the problems and needs of customers is more important than ever before (Ciupek, 2015). This is emphasized by Abele (2013), who alleges that technical specifications cannot be defined for new solution ideas because need specifications are often lacking. However, the process of developing a refined task for further process steps has to be adapted to the respective company.

Mencke (2012) recommends obtaining a clear understanding of what exactly the problem is. This also includes the examination of the cause and reason. An initial insight and clarified description of the problem should also be elaborated (Mencke, 2012). By knowing the causes and reasons for the problem, solution ideas can be developed precisely with regard to the origin of the problem. Furthermore, it is important to know why a problem exists, e.g. whether environmental regulations influence a solution for a given problem. This should be followed by the questions concerning the structure of the problem and consideration of relevant elements associated with the problem. Marginal problems and sub-issues affecting the main problem should not be disregarded. It must be established whether the problem can be structured into main problems and sub-items. A structured order must be determined and the question of which items must be edited first needs to be clarified. (Mencke, 2012)

Additionally, Vahs and Brem (2015) recommend that information about target markets and the intended market position compared to competitors is gathered. Beyond this, strategy goals for clarifying the exact path the company is developing should be defined completely, demonstrably and transparently. Determination and distribution of resources for attaining defined goals by achieving targeted costs and time variables should also be communicated. (Vahs and Brem, 2015)

According to Schlicksupp (2004), innovation projects are always different and complex to a varying degree, although every innovation process needs an impulse (compare Geschka, 2005). In actual fact, this impulse can be found in the phase while developing new search fields, although an exact analysis of this issue is inevitable after this point. Information should therefore be obtained and interpreted and the task should be defined to support the process for generating solution ideas. (Schlicksupp, 2004)

4.2 Problem analysis and information gathering

This section considers the question of how information about the problem is developed or found and which methods exist to analyze the problem. The pertinent literature recommends a variety of methods for gaining a better understanding of problems, encompassing both simple tools and complex methods. In this paper, only a brief overview is presented:

Seifert (2006) introduces general method for structuring and analyzing a problem called the "problem-analysis-schema", which addresses four general questions: What are the symptoms of the problem?

What are the causes? What could be done to solve the problem? What barriers exist to hinder solving the problem? This tool is structured as a kind of checklist. (Seifert, 2006)
Krüger (1981) considers a problem analysis within a holistic context. He presents a method of problem analysis as part of a general organizational process. This generic process starts with the step of goal formulation, followed by the actual problem analysis and the steps that involve searching for alternatives and evaluation, ending with a decision for an alternative. Krüger's (1981) proposal for problem analysis consists of three stages: problem identification, problem investigation/search for reasons and problem documentation. The problem identification stage includes a search for a problem, a problem presentation and an evaluation. The second stage starts with analyzing the framework conditions, followed by an analysis of input and output parameters. A system analysis comprises the third step of the second stage. Stage three – the problem documentation – gives an overview of the problem, causes, chances and conditions for realizing an alternative. (Krüger, 1981)
Methods concerning a problem analysis are also known from disciplines such as Quality Management. These methods are usually used to eliminate the actual/target deviation (Brüggemann and Bremer, 2015). The basic idea is transferred to the combination of problem and solution ideas described in this paper. Examples for problem analysis tools are 8D reports, problem-decision plans, the "5 Why" method, checklists, tree analysis or Ishikawa diagrams to analyze the cause-and-effect connection (Brüggemann and Bremer, 2015; Schmitt and Pfeifer, 2015). These tools are all instruments for systematizing, visualizing and structuring a problem and examine causes and effects, countermeasures and activities for improvement. However, there are few recommendations to use these tools for analyzing problems in the front-end phase as a preparation for idea-generating steps, for example. In common practice, a problem analysis in this context is generally often abbreviated and rather unstructured (Schlicksupp, 2004). A method providing a sufficient status of problem analysis using existing techniques as a preparation for idea creation is still lacking in the pertinent references.

4.3 Saving and providing information for idea creation

In addition to the analysis concerning the necessary aspects and information derived from a problem analysis (Section 4.1 and 4.2), a formal and transparent way to store, transfer and provide the analyzed information should be utilized. Kim and Wilemon (2002) state that formal processes and tools in the front-end phase have many advantages. Generally speaking, the documentation of relevant information and steps leads to the success of innovation projects (Lechler, 2005). In small and medium-sized enterprises, in particular, clear documentation of facts and information is often lacking (Völker and Friesenhahn, 2016). In actual fact, a precise description of an instrument for documenting information about a problem used as preparation for idea generation steps does not exist in the pertinent literature. However, idea profiles or data sheets are known in literature for solution ideas carrying information about new solutions. Two examples are the "product idea data sheet" based on Gerhards (2002) or the "product idea sheet" according to Brandenburg (2002).These idea sheets or profiles carry information about new solutions and are mostly prepared as clear overview sheets. They are also considered to be the right medium for problem ideas (Herrmann et al., 2016a).

5 ELABORATION OF THE PROBLEM ANALYSIS TOOL

The elaboration of the problem analysis tool is divided into three steps. First of all, a set of necessary information for specifying a problem is derived and presented (Section 5.1). After that, the results of a support evaluation dealing with this set of information are shown (Section 5.2). Step 3 includes the elaboration and presentation of a tool to analyze a problem in order to receive required information.

5.1 Set of necessary information

Based on the need for a problem analysis (Herrmann et al., 2016a), in-depth literature research was performed and important results have been presented in Section 4. According to this, a list of all required information mentioned in literature sources was derived and has been clustered into important problem aspects which should be determined, known or clarified before starting to create new solution ideas (see Table 1). In the left-hand column of Table 1, information details are listed which have been assigned to the aspects. The literature references are indicated in the central column.

Table 1. Derived aspects to be considered in a problem analysis

Important information in the front end based on literature contributions	Reference	Derived problem's aspect
Impulse	*Schlicksupp, 2004*	**Description/ derivation of a problem idea**
Symptoms	*Seifert, 2006*	
Present problem investigation	*Krüger, 1981*	
Clear understanding of problem	*Mencke, 2012*	
Description of customer's needs; information about problem	*Ciupek, 2015*	
Need specifications	*Abele, 2013*	
Causes for the problem	*Seifert, 2006; Brüggemann and Bremer, 2015; Schmitt and Pfeifer, 2015; Mencke, 2012*	**Problem causes/ reasons/origin**
Reasons for the problem	*Krüger, 1981*	
Origin of the problem	*Mencke, 2012*	
Input and output parameters; problem investigation so far	*Krüger, 1981*	**Structuring a problem**
Analysis steps	*Gerhards, 2002*	
Product's core benefits	*Khurana and Rosenthal, 1997*	
Systematization, structure,	*Brüggemann and Bremer, 2015*	
Structure of the problem (marginal problems and sub-issues)	*Mencke, 2012*	
Conditions for realizing an alternative	*Krüger, 1981*	**Barriers**
Company's potential	*Herrmann et al. 2016*	
Technical regulation (policy, patents…)	*Mencke, 2012*	
Visualization	*Brüggemann and Bremer, 2015*	**Sketch**
Target markets	*Vahs and Brem, 2015*	**Target market**
Targeted time; targeted costs	*Schlicksupp, 2004*	**Strategy**
Resource determination and distribution	*Mencke, 2012*	
Strategy; innovation strategy; market position; strategy goals	*Vahs and Brem, 2015*	
New future, search fields; choice of market segments	*Khurana and Rosenthal, 1997*	
Trends, scenarios	*Koen et al., 2002*	
Future chances	*Krüger, 1981*	**Effects of a solution**
Effects (in general)	*Brüggemann and Bremer, 2015; Schmitt and Pfeifer, 2015*	
Effects on the company	*Schlicksupp, 2004*	
Benefit of the solution to a problem	*Baker et al., 1967*	
Product's core benefits	*Khurana and Rosenthal, 1997*	
Solution approaches	*Seifert, 2006*	**Approaches to solve problem**
Countermeasures	*Herrmann et al., 2016; Brüggemann and Bremer, 2015; Schmitt and Pfeifer, 2015*	
Method or technique for the satisfaction of needs and problems	*Baker et al., 1967*	
Competitors	*Vahs and Brem, 2015*	
Problem evaluation	*Krüger, 1981*	**Importance/ evaluation**

To provide a summary of Table 1, ten main problem aspects have been ascertained: description of the problem or a derivation of a problem idea, the problem's causes, reasons or origin, the way the problem is structured including previous studies, sub-issues, input and output parameters, barriers for a solution (e.g. patents), a visualization as an initial sketch, the target market, the strategy (especially the innovation strategy, e.g. innovation follower or leader), goals, target costs and time, the effects of a solution differentiated by effect for the company and the user of a solution, approaches for solving the problem (e.g. competitors) and the importance of the considered problem or type of evaluation.

5.2 Support evaluation of set of information

To verify the necessity of all information mentioned in Section 5.2 and the supporting effect while keeping all this information for creating solution ideas, a support evaluation was performed. For this purpose, a group of 40 design students completing their Master's program in the field of Engineering Design were asked about their experiences and the support value of the information provided.
The students were invited to a workshop, where they had to generate new solution ideas for a different determined realistic practical problem using a creative technique. In an initial workshop round, the students were only given little information about the problem. After having developed and documented several solution ideas and recorded these in the form of solution idea profiles, the second problem and the way in which the problem was presented to the students changed. In the second round, students received clear information on the problem considering every aspect shown in Table 1 of Section 5. With all this information provided, they were firstly to form a well-defined problem idea and secondly try to develop new solution ideas according to the derived problem idea. At the end, the students were asked about their experiences with the information and their assessment of the assistance and supporting impact of the information provided and the derived problem idea while generating new solution ideas. For this purpose, a five-tier Likert scale (Likert, 1932) was used (see Table 2, line 1). The question asked

and the results are shown in Table 2. Some important aspects will be emphasized in the following while the focus is on the respective evaluation average (last column).
In general, the students felt supported by the set of information (average 1.85) and they mainly favored the use of a tool to elaborate information about a problem (average 2.21). The problem analysis ensures that one is addressing the problem (average 1.46). The level of inhibition by the information during idea creation was mostly negligible (average 3.87).

Table 2. Results of the support evaluation

	Strongly agreed Level 1		Agreed Level 2		Neither Level 3		Disagreed Level 4		Strongly disagreed Level 5		Not answerable		Aver-age
	Answers/percentage of answers given												
The given set of information supported me by generating new solution ideas.	14	35.9%	**20**	**51.3%**	2	5.1%	3	7.7%	0	0.0%	1	2.6%	1.85
I endorse the use of a type of tool to elaborate information about the problem.	7	18.4%	**19**	**50.0%**	10	26.3%	1	2.6%	1	2.6%	2	5.3%	2.21
The derivation of information through a problem analysis ensures that one is dealing with the problem in detail.	**24**	**61.5%**	12	30.8%	3	7.7%	0	0.0%	0	0.0%	1	2.6%	1.46
Controlling question: I was inhibited by the information of a problem analysis.	0	0.0%	5	13.2%	8	21.1%	12	31.6%	**13**	**34.2%**	2	5.3%	3.87
Which of the following information aspects are necessary and support idea creation process steps?													
Problem description (including causes and reasons)	**13**	**34.2%**	12	31.6%	8	21.1%	4	10.5%	1	2.6%	2	5.3%	**2.05**
Structure	10	25.6%	**13**	**33.3%**	9	23.1%	4	10.3%	3	7.7%	1	2.6%	**2.41**
Sketch visualization	**29**	**72.5%**	9	22.5%	2	5.0%	0	0.0%	0	0.0%	0	0.0%	**1.33**
Target market	6	15.4%	4	10.3%	10	25.6%	**12**	**30.8%**	7	17.9%	1	2.6%	**3.26**
Innovation strategy	11	28.9%	**12**	**31.6%**	7	18.4%	3	7.9%	5	13.2%	2	5.3%	**2.45**
Time-to-market	3	7.9%	8	21.1%	5	13.2%	10	26.3%	**12**	**31.6%**	2	5.3%	**3.53**
Costs for product development	**7**	**18.9%**	**7**	**18.9%**	**7**	**18.9%**	6	16.2%	10	27.0%	3	8.1%	**3.14**
Effects of problem solution	**14**	**36.8%**	11	28.9%	8	21.1%	3	7.9%	2	5.3%	2	5.3%	**2.16**
Approaches to solve the problem	10	25.6%	**14**	**35.9%**	10	25.6%	1	2.6%	4	10.3%	1	2.6%	**2.36**
The derived problem idea supported me in creating new solution ideas.	12	31.6%	**14**	**36.8%**	9	23.7%	3	7.9%		0.0%	2	5.3%	**2.08**
***Controlling question:* The problem idea does not make any sense.**	0	0.0%	2	5.6%	6	16.7%	11	30.6%	**17**	**47.2%**	4	11.1%	**4.19**

The students were also asked which information was necessary and helpful in delivering a level of support for the subsequent step of creating new solution ideas. The problem description, including causes of and reasons for the problem, turned out to be one of the most important information aspects for the workshop participants. The students endorse having a sketch or some visualization of the problem (average 1.33), initial approaches for solving the problem (average 2.36), information about the structure (2.41), the innovation strategy (average 2.45) and the effect of the problem solution (2.16). They tend to disagree with or do not perceive a supporting effect with information about time-to-market (3.53), target cost for product development (3.14) and the target market (3.26). The last two questions the students were asked (see Table 2) addressed the derivation of the problem idea. The students mostly favor this step for receiving a derived kind of task for the subsequent step of idea creation (average 2.08). As a controlling question, the average level of the question of whether the problem idea does not make any sense was 4.19 and underlines the students' opinion concerning the supporting effects.

5.3 Elaborated tool for a problem analysis

In accordance with the support elaboration (Section 5.2) and the information about saving, providing and transferring information (Section 4.3), a tool for performing a problem analysis was elaborated.
To shape an intuitive instrument for transferring information about a problem, a self-explanatory tool was to be introduced. For this purpose, and for detailing the problem, a checklist was elaborated which acts as a problem idea profile (compare with Section 4.3). The so-called "problem idea profile" which was elaborated is shown in Figure 3. This profile includes all information aspects of Section 5.1 (see Table 1) as a set of must-know fields to be completed. As a result – and to provide a defined target-oriented task for idea creating steps – the problem idea at the bottom of this idea profile sheet functions as a task in steps to create a solution idea. To explain the use of the sheet in detail, a very simple example was chosen (see Figure 3).
Here, the problem title is simply "Hanging up a picture", which should be reconsidered. In the top line, the creator of the problem idea profile should also be named and the date should be recorded. Moreover, a description which covers the problem's details and effects should be presented briefly including the main aspects. This goes hand in hand with causes, reasons and the origin of the problem, which is also mandatory information required by the problem idea profile. Furthermore, some thoughts on the problem's structure including sub-items and previous investigations of the problem until now should be recorded. Concerning the company's strategy, the innovation strategy and target markets should be

derived. Knowing whether the strategy proceeds according to an innovation leader or follower can provide information about the risk of a certain idea, or rather a strategy. Furthermore, the fact of providing a small but helpful sketch or other kind of visualization is very important (see Section 5.2). Afterwards, some observations about the effects of a solution both for the company and for the customer or user are made. In this context, it is necessary to know about the targets and the effects a solution may and must have. These might be financial, organizational and market-related effects. Critical aspects concerning a solution (= barriers) should also be mentioned (e.g. competitors). People involved in the generation process for solution ideas often do not gain insights into time and cost restrictions. This should be essential background knowledge to satisfy the company's strategy and to eliminate solution ideas which do not fit into those restrictions. The target development time (time to market) and the target costs for product development are decisive and should also be known. The reason why the students disagreed with the supporting effect of the market, cost and time might be justified by the fact that they were presented with a kind of role in a fictitious company they work for. The derivation of a problem idea is mandatory at the end and should include precisely described goals and describe the problem in a transparent and self-explanatory way (see Figure 3).

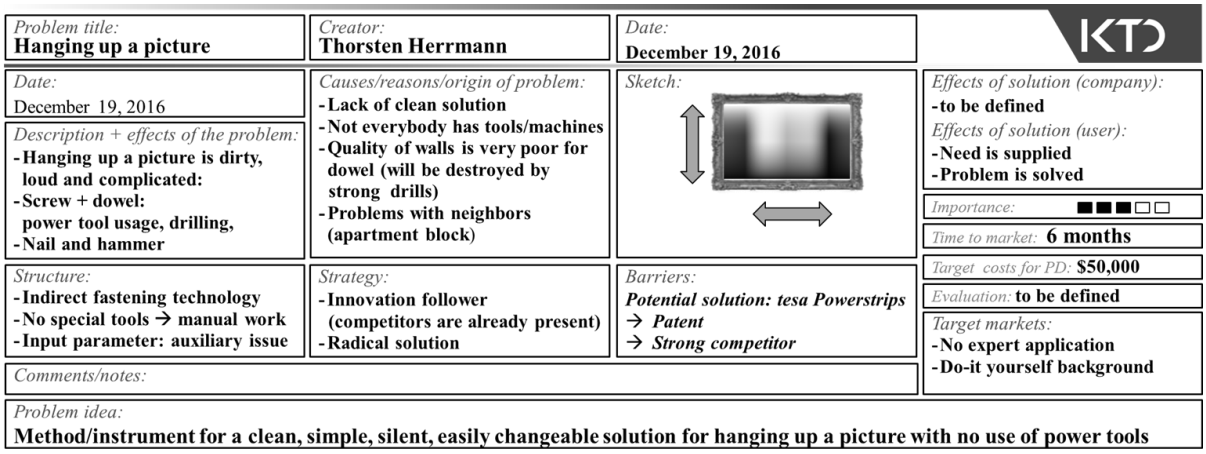

Figure 3. Elaboration and assessment of information in a problem idea profile

6 ASSESSMENT IN BUSINESS PRACTICE

In Section 6, assessments in business practice about the elaborated tool of problem analysis will be presented. For that reason, 18 experts (mostly designers or in a similar position; work priorities: product development; new design development) from a medium-sized company (sector: Engineering, Medical Engineering) were asked about their assessments after applying the problem idea profile presented in Section 5.3 as a preparatory step in advance of the idea creation steps. The experts took part in a workshop. The 18-person group was divided into two smaller groups of nine people. Each group got information about a general realistic designing problem. The groups should use the blank problem idea profile (compare Figure 3) to specify their given problem and to derive a problem idea as a task in order to create solution ideas. Afterwards, each group passed the problem idea profile to the other group. The next task for both groups was to create new solution ideas addressing the given problem idea by using a creative technique and only having the problem idea profile as an information base. The step of idea creation was repeated with the other problem idea, which was specified by the group itself in the first step of the workshop.

In connection with this, all experts were asked about their assessments on the used problem idea profile. For this purpose, a five-tier Likert scale (Likert, 1932) was used again. The results of the survey are shown in Table 3. In general, the experts support the thesis that a detailed problem analysis is helpful for idea creation (average 1.17) and they state that one is dealing in detail with the problem (average 1.28). The experts were mostly supported by the problem idea profile (average 1.89) and they endorse using the problem idea profile in order to specify the task of idea creation (average 1.78). The two controlling questions (see Table 3) underline the positive feedback of the experts on the problem idea profile. Being asked if the profile is practical (average 2.50) and if the experts would use it in their daily activities (average 2.28), most of the experts agreed with the statements of Table 3, but they expressed some recommendations for improvements. Most of the experts requested a kind of instruction how to

fill up the problem idea profile and some detailed explanations (glossary of terms) elucidating what concretely is asked within the single boxes of the problem idea profile. As an example, three experts had problems to understand what is meant by "Structure". Two of them even claim that the "Structure" is not needed and useful. Three other experts did not agree that the time and the cost should be assessed by the problem idea creator and should be dictated by the upper management. One expert underlined the time aspect as very important and helpful. Two experts recommended emphasizing the problem idea itself and underlined its importance. One expert highlighted in detail the usefulness and the simple application of the problem idea profile, which is not used in his daily practice so far but should be introduced as soon as possible.

Table 3. Results of the assessment in business practice

	Strongly agreed Level 1		**Level 2**		**Level 3**		**Level 4**		**Strongly disagreed Level 5**		**Not answerable**		**Aver-age**
	Answers/percentage of answers given												
I support the thesis that a detailed problem analysis is helpful for idea creation.	**15**	**83.3%**	3	16.7%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	**1.17**
A problem analysis ensures that I deal in detail with the problem itself.	**13**	**72.2%**	5	27.8%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	**1.28**
The problem idea profile supported me during idea creation.	4	22.2%	**10**	**55.6%**	2	11.0%	1	5,6%	0	0.0%	1	5,6%	**1.89**
I support the specification of the task for idea creation by using the problem idea profile.	7	38.9%	**8**	**44.4%**	3	16.7%	0	0.0%	0	0.0%	0	0.0%	**1.78**
***Controlling question:* The problem idea profile has not supported me.**	0	0.0%	0	0.0%	1	5.6%	5	27.8%	**12**	**66.7%**	0	0.0%	**4.61**
***Controlling question:* I was inhibited by the problem idea profile.**	0	0.0%	2	11.0%	2	11.0%	6	33.3%	**7**	**38.9%**	1	5.6%	**3.83**
I consider the problem idea profile practical.	0	0.0%	**8**	**44.4%**	7	38.9%	2	11.0%	0	0.0%	1	5.6%	**2.50**
I would like to integrate the problem idea profile into my daily activities or the process sequence of our company.	3	16.7%	**8**	**44.4%**	6	33.3%	1	5.6%	0	0.0%	0	0.0%	**2.28**

7 DISCUSSION

Assessments of the set of information and the problem idea profile as the formal framework of the elaborated problem analysis have identified potential for small improvements. However, in general, the supporting effect of the presented tool has indeed been proven. According to the experts, no important aspects are missing. Most of the information aspects are suitable for analyzing a problem and all experts underlined the importance of a problem analysis before starting with the creation of solution ideas. For some information or queried aspects, a more detailed description, and the goal behind the analysis of that information aspect have been proposed. Most of the informative aspects were comprehensible to the experts, although the formulation of certain terms needs to be adapted in some cases. This feedback can be used to optimize the set of information and the problem idea profile. In general, it should be noted that the assessment of the information set and the problem analysis can only be seen as an initial step. A limited number of designers took part and there is therefore no empirical evidence that the same results would be observed in all other companies.

8 CONCLUSION AND OUTLOOK

In this paper, a tool for problem analysis has been elaborated and presented as a process preceding the idea creation process. The goals were to consider all aspects that are relevant for analyzing a problem and to prepare further steps of idea creation. A clear and precise transferring process of the information aspects was aspired to. Based on the results and their discussion, certain conclusions can be drawn. The requirement for a tool to improve communication within the front-end of the innovation process is not seen as imperative. However, it has been shown by a review of literature and an expert survey that an analysis of the task is necessary. The presented concept shows how such a problem analysis might look. Additionally, the applicability and usefulness of the information aspects have been assessed in a support evaluation with 40 students during the Prescriptive Study. After the elaboration of the complete tool, experts were asked about the usefulness and the supporting effects in the Descriptive Study II.

The main reason for the implementation of a problem analysis is to save time and costs by downstreaming activities during product development. After all, the solution ideas are intended to focus on the actual problem itself. The information and data analyzed should thus reduce the need for coordination and enhance transparency. Consequently, designers dealing with the evaluation and selection of solution ideas should be supported. In future research, the question of whether the problem analysis with the result of a clear task can also support the evaluation and selection of solution ideas must be examined. Furthermore, the examination must be conducted to determine whether the quality and quantity of solution ideas can be improved by the presented tool. This paper only presents a

subjective assessment by experts. It must be emphasized that the practical application of the problem analysis needs to be evaluated further, especially in industrial applications. Additionally, the adaptability of the method to the specific circumstances within a company and the training of employees in order to enable them to use the tool successfully by gaining the same understanding are necessary to examine.

REFERENCES

Abele, T. (2013), "Einführung in die Suchfeldbestimmung und Ideenbewertung", In: *Abele, T.* (Ed.), Suchfeldbestimmung und Ideenbewertung, Springer Gabler, Wiesbaden, pp. 1–18.

Baker, N.R., Siegmann, J. and Rubenstein, A.H. (1967), "The effect of perceived needs and means on the generation of ideas for industrial research and development projects", *IEEE Transactions on Engineering Management*, Vol. 14, pp. 156–163.

Blessing, L.T.M. and Chakrabarti, A. (2009), *DRM, a Design Research Methodology*, Springer, London.

Brandenburg, F. (2002), *Methodik zur Planung technologischer Produktinnovationen*, Shaker, Aachen.

Brüggemann, H. and Bremer, P. (2015), *Grundlagen Qualitätsmanagement*, Springer, Wiesbaden.

Cantamessa, M. and Montagna, F. (2016), *Management of innovation and product development*, Springer, London.

Ciupek, M., "Der amerikanische Ansatz ist: Geh' pleite!", In: *VDI Nachrichten*, Vol. 44 (2015), No. 30, pp. 2–3.

Cooper, R.G. (2011), *Winning at new products*, Basic Book, New York.

DIN EN ISO 9000. Dezember (2009). *Qualitätsmanagementsysteme - Grundlagen und Begriffe*, Beuth, Berlin.

Gassmann, O. and Granig, P. (2013), *Innovationsmanagement*, Hanser, München.

Gerhards, A. (2002), *Methodik zur Interaktion von F & E und Marketing in den frühen Phasen des Innovationsprozesses*, Shaker, Aachen.

Geschka, H. (2005), *Ideenmanagement - Grundlage für einen dauerhaften erfolgreichen Innovationsfluss*, Industrie Management, No. 3, pp. 29–32.

Hauschildt, J. and Salomo, S. (2011), *Innovationsmanagement*, Vahlen, München.

Herrmann, T., Binz, H. and Roth, D. (2016a), "Approach for creating a refined task as preparation for a target-oriented idea generation process", In: Marjanovic, D.; Storga, M.; Pavkovic, N.; Bojcetic, N. and Skec, S. (Ed.), *Proceedings of 14th International Design Conference, Dubrovnik*, pp. 1035–1044.

Herrmann, T., Binz, H. and Roth, D. (2016b), *Methodeneinsatz im Innovationsprozess, Ideen- und Innovationsmanagement*, Vol. 42, No. 4, pp. 133–140.

Khurana, A. and Rosenthal, S.R. (1997), "Integrating the Fuzzy Front End of New Product Development", *Sloan management review*, Vol. 38, No. 2, pp. 103–120.

Kim, J. and Wilemon, D. (2002), "Focusing the fuzzy front-end in new product development", *R&D Management*, Vol. 32, No. 4, pp. 269–279.

Koen, P.A., Greg, M.A., Boyce, S., Clamen, A., Fisher, E., Fountoulakis, S., Johnson, A., Puri, P. and Seibert, R. (2002), "Fuzzy Front End: Effective Methods, Tools, and Techniques", In: Belliveau, P.; Griffin, A. and Somermeyer, S. (Ed.), *The PDMA toolbook for new product development*, John Wiley & Sons, Inc, New York, pp. 5–35.

Krause, F.-L., Franke, H.-J. and Gausemeier, J., (Hrsg.) (2007), *Innovationspotenziale in der Produktentwicklung*, Carl Hanser, München.

Krüger, W. (1981), *Techniken der organisatorischen Problemanalyse*, Gabler, Wiesbaden.

Lechler, T. (2005), "Projektmanagement: Konzepte zur Einzel- und Multi-Projektführung", In: Albers, S. and Gassmann, O. (Ed.), *Handbuch Technologie- und Innovationsmanagement*, Gabler, Wiesbaden, 493-510.

Likert, R. (1932), (A technique for the measurement of attitudes), *Archives of Psychology*, Vol. 22, No. 140, pp. 1–55.

Mencke, M. (2012), *Kreativitätstechniken*, Cornelsen, Berlin.

Messerle, M., Binz, H. and Roth, D. (2013), "Elaboration and assessment of a set of criteria for the evaluation of product ideas", In: Lindemann, U.; Venkataraman, S.; Kim, Y.S. and Lee, S.W. (Ed.), *Proceedings of 19th International Conference on Engineering Design*, Design Society, pp. 125–134.

Miecznik, B. (2013), "Ideenmanagement", In: Abele, T. (Ed.), *Suchfeldbestimmung und Ideenbewertung*, Springer Gabler, Wiesbaden, pp. 143–168.

Schlicksupp, H. (2004), *Ideenfindung*, Vogel, Würzburg.

Schmitt, R. and Pfeifer, T. (2015), *Qualitätsmanagement*, Carl Hanser, München.

Seifert, J.W. (2006), *Visualisieren, Präsentieren, Moderieren, Gabal, Offenbach*.

Vahs, D. and Brem, A. (2015), *Innovationsmanagement*, Schäffer-Poeschel, Stuttgart.

Verein Deutscher Ingenieure, Richtlinie 2220. May 1980. "VDI Richtlinie 2220 Produktplanung - Ablauf, Begriffe und Organisation", *Beuth*, Berlin.

Völker, R. and Friesenhahn, A. (2016), "Innovationsmanagement in der digitalen Welt", *Wissensmanagement*, Vol. 2016, No. 08, pp. 30–32.

Zhang, Q. and Doll, W.J. (2001), "The fuzzy front end and success of new product development: a causal model", *European journal of innovation management*, Vol. 4, No. 2, pp. 95–112.