

THE RESEARCH PAPER AS AN OBJECT OF COMMUNICATION IN INDUSTRIAL DESIGN EDUCATIONS

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ABSTRACT

The writing of research papers gives students at industrial design education's the opportunity to gain experience with design research and papers as an object of communication. Design research is an interdisciplinary field that is both relatively new and also has a fuzzy borderline to the professional disciplines which designers usually work with or compete with. Design research is in nature quite an abstract field of science, which is a big problem for students who for first time are going to design a scientific approach for their study's field. It is an interesting problem because it reflects a symptom of design research in general. In order to exemplify and provide an overview of useful approaches, this study develops archetypal design research approaches where the abstraction level is adjusted so that they represent a real support for new researchers.

Keywords: Design research approach, science studies, object of communication

1 INTRODUCTION

Scientific research and industrial design is a fairly new combination at university programs, and to a large extent they represent the classical dualism between theory and practice. 'The research paper as an object of communication' is an attempt to bridge this dualism and create a meaningful space for reflection on action. In 2005, the Danish Ministry for Research, Innovation and Education decided that all engineering educations should have compulsory courses in philosophy of science, because a need for scientific competences in methodology and reflection had been detected in the educational system. The courses that we are going to deal with in this paper are one such attempt to infuse methodological credibility and validity into the programs, and at the same time to teach the students to communicate in a proper language and style. This does not mean that we are trying to establish a closed and specific scientific lingo on industrial design, on the contrary, we are trying to open up for variety and hybridity in creating this 'object of communication', because it is precisely meant for communication in contextualized, cross-disciplinary and engaged environments.

There are several challenges to confront when research papers are produced and discussed. It is how we meet these challenges that are at the core of this paper. The main challenges are: definition of the scientific foundation of the enquiry, lack of identification on how phenomena are to be read and understood, lack of structure in dealing with the topic/problem of the paper. There seems to be very little documented experience (at least in a Danish context) on how to frame industrial design in a scientific and theoretical perspective, which is probably the reason why students are finding it difficult to produce research papers of scientific and methodological quality in the spirit of 'mode 3' knowledge-production [1]. The two contending 'modes' are also a 'problem' in this case, because they use models and theories that both rival and complement contextualization, engagement and cross-disciplinarity. Furthermore, the core of industrial design in this perspective is not a fixed, frozen or clearly defined entity. On the contrary, it is in a process of constant becoming and as such impossible to classify and standardize. This dynamic and emergent situation of uncertainty is of course difficult for the engineering students to handle, because in general they are used to clear and certain answers delivered by mathematics and physics.

In order to give some sort of understanding of the processes in knowledge-production, which is not based on certainty and truth, we have tried to introduce the 'scientific logic of discovery' as visualized

by Imre Lakatos. Lakatos' model shows how there are a core of claims and reasons, and how this core is immersed in an environment of heuristics. Knowledge-production in this perspective is to work with negative and positive heuristics where we (critically) question the reasons and claims of the core. This means, in our reading, that the core is constantly under critical pressure and that claims and reasons change as evaluation processes are developed and take form as 'objects of communication', e.g. research papers and articles.

Heuristics in a scientific perspective has to do with discovery, and how to act in order to be able to make discoveries that expands and enhances our knowledge of the world and reality. The ways of heuristics are not defined as such, but depends on, or are interdependent with, the context. This means that the scientific work, the research paper, is entangled and intertwined with the context, and that the importance of the context should manifest itself when it comes to clarifying values and interests present in the context. And this is at the foundation of all scientific discoveries. When structuring and designing the research paper in an industrial design context, it is obvious that we cannot exclusively depend on the extreme heuristics of random (negative heuristics), but should complement with positive heuristics where clearly identified 'tools' and theories are at hand. In this way, we pose critical questions where we challenge the claims and reasons of the core. This means that Lakatos' protective belt needs a redefinition, because it is uncritical in its protection, hence pointing towards Karl R. Popper's emphasis on critique in relation to logical deductive thinking.

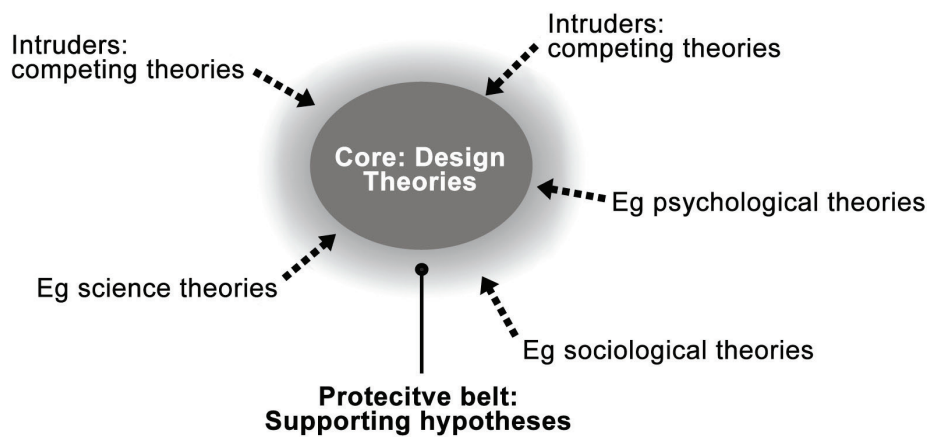


Figure 1. The hard core of theories¹ by Imre Lakatos [2]

Chucholowski et al. [3] have recently made an attempt to systemize and categorize the relationship between activities (practices) and research (theories) in design processes, where they establish a taxometry based on the intertwining of activity and research. Their model addresses a branch of design which focuses on the technical, functional and practical elements in the process. In comparison to the approaches (13) that are present in this specific paper writing course, the taxometric model could be classified as one approach out of several, because we find that there is a lack of context in the taxometric model. There is a lack of cultural and social practice and reflection, dealing with the importance of the user as a social entity, the importance of aesthetics as a clearly defined parameter in the design process, the importance of history, e.g. the genealogy of process and design, and the importance of philosophical reflection on technology. The 13 approaches that constitute the methodological framework of the course mirror this integrated and holistic understanding of research in design, where science and engineering, social studies and humanities meet in the 'critical belt' engaging with dynamic and transformative core design theories.

Emergent studies and programs like industrial design should be framed in dynamic and transformative ways, because the core is not defined and probably never will be. How do we handle this situation of uncertainty and heuristics in an educational setting, which to a high degree is layered within the framework of empirical-analytical science? How do we create the scientific and research framework that promotes critical and reflective thinking in the research paper as an object of communication? And finally how do we make way for practice to be part of such reflective thinking?

¹ The figure is inspired by a figure of Martina Maria Keitsch

2 THE STUDY - PREMISES

Presentation of the frame for the "archetypal design research approach" is assumed to be necessary to give useful understanding of the study's result. The frame consists of two courses with contents of philosophy of science in industrial design education and the tools of production of research papers as well as The Pentagon of Scientific Enquiry [4]. The last-mentioned model is an actual tool, but the model plays a leading role given that it helps gather and organize the results of other tools. Pentagon also constitutes the taxonomic backbone for building the design research approach.

2.1 Philosophy of Science in Industrial Design Education

Industrial design is characterized by multi- and interdisciplinarity, which creates a number of problems when it comes to designing the curricula on philosophy of science for the course. On an ideal level the study aims at interdisciplinary processes and solutions, but in reality these are multi-disciplinary, which means that the various disciplines involved in the process are not connected and even less intertwined. This means that ontology, epistemology and methodology often are contending the field which leads to confusion and frustration among the students.

The curricula of the courses are focused on the concept of the matrix of paradigm. This means that we search for theories and methods that will enable some sort of core construction of the discipline. We do that by introducing to Thomas S. Kuhn's definition of the paradigm [5], which we supplement with the ideas of Karl R. Popper on the 'logics of scientific discovery' [6]. It is especially Popper's creed in abduction as reasoning that we find relevant for a program that is both revolved around science and artistic creativity. Furthermore, we introduce the students to circular reasoning and fusion of horizons in the perspective of Hans-Georg Gadamer [7], where the eminent qualities of the hermeneutic circle are discussed. Besides that we also discuss the potentials of empirical experience through our senses based on the ideas and models by Ernst March and Hal. R. Varians [8]. This ontological, epistemological and methodological patchwork is necessary in order to embrace all the practices and knowledge types of industrial design, and certainly it makes the students understand that this discipline is multifaceted and trans-disciplinary. The weakness of the construction of the patchwork is that the different positions have very loose, if any, connections, they also have different rationales, different terminology, and different criteria for validity, credibility and truth and different aims for what concerns the actual knowledge-production. This means that there are constant clashes and contentions, which are hard for the students to handle.

We think that the curriculum is in need of a refurbishing where we emphasize the hybridity of the education, and make it clear that the program is 'in between' disciplines. We think that there is a need to pinpoint the multiplicity of competences that constitutes the role and identity of industrial design, where we point at the capacity to construct models and design based on mathematical and physical principles, the capacity to understand societal and cultural consequences of technology, the capacity to understand use/user of technology. This requires 'a hybrid imagination' [1] where things are intertwined and we enable and support connections and translations in between disciplines and competences, which in this case is layered within the education itself. In the following, we shall look into the actual practices in the course, and we will discuss the tools that we use in the production of research papers.

2.2 The Tools of Production of Research Papers

Students in bachelor programs, that for the first time have to prepare a paper about a professional design subject, have, in addition to the theoretical knowledge about design research, a need for tools which supports the paper creating process. The tools which were included in the paper creation are presented here briefly, because they provide a central part of the framework, to which "the heuristic design research approach" belongs. The tools are presented in next to the activity they contribute to and in the order they are brought into the process:

- Topic selection ⇒ thematic structured catalogue which exemplify and inspire to selection of a topic within three themes: Form & Aesthetics, Method & Process and Technology & Production.
- Selection of keyword ⇒ mind map, where the chosen topic constitute the core. All the students help each other by working on each other's mind maps.
- Knowledge about the genre and experience with scientific review ⇒ presentation and review of a published E & PDE paper in two-man teams to the rest of the students [9].
- Literature search ⇒ online searching by Primo was introduced and started up with supervision.

- Relevance checks ⇒ a verification of the professional relevance of chosen topic on the basis of a working title, research question or problem that will be analysed, and a brief description of the different needs of knowledge the topic offers.
- Progress in the creating process ⇒ an introduction to writing clusters in association with synopsis² feedback and rewriting of paper drafts [10].
- Practice-based research ⇒ is exemplified during an excursion to companies such as Møller-Jensen Innovation & Design Aps, Kontrapunkt A/S, Damvig Develop A/S and to institutions such as MindLab, Danish Technological Institute and Danish Patent and Trademark Office.

The students have also been presented to a number of examples of the content, overall structure and requirements for quality of good research papers [11].

2.3 The Pentagon of Scientific Enquiry

Pentagon is used at many Nordic universities as a tool to ensure the scientific foundation of the student's research [4]. This study's students were also presented for this tool. The Pentagon corners focuses on: 1. *Research question* ⇒ what do you ask about? 2. *The research's academic purposes* (potential use) ⇒ why do you ask? 3. *The research's empirical* ⇒ which substance, data, phenomena, etc. do you ask for? 4. *The research tools* ⇒ which theories, concepts and professional methods, do you ask with? 5. *The research's approach* ⇒ how do you ask? The design professional topics the students preferably choose to treat are either based in the reality they live in or have grown out of something that has not functioned optimally during the study. As mentioned above, the Pentagon of Scientific Enquiry gives a general template for each research, but it is also a challenge given that the tool's activities must be specified relative to the topic's professional field. Despite the fact that subject-specific context is given and the issue is selected in relation to a theme, the interdisciplinary field makes it difficult to select an approach for the research. When the synopsis has been based on review of relevant literature, feedback on each synopsis from the writing cluster has been good support. The course introduces many theories to give as many students as possible a good starting point for their investigation and for contributing actively in discussions. It has also been emphasised how important the "design research approach collection" can be as notes for remembering. Preliminary studies suggest that the notes are especially helpful when recalling the assumptions, approaches and presumptions about the character of returns.

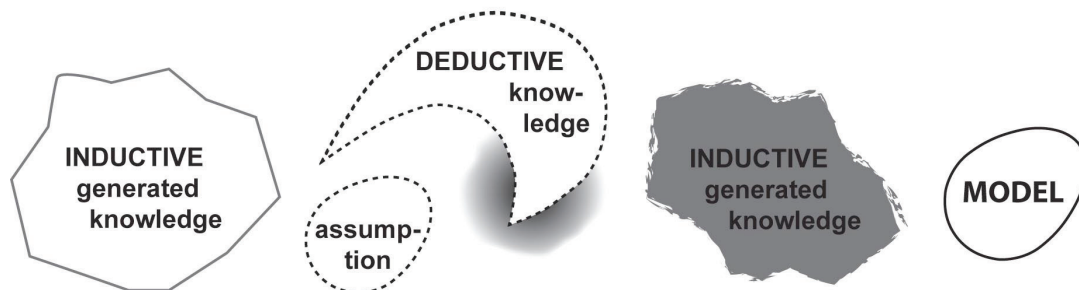


Figure 2. The double-focused approach

A special need arises in situations where the selected topic is new or in the absence of scientific treatment in relation to the design profession. It happens when only sporadic knowledge is available in practice or when the problem is addressed only in a science field that is not directly related to the design profession. For that reason, the first approach was to give input to these topics without design professional literature, but with an incipient interest in practice. This approach is based on the double-focused approach [12], which is based on an inductive approach, where one without preconceived opinions gather knowledge through field studies, investigation of the documentary sort and what else the situation might offer. The understanding of this collected material forms the basis for the deductive approach of the next phase. The first idea of a possible answer to the research question or a solution to the problem is only rarely complete; but enough to define a previously uncovered area which a new

² The synopsis should include: Title of the paper, the state-of-the-art, problem / research question, the approach to the study of the problem, the theoretical background of this matter / method of analysis / hypothesis, if possible ideas for solving the problem and a proposal for paper's outline and references.

study with an inductive approach may shed some light on or result in a delimitation of the use of a theory. See Figure 2. Such an exchange interaction between the inductive approach and the deductive approach can be used to cultivate new fields where the approach can either lead to an answer, outline a model or a method of investigation.

3 THE STUDY - PROCEDURES

The papers that are the subject of this study are the results of the two courses Philosophy of Science 2007-2010 and Theory, History and Analysis 2011-2013, which both were of an extent corresponding to 5 ECTS and offered to students in the third year of the bachelor's program. The number of students participating in the Philosophy of Science course, which was offered to architecture students as well as to design students, grew from 100 to 150 over time. The other course, which was offered only to industrial design students, had 26-32 participants. It may be a surprise that this study is based on the papers and not on the courses' theoretical and methodological basis, but both courses have suffered from the fact that the scientific level of abstraction did not match the students' initial proficiency. The aim of the curriculum was high, since the purpose of paper production was *"to convey the student's independent research of an important theory position or method in industrial design professionalism."* In the light of these experiences attained in the courses, the study's purpose with the design research approaches was first and foremost to support practically oriented students and students, who have not evolved from "solving tasks" to define, delineate and answer research questions yet. The papers from the two above-mentioned courses were scrutinized for fragments of known and unknown scientific approaches, with the aim of identifying the approaches and isolating missing link between the fragments.

Subsequently, the preliminary design research approaches based on this scrutinising were corrected so that they represented a pattern of scientific approaches. Experimental investigation has been difficult for students to fit into the short course, therefore it has been necessary to supplement the collected design research approaches with elements that can inspire the students to make such investigations. Finally, some testing on this collection of "archetypal design research approaches" was necessary in order to get an answer to the study's research question: do such a "heuristic design research approach" really support the students' design of approach to the research. The first criterion of success is the clarity of procedures, and the second is the emergence of new approaches possibly developed by combining "archetypal design research approaches".

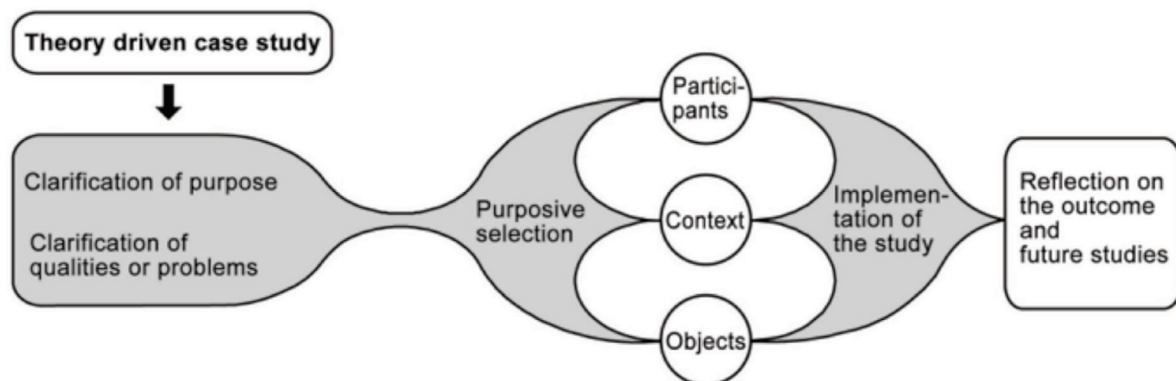


Figure 3. Design research approach to a case study.

3.1 Exemplification of Design Research Approach

Roughly a quarter of the students saw the preparation of their papers as a chance to challenge the theories they had more or less good experience. Typically, the motivation is in the dissemination of a theory field of application to industrial design or in the developing of theories to improve the match between theory and practice (the students' own project practice). One example of a title of a design research approach is: Case study of theory testing. One thing that characterizes the approach to such a theory-driven study is that it is purposive. The theory-driven studies completed by our students aim to provide an abundance of information, therefore they are qualitative studies. The purpose of the student papers is mainly to provide guidelines for design of something or recommendations to the design process. Rarely, there is time to complete more than one case study, however the visits to various companies during the excursions often present several cases for study, however the reflection on each

case is not made until after all visits are completed, therefore we are not talking of serial case studies per se. The model for approaching this type of case study can be seen in Figure 3. The approach is idealized based on the description in the booklet: "Selection of cases" [13]. Where the concept "object" is used in the model, it is used as "object of communication".

4 RESEARCH FINDINGS AND IMPLICATIONS

Our study showed that the collection of "archetypal design research approaches" both contributes to increased quality of student surveys and to the communication of their researches, given that the collection has inspired the students to describe, to a greater extent than earlier, their approach in the synopses. The collection of approaches is still rather limited, which means that the possibility for creating hybrids for investigation and understanding is restricted. This is for now a weakness in the set-up. In the future we will stress the importance of heuristic hybridity in experimental investigation. Archetypal approach for case studies and experimental investigations has increased the incidence of case studies and given the students the courage to throw themselves into experimental investigations. The study also revealed that the archetypal approach does not sufficiently exemplify how the parameters, which are subjects of the research, can be described as recognizable phenomena or graduated measurable qualities. Unfortunately, we found that instructed literature searches were not sufficient to get a clarification of all the state-of-the-art. Approximately one third of the papers were based solely on searches completed in Google Scholar. This is a dilemma between a desire for a small manageable collection of "archetypal design research approaches" that all students can use as inspiration for choosing both topic and approach and a desire for detailed description of approaches that also exemplifies the construction of parameters. In order to solve this dilemma, we suggest that the collection of approaches is combined with a design research taxonomy model like the one mentioned above. Such a model will accommodate literature, where the students can find examples of parameter construction.

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