INTERNATIONAL CONFERENCE ON ENGINEERING AND PRODUCT DESIGN EDUCATION
7 & 8 SEPTEMBER 2017, OSLO AND AKERSHUS UNIVERSITY COLLEGE OF APPLIED SCIENCES, NORWAY

# A SHIFT FROM TECHNICAL PROPERTIES TOWARDS SENSORIAL CHARACTERISTICS IN PRODUCT DESIGN EDUCATION

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**ABSTRACT**
The aim of this study is to evaluate a new pedagogic approach implemented in a compulsory materials course for product design students at bachelors level at ABC University. When developing a new curriculum for the material course, a decision was made to teach materials and production methods in a contextualized setting with emphasis on how students can deal with materials in a design process. Methods can be seen as mental tools that aid the design students in navigating complexity and offers them a structure to deal with unfamiliar territories. After an evaluation, some methods, guidelines and tools were selected to integrate in the compulsory materials course for the product design students, e.g. the Expressive-Sensorial Atlas [1], Meaning Driven Materials Selection [2] and the Material Driven Design method [3]. The implementation is made in two steps in order to test, evaluate and further develop a framework for teaching materials courses to product design students. The study evaluate the first step of implementation in general, and the implementation of the Material Driven Design method in particular. It is hoped that this research can contribute to further development of pedagogical approaches for teaching materials and production methods in a contextualized setting for product design students at bachelors level.

*Keywords: Material Driven Design; Material education; Product design; Material selection; Teaching practice.*

## 1 INTRODUCTION

This study evaluates a new pedagogic approach implemented in the two mandatory material courses for product design students at bachelors level: '*Applied materials and tools for model making in Product Design, 15ETC*' and *'Material and Production methods, 15ETC'*. In particular, the integration of the Material Driven Design (MDD) method is addressed. After a several-year long process of gathering knowledge, gaining experience and finalizing negotiations with involved stakeholders, we implemented a new curriculum in the fundamental materials courses that are mandatory for all Product Design students at ABC University. The radical shift in how product design students are taught materials and manufacturing methods was possible after transferring Product Design education from the Faculty of Technology and Society to the School of Arts and Communication. The first step was implemented in the existing materials courses, without changing the learning outcomes in the course syllabus; instead, literature, methods, tools and the pedagogic approach was updated. By doing it in two steps allowed for testing, evaluation and to further develop a framework for teaching materials courses to the product design students. The second step of implementation is to restructure the Product Design bachelor program and write new course syllabi. This study only reports the first step of implementation since the second step is under development and will be implemented during autumn 2017 and spring 2018. First part of this article describes the dilemma of the product design education placed at a technical faculty. In the following section, we outline the new pedagogic approach and describe how is the first step is implemented in the product design education at bachelors level. We then discuss the use of methods in design education in general and then present the implementation of the MDD-method. The final part of this article consist of a discussion on the radical shift that occurred in the pedagogic approach of teaching product design students about materials followed by the results of the study. Finally, we reflect on the benefits and drawbacks of our approach and suggest some improvements.

### 1.1 Design education at technical faculties

Design education at technical faculties is often characterized by a curriculum for materials education with a predominant focus on technical properties. Due to long scientific and technological tradition, the engineering discipline has well developed curricula for materials education supported by textbooks, digital tools, etc. Effective communication of materials knowledge and design knowledge between the two disciplines - material science and design - has been challenging due to their different perspectives on materials. Engineering students, at bachelors level, study well-established textbooks with scientific knowledge that is 'unquestionable' and developed during the past two centuries (Bucciarelli, 2003). This kind of 'content knowledge' can be seen as static and difficult to apply in an open-ended learning exercise typical for design students. There is a tendency of 'watering down' the materials education for design students, instead of using adequate, up-to-date scientific methods from the field of design to cover both the technical properties and sensorial characteristics [4]. Design education at bachelors level needs to offer material courses that prepares the product design students to work both on inspirational and analytical levels in material selection processes. Early in the design education, students often have a preconception of materials, and they need to be introduced to an open-minded inspirational material selection process, based on scientific design methods.

### 1.2 Development of a new curriculum

When developing a new curriculum for the material courses it was regarded important to teach materials and production methods in a contextualized setting with emphasis on how students can deal with materials in a design process. Methods can be seen as mental tools that aid the product design students in navigating complexity and offer them a structure to deal with unfamiliar territories. Experience from the old curriculum had indicated that when product design students and engineering students were taught the same courses in material and production methods, the courses tended to become too general and decontextualized. Design students are generally interested in applied materials and often discouraged by the technical approach in the introductory courses. It became difficult for the design students to relate the purely technical aspects of materials to the applied material knowledge gained through the design projects. Early in the development of the new curriculum, it also became clear that it was important to make a distinction between material selection and material exploration, as they are two different ways of approaching materials [5]. Materials considered in the fuzzy front end of the design process are dealt with at a more abstract and holistic level, e.g. creating a material vision instead of defining materials requirements for product realization. This could contribute to strengthen the abilities of product design students to integrate their material knowledge and skills in the design process, from the fuzzy front end to the structured back end in a professional setting. A literature review was carried out with a focus on guidelines and tools used in or developed for materials education in the field of design [4]. Methods, guidelines and tools (see Table 1), were selected and integrated in the existing material courses for the product design students. By restructuring the course, the interaction between theory and hands-on learning were put at the centre, as we believe the students gain a deeper understanding of materials if the theoretical lectures on materials are closely linked to hands-on material experiments. In practice that could be a lecture on the material family of metals in the morning followed by working with tube bending and welding in the workshop later in the day.

*Table 1. Selected methods, guidelines and tools*

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| **The Expressive-Sensorial Atlas** | Uses four parameters, namely texture, touch, brilliancy and transparency [1]. Charts provide illustration of sensorial qualities using a sample of materials combined with a simple, concise textual definition. Design students rank material samples, based on personal sensation that result in a subjective and qualitative sensorial scale from one sensorial extremity to another e.g. light-heavy. |
| **MDMS** | *Meaning Driven Material Selection*, aims to assist designers in manipulating meaning creation in materials selection [2]. The guidelines help students to understand how the complex combination of manufacturing methods, shape and |

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|---|---|
| | function relates to the user experience defined by, for example, expertise, gender, age, and cultural background. |
| **Materials and Product Attributes** | Hodgson and Harpers guidelines (fig.3) offers an overview of how a range of 10 materials related product attributes contribute to the realization of Form, Function and Fabrication in a product. These in turn ultimately determine both the cost and value of the product, which must ultimately match the need, or market demand [6]. |
| **MDD-method** | The Material Driven Design method facilitates design processes in which materials are the main driver [3]. |

The lectures were developed in the spirit of active learning (Felder & Brent, 2009) with brief interludes of practice and feedback to offer the students an understanding of the more complex context of, for example, the relation between technical properties and sensorial characteristics. The Expressive-Sensorial Atlas [2] was introduced and used during the lectures as a way for the students to explore the relationship between what is perceived subjectively and what is measured objectively. The content of the lectures was also adapted to design students' prior knowledge of materials and developed to reflect the latest research in the design and materials domain. The number of commercial materials available is rapidly increasing and the traditionally used taxonomy of material families is gradually decomposed with hybrid materials such as composites. Therefore, it is fundamental to provide students with tools to create their own understandings of materials [7]. The MDD-method (fig.1) is a synthesised method of well-established creative and rational methods, such as tinkering, ideation, user studies and benchmarking. By working with an explorative approach, the product design students understand the material in-depth, e.g. they understand experiential qualities, physical properties and '*the material's purpose within a situational whole'* [3]. The MDD-method guides the product design student on a journey organized under four main steps as: (1) Understanding the Material: Technical and Experiential Characterization, (2) Creating Materials Experience Vision, (3) Manifesting Materials Experience Patterns, (4) Designing Material/Product Concepts. In order to create a meaningful application, the product design students need to move from material characterization to a holistic vision (Step 2 of MDD). They also need to enable novel experiences by crafting the vision into a meaningful application (Steps 3 and 4 of MDD).

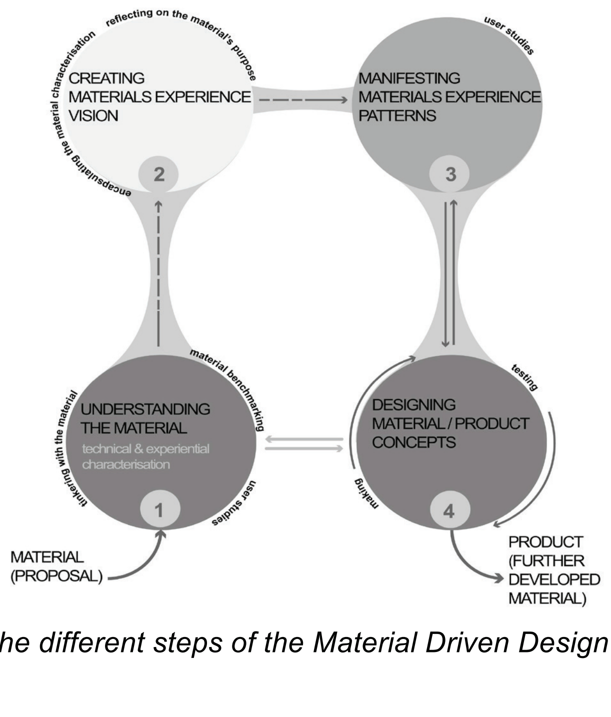


*Figure 1. The different steps of the Material Driven Design Method [3]*

# 2 EVALUATION OF THE MDD-METHOD

The students were introduced to the theoretical framework of Material Driven Design in a series of seminars where the class became a part of structuring the MDD-activities and timelines in the course. It is important to encourage students to work explorative and also learn from failures in the iterative process of tinkering with materials, and as a consequence create a certain degree of flexibility in the timeline. The students were asked to apply the MDD-method to material proposals that were semi-developed/exploratory (textile waste and coffee ground) or with a relatively unknown material (mycelium). Learning to investigate a material in an explorative yet structured way increased the integration of material thinking in the design process and motivated the design students to reflect on the materials they use. The MDD-method was integrated in the course structure so that the different learning activities supported each other, e.g. the pull test in the applied mechanics of materials module was performed on the material samples the students produced in the course. The benchmarking of materials was connected to the methods used in the production economy module and so forth.

## 2.1 Understanding the material

By combining the theoretical knowledge of the technical properties, found in literature, with tinkering the students created their own range of fiber composites. To understand the technical properties of the new composites, they were tested, e.g. pull test, fire resistance, water resistance (Figure 2).

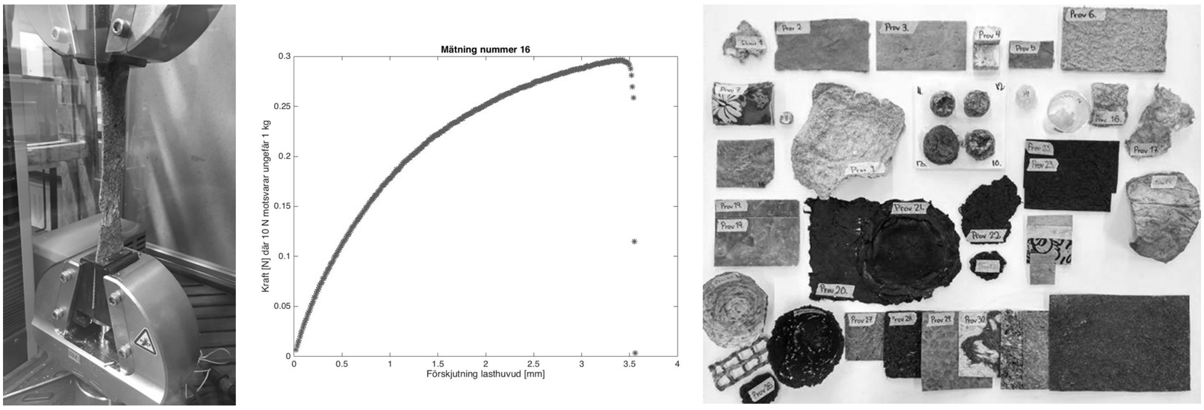


*Figure 2. A pull test of one of the material samples produced by a group of students in the course 'Materials and Production methods' 2016*

A user study was conducted to unveil the sensorial, emotional, performative and interpretive characteristics of the new fibre composite. For this purpose, an '*experiential characterization toolkit',* was introduced [3]. The '*experiential characterization toolkit'* is made up of a facilitator's brief that guides the facilitator through the different steps of the user study and a set of templates for the participant. The participant is asked to (1) freely explore the material sample, while commenting aloud (2) show which actions the material makes her/him do (3) explore the material with her/his senses and rate it with the sensorial scale provided (4) describe which emotions the material elicits (5) choose 3 adjectives from the set provided and to select 2 pictures for each word, to explain what they associate with that word (6) reflect generally.


*Figure 3. Step 5 'the interpretive level' in the 'experiential characterization toolkit'*

When using the pictures in the '*experiential characterization toolkit'*, the students discovered the importance of cultural context. In step 5 *'interpretive level*', the participants were asked *'what do you associate with the material? how do you describe it?'.* They were then asked first to choose three adjectives from the set provided and place them on a template. The adjectives were selected from Desmet [8] and Fokkinga [9]. They then were instructed to select two pictures for each adjective, to explain what they associate with that word by using pictures (Figure 2). It is important to notice that the pictures were not validated before selected for the '*experiential characterization toolkit'*. The majority of participants were confused when asked to pair adjectives and pictures that could convey their interpretation of the material. They asked if they could choose other pictures, and were then allowed to only choose one instead of two for each of the three adjectives if they could not find two suitable ones. The pictures were interpreted in different ways depending on the participants in the user study. Some participants were not able to interpret the symbolic meanings of the images and instead interpreted the actual information in the pictures. This could also later be seen in results from the user study. When the students analysed the result of the different steps of the user study it became clear that step five *'the interpretive level*' stood out from the rest, as it was difficult to discover a pattern in the data. It was clearly difficult for non-design professionals to communicate with a combination of pictures and words to describe a material. The majority ended up focusing on choosing pictures that explained the adjective and not in relation to the experience of the material itself. One improvement that was discussed in the course was to exclude the adjectives and instead develop guidelines for the facilitator how to select suitable pictures that have contextual relevance.

## 2.2 Creating the Material Experience Vision

The greatest challenge for the product design students turned out to be the creation of the Material Experience Vision. This is a critical step in the MDD-method as it synthesizes all the knowledge about and experiences of the material gained so far in the process. The purpose is to expresses how a designer envisions a material's role in creating functional performance and a unique user experience when embodied in a product as well as in a broader context [3]. The product design students found it difficult to keep a certain level of ambiguity and not focusing on a final product or product category when creating the material experience vision. It is important that the students understands the difference between a *material* experience vision and a *product* experience vision as it influences the quality of the outcome of the project.

## 2.3 Designing Material/Product Concepts

In the final step of the MDD-method, it became clear how important good documentation of the material experiments performed during the tinkering was. At this stage, the final version of the fibre composite had to be produced in greater quantities, different colours and textures for the prototypes (Figure.4). The product design students that had felt most challenged by crafting the material experience vision gained renewed confidence in the final familiar stage of the MDD-method.

*Figure 4. The project Flexstil by A.Burdette, N.Krig, T. Lindqvist 2016*

## 3 DISCUSSION AND CONCLUSION

The MDD-method should be seen as a sequence of steps that can be altered depending on the educational background of students. In the course '*Material and Production methods*', we focused on the steps: understanding the material, creating materials experience vision and designing material/product concepts. We chose to skip the step 'manifesting material experience patterns', as it was too time consuming and not relevant in relation to learning outcomes defined in the existing course syllabus. We found it valuable to introduce tinkering as a mind-set and not only as a step of the MDD-method. Tinkering takes place both in a physical and '*mental*' space and demands a flexible creative space with suitable tools and materials e.g. a workshop or a kitchen. In the course, four seminars introduced the main steps of the MDD-method. Retrospectively, it would have been pedagogic to introduce the different sub-steps of the methods gradually, as some of the sub-steps e.g. material benchmarking, tinkering and user studies, are the result of several connected activities. In the course, the product design students got both hands on experience and theoretical knowledge of materials and production methods. It was challenging for the product design students to systematically analyze the data collected during the project. This provides scope for further improvement in the next step of developing the curriculum, as it is an important skill to master both qualitative and quantitative methods. An unexpected learning outcome of the new curriculum was navigating ambiguity in an explorative design process; this became evident when crafting the material experience vision. Ambiguity is a powerful tool for raising topics or asking questions and avoiding dictating answers in a design process. Working with the different steps of the MDD-method in a course structure is rewarding but challenging for both teachers and students as it demands good communication between everybody involved or else some of the synergies in learning activities are lost.

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