THE MATERIALITY OF COLOUR IN DESIGN EDUCATION: FUNCTIONAL CODES AND CULTURAL CONTEXT

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ABSTRACT
Colour competence is often seen as a basic knowledge introduced in the early stage of product design education. A knowledge gap was identified that required more advanced learning outcomes for colour in curriculums of product design education at master levels. How can colour knowledge in product design contribute to corporate social responsibility? This was explored through a case study approach. The first case study was a master student's development of various bottle-green glass lamps in collaboration with the glass industry. The second case was the development of shades of blue in a ceramic colour surface used in public art in a chapel of rest. The third case was the use of signal yellow colour to demonstrate interface areas in an offshore context in the oil industry. The implementation of all solutions concerned both technical challenges and people's emotional experiences of what was meaningful in each context. The learning outcomes of the study were an expanded understanding of how colour can be substantial in certain contexts. The first was that knowledge about technical premises in materials was needed to design colour surfaces. The second was that ethnographic competence was needed to analyse possible emotional experiences of colour in various cultures. The third was that competence in product semantics is needed to implement a coherent use of colour as indexical signs in health, environment, and safety.

Keywords: Colour technology, ethnographic methods, corporate social responsibility CSR, master education.

1 INTRODUCTION: BASICS OF COLOUR IN PRODUCT DESIGN

Colour competence is often seen as a basic knowledge introduced in the early stage of product design education. Colour as a phenomenon, however, is complex and has, in the classical studies by the scientist Goethe [1] and later the artist Albers [2], been explored through advanced practical experiments and physical experiences. Through such empiric experiments, they demonstrated practice-based principles of colour competence that can be transferred into the more advanced tech-based training courses in the field of design. In spite of this, their theories seldom have been implemented as learning outcomes in master levels of design education, although the Bologna process requires that formulating knowledge should be done with regard to learning outcomes [3]. There is therefore a need to develop more advanced learning outcome formulations for design students at a master level, informed by relevant theory and professional design practice.

2 BACKGROUND: EXPLORING COLOUR IN PRODUCT DESIGN

Colour can promote corporate social responsibility (CSR), creativity, and innovation in design and engineering, because according to Karjalainen, the visual appearance and the semantic signs in the design of a product are closely connected to the strategic branding of a company [4]. Colour is frequently mentioned in regard to learning outcomes in introduction courses at a Bachelors level but rarely at a master's level.

One of the few examples was a Swedish study that explored colour as the main approach in product design for Bachelor students in the 3rd year and Masters in their 1st year [5]. They explored the concept Identity Tool Kit (ITK), a method that aims to assist designers and contractors in meeting on "visual platforms" in relation to the development and production of products and services, and started from point 4 of the ITK method, "Shape & Colour". The aim of the research was to find a method to

represent the complexity of the relationship between colour and shape, in the specific context of the design of product or service. This was in order to make possible communicating this parameter during discussions in a team of professionals or to the end user, and to be further adoptable in design education. They found that the students that participated in the workshop showed enthusiasm and true passion and succeeded very well in their task.

2.1 Colour identified as learning outcomes

However, although much experimented with in practice, there have been few learning outcomes that are mentioned specifically at Masters level in product design, although learning outcomes in education should be identified and formulated in curriculums for all three cycles, according to the Bologna process [3]. It is even less described as a learning outcome in PhDs in Design & Engineering. A reason to focus more on the phenomenon of colour in product design education is that colour engages both students, teachers customers and mass media in visual culture in practice, so how to integrate colour as an explicit element in projects and problem based learning should be further discussed [6]. Colours are connected to people's lives in various ways. According to the social anthropologist Taussig, colour appears in different ways in the community, both in culture and working life [7]. He promotes the fact that colour is important because it is attached to people's feelings, their social rituals, and cultural codes. Further, he claims that to understand colour it should be seen as much more than a technological issue or trying to reduce it to a simple colour code, as it is associated with the experience of people's physical surroundings, social behaviour, and their way of expressing themselves. For a product designer it is essential therefore, to be able to relate to the complexity of colour parameters, and to have competence that exceeds the basic colour theories.

2.2 User experience

One of these competences is to expand the understanding of user experience of a product in the environment. Thus the aesthetic experience connected to colour in design products is essential [8]. A social dimension is the challenge to motivate people to accept and make use of new solutions and new surroundings [9]. Sustainable environmental development requires a balance between economic, ecological, and social interests [10] and from a social and cultural perspective, colour competence is therefore useful in design practice.

2.3 Colour in product design master education in Norway

Although the cultural understanding of colours varies, and although ethnographic studies demonstrate various cultural meanings of one colour, the social anthropologist Taussig criticize that the use of colour in the environment often is based on an indexical use of colour codes [7]. A pilot study in Norway has shown that in some companies that aim for design to achieve strategic competitive advantage, the leaders think that knowledge about colour is one of the least important competences they expect from a designer. This is not only happening in business life, but also in design education. Although there is often an introductory course in colour at the bachelor's level, colour is rarely mentioned as a learning outcome in the master curriculums of Norwegian design education. The institutions with master curriculums in product design, industrial design, furniture design, and engineering product design have colour in the curriculum but the only learning outcome on a master level was, 'The basic course focuses primarily on the design aspects of industrial discipline, through individual design and an aesthetic exploration of two- and three-dimensional expressions, including the use of colour'. Other descriptions were advanced on a scientific level but connected to purely technical perspectives on colour. Based on these educational situations and recent studies, a knowledge gap was identified that required more knowledge about implementing advanced learning outcomes on colour in design education at a master level. The research question was, therefore; how can colour competence contribute to a corporate social responsibility at a master-student's level? The aim was to identify what kind of knowledge was needed in design practice at master's level, and to see how this could be implemented with regard to learning outcomes in a master study of product design.

2.4 Method: Case study of colour competence for corporate social responsibility

A suitable method was case study [11] because the colour phenomena could be explored in a real life context, as experienced by professionals and internship master students. In case study methodology, Yin recommended establishing some theoretical propositions based on earlier research in the field, and

on practice. The theoretical propositions in the case study were threefold based on the background: The first was that knowledge about technical premises in materials is needed to design colour surfaces. The second was that ethnographic competence is needed to analyse possible emotional experiences of colour in various cultures. The third proposition was that skills are needed to implement a coherent use of colour as indexical signs in health, environment, and safety contexts. These propositions were explored through a case study approach in three contexts: in the glass industry, in a chapel of rest, and in offshore technology. Thus the case studies were validated through earlier studies, practice in the field of education, and in professional design practice [6]. Further, an embedded case study design allows for theoretical sampling in a cross case analysis [11] and by concept mapping [12].

3 RESULTS: COLOURS IN CONTEXT: GREEN, BLUE AND YELLOW

Figure 1 A, B, C. A. Green glass. B. Light blue porcelain. C. Signal yellow interface points

3.1 Case study 1: Transparent tones of green glass for lamps in the glass industry

The first case was a master student's development of various green glass lamps in collaboration with the glass industry. The student Caroline Olsson writes on her homepage: 'The Skog series (Figure 1A) consists of several lights in different sizes, shapes, and colours, which can be used in combination with each other or as stand- alone pieces. They are all made out of mouth-blown crystal with a base of oak made by using a wood turning technique. The design is inspired by the large forests surrounding Magnor Glassverk. Skog is the Norwegian word for forest. Simply place a few of the lights together on the floor or on a table in order to create your own little forest.' The lamps are manufactured by Magnor Glassverk. Materials: Oak and mouth-blown crystal. Dimensions: Bruse 255 mm. Furu 310 mm- Gran 455 mm. Light: E27 lightbowl.

In the interview, she explained that, 'The lamps are a good example because that is the project where I have worked most consciously with colours.' The products should represent 'Forest' in shape and colour. The colour contributed to a story about the products, but it was also connected to cultural heritage and the tradition of the company she collaborated with. Through research, she had found out that people have a good relationship with green glass; it reminds many people of old bottles in green tones that stand together. Therefore, the design leader at Magnor Glass Company felt that green colours helped to represent their values and their history.

Health, safety, and environment were addressed by choosing a bulb without heat, which when touched is lukewarm and not hot. It is the opposite to glowing red, and the function of the colours is that if you take on the cool green colours, the feeling is as expected: lukewarm. Technical challenges were resolved through dialogue with the chief designer at the factory and those who worked in the glass production department. They knew which colours were difficult to keep in the cooling phase when there were different types of tensions in different kinds of glass. There were many tests and a lot of glass was discarded. She tried many colours in the process, to choose a suitable triad. The composition of this colour triad was one of the most complicated tasks; the form and colour of the lamps were not supposed to be too figurative or to give overly clear references to a forest. The associations would possibly first occur when multiple lamps stood together so becoming a 'forest'. There was a slight complementary colour contrast in the foundation through the use of oak colour, which was chosen because it has a texture similar to small branches, where the fibres follow the shape of the trunk of a tree. Through complementary contrasts perceived by the eye, new colours could emerge, and there were additional colours in overlaps created by transparent tones from moss yellow to aqua blue to aqua green.

She explained that during her studies, she had gradually begun to miss more knowledge about colour, and at the end of the master study, students had discussed in class that they should have known more

about it: 'We did everything the safe way because it was the last exam. We tried a few colours but it felt risky. The exception in my case was these lamps. Now that I'm working in the design profession, I see in practice that the purpose of colours can be particularly helpful in marketing by use of photography.' This photo (Figure 1A) was shot by the photographer Kaja Bruskeland. Olsson believed that it is important to focus consciously on colour throughout design study. The photos created an increased value in marketing and added value where customers related to the product because the colour reinforced its story. She also believed that the use of colour was inspiring for her own creativity in the design process, because it allowed for a different way of thinking and initiated thoughts about new ranges and collections.

3.2 Case study 2: A light cobalt blue ceramic surface for art in a chapel of rest

The second case was the development of a specific blue ceramic colour surface (Figure 1B) used in public art in a chapel of rest. Through participatory design, colour was implemented in a mourning room integrated in the church. Participatory design had been chosen because it ethically and emotionally could contribute to create a meaningful surrounding. In the study, the mission was to create an atmosphere of spiritual guidance. The implementation of the solution was therefore not limited to technical challenges, but strongly related to people's emotional experiences. Colours were developed based on ceramic crystal structures and their optical properties. Studies of technological behaviour of colours in the Co-Cr-Fe-Mn system were carried out to define the best compositions and to disclose the role of crystal chemistry in colour expressions and pigment-glaze interactions. Categories of colour phenomena that were identified in the study were based on the procedure that was used to connect colour, emotions, and environment. Eventually, material experiments of colour shades were developed and connected to people's experience of hope. Thus it was shown how the technologically developed colour through participatory design could be associated with a cultural phenomenon in a chapel of rest.

3.3 Case study 3: Signal yellow and reflective light in the offshore oil industry

In the third case, signal yellow was used for safety reasons in an offshore context in the oil industry (Figure 1C). In an interview, the designer Nenad Pavel explained that his experiences from the oil industry were not from oil platforms but from a seismic anchor ship where one examined the seabed. He was hired to help to create a subsea seismic sensor for measuring the seabed, a sensor that could be operated via a robotic operative vehicle (ROV). He said that there was, in general, a different use of colours on the water and on board the ship. It was generally a completely new context for him. He said, 'I got a culture shock'. He had to think quite differently than he had done earlier as a designer. 'I attended a safety course at once, and learned to jump from a platform, how to position my arms and to look up, not just around me; one gets a whole new sense of how to be. I let myself fall from a helicopter into the water, and it was similar simulations in a pool. You were a kind of James Bond after that.' As a designer he was used to thinking about user experience, colour, and shape, but now suddenly he thought security - security - security and then: function - function. He also put in many hours in modelling CAD. Now, planning the design mostly revolved around security and legal procedure; the colours were just there to ensure that everyone would know what was being talked about and that everyone knew what an interface point was; under water, there should be a common understanding of the equipment. 'Everything is very pragmatic. All the ships I saw were red outside and white inside; they followed an industry standard.

For the underwater sensor, he first considered various colours in yellow and orange, but when he asked the supplier, they came with a book of rules on the use of colour. There were examples of how to design interfaces, and all interface points; it was all about suppliers and implementation of technology. 'There were components you purchased and put together.' There were strict rules for the use of colour under water, and different rules for colours used on ships. This was because all things under water had to be seen with a camera from a ROV. The camera technology was essential for colour selection. It was common to have yellow colour in all subsea products, because then the light and the reflection of light were easier to see. It was especially the interaction points that had to be visible when the robot looked for interface points as orange and yellow dots based on a standard RAL colour palette.

At one point he relied not on the colour alone, so he chose to use some additional measures. For example, metal was used in some places because it was cheapest, and then some engineers, in practice,

had marked these locations with orange tape to define the interaction point. The designer had another suggestion which was to use a reflective tape, whereby the ROV illuminating node points displayed in the dark provided clearer references. There were five white dots and a metal piece around omega-shaped hollows that were marked with reflective tapes so that the ROV could manoeuvre with propellers and camera to see into the cavity from a good angle.

'Using the reflective tape was a typical idea I had because of my design background, I think. I experienced that the engineers I worked with thought in a slightly different way because they did not simulate as much in advance; they tried it out in practice, and when something failed, they tried again. They appreciated completed drawings to be a total picture before testing. This was valuable to them because when I made drawings the totality emerged.' He thought that in this way he could use his design skills in geometry and drawing to complement these features. The design product received a national design award for the year's best design in Norway. Something the designer thought was comical was that an article was written about the product in a technical magazine, but it was written in a slightly ironic tone: 'It was a nice yellow colour so that the fish could thrive under water'. The designer thought the article could give the impression that 'now product designers are creating pretty things under water', but the purpose was, he said, to make it more visible and functional with reflective tape, and the yellow colour was already determined in the regulations.

He felt that his earlier design expertise - like use of colour in offset print and colour use in classical drawing and painting were not relevant expertise for this type of project. It was mostly about following rules and to be creative within these frames. He thought it would be interesting to study how to prepare students for such a culture shock: 'One thing is to do your research with observation and interview. Another thing is that designers also need to go into completely new roles and contexts; this can be a good thing for designers: to try to be offshore people, to try to be a nurse, to feel it in their bones'. He thought it was important to have the ability and knowledge to understand different practices from the inside.

4 DISCUSSION: COLOUR IN A CULTURAL CONTEXT

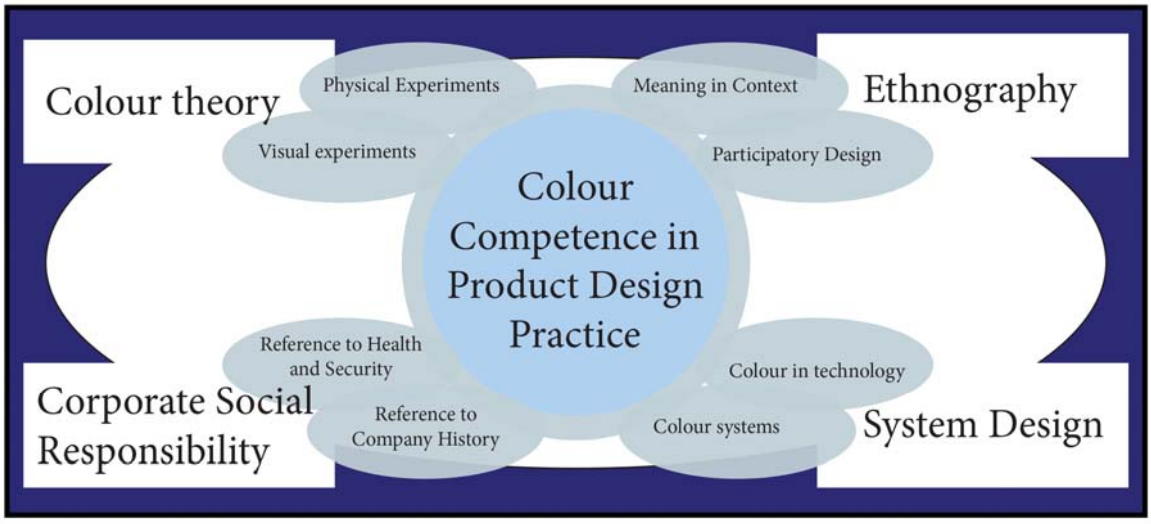

Figure 2. A pedagogical concept connecting colour competence with learning outcome topics and relevant theory

The research question was, 'How can colour competence contribute to corporate social responsibility at a master-students level?' The topics identified through the initial propositions were adjusted according to the findings in the case studies. The case studies tended to focus around colour in context and colour in various cultural settings. The findings are therefore first discussed in relation to colour in a cultural context [7] before some topics are identified through concept mapping [12] visualised as a pedagogical concept (Figure 2) and validation with cross case analysis of the initial propositions as recommended in case study research [11]. Finally, this was connected to how design education at higher levels may have the advantage of implementing the use of colour in the study plans [3] because, through ethnographic methods and participatory design, empirical data can be generated in new ways

[7, 13]. The materiality of colour is, in this case, therefore an integral part of the concept, in line with other non-figurative qualities, such as texture and shape. Taussig [7] reflects on how colour is integrated into a cultural context, and in his search for the 'sacred colour', he exemplifies with blue several times. For instance he does not see any relation between a colour and a specific value; rather, he sees the colour quality as being connected to each unique situation. Further, he sees colour like no other substance we have ever seen or can imagine, but more like a substance which has no substance, suspending the laws of time and space, manifesting itself in different ways as a 'polymorphous magical substance'. An example which he uses is the colour blue emerging in the blue linen used in the mummification rituals in Egypt in 2400 B.C In this context, he describes colour as the divine breath that gives life to all creatures; 'drawing gives shape to all creatures, but colour gives them life'.

4.1 Conclusion

The learning outcomes identified in the study were based on the idea that colour could be more included as a relevant topic at masters level of product design. It seemed like the advanced experimental approaches promoted by Goethe and Albers are still valuable, but that in design practice more theories about contexts are necessary for designers to be able to contribute to corporate social responsibility. Therefore, the first learning outcome identified was that students should have an advanced understanding of how colour can be substantial in certain contexts of design practice. Another learning outcome was that knowledge about technical insight in materials and understanding of the systems in which they were practicing was needed to design colour surfaces. Further ethnographic competence was needed to analyse possible emotional experiences of colour in various cultures and work places that contribute to the values of a company. Finally a general competence on product semantics was needed to implement a coherent use of colour as an indexical sign in health, environment, and safety. The study thus identified a variety of technical and emotional knowledge, skills, and general competence that was needed to understand how colour in product design could be experienced in a broader cultural perspective.

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