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EXPLORING MENTAL SCALING AS SOURCE FOR CREATIVITY DURING THE PRODUCT DESIGN PROCESS

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ABSTRACT
In product design practice, design problems may occur on different levels and through different stages of a design process. The diversity of these different levels - from an abstract philosophical, ideation and conceptualization level, to a concrete detail solving one - requires an ability to flexibly grasp the nature of the actual problem, independent of where in the design process it occurs. Academically, these challenges are addressed in different ways in design schools worldwide, via an institution's culture, traditions and experiences of applied pedagogical methodologies.
For a product designer, the commercial race for technological optimization and functional efficiency combined with complex market mechanisms, demands an increased ability to adapt. This refers to future technological development, rapidly changing consumer behaviour, and the prediction of future trends. The Institute of Design (IDE), The Oslo School of Architecture and Design, has carried out educational training to meet these demands. Our motivation has been to launch and test new design methodologies in order to stimulate the product design student's ability to generate ideas and execute design processes by implementing holistic views. The starting point for the pedagogical research project was: How can we stimulate and thereby improve design student's creativity through the execution of different stages of a product design process? The question is answered by providing examples of how stimulus for enhanced creativity was provided to our students. The conclusion indicates that the mission gained positive pedagogical effect through the practical student projects.

Keywords: Creativity, product design process, mental scaling, idea stimulus

1 INTRODUCTION

When facing a society in rapid change, accelerating sustainability challenges, rapidly changing consumer behaviour and shifting demands within contemporary products, systems and services, designers are increasingly challenged by new constraints to design solutions. Therefore, academic staff in design education, and practitioners within the industrial design profession recognize an increasing demand for applied design methodologies in the design education, with the aim to prepare for and adapt to future trends. Aspects such as social changes becoming the norm, internationalization, globalization, and an emerging awareness for sustainable solutions, add to this emerging professional consciousness. As a consequence, there is a strong need for intensified focus on the development of design methods that contribute to pedagogical development of design thinking within academia and higher design education. This development could also enable the making of cutting-edge products, systems and services becoming corporate assets in emerging future markets.

2 BACKGROUND

2.1 The research field

Design problems may lie at different levels on a mental "ladder" or framework. A problem can be cognitively challenging, as it can be interpreted as a philosophical problem or even an attitude issue. Conversely, the problem may be physically oriented, as its response may require actual artifacts or physical attributes, or a detailed solution proposal to satisfy a defined need by way of specific requirements. A formulated design problem requires - and corresponds - with a search for a design solution on the similar mental level. A given design problem reflects a defined demand or a certain need. According to Jan Landquist [1], *need* is the foundation of any design process. He suggests that

this process is principally the foundation of all design methodologies: *Needs – analysis – visualization/design – result/product.* This process might work in principle, however, the stage of evaluation is lacking in this model. In order to grasp the often complex mental process that designers experience, there is a need for a broader description of both the perceptual and cognitive stage of both analysis and synthesis elements of the creative process. Peter Rowe [2] presents an iconic model of a design process consisting of *Analysis - Synthesis - Evaluation - Communication*, applied to a crossing axis from abstract to concrete. This model clearly identifies the importance of iterations through the process across these levels. Following this line, Bryan Lawson [3] refers to the Markus/Maver map of the design process, by suggesting that each step of the process from outline proposals via scheme design to detail design demands a separate internal loop of analysis, synthesis, approval and decision. Our theory reflects this idea of a holistic and generative approach enabling a structured product design process, by integrating a substantial internal loop of evaluation, and by introducing a strategic stimulus for both *divergent and convergent procedural fluctuations within each step of the design process*.
When referring to theory on pedagogy and different modes of learning, Donald Norman [4], suggests that different modes of learning need to be accommodated in the design of instruction. This approach accords with what we have tried to explore. It includes a focus on developing a diverse set of tools for establishing an open mind-set. This is done in order to be able to search for new angles and holistic approaches for solving design problems, and different modes or levels of cognition may be addressed. In order to further examine these modes of cognition, we pose a key question: What kind of procedural tool could serve as a "compass" for the mental navigation? In answering it, it is useful to consider a number of typical stages in a generative product design process, suggested as follows:

- Needs
- Analysis
- Design requirements/specifications
- Ideation process
- Conceptualization process
- Design – overall- and detail process
- Visualization
- Dissemination

3 MENTAL SCALING

3.1 Some general reflections

The theoretical framework for this paper is found in the theory of creativity and cognitive psychology. Eysenck, M. W. and Keane, M. T. [5], discuss mental scaling influenced by reasoning and decision making, and the dilemma of choosing alternative courses of actions. Another theoretical reference is found in theory of *the trial and error method* for innovative problem solving, where Yuri Salamatov [6] acknowledges the importance of incorporating the rules of dialectic thinking into the theory of creativity. This supports our theory of the importance of relevant instructions in teaching. Pedagogic principles is constantly, and necessarily, in fluctuation in academia. In higher design education, design methodology is a field which has been influenced by academic trends, pedagogical developments, national educational characteristics, and identity given by each individual pedagogical institution. When discussing principles aiming at stimulating creativity, the relation, or dependency, between input and output is always an important consideration. The degree of open-mindedness in approach depends on the cognitive levels at which the requirements are situated. If the problem solving process is not carried out in accordance with the right mental level of a given problem definition, the designer is likely not to succeed in answering relevantly to the given task.

3.2 Mental scaling as phenomenon

Mental scaling -or mental "zooming"- is principally comparative to the way one may zoom in and out of a digital map, where different layers of information are either revealed or hidden on each level of resolution. In this manner, the information of the map is filtered, depending of the chosen resolution. In our model, this principle of "magnification" is similar with the act of shifting focus on the mental scale, Figure 1. Further, the principle of navigation on the mental scale is dependent on the actual design constraints. These may vary from flexible/optional to rigid/mandatory, being either external or internal, depending of the scope of the actual design task. One measurement of the actual effect of mental scaling could be how adequate or relevant the produced solutions are to the given constraints and requirements defining the design task.

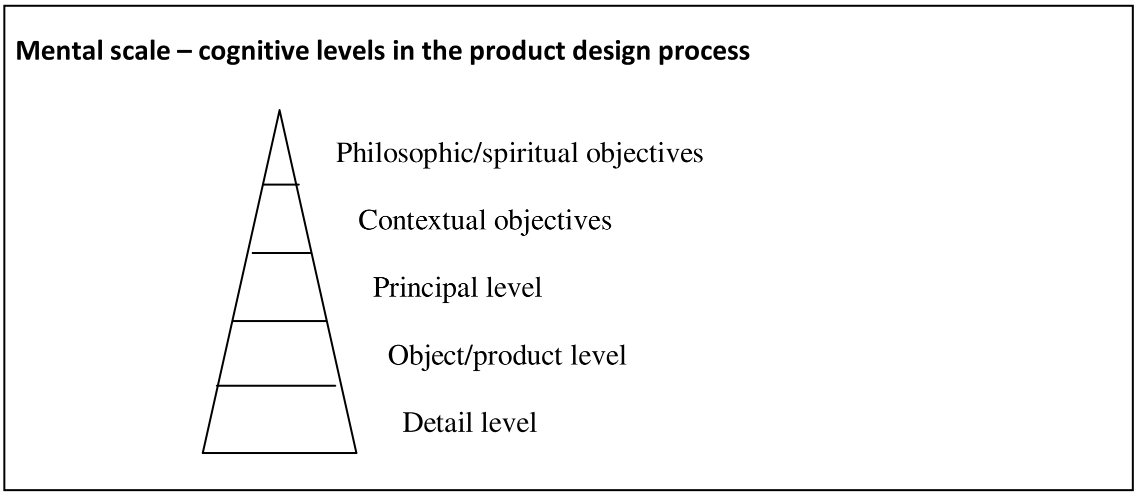

Figure 1. Mental scale – cognitive levels in the product design process

This paper supports the idea that *each step* of this model may be applied into the process of mental shifting needed through the design process.
What could serve as a stimulus for the students, in order to help them view a problem from other angles than traditions suggest, and by that fighting conformity? Several lectures focusing on mental scaling [7] seemed to trigger the group of students to recognize the importance of relevant mental navigation through the design process. Our ambition was to observe and recognize whether this mental triggering -or stimulus- could produce a change in student behaviour compared to previous design tasks.
The term 'mental scaling' refers to both the conscious and non-conscious navigation between an abstract and concrete level of a scale representing a mental consciousness, when discussing a certain topic. This ability could also be described as mental elasticity. By deliberately and consistently asking 'why?' and 'how?' to *each* idea on each level, this procedural elasticity is being provoked, as the student is *forced* to think either divergent or convergent, in order to answer the question. We envisage that this *forced mental fluctuation* may be understood in our suggested scheme, Figure 2:

Mental scaling stimulus – triggers for forced mental fluctuation/shifting

ABSTRACTION **Meta-level; ethics, values, morality, existence, stances (divergent)**
Holistic view

"Why" *should this problem be solved?*
Requires an answer towards abstraction, upper meta-level, holistic view

"How" *should this problem be solved?*
Requires an answer towards concretization, physical solution mode

CONCRETIZATION **Physicality level; object, solutions and details mode (convergent)**
Fragmented view

Figure 2. Mental scaling stimulus – triggers for forced mental fluctuation/shifting

In order to apply this mode of asking these key questions, the author chose to explore the use of form characteristics -more specifically antonyms- as idea triggers. These antonyms were deliberately

chosen, presented, and clearly instructed, to indicate opposite positions or values, with the intention to stimulate mental fluctuations, as decisions based on the shifting between opposite mental positions.
In order to stimulate the student's conscious mental fluctuations during the form synthesis stage, a set of antonyms were presented to the students. Typical examples of these were: geometric-amorphous, dynamic-static, active-passive, stable-unstable, robust-fragile, symmetric-asymmetric, convex-concave, horizontal-vertical, massive-porous, positive-negative shape, opaque-transparent.
Being a relevant reference to theories of creativity, Osborn A. F. [8] and his CPS, Creative Problem Solving process, introduced brainstorming and creative techniques based on creative thinking. This work has been inspirational for our pedagogical theory. Our theory develops this model further, by introducing forced mental fluctuation -idea triggering- as inspiration for our pedagogical model for deliberately and consequently stimulating divergent and convergent thinking further.

3.3 The design case – problem scope

To describe our case at IDE more specifically, a group of students were given the task to develop functional objects from idea level to physical appearance models, based on their personal requirements from practical daily life experiences. By recognizing a general need for abstract, conceptual thinking, and to stimulate a holistic approach to the initial ideation phase of the design process, we decided to define the tasks on an abstract, conceptual level. As a consequence, the design tasks were given to clearly allow for a wide ideation process, through the conscious use of semi-abstract terms: The students were given the task to develop new designs for one of three electrically driven, functional objects (formal, common names such as 'iron' were never used): *1) an object for flattening textiles, 2) an object for drying hair, and, 3) an object for cutting wood.*
By using these abstractions, the mental focus was moved towards abstract conceptualization, instead of relating the concrete task to the common understanding - or conformity - of daily, well-known tools. The preferable, interesting question would be: "Which new functional and aesthetical values could be introduced to an object for flattening textiles?", rather than asking: How would you design a new iron? The intention was to formulate questions on a more abstract level, and to study how this mental approach could open up for a whole new way of producing and capturing initial ideas and concept suggestions through the sketching stage of the design process. In this way, a stimulus towards a wide idea-generating process was created, which could lead to a wider specter of ideas for selection and development through a form synthesis process, using the principle of form iterations.

3.4 Categories of student's procedural capabilities

In order to achieve better understanding of the variety of cognitive patterns observed from design students working through the different product design courses at IDE, we also recognized a need for developing a new tool for categorizing the personal abilities of each student, discussing their mental focus, and to plan and structure the tutoring of each student. Thereby, a more systematic framework for the individual evaluation of each student through our feedback could be produced. Based on daily observations, a scheme was designed to reflect each student's improved ability to navigate across established individual patterns, Figure 3. Parameters for registering student qualities were as follows:

Attitude:	**Process:**
• Degree of curiosity, ability to explore, and ability to formulate critical questions • Open mental attitude • Empathy towards the concrete design case, focus on the user and user situation • Ability to challenge own ideas • Creativity, in terms of ability to develop a wide specter of initial ideas • Courage	• Performing analysis, execution/thoroughness • Shifting between abstract and concrete level • Width and depth discussing potential solutions • Ability to transform analytic result to final design

Figure 3. Student capability parameters

When used as a pedagogical principle, we acknowledge the value of describing these attitudes and process capabilities as being both valuable instructional and psychological tools for creating student enthusiasm, and also as important parameters to systemize the individual feedback and tutoring.

4 RESULTS AND REFLECTIONS

The effect of mental scaling can be measured by how relevant a developed solution is to the initial problem definition given by the analysis. Experience indicates that different design methods are applicable to different problem specifications. Experience from earlier student design tasks - carried out as part of the foundation studies of the IDE product design- indicate that amongst a class of both male and female students, there are always representatives of both mental “A-navigators” and “C-navigators”, as described below.

4.1 Definitions and principles of categorizing

Based on a need for categorizing student’s capabilities and personalities during the foundation course, it seemed to be fruitful to describe the opposites by a set of characteristics, indicating typical mind-sets, or personal attitudes of our design students.

A-level is an abbreviation for “*Abstract level*”, representing the upper holistic or the philosophical sphere of the mental scale. This indicates a focus towards abstraction, or the attraction of solving problems on an abstract level, through philosophical or conceptual thinking, Ref. Figure 2. *C-level* is an abbreviation for “*Concrete level*”, indicating a fragmented view on the lower, concrete section of the mental scale. The term indicates a focus towards concretization, or the attraction towards solving problems on a detail level. Those students typically represented with an interest or approach towards an A-level, are tagged as “A-navigators”, while those students typically represented with an interest or approach C-level, are tagged as “C-navigators”.

4.2 Mental navigation characteristics

4.2.1 The ‘A-navigator’

The A-Navigator tends to navigate within the abstract sphere of the mental scale. Typically, the A-navigator is often triggered by stimulus from holistic, abstract thinking. This student is mostly comfortable with discussing solutions in the upper part of the mental scale, as their thinking mainly concerns this section of the mental scale. The project often demonstrates a good ability to discuss conceptual, strategic or ethical problem topics. As a consequence of this, the initial idea mapping stage of the design process is often well carried out, and the number of possible conceptual solutions is often convincing. However, the A-navigator often hesitates when arriving point of decision when there is a demand for concrete, physical solutions. The student tends to have problem with turning focus towards C-level, and thereby missing the required attention to final details.

4.2.2 The ‘C-navigator’

The C-navigator tends to navigate within the concrete sphere of the mental scale. Typically, the C-navigator is often triggered by stimulus from concrete, fragmented thinking. This design student is most comfortable with discussing solutions in the lower detail-focused part of the mental scale. The design project tends to show evidence of this, as the project often displays a limited ability to discuss overall, conceptual, strategic, or ethical problem issues. The consequence of this is that idea mapping with philosophical aspects is lacking or is poorly dealt with, as highly relevant or novel solutions might be missing. The student tends to have problem with turning focus towards A-level.

4.3 Output

Before our mental stimulus initiative was provided to our students, approximately 25% of the student mass seemed to represent A-navigators, approximately 25% of the mass seem to represent C-navigators, while approximately 50% of the students did not indicate either of these tendencies.

After evaluating the students thinking and the physical documentation material such as sketches, physical mock-ups, posters, renderings and appearance models, the distribution of A- and C-navigators changed, being an observation our scheme also indicated. Now both the A-navigators and C-navigators decreased in numbers, as evidenced in our scheme under category ‘*Open mental attitude*’. Some of the students were inspired by our focus and instruction towards mental shifting, and succeeded in changing their mental focus by reducing a *static* A-level or B-level attitude towards a more *dynamic* procedural thinking. This result suggests that our intended inspirational influence actually produced a change of the student's mind-set towards a more holistic approach to the complete design process.

Experience gained from the practical exercises proves that mental scaling appears to be a diverse tool for creative idea triggering and problem solving, as well as a structural framework on which different points of view may be adapted to. It seems that implementing mental scaling as a pedagogical methodology improves the ability to carry out a wide variety of operational tasks in a feasible manner. If put into practice, an increased potential for corporate use, and thereby an increased commercial effect through skilled product solutions could be within reach.

Experience gained from these experiments indicate that an active mental switching between A-level - "abstract" and C-level -"concrete" during any stage of the design process increases the student's ability to:

- establish a better overview of complex design problems and their internal relations
- perform conscious navigation through the successive stages of the design process
- stimulate independent idea development
- endure the challenging process of actually making independent decisions, by transforming a qualified selection of ideas into results relating to given requirements
- develop and produce results on an appropriate mental level according to the corresponding mental level of the given requirement(s)

After actually implementing the developed scheme, ref. figure 3, we –as course responsible from the academic staff- recognized this as a valuable tool in order to:

- discuss internally each student's mental focus in a given design case
- plan and structure the tutoring and guidance of each individual student
- produce a more structured framework for the individual evaluation and feedback to each student

5 FUTURE DISCUSSION; MENTAL SCALING AS CREATIVE TOOL

When examining our mission retrospectively, it seems that our core question has been answered, as the tasks given to the students contributed to a cognitive stimulation in order to improve design student's creativity through the execution of their design tasks.

Mental scaling as a creative tool needs to be an on-going, discussed topic in academia. We invite educational trainers from other institutions to comment our thoughts, and to forward their own experiences and other approaches to mental scaling and pedagogical effects of their efforts. Further discussion concerning experience from similar pedagogical activities in other universities and higher education institutions could contribute positively, as confirmation or disproval of these results in other design cases could contribute to a better understanding of the challenges that academic staff face in order to development design methodologies as a broad pedagogical field. Therefore, suggestions to other approaches to mental scaling as procedural tools for stimulating creativity are therefore highly welcomed to be discussed further on.

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