IDEA GENERATION: IS ILL-DEFINED BETTER FOR INNOVATION?

Christian TOLLESTRUP[1] **and Linda Nhu LAURSEN**[2]
[1]Aalborg University, Department of Architecture, Design and Media Technology
[2]Aalborg University, Centre for Industrial Production

ABSTRACT
It is well known that designers can tackle ill-defined and wicked problems with no apparent right solution [1] as opposed to well-defined problems with a single answer. So in Industrial Design Engineering education we focus on teaching students how to approach and deal with wicked problems without necessarily reflecting on what happens if they do not use this approach and when is the approach irrelevant. It is such in intrinsic part of the Design Thinking approach it is hardly questioned, nor clear in terms of influence on the result of ideation.
So to what extent does it influence the outcome of an idea generation whether the outset is ill defined and questioned as opposed to straightforward ideation on a proposal for a solution?
This paper discusses the results of an experiment with 32 students on idea generation and product concept development. The experiment was setup as and A-B comparison between two set of students with the same objective: designing a new coffee machine for a specific brand, but one group was asked to seek ambiguity and dissonance before creating proposals. Results indicate a very clear difference in the outcome in terms of radical changes in relation to. Group A produced 12 out of 16 proposals in the Styling category, whereas Group B only had 1 of 16 in this category.
The interesting aspects discussed in terms of Industrial Design Engineering education are: Is the deep and questioning ideation, radical innovation and conceptualization always relevant for all stages and assignments and should straightforward conceptualization be used more deliberately to increase students skills in assignments they will face in their professional career?

Keywords: Ill-defined, idea generation, conceptualization.

1 INTRODUCTION

The notion of dealing with ill-defined and wicked problems in an intrinsic part of the Design Thinking approach, especially relevant in the early phases of innovation and product development where the objectives and criteria are not locked or well-defined. E.g. the Search phase in the Delft innovation model [2]. Wicked problems are complex, indeterminate and ill-defined problems in the sense they are characterized by incomplete, changing, contradicting and interdepended information, which is difficult to gather [1][3]. Challenges like conflicting organizational pressure, tacit knowledge, complex information processing and a limited amount of information to build decisions upon, makes the early phase hard to manage, hence its characterized as ambiguous and contradictory [4][5].
In previous research on concept development within Design Engineering there tend to be a focus on how to decrease the fuzziness using elaborate process models, structured selections matrices and approach [6].
However this paper seeks to understand what the experienced fuzziness actually contributes with in the initial ideation phase and how it relates to educating Design Engineers. The fuzziness in the early phases can be divided into 2 main elements, the experienced uncertainty (especially the ambiguity) and the contradictory elements (discrepancy) [7]. Lack of information to perform the required task is called uncertainty, whereas multiple interpretations of the same phenomenon or data create the ambiguity [8], due to a lack of clarity, high complexity or paradoxes [9]. The issue is characterized by being ill defined, so the either the question or answer is unknown, hence it is difficult to search for information Additionally more information alone does not decrease ambiguity, as information is difficult to interpret.

If the elements, data or pieces of information is contradictory (discrepancy) and does not fit together, it is defined as a cognitive conflict that calls for a sense making process. As Andersson states:
"*An individual's inconsistent or contradictory parts of a frame of reference about the phenomenon* indicated through *complete confusion, fuzziness, and lack of understanding* thus; there is a need for *sensemaking processes*." [7].Weick [10] points out that ambiguity and contradictory are triggers of sense making and sense-making as a driver of change. This leads to the assumption that creating new sense is an intrinsic part design process where the design gives meaning by framing experiences [10] through reflective practice [11]and questioning the intention behind immediate objectives can be a part of enlarging the solution space (Value focused thinking [12]).
The purpose of educating Industrial Design Engineers in the PBL context also revolves around the ability to navigate the fuzzy front-end, define and frame a direction for a development project and design a solution that integrates many aspects. E.g. looking at the learning objectives stated in the profile description of the Industrial Design Engineering master related to the ideation and scope of development:

- Knowledge: Must be able to explain, analyse, apply and reflect on a creative combinations of methods, technologies and approaches from various engineering fields in order to create new solutions
- Skills: Must excel in revealing and integrating explicit or tacit user needs and synthesize these needs and market opportunities into innovative integrated solutions**, in non-standard situations with complex and ill-defined problems.
  Must be able to design by integrating a desired expression and experience through form and function into technical sound products, constructions and solutions, with due consideration to state of the art technology, manufacturing abilities, costs and configuration of supply chain
- Competence: Must be able to recognize the relevant disciplines and aspects like functionality, technology, aesthetics, use, market and marketing, manufacturing, logistics, consumer, business and sustainability and is able to integrate and synthesise these aspects in the design and development of products

This clearly states the focus on the ability to deal with the ambiguity and discrepancy in the early phases of innovation. So to what extent does the ambiguity and discrepancy in the ideation phase contribute to the innovation, sense making and level of reflection in the process that is part of the profile for the Industrial Design Engineer? Based on a laboratory experiment this paper investigates the effect of deliberately seeking ambiguity and discrepancy in the initial ideation phase.

2 METHOD

The hypothesis is that an approach to ideation where ambiguity and discrepancy deliberately is sought creates more radical innovation that an approach without this. Using a straight proposal creation process is expected to create proposals that operate within the present sociocultural meaning. Whereas an approach seeking ambiguity and discrepancy in the initial ideation sparks a deeper sense-making process, which in return creates proposals that can be interpreted as having new sociocultural meaning in line with Vergantis [13] definition of radical innovation.
To investigate the hypothesis validity a laboratory experiment is set up, to test the difference in solutions from respectively a straight proposal creation process and a process where ambiguity and discrepancy is sought before creating proposal.

2.1 Participants

Choosing participants for the experiment was primarily done looking at the experience level. They needed to have a basic skill set in drawing and understanding the construction of products to be able to create a conceptual proposal. But they could not too experienced, so they would revert to a processes including questioning or reframing the assignment by default. The participants in the experiment were a group of 32 1st. MSc. Industrial Design Engineering students.

2.2 Experiment setup

The students are randomly divided in two groups (A&B) of 16 participants each and both groups are given the same basic task, to create proposals for the next version of a coffee-machine for specified firm. In order to be able to analyse the change in sociocultural meaning the coffee machine assignment was chosen because of the archetypical sociocultural meaning of this product in the Danish culture.

Group A are instructed to seek ambiguity and dissonance before creating proposals and Group B are the control group that are asked to just create new proposals. The groups get an equal amount of time and are asked to deliver proposals in the same format. Table 1 shows the overview.

Table 1. Comparison of task and process of groups A and B

	Group A	Group B
Task	Develop a new product concept for a Melissa Coffee machine 2015	Develop a new product concept for a Melissa Coffee machine 2015
Process instruction	Straight proposal-making Instructions to go straight to solution mode	Deep sense-making Instructions to seek ambiguity (in how) and dissonance (in why) before going into solution mode.
Process delivery	None	Why paper: Midway deliver a A4 paper, pitching a number of contradictions concerning the current concept
Deliver	Proposal: A3 paper, pitching the final concept All working paper including initials, timestamp and notes	Proposal: A3 paper, pitching the final concept All working paper including initials, timestamp and notes

3 ANALYSIS

Based on the expected change in sociocultural meaning in the proposals using the approach of seeking ambiguity and discrepancy the 3 main evaluation criteria are changes in Product Category, Use Scenario and Product Architecture. Using a short laboratory experiment without a context of company, market and users, the main evaluation on change is relative and subjective compared to the outset, in this case a traditional tabletop home based filter coffee machine. The concept of change is therefore subdivided into the following 2 categories in Table 2

Table 2. Criteria of Insignificant meaning (left) vs. Significant new meaning of proposals

Insignificant or no new meaning	Significant new meaning
I.1 The proposal is a filter based coffee machine to be put on the kitchen table at home.	S.1 Goes beyond the original product category, i.e. differing from a filter based coffee machine to be put on the kitchen table at home. This would change the perception what the product is, albeit the evaluation is relative to the given starting point and not screened and tested on the market in this closed short laboratory setting.
I.2 And there is no change is the use scenario	S.2 And/or the proposal implies a significant change of the use and scenario of use of the product relative to the starting point.
I.3 And there is no significant visible or understandable change in the product architecture compared to the given coffee machine that implies new functionality.	S.3 And/or the proposal in compared to the given coffee machine significantly changes the relation and positioning of the internal and external components in the machine, or changing/adding/deleting components that would be visible or understandable for the market/user.
I.4 Or if the change/newness relates only to shape, colour and size but remain in the product category.	

3.1 A-B comparison

The initial difference between group A and B's proposals is evident in the number of proposals that are variants of the filter based coffee machine.

- Group A has 12 of 16 proposals that are variants of the filter-based coffee machine

- Group A has 4 of 16 proposals that are creating significant new meaning.
- Group B has 1 of 16 proposals that are variants of the filter-based coffee machine
- Group B has 15 of 16 proposals that are creating significant new meaning.

In more popular terms the majority of participants in group B are thinking ‘outside the box’ compared to the original reference point.

3.2 Group A

A closer examination of the 12 proposals in group A that looks like variants of the reference filter based coffee machine reveals the main ‘newness’ is related criteria I.4 for insignificant change in meaning concerning shape, colour and size. Proposals A. 3, 5, 6, 7, 8, 9, 12, 14 and 16 (Fig.1, left) all relate to this criterion. A.2 and A.10 have minor changes in the product architecture (criteria I.3), concerning the positioning of the water container (behind or above filter) and the change the use scenario is insignificant (I.2) and it is still perceived as a traditional filter based table top coffee machine (I.1).

The 4 proposals with significant new meaning in group A are A.1, A.11. A.13 and A.15. In A.1 the use scenario is altered (S.2) to a “His and Her” coffee machine and the product architecture altered (S.3) to a twin-cup and twin water container structure. A.11 changing the product architecture significantly (S.3) by rearranging and removing components like the disposable filter and introducing a steaming principle that leads to a new use scenario (S.2).

In A.13 the proposal is changing product category to capsule-based coffee machine (S.1) and A.15 is changing and revealing the product architecture in a new transparent way (S.3) and hanging the machine on the wall differs it from the reference table top based machine (S.1).

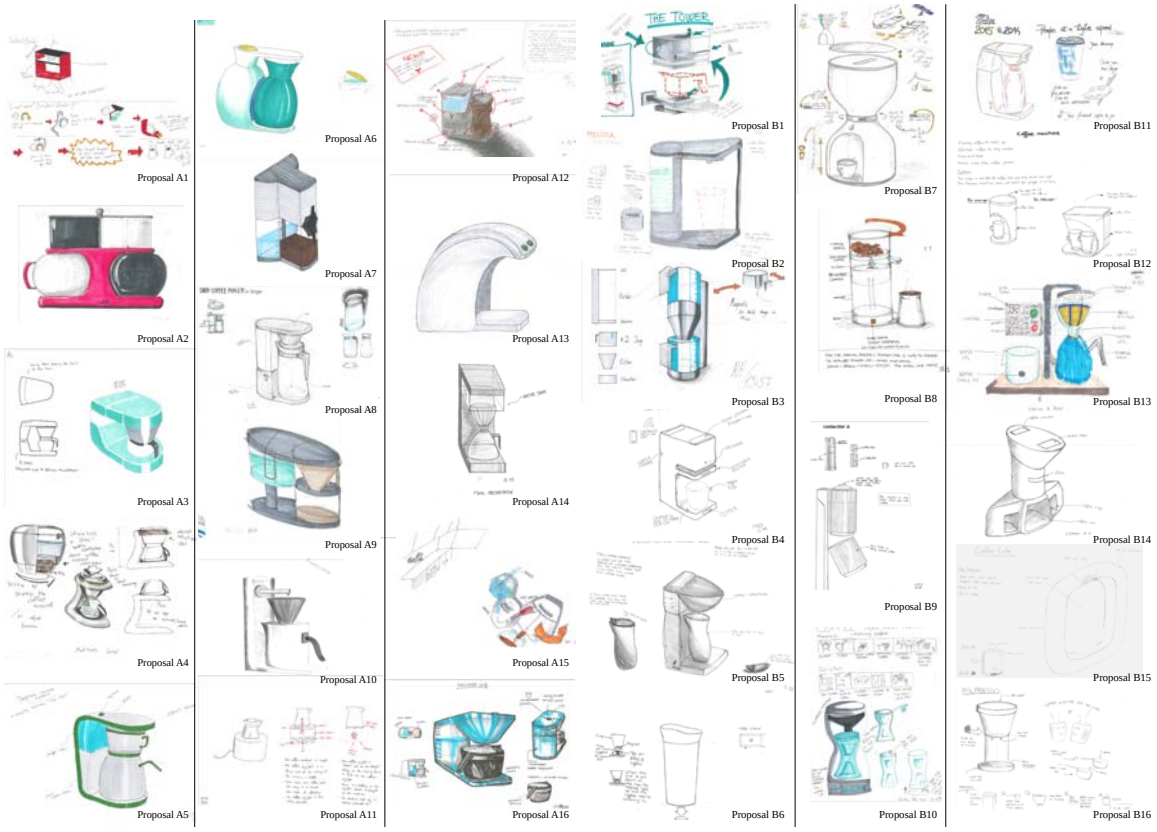

Figure 1. Sketches from group A (left) and Group B (right)

3.3 Group B

The main newness in the 15 variants of group B that are evaluated as significantly different are primarily changing the use scenario (S.2) adopting it to a different situation and creating a new experience/interaction with the coffee machine compared to the original filter based table top coffee machine. One category of changing the scenario is the coffee-to-go in proposals B.2, 4, 10 and 11 (Fig 1, right) or the scenario of just making 1 cup at a time in proposals B.7, 12, 14, 15 and 16.

2 Proposal changes the product architecture and functionality (S.3), in proposal B.6 so the coffee rise from the bottom of the brewing cup to create a new surprising effect (S.2). Proposal B.8 integrates coffee bean churning by hand (S.2) and a pressing piston mimicking a French press (S.1 and S.3).
In two proposals B.3 and B.9 the immediate visual reference seems to be a more traditional filter based coffee machine, but reading the comments at the sketches in B.9 discloses a change in the functionality (S.3) that allows the machine to dispense coffee like a tap. This leaves B.3 as the only one without any significant changes in the sociocultural meaning.

3.4 Additional findings on reflective practice

Examining the two groups also revealed another significant difference, proposals from group B in general had more comments and text on their final proposals than group A. Asking group B for an intermediate written description of the ambiguity and discrepancy that they have identified, may have triggered a more reflective sketching practice throughout the entire session.
Looking at the text in the sketches it shows that the text is commenting and reflecting, like Schön [11] describes in the reflective practitioner: *"In a good process of design, this conversation with the situation is reflective. In answer to the situations back-talk, the designer reflects in action on the construction of the problem, the strategies of action, or the model of the phenomena, which have been implicit in his moves."* (pp.79).
This indicates the elevated level of reflective practice is related to the higher number of radical new proposals with an articulated meaning and purpose, as well as created a more focused proposal with a higher sense of direction.

4 DISCUSSION

The obvious significant difference in the approaches of straight versus ambiguity and discrepancy oriented ideation and conceptualisation is the significant higher level of radical different solutions when seeking ambiguity and discrepancy. Within the very limited experiment the conclusion seems to be very clear, it leads to more innovation if the designer seeks to question the framing and scope of the task.
However there are of course some consideration concerning the experiment that would question the extent and level of innovation. In the experiment the measurement of innovation is only relative to the reference product given to the participants. Even though it represents an archetypical product that relates to a certain old fashion coffee drinking culture, the proposals deviating from this reference point cannot be said to be absolutely new to the company, the market or the world. The feasibility of the proposed constructions is not taking into consideration either, leaving some of the 'innovative' proposals questionable and potentially unrealistic. But it does not eliminate the fact that the two approached produced significantly different results that only can be contributed to the difference in instruction and approach.
In the evaluation of creating new meaning, the aesthetics in terms of visible features like size, shape and colour have not rated as high impact in regard to creating new meaning making as changes in the use scenario and functionality. This validity of this distinction could be questioned with regards to Verganti definition and examples, but it is very relevant when looking at the development of new products as an activity that integrates multiple disciplines and perspectives and not just styling products. In this perspective it aligns very much with the learning objective of the Industrial Design Engineering Masters profile as stated in the introduction, especially in the competence learning objective: *"…functionality, technology, aesthetics, use, market and marketing, manufacturing, logistics, consumer, business and sustainability and is able to integrate and synthesise these aspects in the design…".*
The side effect of increasing the visible reflection in the process as the notes and comments on the sketches and proposals demonstrates, is also a requested ability of an Industrial Design Engineer. This is especially evident in the knowledge learning objective: *"…explain, analyse, apply and reflect on a creative combinations of methods, technologies and approaches from various engineering fields in order to create new solutions."*
So seeking ambiguity and discrepancy in the ideation phase aligns with the intention of educating Industrial Design Engineers that by default will challenge the initial framing of the task in order to open up the potential solution space and seek innovative solutions on more radical level.

On the other hand one could then question the relevance and validity of this approach when acting in the profession of product development. It may not always be relevant for the client or company the Industrial Design Engineer work for to seek radical new solutions rather than incremental new solutions. One could argue that the holistic approach of also integrating manufacturing capability, market and business aspects would then balance the quest for innovation with the actual possibilities.

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