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Tollestrup, Christian

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# SEMI SCIENTIFIC ATTITUDES THROUGH PROCESS REPORTING ON KNOWLEDGE PRODUCTION

**Christian Tollestrup**

Associate Professor, Department of Architecture, Design & Media technology, Aalborg  
University, cht@create.aau.dk

## **ABSTRACT**

How can you improve and focus on the knowledge produced through a design project by design students? The range of skills and competencies in design education is not limited to the ability to handle different types of projects themes. In an overall perspective a master education at a university is also about acquiring skills and competencies in adapting, producing and reflecting on knowledge in a design process. Using learning theory in a number of cases this paper will unfold the principles, structure and tools used in the process reporting to describe the inherent reflections in the design process can emphasize the knowledge production aspects of the process. By making the reflections and evaluation more explicit and accessible this provide a platform for the student to relate to the type of knowledge produced by various activities and methods making theory of science very tangible and inherent in the process. It also allows for an examination that revolves around how the design solution came to be, rather than focusing on the solution itself and thus placing the design student's awareness on knowledge production as a central and embedded part and of the education.

*Keywords: Knowledge creation, process reports, reflection, learning theory.*

## 1 INTRODUCTION

Mastering design is not just the ability to produce design proposals; it is also mastering the process of design. And design is a very broad profession and field, so covering all kind of subjects that designs students may encounter in their professional life is futile.

Educating design engineers includes a broad focus on various elements in the education package, ranging from building skills in various techniques, tools and software programs to acquiring knowledge about processes, materials, methods, etc, and, of course, the gradual combination of skills and knowledge into competencies in solving problems, spotting opportunities and developing solutions and so much more. In a design education within the university the ability to handle and understand the design process and methods takes precedence over the ability to handle a specific design task, e.g. designing medical equipment. At Aalborg University in Denmark the Program in Industrial Design has dealt with this by requiring that design students hand in 2 reports; a Product Report and a Process Report. The process report is a phase by phase description of the design process. Thus the ability to design and the ability to master the design process can be demonstrated and examined somewhat separately, even allowing a student to demonstrate understanding about the process with an inferior result or results that fail due to external circumstances.

The rationale behind this double reporting is double; first of all the design process is open-ended and experimental, as pointed out before [2], and the process behind the proposed solution reveals the reasoning and limitations in the knowledge on which the solution is based. Second; in an educational setting the emphasis is on learning the process and methods, thus it must be accessible also for external parties for exams.

## 1.1 Design is suggesting and reflecting

The process is not given beforehand, as Roozenburg and Eekels [3] argue design reasoning is abductive. It is not hypothesis testing (deductive reasoning), nor a large set of inquiry forming a basis for arguments (inductive reasoning), rather designers starts with connecting apparently unrelated facts armed with a hunch that they may be related and both the solution and hypothesis derive as a result of connecting these facts. As Pierce introduced abductive reasoning the explained the difference as “Deduction proves that something must be; Induction shows that something actually is operative, abductive mere suggest that something may be” (Pierce in Cross[4]).

The other significant aspect is the reflective action, as introduced by Schön [5], where the designer engages in a dialogue with the material. In a team setting this implies the dialogue must be externalized; sketches or models for materialization, the material being the current suggestion for a solution. And suggesting solutions to move forward is an inherent part of the design approach as Bryan Lawson explains in “How Designers Think” [6]: “...designers learn about the problem as a result of trying out the solution.”

Given the abductive and reflective nature of the design process, understanding the particular process is a major contributor to understanding any design proposal by investigating the reasoning behind the design and the knowledge embedded in the solution.

## 1.2 Mastering design; methods and process.

Design projects in a study environment is not just about communicating the proposed design solution in all its different aspects of use, materials, form, production, manufacturing, economy, etc. In an educational setting it is also important to convey the range of experiments, tests, research and decisions made during the process in order to thoroughly examine and develop the students’ skills and competencies. As opposed to the design profession there is a different and more level balance between learning the design process and methods and producing an acceptable design proposal.

I.e. there is both a process and product element that the student will have to master. As opposed to the arts and craft oriented design approach, the design engineering approach to design leans toward the guideline school [7] where the focus is primarily on methods and processes, rather than the individual designer. It also complies with the nature of the design profession; you never know what the next assignment will bring, hence the “toolbox” of the designer must rely on competencies to handle the process and tools required.

# 2 PHASES, LEARNING CYCLE AND DOUBLE LOOP LEARNING

## 2.1 Design phases

The design processes are in broad terms almost identical regardless of the project being undergraduate or graduate projects. The processes used at Industrial Design Program at Aalborg University are variation of part of the design process described in Ulrich & Eppingers Product Design [8] and the main phases usually covered by students projects are; Planning (programming), Ideation, Conceptualization and Detailing. Being students’ projects, they do not cover all aspects and detailing is primarily done by exemplary dives into part or aspects of the product in order to demonstrate how one could solve production, material, assembly, etc. issues on non-trivial components.

## 2.2 Learning cycle and double loop learning

The process is iterative and the iteration itself presents a reflection. Reflection is a part of the learning process [9] thus linking the design process and the learning process. Schön [5] has described the type of reflection as ‘Reflection in action’. The reflection in action concerns the relation between experiments / suggestions (actions) and the problem. This reflection evaluates and analyzes how the current experiment solves the problem. In terms of the design process, it means that one reflects upon the current status of suggestions and experiments in relation to the defined problem and requirements. However, there is another level of reflection described by Schön that also relates to the design process; the reflection on action. This reflection concerns the perception of both handling of the problem and the problem itself; learning to correct the way one handles a problem constitutes a double loop learning [1] as shown in Figure 1 In terms of design, this means a reflection upon the methods employed to deal with the problem as well as reflecting upon the perception of the problem.

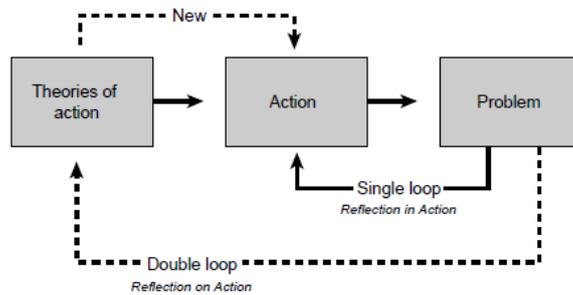


Figure 1. Reflecting in and on action relates to single and double loop learning. Own illustration. [1]

In other words, is the problem defined “properly” and are the methods employed appropriately to deal with the problem or aspects of the problem, or should other methods be used to deal with a certain aspect of the problem instead. This constitutes a learning process regarding the perception of the problem that unfolds parallel to the design process, as experiments reveal new aspects of the problem and the perception of the problem.

### 3 REPORTING THE DESIGN PROCESS

The projects are described using two separate reports; the Product report and the Process report. The following examples are all from process reports. The Product report only describe the proposed solution and because it might be read separately the Product report usually includes the main points from the Design brief and very condensed descriptions of the main problem solved and the target group for the proposed product. The process report on the other hand is a selected description of the design process that the group has conducted; it is not a diary, nor a log. It is a description of the main activities, experiments, reflections, etc. that represents the process. For further details appendices are often used, keeping the main process report below 100 pages for a semester project of approx. 15 ECTS. In the following sections, examples on process reports structure and content will be given.

#### 3.1 Structured reporting of process, phases and activities

There are no official specifications on what the process reports should contain, or how they should be structured, so there is some variety in the way they are laid out and how the content is structured. Overall they are mostly chronological following the phases of the process; however some content e.g. a series on experiments on ergonomics may be reported by theme under a certain phase in order to restructure and focus the development to increase readability. As seen in the example in Figure 2, some groups provide reading guidance overview (far left) of the report and connect the overall activities and their relations in the progress of the process. Going deeper into the material (middle), the groups are able to provide a detailed overview of the progression of 4 concepts and relate them to the level of abstraction they have been working on.

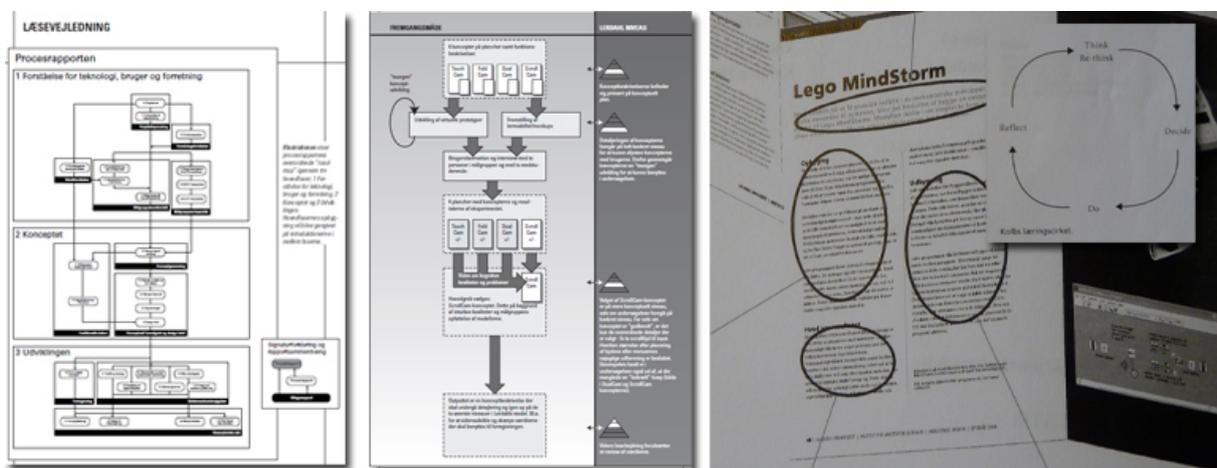


Figure 2. Direct reference to Kolb's learning cycle for dissecting each step in the design process. Process report from “Beolab N” project [10]

For each activity material have been structured to follow the Kolb learning cycle [9] (far right), going from planning the activity, doing the activity, evaluating the activity to reflect and plan new activities. First of all the task of providing the reader with a structured overview of the main activities and flow of these in the process, prompts the students reflection in the later phases of the process on the relation between theories applied, activities performed and the progress of their solution. It is mostly a reflection on action whereas the use of the learning cycle for structuring is each activity is a more extreme example on how students open the process of experiment and reasoning of both reflection in and on action for the reader; in-action-reflection (Reflect-step in Figure 2 far right) is on how the proposal relates to the problem and the on- action-reflection is the reflection on what the next step in process should be (Think-Rethink step). The latter step can also include reflections on how the applied method or tool performed in that particular situation, thus representing a different kind reflection on action.

### 3.2 Opening the reasoning; Inspiration, experiment and evaluation

The content of the process reports contains commented and explained experiments, sketches, proposals, models, etc. The idea is to open the process to the reader of the report; showing the relations between e.g. inspiration (see far right example in Figure 3) and sketches and proposals for the overall form. These relations are always commented and can also contain an evaluation of the groups own proposal compared to the specifications and goals they have set up for the product as seen in the example (left side) in Figure 3, where the group analyze and compare the 3 proposed expressions to the target group.

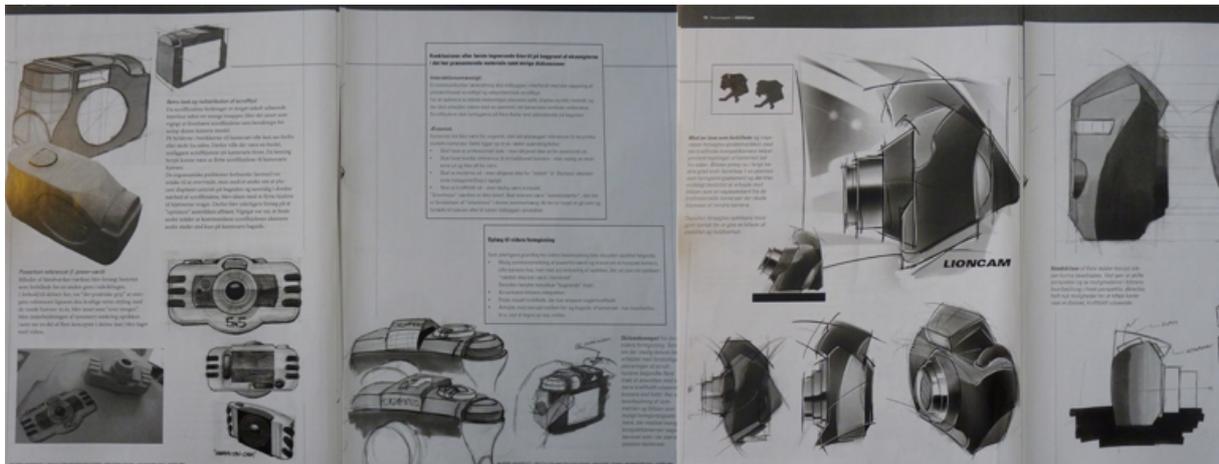


Figure 3. Outlining the potential different directions and presenting the groups evaluation of their own suggestion. Right: The source of inspiration for form: a Lion. Project "In:situ" [11]

Commenting and evaluating their own suggestions, experiments and proposals using the target specifications is primarily single loops of reflection in action: comparing the proposal to the problem perception or specifications.

### 3.3 Continuously revising specifications and reflecting on goal

From the very beginning of the projects the groups program their own assignment specifying the problem, requirements, goals, target group etc. However as the students move forward with experiments, proposals and investigations they update these specifications and problem framing based on what they learn from these activities. This goes into the process report to demonstrate when, where and why the group deviate from the original specification, allowing the reader to understand the current status at any point in the process report. As seen in the example in Figure 4 (left), this can be done very condensed by aggregating photos of experiments combined with sketches of principles and short descriptions and highlighting the decisions the group made based on these activities. Consequently reflections on a regular bases, e.g. after each phase or theme can summarize the main reflections and learning points (Figure 4, right side).

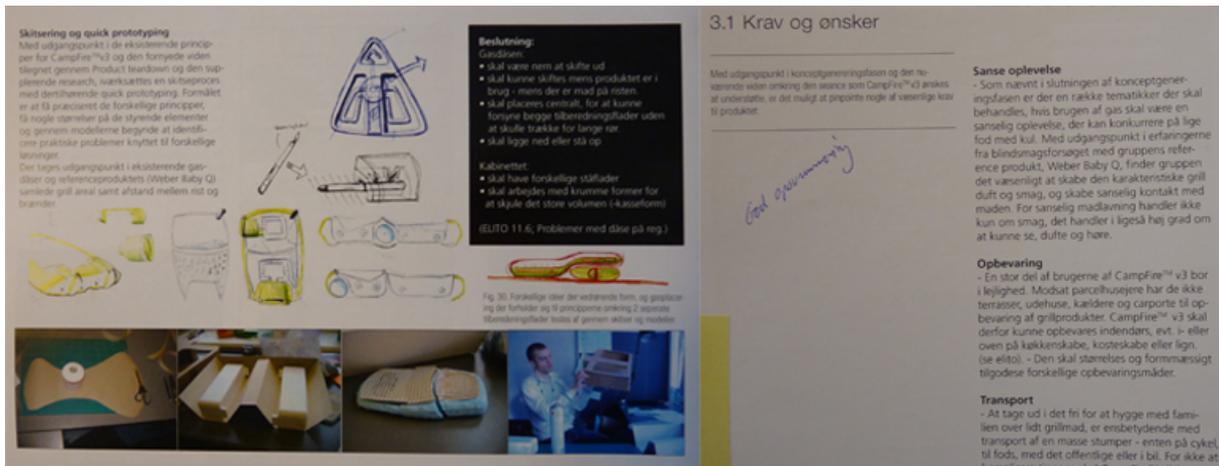


Figure 4. Experiments with models and sketches lead continuously to decisions on specifications for a solution and focus point for next step in the process Project “Feinschmecker – urban food movement” [12].

Highlighting decisions and summarizing updated specifications represents reflections on action in the sense that the perception of the problem is slightly revised and the students connect their reflection to specific actions and learning points from these.

### 3.4 Balancing focus and divergence

The design process usually consist of a mixture of divergent and convergent moves [13] and the purpose of the process reports is to give an adequate insight into the main activities of the process not all activities and sketches are explained or used directly in the report. The students have to make a conscious selection of which experiments and sketches to show to give a sufficient and representative impression. Due to the abductive and non-linear nature of design, an important part of the argumentation behind a proposal is also what is not the solution, i.e. what have the group tried and tested in their process This means that especially the divergent activities must be represented and evaluated. However to keep the work load down and increase readability, detailed elaborate descriptions, details of experiments, research, interviews, etc. are often put in appendices. As seen in the example in Figure 5, the 4 concepts for cameras are compared in the process report (left), whereas the detailed evaluations, arguments and descriptions are put in the appendix (right side).



Figure 5. Left: the 4 proposals for Cameras compared in the Process report. Right: One of the Cameras extensively described and evaluated in detail in the Appendix report [11].

This division between what is highly relevant and what can be put in appendix, forces the group to make a conscious reflection on their process and what the main activities and decisions where. Furthermore it represents an exercise in communication of design methods and process.

#### 4 CONCLUSION: AWARENESS ON PROCESS AND METHODS

Does reporting on the process improve and focus on the knowledge produced through the project? Yes, it improves the student's ability to argue the design decisions and reflect on the usability on the methods applied in the project, related to both the time of application and relation to the nature of the problem to be solved.

Does process reporting increase the scientific attitudes of design students? Not by itself, no. First of all the distinction between product and process report is introduced at the 3rd semester on the BA program as an intrinsic part of the workload and is not related to courses or to theories of science or philosophy of science. In fact design students may not realize the scientific aspect of knowledge production before their 3<sup>rd</sup> MA semester, where it is part of the curriculum.

Second, without theoretical support or course modules to teach the subject, the students learn by reading other groups Product and Process reports and from the exams. It creates a variance in the reports and this does not ensure that all the reflective aspects are learned by all students.

The scientific attitude amongst student is therefore not specifically scientific in terms of rigidity and theory of science, however it does prompt a *semi*-scientific attitude in terms of focus on the arguments and foundation for any design proposal the students produce while continuously adding to the students' explicit knowledge on strengths and limitations within different tools and methods. The process reports provide a valuable foundation for examining the learning objectives for the project by allowing the examiners to ask detailed questions about the process, method applied and step by step reflections. Most learning objectives are related to awareness; blooms taxonomy dictates that evaluation and perspectives on the proposed solution is more valuable than just explaining it. Hence the learning obtained by the students is reflecting the level of knowledge produced by the student during the project which is accessible from the process report.

The more precisely students combine experiments (models, sketches, etc.) with their own comments, evaluation and reflections the more valuable the process reports becomes. If the students also manage to apply a sensible use of appendices, phase summaries and updated goals, as well as presenting an adequate range of divergence in the process report, it provides a relative brief but extensive description of a design process building knowledge about both the solution and the problem.

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