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# Visualizing the design process – an educational approach for the synthesis of design diaries

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## Abstract

There have been a lot of efforts in the research community for describing the design process and visualizing it in general roadmaps. But when it comes to designers, they have difficulties in explaining how they work and what they do. Since designers draw upon their personal experiences, through time they develop a more or less individual process. The ability to explain and reflect on the design process will not only facilitate self-evaluation for the designers, but also would assist them in communicating with other stakeholders in the product development process. While there are various educational approaches for teaching different design skills, design literature has not provided many examples of approaches for familiarizing the design students with reflecting on, and communicating their individual processes. This article reports on such an approach, which aimed to provide the design students with the ability to communicate their design process through documenting self-reflective comments in form generation diaries and synthesizing their self-reflections by visualizing their process.

**KEYWORDS:** form generation process, diary study, design process models, design education, visualisation of reflective data

## Introduction

Understanding the design process has always been considered a challenge within the design research community. Since the 1980's, investigating the design process has been in an

experimental phase to find out how designers work and what impacts new tools and methods have on their designing. (Blessing & Chakrabarti, 2009)

Different research methods and approaches have been used in empirical studies to shed light on design activities, for example, interviews (Lawson, 1994), protocol studies (Cross, Christiaans, & Dorst, 1996) and observations (Bucciarelli, 1994). Over the years, these efforts have led to different models and roadmaps portraying the design process, which generally describe design as a logical and methodical procedure (Cross, 2000; Lawson, 1997; Roozenburg & Eekels, 1995; Ulrich & Eppinger, 2008). However, when it comes to designers, they have difficulties in explaining how they work. They mainly focus on the result of their projects when they are asked to explain how they design (Cross, 2011). This is while it is argued that designers are the only source for finding information about the underlying thoughts when designing (Pedgley, 1997).

Using a method for allowing a period of reflection would (i) enable the design practitioners to explain and articulate their activities, (ii) result in self-assessment (Pedgley, 1999), (iii) assist the designers in communicating with other stakeholders in the product development process, (iv) and eventually lead to a better understanding of the design process.

This article elaborates on an educational approach for encouraging the design students to explain their activities through employing self-reflective methods in form design projects. As a complementing step, the students were asked to synthesize their self-reflections into “infographics”.

## Understanding the design process

Design is described as a divergent task requiring imaginative processes and creative thinking, which also includes stages of convergent thinking (Lawson, 1997). Designers employ different means to exteriorize their imaginative thinking process (Archer, 1991) such as drawing and sketching, verbalization, the use of models and prototypes, and computer aided design. The externalization of shape ideas is an essential part of the design process, which not only freezes and represents one instance of the designer’s cognitive process (Lawson, 1997) but also influences the design process (Menezes & Lawson, 2006). However, these externalizations may not reveal the designer’s underlying thoughts entirely, as the design process takes place inside their head (Lawson, 2006). This accentuates the importance of the designer’s own explanations of their motivations and thoughts during the process.

Different design process charts or models have been developed to explain the design process, either describing or prescribing a logical sequence of typical design activities (Cross, 2000). Examples of such design process models are given in figures 1 and 2. The activities of analysis, synthesis and evaluation are the outstanding commonalities shared between the design process models, through which the designers organize and reduce their data in order to find cohesion and clarity.

The design process models are generally found theoretical, and show no evidence that the designers actually follow these patterns (Lawson, 2006). Designers draw upon their personal experiences (Schön, 1991) and develop, through time, a more or less individual process. As shown in various case studies (Cross, 2011), there are great individual differences and preferences among designers. Explaining designer's individual approaches in the design processes would further contribute to better understanding of the design process as such.

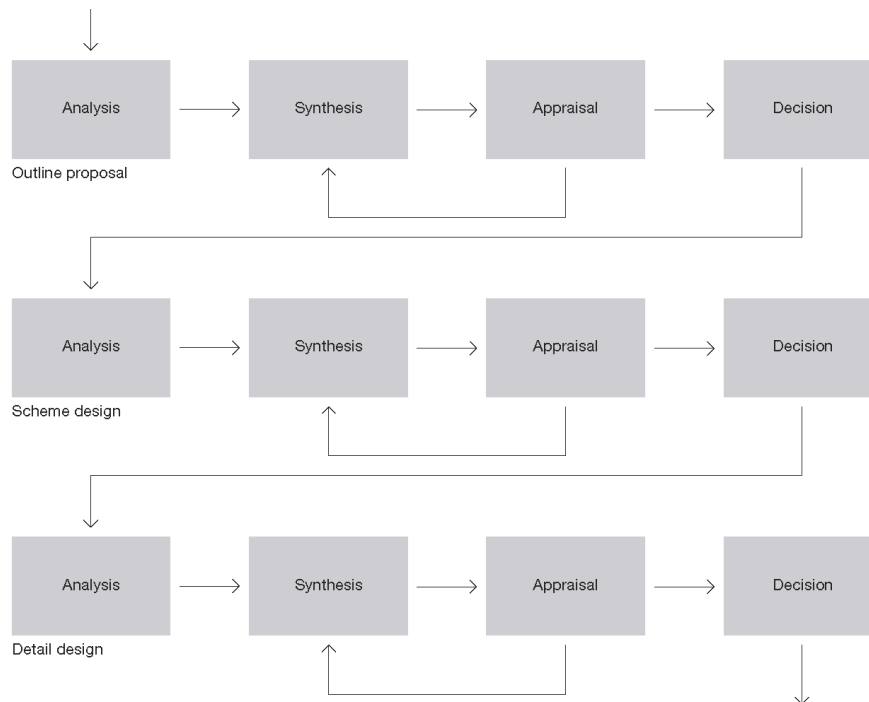


Figure 1 - Design process model by Marcus and Maver, casting the design process as a series of decisions in three levels; outline proposals, scheme design, and detail design. (adopted from Cross, 2008)

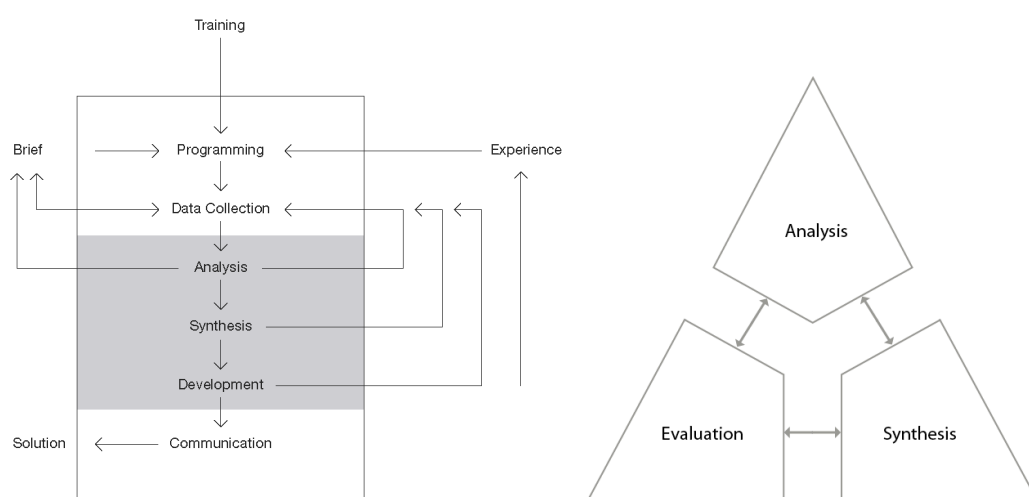


Figure 2 - From left to right: (a) basic design procedure by Archer, proposed as representative of an emerging "common ground" within the "science of design method" even while acknowledging continuing "differences", (b) design process model by Lawson, consisting of analysis, synthesis and evaluation linked in an iterative cycle. (adopted from Lawson, 2006)

## The importance of reflection in design education

Critical reflection enables designers to draw upon certain routines, to build theories and responses that fit the context (Schön, 1991). Importance of reflective activities has been also emphasized in educational contexts. In the experiential learning model of Kolb (1984), processing information, constructing meaning and drawing conclusions is achieved through active experimentation and reflective observation.

In the cognitive domain, educational objectives are classified in six major categories according to Bloom's taxonomy of learning, ranging from "remember" to "create" (Krathwohl, 2002). Table 1 shows different dimensions of educational objectives in design education.

Table 1 - different dimensions of educational objectives (adopted from Krathwohl, 2002) and their implications in design education.

<b>remember</b>	<b>understand</b>	<b>apply</b>	<b>analyse</b>	<b>evaluate</b>	<b>create</b>
identify	interpret	ideate	compare	reflect	generate

Progressing through the Bloom's taxonomy of educational objectives, "remember" is achieved by identifying existing problems and solutions; "apply" is achieved through creative ideation for proposing possible solutions to identified problems, and "analyse" through comparing the solution concepts. "Evaluate" is inevitable for the designer in order to forge connections and construct meanings based on the gathered data and the previous steps and activities, which build foundation for drawing conclusions and generating the final solutions.

During the application stage, a large amount of data is generated, which often take many forms; gathered photos, video, transcripts, magazines, and other material related to the context as well as the externalized ideas in form of sketches etc. The quantity of this data is often too large to hold in attentive memory at one time. The most common approaches for organizing and analysing data are digital folders, sketchbooks, big boards and lots of sticky notes, which help the designer to get a holistic understanding of the situation. However, these methods are quite time consuming, and limited in different ways; (i) physical limitations imposed by the size of the boards, sketchbooks and laptops or desktops, (ii) digital limitations imposed by popular software tools and operating systems. (Kolko, 2010)

For analysing and evaluating the results from the application stage, reflective observation is inevitable. Furthermore, similarities between the educational objectives and commonalities among the design process models accentuate the need for nurturing self-reflective activities in design education. Keeping logs and journals are among the activities suggested for reflective observation (Svinicki & Dixon, 1987).

## Advanced Form Design courses

Advanced Form Design I and II are two elective courses given in the framework of the Industrial Design Engineering master programme at Chalmers University of Technology in Sweden. The goal of the course is to provide students with a further understanding of understanding of product form creation. In Advanced Form Design I (7,5 ECTS), the students work with formal aesthetic concepts and methods by means of both lectures and individual and seminar exercises. The course provides tools and training for advanced form design and configuration of forms and formal systems based on theory and methods presented in lectures and course literature. In addition, the aim is to explore, experience and reflect on the correlation between form design approach and formulation of a specific form language.

Advanced Form Design II (7,5 ECTS) provides opportunities for students to apply theories and methods from the basic course in Advanced Form Design I and to experience how different types of 3D visualisations (on screen and in form of physical models) can be alternated and may cross-fertilize each other in form design development. The course offers a possibility for an explorative transformation process from abstract form design creation to a concrete product design development, which offers a chance to work with forms and their semantic, syntactic and contextual significance as well as with a concrete product design application. Within the framework of the project, the students were to look for approaches that would lead to a creative and experimental yet structured generation of formal product solutions. For project completion, the students were expected to develop an innovative formal idea into a product design concept with high level of novelty, aesthetic details, functionality and performance. Since 2010, an additional aim of this course has been to provide the students with the possibility to further understand the form design process through documenting their form process using *form generation diaries*.

After the course completion, the students were asked to evaluate the course and comment on their experience of using different self-reflective methods, which provided the authors in the end with their overall view.

## Visualizing the form generation process

For the academic year 2011/2012, an empirical approach was adopted for understanding the form generation process by familiarizing the students with visualizing their process through using three different types of self-reflective data: (i) Form Generation Diaries, (ii) Form Design Process Review, and (iii) Form Design Process “Infographics”. In previous years, the course already employed “Form Generation Diaries”, also mentioned as “Form Design Process Protocols”, “Form Design Process Reviews” for collecting students’ self-reflections in which they described and discussed the process of form design including comments on the results, methods and tools used, data sources, and all major decisions. However, the interpretation and synthesis of gathered data in form of “infographics” had not been addressed in previous courses.

The main obligatory part of the course was for the students to engage in a seven-week design project, working roughly 20 hours per week. The project topic for this course was predefined as "porcelain tableware". A total of fifteen students<sup>1</sup> (24-27 years old, 5 men and 9 women) were registered in this course. They were encouraged to form groups of two or three students for conducting the design project.

As a first step for understanding the form design process, the students were to document on their process using a template called "Form Generation Diaries" on a regular basis. These documentations included self-reflective comments on the steps, decisions, use of methods and tools in addition to motivations and hinders during the form design project. After the project completion, the students summarized their process in a review and further translated their findings from the self-reflective data into "Infographics".

### Form Generation Diaries

The primary aim of the Form Generation Diaries was to record participants' retrospective reflections on their form generation activities. Based on the experiences from using different diary formats in previous courses (Babapour, Rahe, & Pedgley, 2012), modifications were made to the format and outline of the diary template for this course. The diary documentations were structured in a one-page template with fixed response categories, which consisted of several parts including steps, decisions, motivations, methods, conflicts, etc. The main difference with the previous years was increased frequency of submissions per week in order to minimize the recall effects in diary documentation (Babapour, Rehammar, & Rahe, 2012). In the previous years, the submissions were either at the end of the term or once every week. This time, the diaries were uploaded on the course homepage two times every week and kept in an electronic format.

Furthermore, the visual outcomes of the form design process were to be integrated in the Form Generation Diaries. This could include scribbles, pictures, CAD-renderings and any other form of visual information essential for understanding the creative form generation process. In the previous years, the visual data was submitted separately in visual diaries. Integrating self-reflections and the visual data facilitates reading and understanding the students' diaries (Babapour, Rehammar, & Rahe, 2012). Additionally, the participants were encouraged to refer to their visual data in the corresponding structured diaries.

### Form Design Process Reviews

In order to encourage holistic reflections, the students were to write overall reviews of their form design process in a critical manner and with respect to relevant literature. This was done to be able to summarize the process at the end of the course by drawing conclusions from the weekly diaries and project results. Further, it would facilitate synthesizing the information for making the Form Design Process Infographics in the final stage.

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<sup>1</sup> Twelve students had a bachelor degree in Industrial Design Engineering from Chalmers. The three remaining students were exchange students with similar backgrounds.

## Form Design Process Infographics

An infographic is a visual form of representing complex data in a synthesized manner *in order to be quickly and easily understood* (information graphics). They are also referred to as “Information Graphics” and “Explanation Graphics”. In traditional media such as newspapers and magazines, infographics are often used to capture readers’ attention and convey information about everything from biotechnology to politics to sports (Grauel & Schwochow, 2012). They are particularly suitable in the design process, while meeting the needs of more visual orientated designers (van der Lugt, 2005). Infographics have been previously used in Visual Brand Identity courses at Chalmers for visualizing quantitative consumer data (Person, Karjalainen, & Rahe, 2008).

In developing the Form Design Process Infographics for the course in Advanced Form Design, we stressed that the visualizations (i) should be a visual explanation of their form design process, (ii) should contain pictures and other representations of their form results, (iii) should be self-explanatory, and (iv) should synthesize the key points from the form generation diaries. The synthesis of the form generation diaries was facilitated through the Form Design Process Review. This exercise resulted in some interesting suggestions for how to visualize the form design process; two of them are presented in figures 3 and 4.

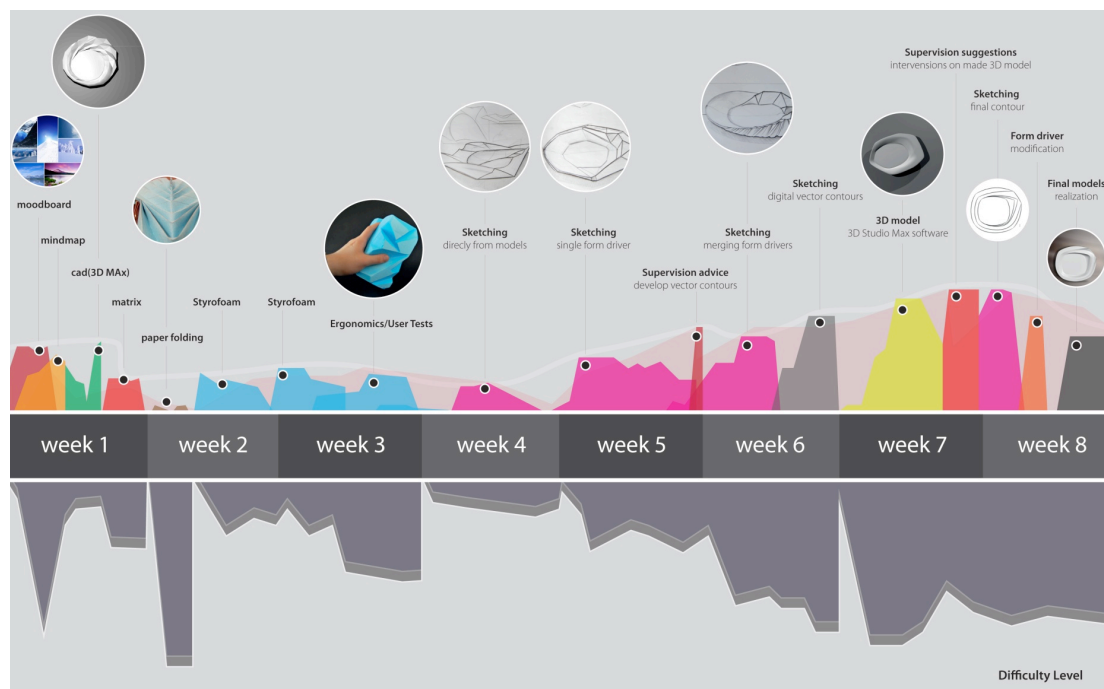


Figure 3 - different stages of the design process during the seven-week period, the use of different tools and methods, and the extent, to which they were used, found influential and difficult. Samples of visual outcomes are also assigned to each phase.



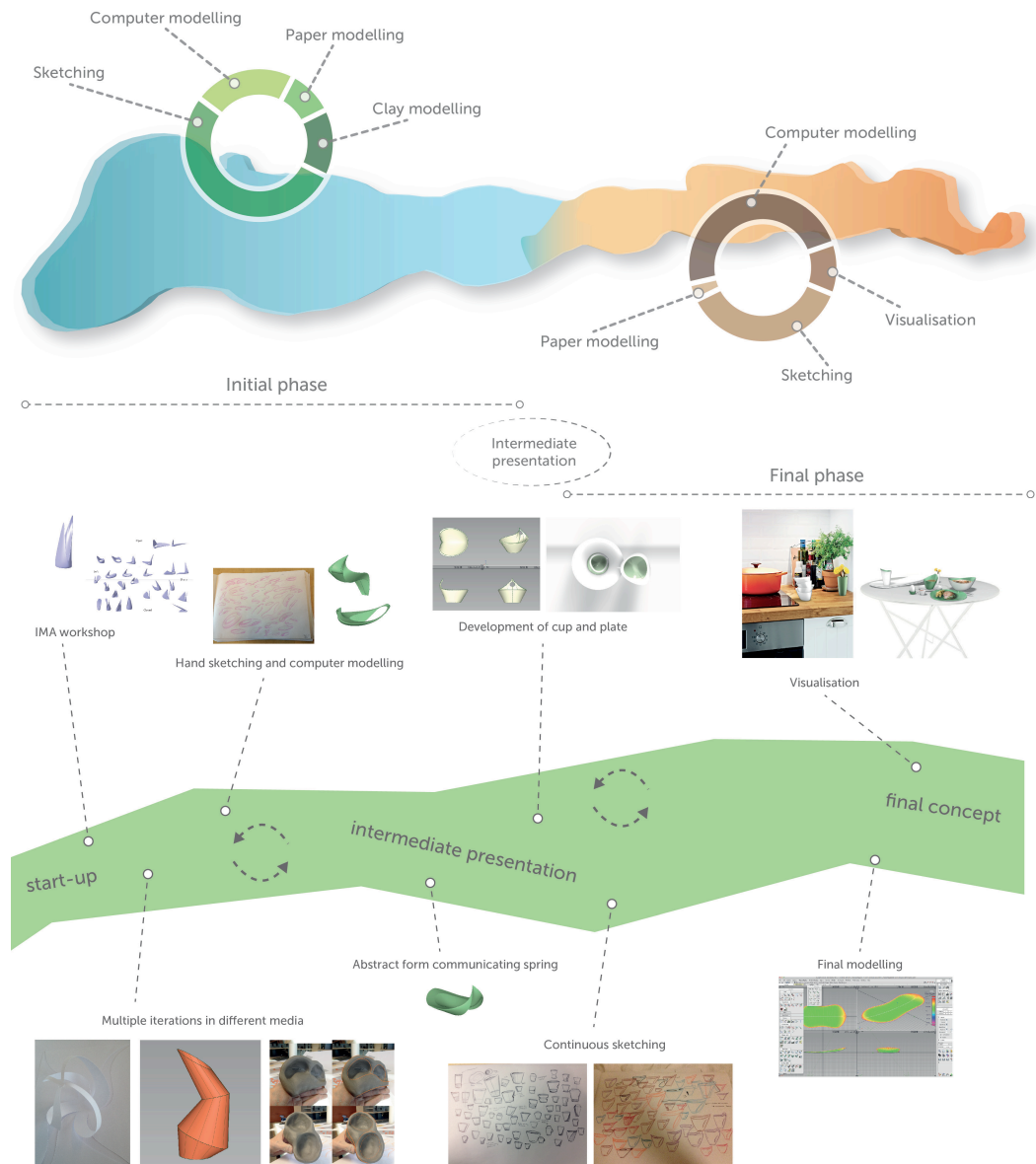


Figure 4 - different stages of the design process, their convergence/divergence, and the extent, to which different tools were used in each phase. Further, samples of visual outcomes are shown and assigned to each phase.

## Concluding remarks

Over the years, the courses in Advanced Form Design have continuously been developed and improved to address ambitious students with a high level of interest on the topic. Thus, the student evaluations have been high, both in terms of interest and relevance. As one result of the course, more and more students decide to further train their skills and choose topics with a high focus on formal issues in subsequent graduation projects. The infographics tool reported in this paper was tried for the first time and was found to be a valuable supplement to the other self-reflective methods used in the course, not only from the diary-analyst perspective, but also by the design students.

The structure and format of the form generation diaries in combination with the submission frequency was regarded valuable, both for the data collection and analysis. The students' elaborations in their written form design process reviews indicate that, (i) the form generation diaries contributed to investigating one's personal preferences and approaches in the individual form design process; (ii) the form generation diaries led to developing a taxonomy/terminology for discussing the form process and arguments for or against certain approaches, and (iii) infographics as a synthesizing holistic reflective tool for form generation led to reflecting one's individual form design process as a whole.

In previous courses, it was in some cases considered difficult to talk about the form design process as such and even more to find the right taxonomy and arguments for or against certain preferences. In the beginning of this course, it was regarded hard to accept the additional task of self-reflections parallel to the on-going product design project, because that imposed additional work above the normal level. The fact that the students thitherto had been preconditioned by more linear and strictly targeted design project training, influenced certainly their willingness in the beginning to accept interruptive self-reflections, until they found their routines and motivation in the learning outcome. The regularly delivered amount of diary data helped to provide the students with a self-critical insight on their form design approach and therefore helped them to become more articulated about what they do.

According to the course evaluations, the students found the project rewarding and motivating, however also challenging and time consuming, as they spent a significant period of time submitting their form generation diaries. This was due to the assessment layout of this course, which forced the students to interrupt their cognitive process in a steered way for diary documentation, contributing to both hinders and benefits: On the one hand, the fact that the students had to stop their form design process for self-reflections resulted in a disconnection in their creative workflow. On the other hand, these imposed self-reflections led to a higher level of understanding and critical judging of their own decisions as well as their outcomes.

In the synthesis part, the infographics submission, in the very end of the course, worked as an instrument for creating an overview of how the students had conducted their form design projects and visualizing the advanced form design process as a whole that thitherto had been split into parts in form of form design diaries. At the same time, the infographics appealed to the students' visualisation capacities, which was an additional motivator. The collected examples illustrate the necessity to regard the entity as a whole to be able to set all parts in a context. They also exemplify very different form design approaches among the students, which is as a result of individual preferences and different experiences, an aspect that certainly demands for further investigations in future work.

In the end, the experience of continuous and finalizing self-reflections did not only raise the students' awareness of form design, but also offered a good precondition to mature in form design for forthcoming learning experiences and was therefore appreciated. After the course completion, many participants were astounded how the combination of continuous and finalising

self-reflections had opened their mind and influenced their self-consciousness far to the positive. A common opinion was that these types of approaches are needed in design education, in particular, when the task is to explore and experience the diversity and endless possibilities of advanced form design, where arguments for or against a certain decision are often lacking as well as opportunities to train these skills. The course was received as a facilitator to mature the abilities to recognize, interpret, differentiate and evaluate creative findings, which raised the students' general level of understanding. Further, students commented on the parallel profit of having developed relevant verbal capacities after the completion of the course and being able to communicate their process by bringing forward arguments and findings without sidestepping to gut feeling and instinct, as noted by the authors as outcomes of course evaluation discussions in the end.

We hope to have inspired further educational work on how to address the development of form design skills in education, based on a combination of self-reflective methods applied to a concrete form design task.

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