Bridging the Discrepancy between Reflective Practice and Systematic Form Generation Approaches

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BRIDGING THE DISCREPANCY BETWEEN REFLECTIVE PRACTICE AND SYSTEMATIC FORM GENERATION APPROACHES

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ABSTRACT
Systematic form development frameworks help the students and designers to broaden their form repertoire. Nevertheless, when they are encouraged in classroom activities, several aspects must be considered. For example, over-reliance on them limits the students' ability to reflect on the process and actively look for alternative ways of finding solutions. This paper presents a classroom experiment that encouraged adopting a systematic yet reflective approach for developing product form alternatives. In a Master course (7,5 ECTS) in Advanced Form Design, twelve student teams, first introduced to the theoretical framework, were asked to find their own approaches for applying the theory on a product form design assignment.
This paper reports on the general structure of students' different interpretations for the form generation process, and discusses its contribution to the overall learning experience. An overall description of the assignment as well as a conclusive summary of the produced results is presented here. Further, an exemplifying case will be used to demonstrate the great form variety in the results of the assignments. The outcomes of the course put to proof that there is a need to encourage reflection-on-action when applying systematic form design theory.

Keywords: Form development methods, form generation, form repertoire, creative form design, reflection-on-action, design education

1 INTRODUCTION

Creating novel product form is one of the many facets of inventiveness in design [1]. Good form evokes an aesthetic experience for people and is perceived with an aesthetic attitude [2]. Product appearance is regarded as an important factor for achieving visual recognition in the competitive market today [3-6]. An important skill for the designers is therefore the ability to generate product form alternatives [7], and the larger the number of alternatives, the more likely it is to arrive at better ideas [8]. Among the programmes that combine engineering and industrial design competencies, there are however shortfalls when it comes to innovative and creative form generation [12]. While a large part of these programmes' curricula focus on acquiring different visualization and ideation skills (e.g. generating perfect CAD-renderings), students have difficulties in generating form alternatives.
Different systematic form generation methods have been developed in order to support the designers in the form development process, all of them bundling shape parameters or operations in a rational and usable manner. *Evolution of form* [13] describes a seven-stage bipolar process for creating form alternatives These stages are join (u-joint), intersectional (core), divide (accordance, discordance), adapt (assimilate, dissimilate), merge (converge, diverge), distort (conform, deform), and organic (concave-convex). Another example is the transformation of basic form elements developed by Knauer [14]. The elements of *bars, surfaces, bodies, and spaces* are suggested to be basic constituents of the designed objects in our environment. Wim Muller's *fish-trap model* describes the geometrical ordering principles for the form development in topological, typological and morphological levels from a basic structure to a material concept [7]. Other efforts have been made to define shape transformations through rules and grammars for generating forms [15, 16].
While these form-generation methods have the potential to broaden the students' form repertoire, they can also impose limitations, as they resemble the hill-climbing problem solving strategy. This strategy

only works for certain problems where it is possible to find the solution by moving step-by-step forward [17]. As a result, over-reliance on these methods creates difficulties for students when confronted with situations requiring alternative approaches, a common challenge in form design tasks, where creativity is one of the main drivers in the process. In other words, they do not encourage *reflection-on-action,* the way in which, as described by Schön [18], practitioners draw upon certain routines, to build theories and responses to their work against a defined context or set of criteria. Not the least, there is also a generic risk of reaching prototypical solutions, as the process for creating form alternatives is confined to the potentials of the applied method [12]. Design methods have also been criticised for limiting students' abilities in dealing with uncertainties, an intrinsic part of the design process [19].

Allowing a period of reflection provides an opportunity for the design students to assess their activities and to self-criticise the progress and content of their design projects [20]. Using diaries in higher education has been considered as a *vehicle for learning* [21]. In the domains of architecture and product design, design diaries have been used to embed reflection-on-action in project work [20, 22].

This paper reports on a master course in Advanced Form Design where a balance between using a systematic form generation method and yet avoiding its limitations was sought. This was done to encourage reflection-on-action when applying a theoretical framework for form development.

2 ADVANCED FORM DESIGN

Advanced Form Design (7,5 ECTS) is an elective course, given in the framework of the Industrial Design Engineering master programme at Chalmers University of Technology in Sweden. The goal of this course is for the students to work with formal aesthetic concepts and methods in order to acquire a superior understanding of product form development. The course provides tools and training for advanced form design and configuration of forms, based on theory and methods presented in lectures given by high-level academic and professional representatives and the provision of an up-to-date package of course literature. In addition, the students are to explore, experience and reflect on the correlation between form design approaches and the formulation of a specific form language. A total of six different themes and assignments are to be completed by the students during a seven-week period of time.

2.1 Participants

A total of 52 students were registered in Advanced Form Design I in two consecutive years. Their distribution and characteristics are provided in table 1.

Table 1. Distribution and characteristics of the participants in each study

Academic year	Number of groups	Participants	Gender		Age
			Men	Women	
2011/2012	6	29	17	12	22-26
2012/2013	6	23	11	12	21-32

2.2 Assignment

One of the assignments for this course has been a variation of the systematic form generation theory behind the *fish-trap model* by Wim Muller [7]. To minimize the problems that generic methods entail, the *fish-trap model* was excluded from the literature and the students were provided with literature concerning geometrical ordering principles at typological, topological and morphological levels. After a literature review and a lecture on the topic, the students were asked to come up with their own approaches for using the geometrical ordering principles and develop form alternatives for a dinnerware object. They were encouraged to form groups of three to five students for this assignment.

The process and the results of this assignment were to be documented, structured and presented in the classroom. In addition to their group-presentation, the students were asked to document their individual self-reflections with relation to the assignment, their process and the produced results in a diary entry and submit it at the end of each week. The diary documentation was facilitated with a template including sections for logging the activities, decisions, tools, methods and underlying motivations behind these choices as wells as difficulties and shortcomings faced during the project. A thematic analysis of the results and diary entries was carried out to address the outcomes of this experiment.

3 STUDENTS' SYSTEMATIC APPROACHES

A large number of form alternatives with a great variety for different dinnerware objects were created. Several benefits and challenges were highlighted in the diary entries. The assignment was found inspirational and stimulating in the process of creating form alternatives, not least due to the structured theoretical framework. One student had mentioned how this approach helped him to overcome the problems that he usually confronts when creating forms: *"This was a great way to try and create different types of form. You get forced to think in different ways, which can sometimes be very hard. Usually [I] get locked into a specific pattern of thinking and these ordering features provided a way of getting out of that pattern…. I always have a problem with generating lots of forms."*

The same student also highlighted that the theoretical framework was difficult to understand: *"…[there] was some difficulties to understand and interpret the theory given by Wim Muller, especially when translating it into our own interpretation of form generation. Discussions within the group helped clear out the confusions."* This problem appeared to be common among most of the students in their diaries. The final results however indicate that the problem was resolved within the groups and they had both understood the theory and found their own ways to apply it.

A remarkable aspect from the results of this assignment was the variety of interpretations and approaches among different student groups. One of the students mentioned: *"It was interesting to hear my classmates' presentations. Everyone had "attacked" the assignment different and I think that I learned a lot from that."* Nevertheless, the students' approach in employing geometrical ordering principles was of an iterative nature. First, they generated a variety of forms separately for each of the topological, typological, and morphological levels. In the next steps, they merged solutions from the three ordering levels. One of the students described this approach as:

"We started out by implementing the theory… and automatically decided to rotate [sketching among] the different topics… Thereafter we tried to find even more form solutions/variations and decided to take inspiration from different topics. For example we could choose one form that we liked from typological ordering and one from topological ordering and combine these... The first [step] was the rotation sketching and the second was form multiplication, which means that you combine different topics and create a new form."

The degrees to which the student groups developed and finalized their form alternatives were completely optional. Many of the groups applied the tools and techniques that they had learned during the course for finalizing one or several form alternatives.

4 THE FRUIT BOWL PROJECT

One of the exemplary outcomes of the assignment - the fruit bowl project - will serve as an illustration for reflection-on-action when applying a systematic form design approach. A short synopsis of the form development project and the main design characteristics is presented here to provide a concrete yet generalisable picture for the group's specific design choices.

Confronting the theoretical framework, the student group were first challenged by the structure and the new terminology: *"We were a bit slow [when] started with the Order and Meaning assignment, but when we finally got going we knew what to do and worked well together in the group. It was a bit hard to really understand all the different terms that were going to be used for the assignment but we worked quite structured so it got clearer after time."*

Having understood the framework, they started to create form alternatives for a fruit bowl at topological, typological, and morphological levels. One of the students mentioned: *"We discussed a lot about the terminology (by Muller) and generated sketches of different fruit bowls that would fit into the different categories."* Figure 1a illustrates the assignment's main form diversification created according to the geometrical ordering principles.

4.1 Iteration for Diversification

In the succeeding phases of the assignment, the student group merged solutions from the different ordering levels in order to achieve a larger form repertoire for fruit bowls. Figure 2b shows two examples of merging form alternatives from (i) typological and morphological, and (ii) topological and morphological levels. The students found this process both inspiring and facilitating in the form design process: **"***The concept generation, where we combined different features in two concepts, was*

stimulating. It felt relatively easy to create new concepts after we've systematically generated simple forms for each sub-feature of the ordering features."

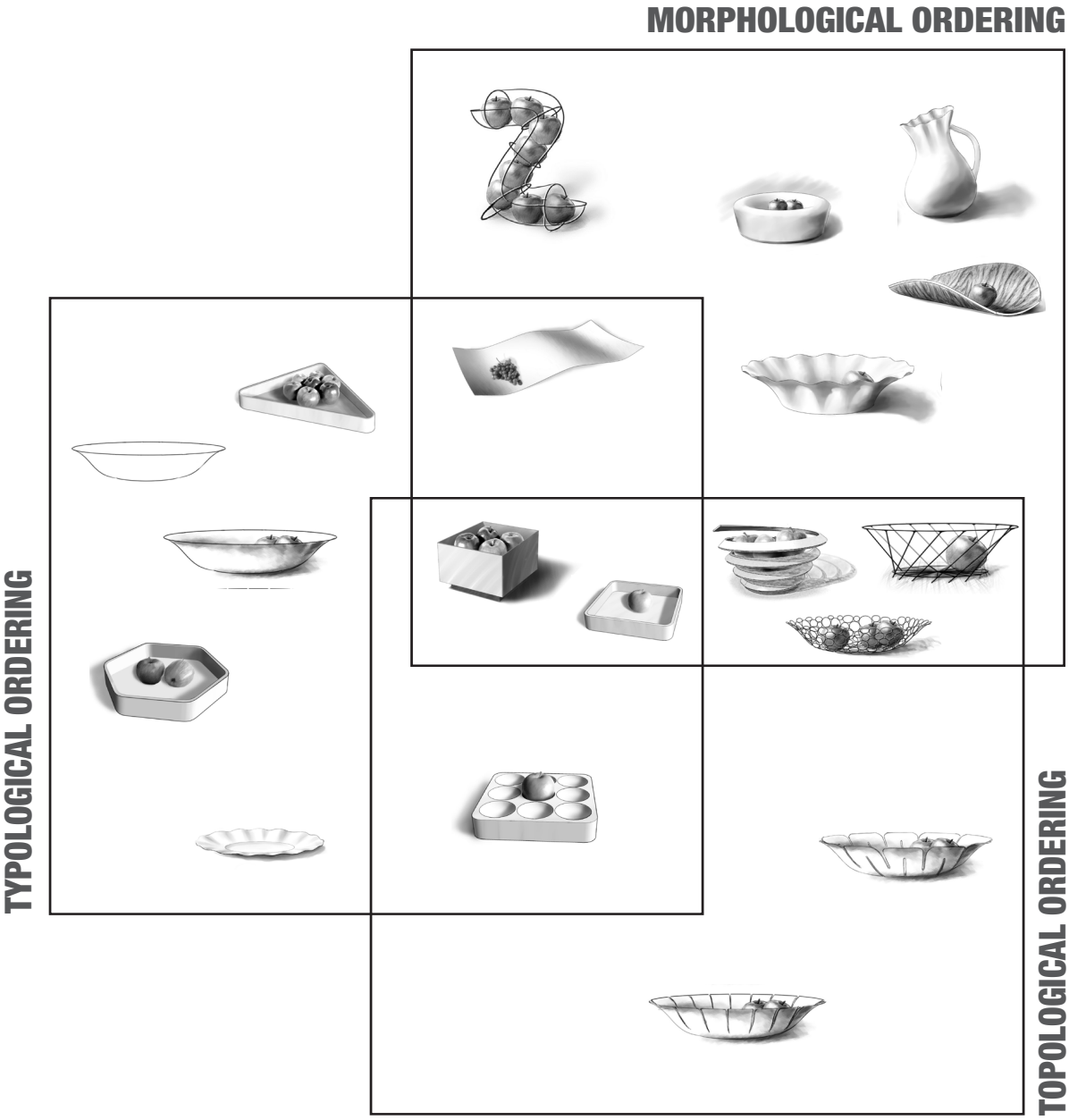

Figure 1a. The fruit bowl project: form alternatives from the first part of the development process with relation to geometrical ordering principles

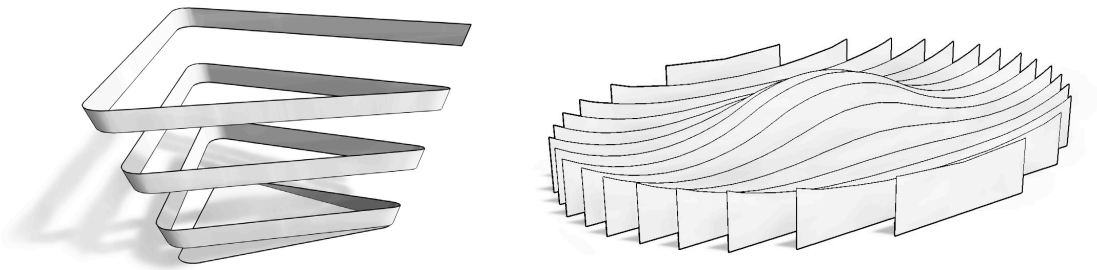

Figure 1b. Merging alternatives from different ordering levels. Left: "This concept is based on the combination of linear morphology and the basic shape of a triangle, which was generated within the category of typological ordering." Right: "This form… consists of planes that are placed in parallel to each other (morphological ordering), creating a linear topological ordering"

4.2 Further Development

Having gone through several iterations, the student group chose one of the fruit bowls that they found most interesting for further development. In this phase, they employed the tools and techniques that they had learned during the earlier assignments in the course. Figure 1c illustrates a part of this development. One of the students describes the process and its challenges in his diary:

"We found that one of the two concepts… have a very interesting form. Hence, we took the project a bit further and a group member made a CAD-model of it and we plan to create it in wood using a laser cutter…. We have been struggling to come up with a way to join the sections. We want the bowl to maintain the simple form of the bowl, i.e. showing mounts as little as possible. Using a technique commonly referred to as waffle we can create sections perpendicular to the original sections, intersecting them and thereby joining them. This also allows the bottom of the bowl to be shaped similar to the top."

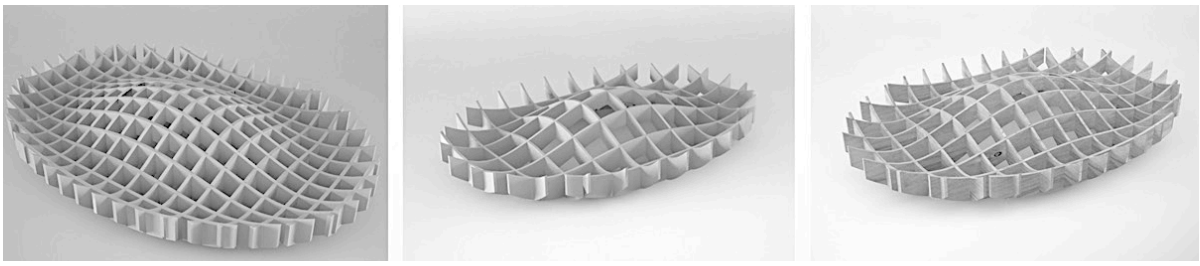

Figure 1c. Further development of a form alternative by merging it with another morphological ordering principle

5 DISCUSSION AND CONCLUDING REMARKS

In this classroom experiment, the primary concern was to encourage reflection-on-action in the process of creating form alternatives when using the theories behind systematic form development methods. The ability to deal with uncertainties during the design process cannot be taught through mere use of design methods [19]. In the experiences from the experiment in two consecutive years, the students found different ways to generate form alternatives using the same theoretical framework. The importance of familiarizing the students with different form development processes has been previously highlighted [12] and this could not be better done than by the students' own approaches.

By encouraging the students to come up with their own rationales for the design process, and reflect on the applicability and the effectiveness of the chosen process, they demonstrated a deeper understanding of the logical and systematic form development theories through synthesis rather than following a prescriptive method step-by-step without critical reflection. From an educational perspective, this experiment has helped the students to develop skills individually, which is of particular importance for the design profession. This has further helped them to gain metacognitive knowledge and higher order thinking skills through planning their own processes and relating it to the systematic form development process. While following the logical and systematic process per se, would only result in a procedural knowledge, which is at a lower hierarchical order with reference to the revision of Bloom's taxonomy of educational objectives [23].

The results of this experiment indicate a general iterative structure among the students' approaches, which broadened their form repertoire. According to students' diary entries, the assignment was found inspiring and helpful for the otherwise difficult process of searching for form alternatives. By the use of diaries, the students were able to trace their routines, their repertoire of visual forms and other information, including their discussions with their peers. Moreover, the students gained a self-critical insight on their form design approach, thereby helping them to become more articulated about what they do. The imposed self-reflections led to a higher level of understanding and critical judgment among the students, not least due to the parallel on-going discussions.

Having a well-balanced mixture of theoretical frameworks and reflective exercises allows design students to (i) assess their activities and self-criticise the progress and content of their design projects and the theoretical frameworks, (ii) better plan and organize their project activities, and (iii) better communicate their process with their group members and others.

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