

Educational Concepts for Developing and Designing Origami-Based Structures

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Abstract

The use of folding as a design principle is currently still quite uncommon in architecture and engineering. However, folded and foldable constructions offer interesting opportunities to established concepts, because origami-based structures combine two technically relevant characteristics. Folded constructions, based on bend-proof connected rigid plates, generate efficient structures and therefore represent a typical lightweight construction system. In contrast, deployable foldings are transformable and statically efficient as long as the rigid, inflexible plates are arranged in an angle to another. Nevertheless, realized folded structures are rarely found and foldable structures are practically non-existent.

One central research objective of the author team is to enable a purposeful application of origami-based structures in engineering and architecture. In addition to own research activities within a common interdisciplinary research project it is attached great importance to combine research and educational activities. On this account, the protagonists offer educational projects on the topic of technical folding at the faculty of architecture and the faculty of mechanical engineering.

In this paper, the possibilities and the challenges of implementing research objectives to educational targets are worked out. The various concepts, from small design projects to research courses to degree thesis projects (bachelor and master thesis projects), are presented. As the education projects are performed as well at the faculty of architecture as at the faculty of mechanical engineering the different approaches are worked out.

The smallest projects are the adhoc design projects with a scope of only 1.5 credit points. As the focus lays on the development of spontaneous creativity in short time periods the teaching activities are minimized. Figure 1 shows one initial presentation which is always held at the kick-off-meeting and which has the objective to inspire the students with origami topics and their principles. Within these very popular adhoc design projects always a lot of fresh ideas are generated in relatively short time periods.



Figure 1: Introductory presentation for an adhoc design project.

In the research courses, the focus is more on generating theoretical background and on dealing with current research questions. As shown in figure 2, the students often start with a critical analysis of existing structures. The purpose of these education projects is to find preliminary approaches for research questions and/or to generate innovative solutions systematically.

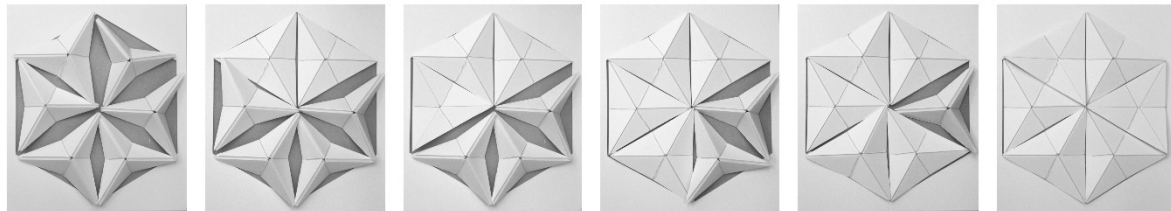


Figure 2: Analysis of existing structures, here by reconstructing the transformable façade of Al Bahar Buildings, Abu Dhabi, Aedas Architects.

Even if the focus of the degree thesis projects varies between the faculty of architecture and the faculty of engineering, they all have as well a theoretical component as a design part. The target of these projects are for example to find solutions in its entirety, from pre-design to preparing solutions for detail connections or to develop a folding-specific method. The thesis projects are individually specified so that very distinct solutions are generated here. One idea generated within a master thesis project is shown in fig. 3. In all student projects supervision is given, normally even by the interdisciplinary research and education team.



Figure 3: Three-dimensional visualisation of the developed folding with two different gear concepts, master thesis project of M. Gottschalk (IGM).

This paper includes the following topics: First, the concept and structure of the diverse education projects are presented. Then, the typical challenges, development of tasks and modifications are discussed and results of student projects are presented in form of a critical analysis. Afterwards, the students' and self- evaluation are held. Finally, an outlook and future prospect is given.