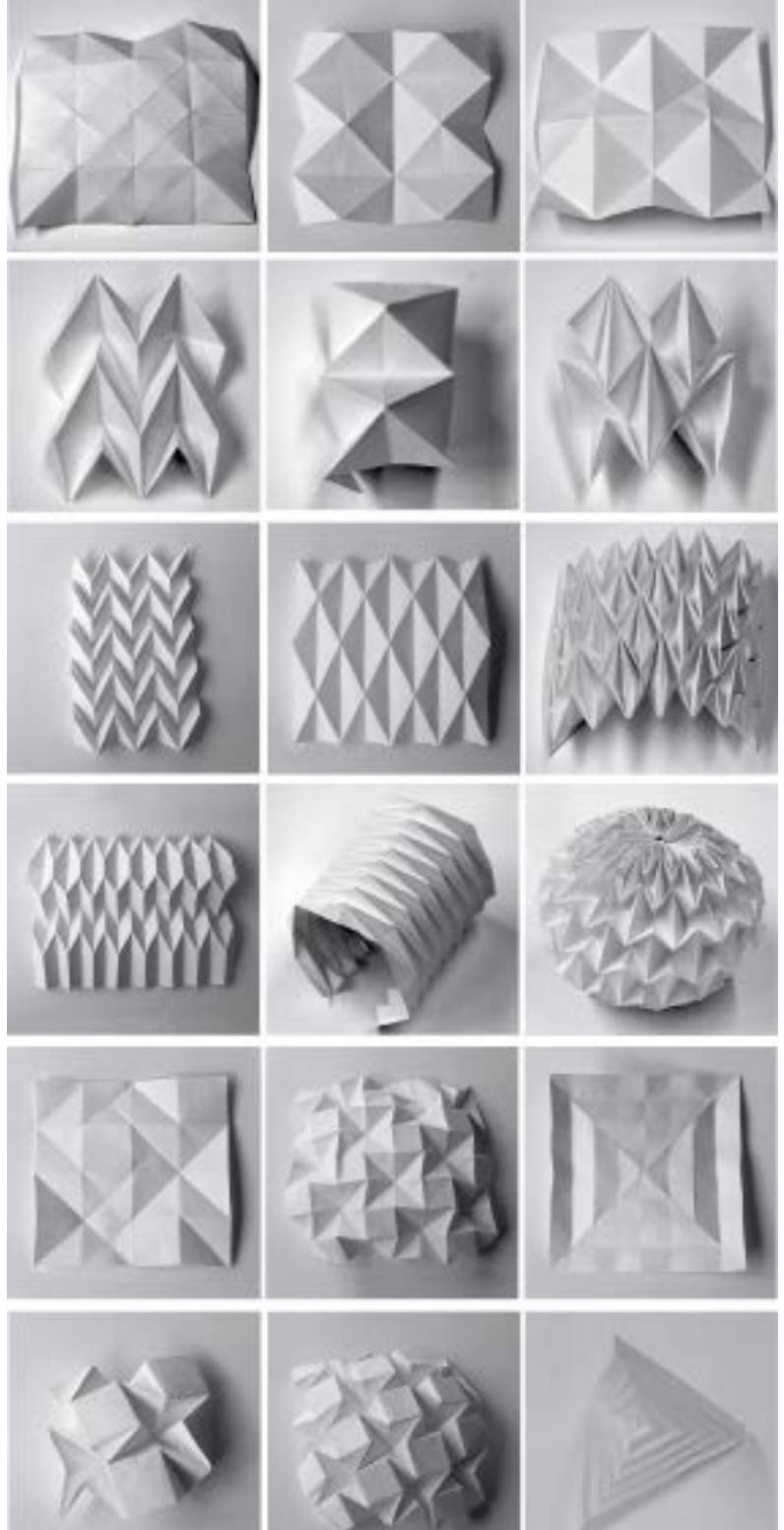
Covadonga Lorenzo Cueva

folding &
parametric design



parametric design

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Parametric design deals with the use of algorithms to define mathematical and geometric relations that allow generating not only a specific design but a whole range of possible solutions. The combination of this tool with the use of paper folding techniques during the workshop seems to be a fruitful field for creative inquiry, because thanks to the construction of parametric models it is possible to digitally simulate the transformational characteristic of the origami structures folded by the students. The aim is to explore design methods and tools, using origami as a vehicle to test their usefulness and demonstrating its potential for architectural application in different areas such as structural analysis, mathematical reasoning and space and form manipulation.

Starting with a square sheet of paper, students fold some basic origami patterns selected by its simplicity and beauty. The goal is not to teach them how to make origami models, but instead, to show them how to fold, relating folding paper with model-making. In this process, elementary geometry is taught, as the idea of symmetry using translation, rotation, reflection or glide reflection. Besides, many different origamis are folded, so students imagine many possibilities, specifically for its application in designing an adaptable multifunctional temporary medium size hermit's cabin, analyzing its crease pattern, exploring variations and their corresponding folded forms. Simultaneously, different material ideas for larger-scale structures are tested so its transformation from a flat sheet to a folded state under the lens of structural analysis is crucial to find the final configuration of the design.

Only then are students introduced into Rhinoceros, that allows them to draw one of the patterns, and Grasshopper, a plug-in that makes possible to control the model in real time, adapting a basic origami to many different situations as the values of the parameters change in shape, size or high, depending on the design. Besides, not only those parameters are flexible but it is possible to divide the basic form into a controllable number of foldable components, so that all of them can be changed. Using parame-

tric design, students can generate series of models, manipulate them and even evolve the basic patterns as they improve their capabilities with the software and explore complex geometries.

That process, where a basic model turn into more complex patterns have similarities with the idea of traditional origami in Japan, where models are passed down from hand to hand and original patterns changes in shape frequently or appear as a new creation, as a result of the experimentation and the properly trained. In fact, this creativity was one of the reasons that the German pedagogue Friedrich Fröbel included origami in his occupations. He was responsible for the greatest contribution to the development of paper folding in Europe during the 19th Century, thanks to a method that included three different categories: the folds of truth, elementary geometrical folding intended to learn the principles of Euclidean geometry; the folds of life, traditional folds to introduce children to paper folding and finally, the folds of beauty, intended to inculcate a sense of creativity and of artistic beauty experimenting with symmetric folding patterns, so an infinite number of variations was possible.

A different approach can be found in the work of Joseph Albers as a professor of the preliminary course Werklehre of the Bauhaus Department of Design, where he introduced newcomers to the principles of paper folding. His material exercises were concerned with exploring features of the materials, such as stability, load-bearing, capacity or strength using purely paper constructions.

Figure: Ron Resch working on some origami tessellations during the sixties. Photo: Erik Gjerde.

On the sixties and seventies, the mathematician and designer Ron Rech was one of the first to explore the architectural potential of 3D tessellated structures. He introduced the use of computers and new software to experiment with many different kinds of origami folding techniques and tessellating units together to create overall forms, not too far from the principles of current computer-aided parametric design.

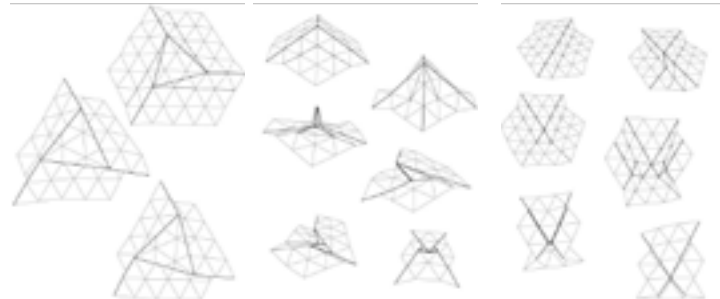

Figure: Examples of origami patterns developed by Erik Gjerde.

Rech's work showed a great possibility to parametric design to have kinetic structures with dual purposes rather than remain in one fixed configuration, demonstrating that it could be possible to simulate the contraction and expansion of a triangulated unit-grid into several configurations and orientations to respond to different factors. Nowadays, the field of computational origami has exploded, and there are many computational tools and theoretical explorations in the field, as the specific software to design origami tessellations developed by Robert Lang or Alex Bateman and the research carried out by Erik Demaine or Erik Gjerde, among others. But this is just the beginning; they have only begun to scratch the surface of what is made possible by applying parametric modeling processes to the design of spatial structures.

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