

Optimisation in Origami design

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keywords: Origami design, optimisation criteria, subjective design criteria

Abstract

What defines a completed origami design? When is a model finished? What are the criteria for determining that a model or folding process has been completed? An examination of Objective and Subjective methods in Origami design, based on case studies from working on Origami commissions through my work through Creaselighting limited and also interviews with other origami designers.

The paper will look at various design methodologies that can be applied to develop origami designs, from crease pattern planning to intuitive methods of model design. It will include classic designs that have evolved from bases and determine criteria for determining whether a model is complete, or as close to complete to be satisfactory to an artist / designer.

Looking at other approaches to problem solving the paper will explore mathematical methods for optimisation and how it is applied to determine maximum, minimum and optimum solutions. Can these methods be applied to artistic design? Can the creative methodologies used in Origami design be applied to developing applied folded solutions?

To answer this question, we may need to define what our origami model seeks to achieve and whether these criteria can be defined in objective terms. These criteria are more obvious in product design. However, how does this apply to aesthetic choice and evaluation of a final presented designed model?

Each Origami artists work is unique. Despite the ability to replicate a particular folding process it is possible to identify a model as being the work of a particular artist through specific folding style or unique characteristics. Some of methodologies explored in the paper could be used to gain a better understanding of the intuitive methods used by origami artists and designers. However, this personal aesthetic is not universal and another designer may consider that the model could be improved.

With reference to case studies from my work as an origami designer I will explore the evaluation of origami designs and what determines when a model is complete. Both from the perspective of a creative designer, but also by applying objective criteria. How can this be affected by the views of others and can a collaborative approach improve the process? I should also like to explore the folding methods of other origami artists and identify similarities and differences in the creative process. Some of this work has been started from a series of videoed interviews with Origami designers produced in conjunction with the British Origami Society.

The paper will explore some design methodologies that I have used in producing origami commissions and how they can be used to adjust completed models. These methodologies show how a model can be defined by a group of ordered folds that could be grouped with the same characteristics. However, within the group of models with similar characteristics only certain members of the group are of interest to a particular brief. Are there ways of evaluating the group and determining which of the possible folding outcomes will be of interest?

Examples of Objective design optimisation;

Case Study One: Unicorn Design of a logo for Ubuntu: Exploring the process to design and develop an Origami unicorn. The final shortlist produced a design with some flexibility that could be amended based on client feedback. This process shows how a folded pattern can form part of a series of models. Adjustments to the folding pattern and process can lead to different models, that are similar and related. This observation would suggest that a “completed model” is one member of a set of similar folds. The application of these techniques can lead to variations of the original model by introducing small changes. This leads to an idea that there are families of models with similar crease patterns.

Case Study two: Looking at the folding process rather than the completed model. Development of folded geometric shapes. There are many ways of folding an equilateral triangle within a square. Methods can be directly compared by determining the size of the final folded triangle. This method of evaluation can also be applied to folding a three-dimensional object, such as a cube from within a square. However, this method of evaluation does not take into account other criteria, such as how complex the folding sequence is, or how elegant the solution. It does though start to introduce ways of evaluating design in an objective way.

Case study three: Aesthetic appreciation; a folded structure has an aesthetic appeal based on various subjective characteristics, these factors include, complexity, simplicity, humour, the overall design. These factors apply to the look of a model. (Further criteria could also be applied to the folding process or sequence of folds in making a model). Are there ways of evaluating models based on these criteria? Can these criteria be applied beyond an individual response, and does a group appreciation help in an objective evaluation?

Case study four: The Intuitive leap. Although some scientific method can be applied to the design process, design also relies on intuition. Although it is difficult to systematise the intuitive process identification of instances of this process can highlight how and when it can be applied.

Other research into Origami design, includes; “Origami Design Secrets: Mathematical Methods for an Ancient Art” by Robert J. Lang (Lang 2003). Mathematical modelling programs to produce folding patterns (Tomohiro Taichi) and Tessellations (Alex Bateman).

Some of the ideas that will be developed in the paper were explored in a presentation given in November 2017 at the Origami Engineering conference in Tianjin. Highlighting design methodologies applicable in paper folding design that could be applied to optimising applied origami solutions in engineering research.