TH-OWL 2019 DETMOLD

From living Labs to Communities of practice

OPEN SOURCE AND THE MAKERS MOVEMENT IN DIGITAL FABRICATION AND LIVING LABS

CASE STUDY: design criteria for an open source design

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ABSTRACT

The aim of this paper is to explore the potential of open source data and the Maker movement. Digital fabrication is mainstream nowadays thanks to a wide set of virtual communities that gather and share digital information, tutorials and even peer to peer explanations of the digital design methodologies. Implementation of state-of-the-art software, instruction manuals are available thanks to an open source philosophy. With the maker movement, geographic location is now irrelevant to a computational community of designers and Digital Fabrication is now accessible to almost everyone, as digital fabrication is accessible with examples like the "how to make almost everything manifesto" for Fablabs. The third industrial revolution has brought not only a shift into mass consumption goods, but in the way, we approach a design problem to realize it. Creative ideas and solutions are shared in collaborative work spaces and Maker Faires or on social media platforms. The discussion is set on what are the design criteria for a parametric design to be open sourced, of easy understanding and easy manipulation. This paper will explore the making of a prototype, using these communities' interactions, with a fixed goal of making the design also accessible to everyone and customizable and discuss on how it affects the design process.

1. INTRODUCTION

The makers movement is driving digital fabrication into the mainstream (quote), today's Internet access, enables anyone with the right skills and equipment to produce "digital content composed of virtual 'bits' and also make it instantly available across the globe". Physical objects fabrication is subject to the same phenomena where anyone with access to a Fablab, normally equipped with tools like CNC machine, laser cutters and 3D printers.

The proliferation of Fab Labs and Makerspaces is associated with the development of the maker movement and the generation of various networks that promote free hardware and software as well as different means for shared knowledge. Fab Labs are also citizen laboratories that allow both social innovation and orientation to business and commercial products.[1] The maker movement is ultimately about empowering us and doing so taking advantage of all the possibilities that technologies and the digital world offer us.

Designing and Prototyping is a process that now involves a wider community of contributors. Forums such as https://www.grasshopper3d.com/, and https://discourse.mcneel.com/c/grasshopper are essential to the design of visual generative algorithms, using Grasshopper® is a graphical algorithm editor tightly integrated with Rhino's 3-D modelling tools. For coding and scripting, https://github.com/ is another platform that enables coding and programming content sharing [2].

The criteria for a design to be uploaded into any open source platform and be successful lays in the logical parametric design and how easy to manipulate the parameters affects the customization. There is no rule set on this, is just a matter of common sense.

2. CASE STUDY

The Case Study focuses in the development of a piece of furniture in the TH-OWL Fablab. The design must meet certain requirements to be open source

[1] *https://mosaic.uoc.edu/2017/05/08/fab-labs-y-movimiento-maker/*

[2] *GitHub is a code hosting platform for version control and collaboration. It lets you and others work together on projects from anywhere. https://guides.github.com/activities/hello-world/*

ready-to-fabricate. This means, a single file must comply all the information necessary. It should be easily customizable, using parametric computational design and specific software Grasshopper for Rhino.

2.1 Methodology and fabrication

a. The design problem: Create a wooden joint that will be developed into a 1:1 prototype

The first phase of the design problem was approached by researching existing wooden joints, and selecting one type to develop and implement in fabrication. The living hinge was selected, commonly known online as kerfs due to the pattern name. The hinge presents characteristics that to narrow down in the structural and material behaviour a round of experiments had to be undertaken. Several boards with variations of the pattern where fabricated in the Fablab. Then Testing the boards and evaluation of resistance and desired flexibility and thickness.

To achieve the different patterns tested the online communities where visited. Several forums hold data regarding the kerf patterns, the pattern behaviour on different types of materials. Through this media, the selection for the testing patterns could be significatively narrowed down and the process to find the desired flexibility, esthetical aspects and strength could be done faster. Mainly due to users sharing in this virtual communities their finding and results in their own DIY projects.

b. 1:1 Prototype: Furniture design

Several prototypes for the final structure where tested in a 1:1 scale model. Improvements on the structural aspects and thickness. Development of the Parametric definition to make accessible to other users meaning manipulation of parameters to make customizable.

2.2 Open source design criteria

Wooden Living hinge into a furniture

Woodpecker is a wood bending system developed in TH-OWL Fablab (**by mysef?)** that allows a flat board of plywood to become a stable structural stool. The springing character of the living hinge is a fundamental part of the design. It can be easily folded into shape and disassembled for storage flat or hanged on the wall. The straps act tensing the structure into place and the supports prevent the hinge from rocking further when fixed. Easily comprehensive assemble steps make it suitable for all users. Thanks to digital fabrication and its parametric design the Woodpecker is customizable and ready to fabricate.

Design criteria

To make the design effective for open source layout, it had to meet the following design criteria:

Easy assembly, Stackable, No need of extra tools, Adaptable, Fast Fabrication, Minimum storage space, Minimum material waste.

Figure 1 Wooden living hinge prototyping

2.3 Digital Fabrication

Within the parameters, the definition had to be adjusted in order to exactly address the measures that are of importance. For example, the thickness of the wood affects directly the ratio of the pattern. And the ratio of the kerf patterns affects directly the curvature radio between the sit and the legs.

Documentation of results

TEST	K 1.1	K 1.2	K 2	K3
Material thickness	6 mm	9mm	9 mm	9 mm
Angle	bending > 90º	bending up to 90º	bending < 60º	bending 70º - 90º
Flexibility	Very Flexible	Flexible	Less Flexible	Less Flexible
Strength	Fragile	Fragile	Resistant	Resistant
Spring	Light Spring	Strong Spring	Very Strong Spring	Strong spring

Chart 1 Test result chart

The previous chart retrieves the different material and design test results that were carried out in the Fablab. To record the testing history for every user, de design also has a built-in component to output the different setting and offer the possibility to register the settings for every try-out. The chart for results is related to the parameter settings (*Figure 2)*.

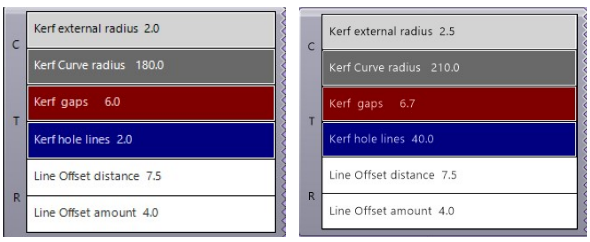

Figure 3. Test K1 and K2. built-in setting output

2.4 Making a customizable design

Setting the Parameters:

What is in the GH Definition:

General dimensions - CNC perimeter
Furniture contour shape
Living Hinge area, location, spacing, repetition
Kerfing pattern and shape
Pin / Clip Tenon Join slot dimension and placement
Strap slot dimension and placement
Chart with input parameters

What does this Parametric Design allow to customize?

Contour Shape
Living Hinge Area, Location, Spacing, Repetition
Kerfing Pattern and Shape
All the Join Slots dimensions and placement

Feature:

Input Parameters Chart records each variation`s DNA.

3. RESULTS

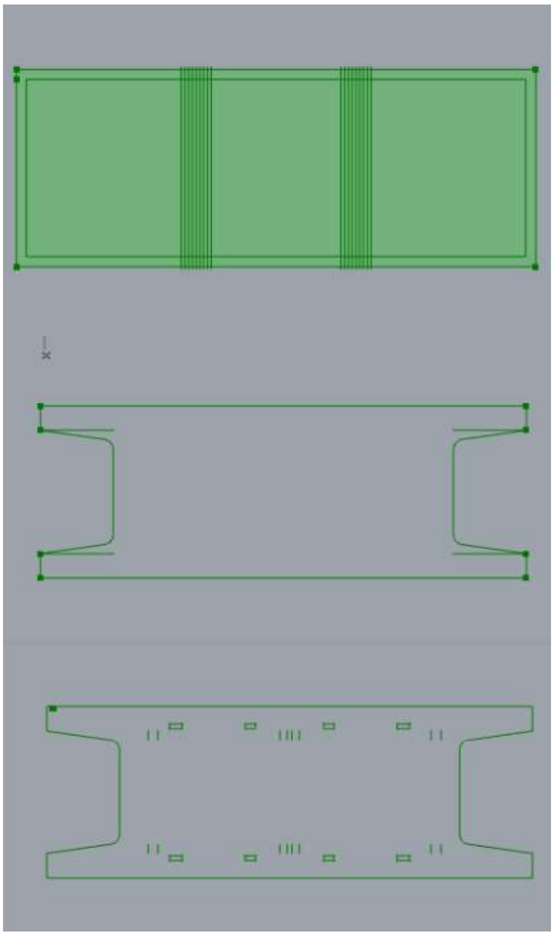

Figure 4 General furniture customization layout

The resulting GH definition enables to have a scaled CAD model ready for digital fabrication. The research took me to revealing information such as: curves in the kerfing pattern makes it less like to crack, the direction of the fibre affects, and witch patter where more suitable to what means. The curves where introduced in the definition and the parameters adjusted several times and it results in the desired bending

4. CONCLUSION

To be part of an open source data community, designs have also to be intended for ready-to-use, with a ready-to-fabricate strategy. Parametric design can make this possible but the right parameters have to be taken into account. Develop further

As a result, I try to answer:

How is the parametric design implementing customization?

What are the requirements for an open source design?

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