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Origami Diagramming

Evaluating and Improving the Origami Diagramming Tool Origrammer

Bachelor Thesis

by

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1 Abstract

2 Introduction

Origami is the Japanese art of folding paper into models of animals, people or other objects. Creating instructions for folding these Origami models is a tedious and time consuming task. These so called origami diagrams (see Figure 2.1) have to be accurate representations of the paper for every folding step, in order to unambiguously explain how to fold the model. Every flap, crease and edge has to be drawn (see Section **??** for exceptions), which makes the process slow and especially error-prone for complex models. While for example the crane model in Figure 2.1 can be folded in 17 steps, more complex models can take hundreds of steps to complete.

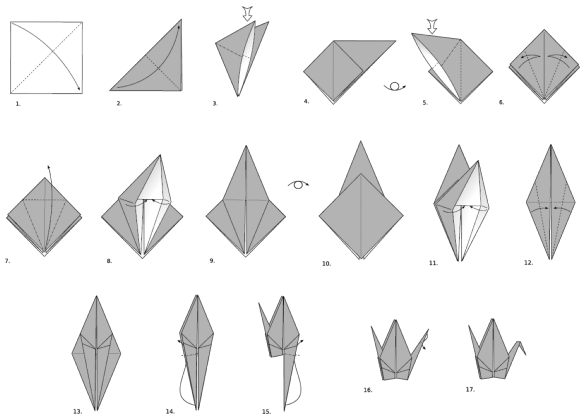

Figure 2.1: Crane Diagram - [Andrew Hudson 2011 [2]]

Historically, diagrams got either drawn by hand or created with the help of digital vector programs like Inkscape[1] or Adobe Illustrator[2]. Even though the digital diagramming improved the accuracy of the finished instructions, the task itself was still quite time consuming especially for models with hundreds of steps.

In contrast to diagramming programs there have been several attempts at creating programs that virtually fold the paper in order to create models. These include amongst others eGami by Jack Fastag [1], Origami Simulation by Robert J. Lang [3] and the Foldinator Project by John Szinger [5]. However none of these projects ever got outside the prototype phase and they haven't been updated in years.

[1] https://inkscape.org/
[2] https://www.adobe.com/de/products/illustrator.html

Up until the point of this publication there is no publicly available program that offers specific features for the origami diagramming process. The previously mentioned vector programs can be used for diagramming, however as they weren't developed with origami diagramming in mind, there are a lot of shortcomings in their feature set. These shortcomings of current programs will be further elaborated on in Section **??**.

The goal for this project is to develop a desktop application that implements features specifically for the origami diagramming process. The standardized symbols and overall notations have to be included and the program has to offer functions that increase the efficiency of creating diagrams.

This work starts with an overview and subsequently a categorization of current origami diagramming notations. Based on these findings, a requirements analysis can be carried out in order to define the required features of the planned program. Any problems or other findings during the development process will be documented so that they may be beneficial to others in the future.

3 Selecting Evaluation Methods

3.1 10 Usability Heuristics by Jakob Nielsen and Rolf Molich

"A disadvantage of the method is that it sometimes identifies usability problems without providing direct suggestions for how to solve them."[4]

The Origrammer should mostly be tailored for professionals that are already well versed in the area of Origami. There is a lot of initial knowledge required when developing new Origami models and subseuently diagrams. This is the main reason why novices most likely won't be using the Origrammer. But that still means that knowledgeable Origami artists should be assisted where possible through Origrammers featureset.

4 Evaluating Origrammer

To begin the evaluation process the 10 usability heuristics by Jakob Nielsen [4] will be used in order to facilitate a base, on which can be build upon with other evaluation methods if required. As established in 3, the Usabilty Heuristics sometimes only identify problems without providing direct solutions. This is why this chapter will focus on finding problems and shortcomings of the Origrammer first. Afterwards, solutions can be developed that optimally fix most, or all, discovered issues without contradicting or counteracting other measures.

As the current (at the time of writing this thesis) Covid-19 pandemic hinders user involvement for the evaluation process, other measures have to be taken to ensure maximum efficiency and thoroughness. This is why there is an exhaustive list of all parts and features of the Origrammer below. Figure 4.1 roughly shows what features are located where on the Origrammer.

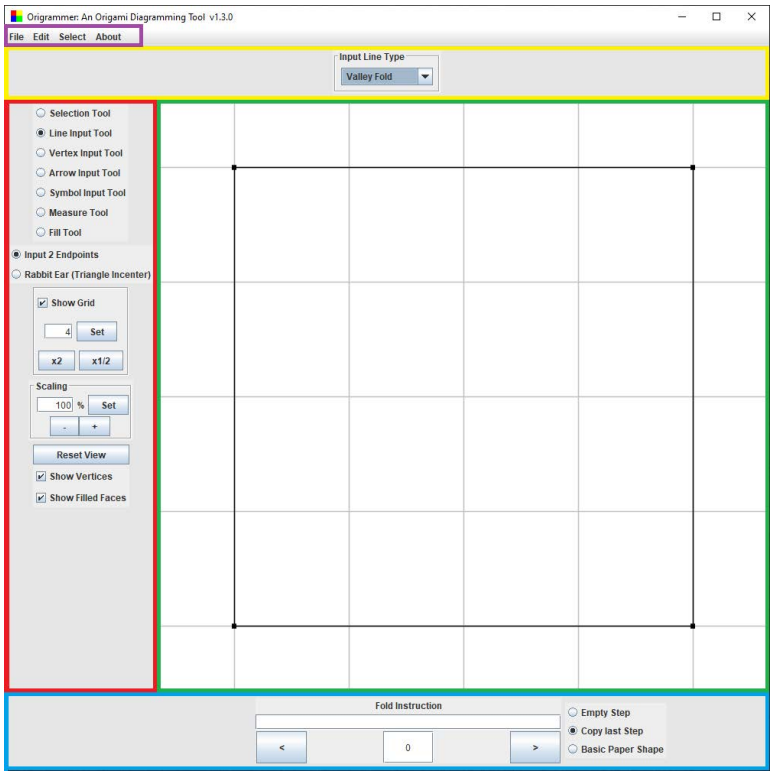

Figure 4.1: Menu Bar (Purple), Top Panel (Yellow), Side Panel (Red), Editing Panel (Green), Navigation Panel (Blue)

4.1 Origrammer Feature List

1. **Menu Bar (Purple)**
   (a) New File (b) Open File (c) Save File
   (d) Export File (e) Model Preferences (f) Origrammer Preferences
2. **Side Bar (Red)**
   (a) Selection Tool
      1. Click to Select 2. Hover over Object 3. Rectangular Selection
   (b) Line Input
      1. Two Point Input 2. Triangle Incenter
   (c) Vertex Input
      1. Absolute Position 2. Fraction of a Line
   (d) Arrow Input
      1. Valley Fold 2. Mountain Fold 3. Turn over
      4. Push Here 5. Pull out 6. Inflate here
   (e) Symbol Input
      1. Leader 2. Repetition Box 3. Next View Here
      4. Rotations 5. Hold Here 6. Hold Here and Pull
      7. X-Ray Circle *8. Fold Over & Over* 9. Equal Distances
      10. Equal Angles 11. Crimps 12. Pleats
      13. Closed Sinks
   (f) Measure Tool
      1. Measure Length 2. Measure Angle
   (g) Fill Tool
   (h) Grid Settings
   (i) Scaling Settings
3. **Navigation Panel (Blue)**
   1. Fold Instructions 2. Step Navigation 3. New Step Options
4. **Top Panel (Yellow)**
   See Side Panel for related features, as options for the selected Side Panel Tools appear on the Top Panel.
5. **Editing Panel (Green)**
   See Side Panel for related features, as the selected Side Panel Tools are being used on the Editing Panel.

4.2 10 Usability Heuristics by Jakob Nielsen

With the Origrammer Feature List as a basis, the evalutation using the 10 Usability Heuristics can be carried out. Every feature from the list will be checked against all 10 heuristics in order to try and maximise the completeness of the result. The found usability issues will then lead to the planning of potential usability improvements.

1. Visibility of System Status

Nr:	Affects	Impact	Description
01	2.b; 2.d-2.g	3	When an action requires multiple input points (e.g. placing a Fold Line by two endpoints), the user doesn't know where he is in the process.
02	1.1-1.6; 2.b-2.i; 3.1-3.3	3	When an action requires multiple steps,

2. Aesthetic and Minimalist Design

Nr:	Affects	Impact	Description
02	2.a-2.i; 4;	3	Redundant information should be removed and/or replaced by Symbols or Icons (e.g. the Tool Selection on the SidePanel can be replaced by icons)

3. User Control and Freedom

User should always be able to cancel an action (like placing symbol)

4. Consistency and Standards

Editing of symbols/arrows should be correctly labeled

When selecting and editing Symbols/arrows make it consistent (don't let multiple different symbols be selected at the same time

5. Error Prevention

Prevent impossible and breaking user inputs

6. Recognition Rather than Recall

Don't make the user remember stuff (only keyboard shortcuts)

7. Flexibility and Efficiency of Use

8. Recognition, Diagnosis and Recovery from Errors

9. Help and Documentation

Show tooltips when hovering over stuff

Show short explanation when using a feature (bottom left –> see **??**

10. Match between System and Real World

5 Planning of Solutions to Fix Discovered Flaws

6 Evaluating Solutions

7 Problems & other Findings

This section discusses decisions and problems during the development process.

8 Prospect

Glossary

Origami (jpn: *ori* = *folding* and *kami* = *paper*) is the art of folding paper into models of animals, people or other objects. 5

List of Figures

References

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