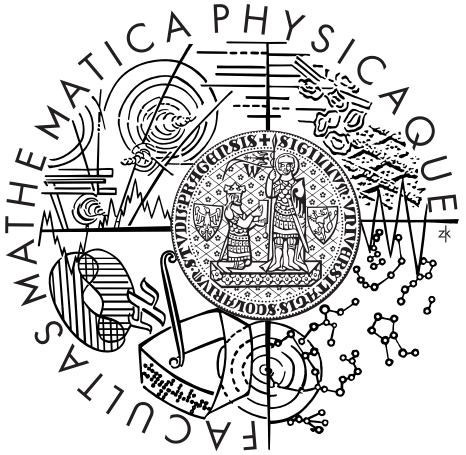
Charles University in Prague
Faculty of Mathematics and Physics

**BACHELOR THESIS**




Martin Pecka

# Origami diagram creator

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Study programme: Informatika

Specialization: Obecná informatika

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Poděkování.

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Název práce: Origami diagram creator

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Katedra: Kabinet software a výuky informatiky

Vedoucí bakalářské práce: Mgr. Martin Petříček, Kabinet software a výuky informatiky

Abstrakt: Program Origamist si klade za cíl pomoci s tvorbou návodů na skládání origami modelů. V současné době jsou nejběžnějšími metodami pro tvorbu těchto návodů buď ruční kreslení všech kroků v obrázkovém editoru, nebo nafocení jednotlivých kroků a jejich manuální poskládání (opět v obrázkovém editoru). Origamist na toto pole přináší novou alternativu. Autor tak dostává možnost přenést posloupnost ohybů papíru, z nichž se návod skládá, do programu Origamist, jenž z nich dokáže vygenerovat několik druhů výstupu - v origamistických kruzích nejrozšířenější PDF návod, ale i návod jako obrázek (PNG, SVG), nebo dokonce jako animaci procesu skládání. Přidanou hodnotou pak je snadná možnost přeložit popisky kroků do více jazyků.

Klíčová slova: Origami, Java3D, skládání papíru, návod

Title: Origami diagram creator

Author: Martin Pecka

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Abstract: The main target of the Origamist application is to aid with creating origami diagram manuals. Recently, the most common methods for creting those manuals are drawing of the steps in an image editor, or taking photographs of the folded steps and composing them together (again in an image editor). What Origamist brings is a new alternative to these methods. The manual's author gets the possibility to transfer the sequence of paper folds the manual consists of to the Origamist application, which is able to export several types of output - the most favourite (among origami folders) PDF manuals, but also image manuals (as PNG or SVG), and even as an animation of the folding process. There is also the added value to translate the steps' descriptions to several languages.

Keywords: Origami, Java3D, paper folding, diagram

# Contents

# Introduction

Everyone who has ever tried to fold an origami model knows how important it is to have a *good manual* describing the steps of the folding process. A good manual consists of lots of images (generally one image per step) and their descriptions.

Why are the manuals needed? It is too hard (if not impossible) for most people to guess the folding process by only seeing the result shape. And this is even harder if you only see the result as a 2-dimensional image on screen or paper. Thus, several methods to aid people with the folding process were introduced.

The most practical help method is learning from someone who knows how to fold the desired model. This method has two disadvantages - a man can forget what he has learnt, and, in most cases, there is simply nobody who knows how to fold the desired model (except in origami communities). Therefore *paper manuals* were invented. They are (conceptually) eternal and are relatively easy to obtain (in books or on the Web). They have another disadvantage - if some steps are unclear in the manual (which happens not so infrequently), there is no other help. The last (relatively new) means to learn the folding process are *video tutorials*.

In the paper manuals (or bitmap image manuals, we will call both of them 'paper' manuals) there are some established graphical marks that indicate the operations to be done with the paper in the step. We will discuss these marks in higher detail further in the text. The marks cover the most of operations one would like to do with the paper, but their meanings aren't fixed and unambiguous, which can lead to lack of clarity of the manual.

'Paper' and video manuals share one more disadvantage, too. They aren't *simply editable* by other people. The 'paper' manuals are either printed or distributed as PDF or image files, and these aren't simply editable (PDF editors exist, but aren't widely used; editing an image manual involves some non-basic knowledge of computer usage). Video editing is even more difficult. So, ways to edit these manuals exists, but none of them is straightforward.

Origamist brings a new alternative to those types of manuals. It presents the concept of 'live' manual. Each folding step is represented as a 3-dimensional model, which the user can view from different viewing angles and zoom levels. Furthermore, everyone can simply edit the model in the Origamist editor. It doesn't matter if the user just wants to add a translation of the steps' descriptions, edit existing step descriptions or if he wants to add some more steps, all of these activities can be done straightforward in the editor.

Also, all of the previously mentioned types of origami manuals (except personal assistance) can be exported from the Origamist application. Only the exported animation has no sound track, which is an important part of video tutorials (but it is possible to add this functionality, also the data model can be simply modified to store this type of descriptions).

# 1. What is origami?

Origami is the name of an ancient Asian art of folding various figures and shapes from a piece of paper.

"Whether it is called 'zhe zhi,' as it is by Mandarin-speaking Chinese, or 'chip chee,' as Chinese who use the Cantonese dialect call it, or by the Japanese name 'origami,' it is generally agreed that the art of paperfolding originated in China perhaps before the 6th century." [1, p. 123]

The traditional Japan origami focuses mainly on animal figures and flowers. You could know the most famous origami animal - the crane. It is considered as a sample of the traditional technique.

In recent times, hundreds of other origami models can be found, including boxes, decorations and ornaments, envelopes, abstract things and much more. [2]

## 1.1 The rules of traditional origami

There aren't much constraints in the traditional origami. Everyone can fold whatever his fantasy invents, but to call the model a traditional origami, there are these rules: [3]

- To begin with a single square sheet of paper.
- Not to tear or cut the sheet of paper.
- Not to use glue.

And that's it. No more constraints on what can be done. This is also the set of rules Origamist tries to hold (in fact, it allows non-square papers).

## 1.2 Other kinds of origami

Besides the traditional origami, there are several other types, differing in what is allowed or disallowed. Here is a short list of some other techniques:

- *Modular origami*, which allows to use and combine multiple sheets of paper. [4]
- *Action origami*, which creates figures whose parts are moveable, so they can be used as toys. [5]
- *Pureland origami*, which only allows one fold to be done at once, and thus disallows folds like reverse folds or rabbit folds. This type of origami is suitable for beginners, children and disabled people. [6]
- *Kirigami*, which allows cutting the paper and using glue. Kirigami is mostly used to make decorations. [7].
- *Technical origami*, which develops the models based on computer-generated crease patterns[1]. [8].

[1] More on crease patterns can be found further in the text

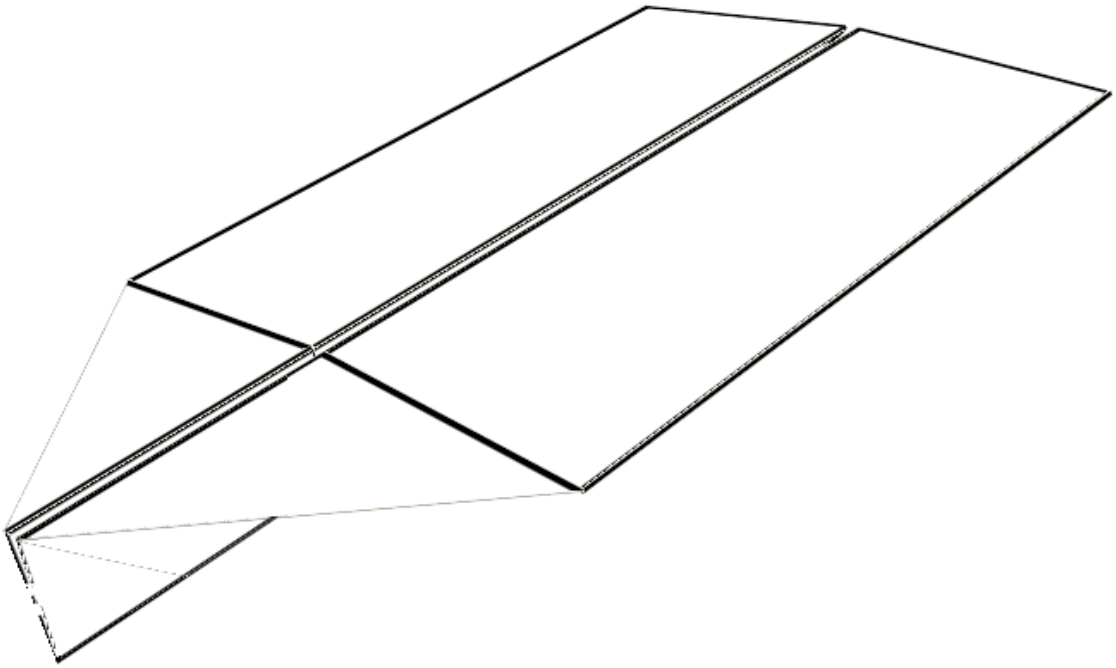
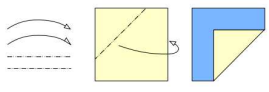


Figure 1.1: Origami model of paper plane

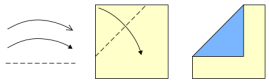
- *Mathematical origami*, which is just abstract and is used for some mathematical and algorithmic proofs.
- *Rigid origami*, which is a subset of mathematical origami and tries to find answers to the question "If we replaced paper with sheet metal and had hinges in place of the crease lines, could we still fold the model?" [8].

## 1.3 Basic folds

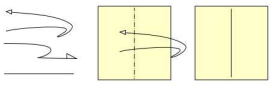
In this section, some basic fold types will be described, along with the common marks for them. Sample images are taken from [9], the steps descriptions are inspired by [2].



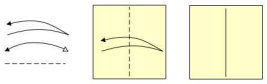
*Mountain fold.* This is a simple fold which bends the paper in the direction 'from the viewpoint'. An arbitrary angle can be specified for this type of fold.



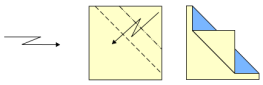
*Valley fold.* This is a simple fold which bends the paper in the direction 'towards the viewpoint'. An arbitrary angle can be specified for this type of fold.



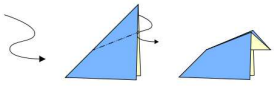
*Mountain fold and unfold.* This fold just makes a mountain crease on the paper. After doing it, the paper has the same geometry as before, but the crease has required moving the paper. This is mainly used for creating reference creases.



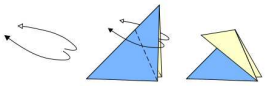
*Valley fold and unfold.* This fold just makes a valley crease on the paper. After doing it, the paper has the same geometry as before, but the crease has required moving the paper. This is mainly used for creating reference creases.



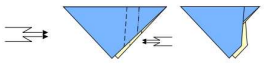
*Thunderbolt fold.* A double fold, one of the folds is mountain, the other is valley An arbitrary angle can be specified for both folds (a different one for each of them).



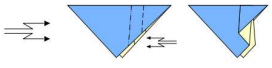
*Inside reverse fold.* Tuck a tip of a flap[2] inside. Uses two mountain folds for side creases, and a valley fold for the inner centre line. For every paper configuration, there exists only one angle for the created folds which guarantees to preserve the paper properties.



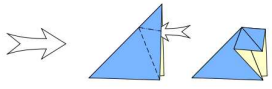
*Outside reverse fold.* Wrap a tip of a flap[2] around its outer side. Uses two valley folds for side creases, and a mountain fold for the outer centre line. For every paper configuration, there exists only one angle for the created folds which guarantees to preserve the paper properties.



*Inside crimp fold.* This is a double fold where both folds are inside reverse folds.



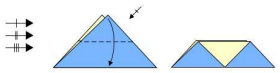
*Outside crimp fold.* This is a double fold where both folds are outside reverse folds.



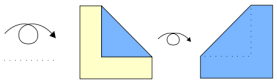
*Open fold.* Open or squash a flap[2] of paper. Origamist doesn't support this operation.

[2]A triangle standing out of the paper, which consists of at least two paper layers.

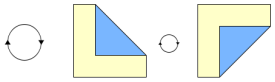
*Pull fold.* Unfold some previously created folds. Origamist has only partial support for this operation. Only one fold can be unfolded at a time, so eg. atomically unfolding a thunderbolt fold isn't possible.



*Repeat.* Repeat some previously done operations. This operation hides (for clearness) some steps and substitutes them with the repetition mark.



*Turn over.* Turn the paper to the other side. Origamist only supports turning around the horizontal axis of the current view, and a single turning angle - 180 degrees.



*Rotate.* Rotate the model of an arbitrary angle around the current view's direction axis (normal of the screen).

# 2. Název druhé kapitoly

## 2.1 Název první podkapitoly v druhé kapitole

## 2.2 Název druhé podkapitoly v druhé kapitole

# Závěr

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# List of tables

# List of abbreviations

# Attachments