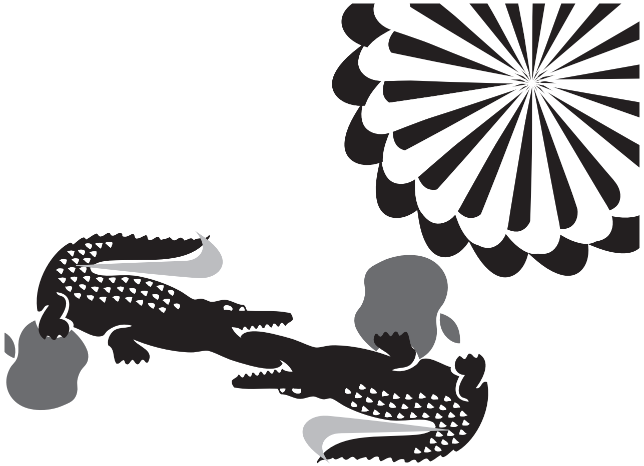
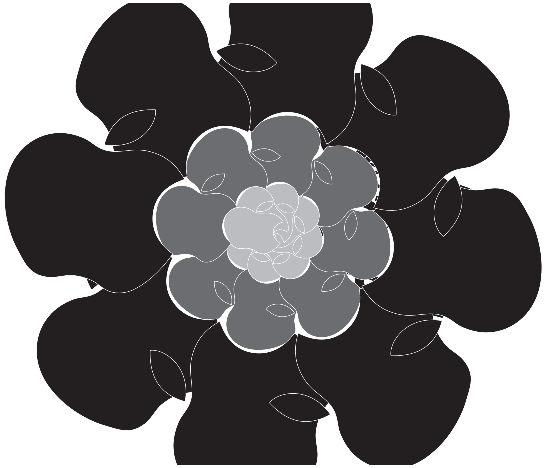
Golden Ratio

Pepijn Fens

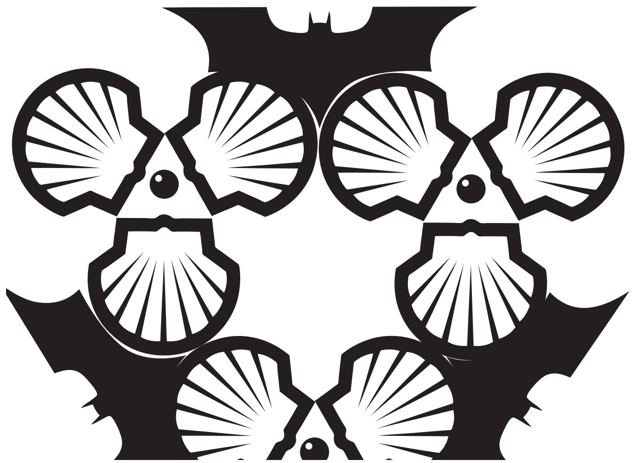
L. Feijs & J. Hu



Experiments with rotation a group of figures



Rotation in combination with scaling



Reflecting groups of figures to create structures

Introduction

My goal during this module was to learn the techniques behind Esscher like patterns. I want to reach this through creating a contemporary version of a typical Esscher artwork, using shapes and or patterns that reflect the current society.

The terms of translation, rotation and reflection weren't new to me and I already had some knowledge about the mathematical principles behind these transformations. Therefore I wanted to focus myself on the aesthetical side of a generated artwork, leveraging the mathematical principles behind it.

Exploration

After theoretical introduction to the subject of symmetry groups, exploration was done in order to find suitable techniques for my final result.

Exploration was done using shapes of popular brand logo's, which in my opinion reflect modern-day views and values.

I planned on finding logos that would fit together and could be transformed in order to create an Esscher like artwork. Because of the mathematical aspect of the module and the fact that no two logo's would actually fit together perfectly, I decided to take logo's as a starting point for my final artwork, that relies on transformation groups.

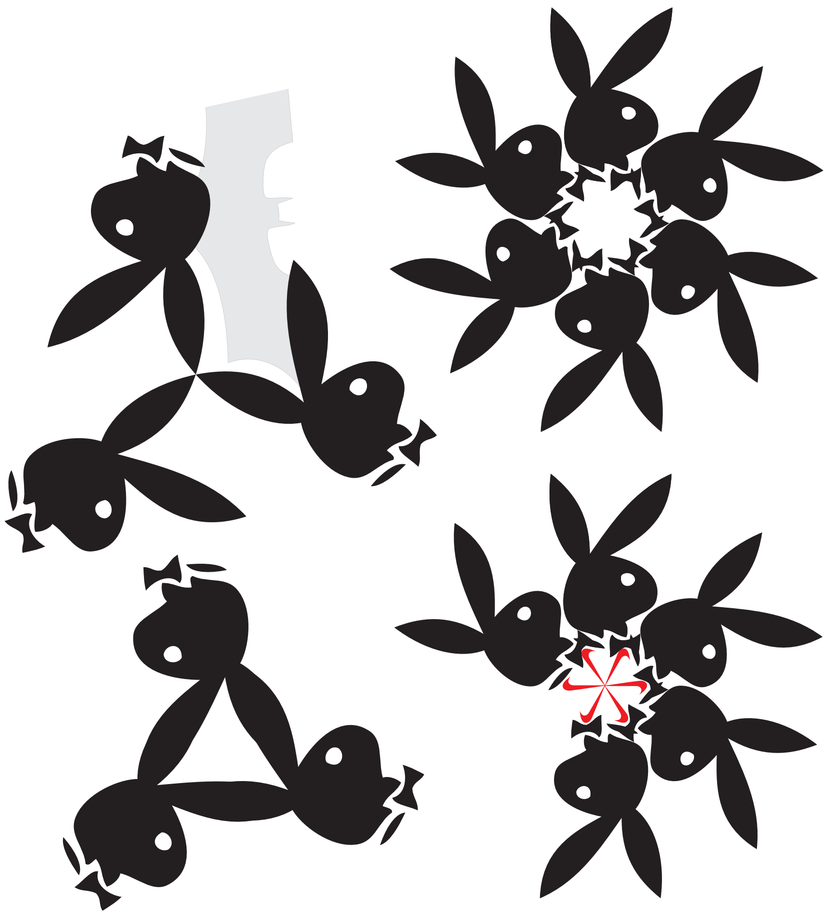
Transformation groups

Above and right figures have been made using a combination of rotation, reflection and translation. Although the figures themselves looked interesting, they did not fit with my learning objectives for this module.

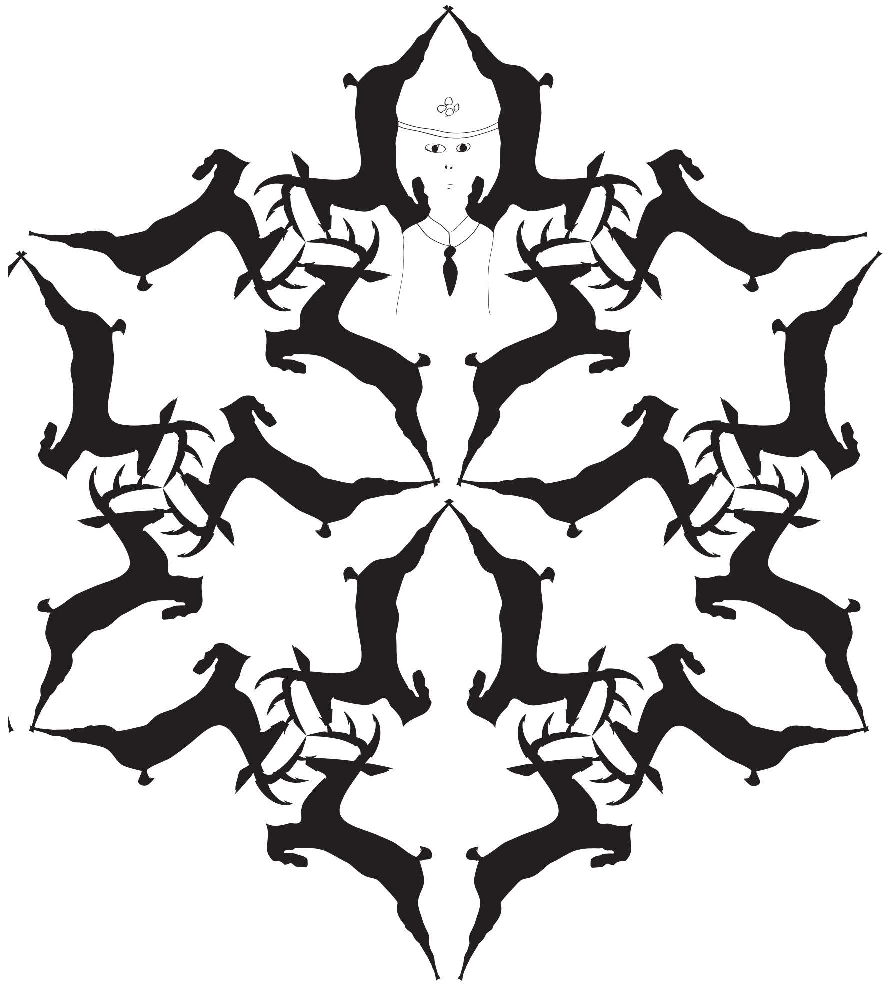
These figures created patterns with lots of abstract negative space, I was looking for shapes from which the negatives would also resemble something.

Process

Initial explorations led to more complex explorations, focussing more on creating Esscher-esque patterns.



Inspired by the rabbits with shared ears

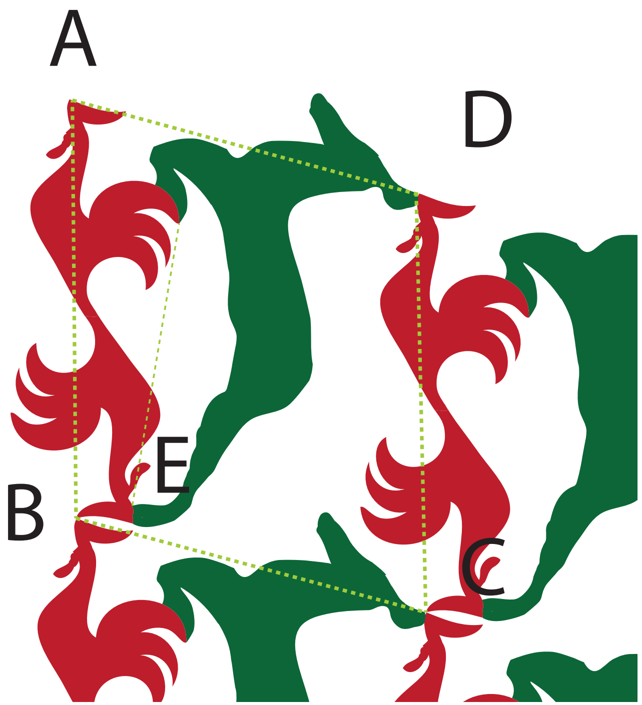


Inspired by the rabbits with shared ears

Final pattern

The final pattern can be categorised as a p1 style, according to the wallpaper group definitions. It only contains translations; no rotations, reflections or glide reflections are present in the pattern. Nevertheless, the Esscher-esque qualities of the pattern are evident. As much as four different shapes are tangled together, and can be repeated infinitely.

Figure ABCD is the underlying polygon representing the transformation points of the pattern. Each horizontal translation, point A shifts to D and with each vertical translation, point A shifts to point B.



Processing

However, translating the curves to processing wasn't as easy as the transformation itself. Because of the internal curves of figure ABCD, I seperated the figure into the following curve segments:

- AB, from the topleft towards the bottomleft corner.
- BDE, from the bottom left via D towards E
- EA, from point E back go point A in the topleft corner.

This still means one curve segment has been written (and therefore cut) double. I did not overly complicate things by dividing the figure into more curve segments.

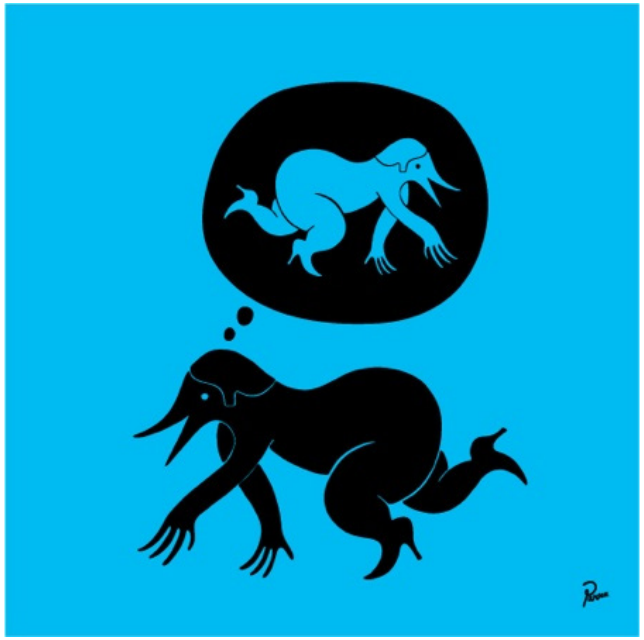
```
import nl.tue.id.oogway.*;
import processing.pdf.*;

int XSIZE=int(3.6*297);
int YSIZE=int(3.6*210);
int defaultScale = 100;
float horseratio = 0.79;

//columns
float transX = 0.779 * defaultScale; // delta x of line AD
float transY = 0.3365 * defaultScale; //delta Y of line AD

float initX = 00;
float initY = 0;

float startX = 0;
float startY = 0;

int vertical = 7;
int horizontal = 4;

Oogway o;

void setup() {
  size(XSIZE, YSIZE);
  o = new Oogway(this);
  noLoop(); smooth();
  beginRecord(PDF, "figure.pdf");
  o.setPenColor(0,0,255);
  o.setPenSize(0.1);
  o.lt(90);
}

void draw() {
  background(255);
  for (int i=0; i < horizontal; i++) { //horizontals
    startX = initX - (i*defaultScale*0.13); //delta x of line AB
    startY = initY + (i*defaultScale*0.9667); //delta y of line AB

    for(int j=0; j < vertical; j++) { //verticals
      tesselation(startX,startY);
      startX+=transX;
      startY+=transY;
    }
  }
  endRecord();
}

void tesselation(float startx, float starty) {
  o.setPos(startx,starty);
  o.remember("figurehome");
  o.setHeading(90);
  o.beginPath("AB.svg");
  o.forward(defaultScale);
  o.endPath();

  //Spin 12.5 degrees, because of inconsistency between two lines
  o.lt(180-12.5);
  o.beginPath("BC.svg");
  o.forward(horseratio*defaultScale);
  o.endPath();

  //Turn around, make CD
  o.lt(180);
  o.beginPath("CD.svg");
  o.forward(horseratio*defaultScale);
  o.endPath();

  //Go back home, and make AD.svg
  o.recall("figurehome");
  o.setHeading(89.71);
  o.beginPath("DA.svg");
  o.forward(0.965*defaultScale);
  o.endPath();

  //Ghost with eyes and mouth
  o.setPenColor(255,0,0);
  o.up();
  o.setHeading(-90);
  o.forward(0.5*defaultScale);
  o.down();
  polygon(25,defaultScale/60);
  o.rt(90);
  o.up();
  o.forward(defaultScale/20);
  o.down();
  polygon(25,defaultScale/60);
  o.up();
  o.backward(defaultScale/40);
  o.rt(90);
  o.forward(defaultScale/20);
  o.down();
  polygon(25,defaultScale/50);
  o.up();

  //Eye of the duck kind of creature
  o.lt(90);
  o.forward(defaultScale/1.8);
  o.lt(90);
  o.forward(defaultScale/10);
  o.down();
  polygon(25,defaultScale/40);

  //Horse?
  o.up();
  o.forward(defaultScale/6);
  o.rt(90);
  o.forward(defaultScale/25);
  o.down();
  polygon(25,defaultScale/50);
  o.setPenColor(0,0,255);
}


public void polygon(int corners, int radius) { //polygon function, used
to create the circles
    o.remember("start");
    o.setPos(o.xcor()+radius,o.ycor()); //starting point of all polygons
    float sidelength = radius * (2*sin(radians(180/corners)));
    float cornerangle = 360/corners;
    o.setHeading(0);
    for(int step=0; step<360; step+=cornerangle) {
    o.forward(sidelength);
    o.left(cornerangle);
    }
    o.recall("start");
}
```

Fabrication

Assembly of the artwork went flawless, the processing sketch could easily be scaled to the right dimensions for use with the laser cutter. Afterwards, all the components received several layers of paint and were glued in place.

Reflection

I wanted to introduce myself into the world of mathematical art; therefore I have chosen to spend some time on the golden ratio module. I have always been intrigued by the Art of MC Esscher and I knew this module would provide the opportunity to create a similar artwork, next to providing me with extra knowledge about patterns, symmetry and transformations.



Artwork by Piet Parra, from: http://www.visioninvisible.com.ar/2009/04/21/parra-soundsystem-the-art-of-partying/

Up front I already decided to create an artwork rather than an abstract mathematical structure. Therefore I focussed on creating interesting fitting shapes from the beginning, with brand logos as representation of contemporary culture as a starting point.

Because of my background with programming and computer graphics I already knew some of the general topics of this module (different transformations), but the lectures about patterns and tessellation were new to me. I found it interesting how researchers have created a set of rules for tessellation that could work with any give shape. This definitely changes how I look at similar art in the future. In the end these rules weren't useful to me for creating an interesting tessellation, since the biggest challenge was to divide the main shape (a simple tessellation) into four different shapes representing different animals.

I definitely see the value of computerised drawing over creating vectors with tools like Adobe Illustrator. Parametric drawing allows for parametric design, which can be used to create custom products, or even custom clothing, based on body measurements. This wasn't mentioned during the assignment, but uses the same techniques, drawing lines based on different parameters and sending the digital drawings towards a rapid prototyping machines such as a laser or 3D printer. I would like to expand this way of thinking in patterns and symmetry into the 3rd dimension. Tools like Grasshopper for Rhino or patterning tools in Solidworks could help to create a 3 dimensional piece of art, using the same principles as the two dimensional drawings.

Final remark

Unintentionally, the final artwork seems to ressemble the artwork of dutch illustrator Piet Parra. I think this is mainly due to the colors used (Parra uses bright blue and pink in combination with black and white) and the eyes and mouth of his creatures.