# NEW PARAMETRIC THINKING

AN ARCHITECTURAL PROJECT FOR THE USAGE OF
CREATIVE ROBOTICS AND PARAMETRIC DESIGN

CONCEPT BY
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IN COLLABORATION WITH

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# OVERVIEW

## THE IDEA

The project „NEW PARAMETRIC THINKING" is based on a multimedia installation that combines technical aspects, scientific research and art.
The original realtime-generating lightpainting-robot-installation was developed by Christopher Noelle and Johannes Braumann for the temporary exhibition „Creative Robotics" (Feb. 2016) at Ars Electronica Center.

During the development-process Christopher came up with the idea if the now following advancement, which opens a new chapter in terms of the creative thinking process.

The aim of this project is to offer a creative interdisciplinary solution to architecture students and professionals by a new art-related method for urban parametric design.

## THE PROCESS

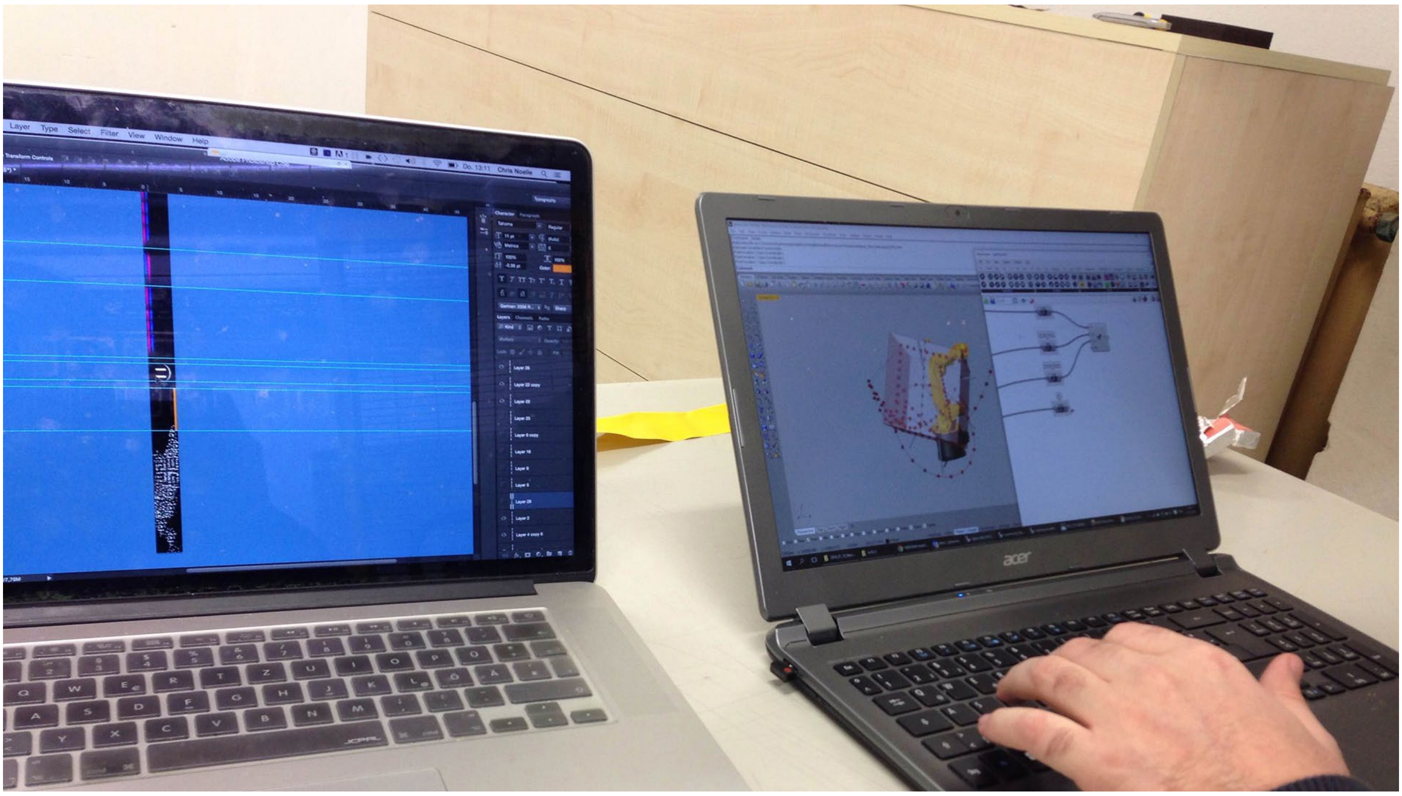
In a first step we developed a KUKA KR-16 robot-choreography that moves an LED-pixelstick. The pixelstick shows one single line of a graphic on 100 LEDs and rolls like a scanner over the entire picture.
By the programmed motion of the robot we are able to generate multiple versions of one-and-the-same dot-/line-graphic that is permanently fired over the pixelstick.
With the help of a new developed MaxMSP software and some simple but effective steps we have created a workflow for generating new parametric design studies.

The variables of speed, exposure-settings and graphical input create endless animation-variations of the pixelsticks´ movement. With the help of AutoDesk Dynamo, the students will learn how to rapidly generate different design alternatives from a vector that´s evaluated from the robots motionpath-graphics. By simply changing values of particular parameters we will be able to generate different architectural and urban scenarios from scratch.

The essential part of the project „new parametric thinking" comes within the final step - with selected students we will develop a series of urban projects with a strong experimental character, an artistic approach, parametric design systems, aiming to develop new urban forms and new urban complex geometries based on our previous researches. This pilot-project will run in 2016.

The process of robotic analysis, artistic and creative thinking during the creation-process and the parametric design research can make this project unique for students, professionals and the creative industry.

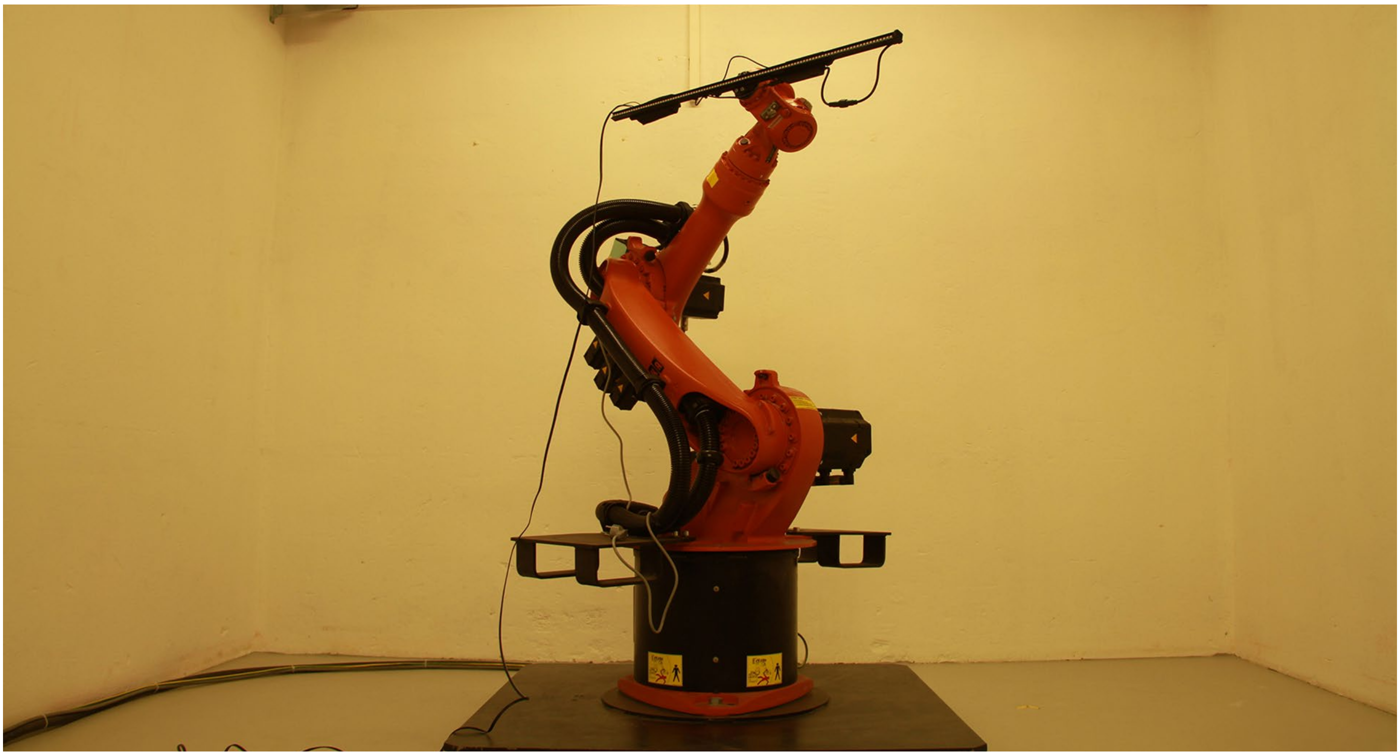
The following pages show the single development-steps.



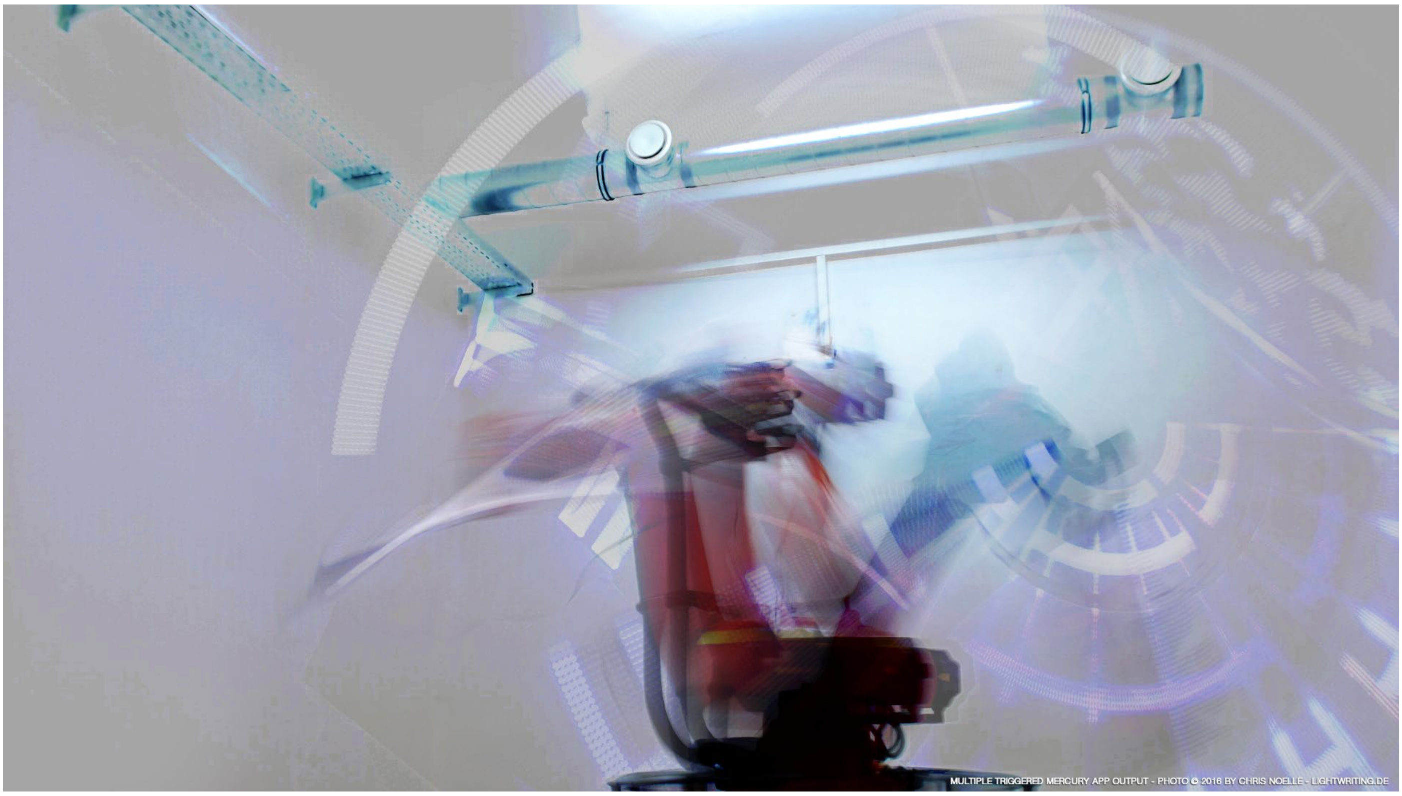
Pic. 1:  Grashopper Patch - Work-in-progress at the laboratory

The robot needs a code so it knows what to do. This code is programmed in Grashopper. (Pic. 2 right side)

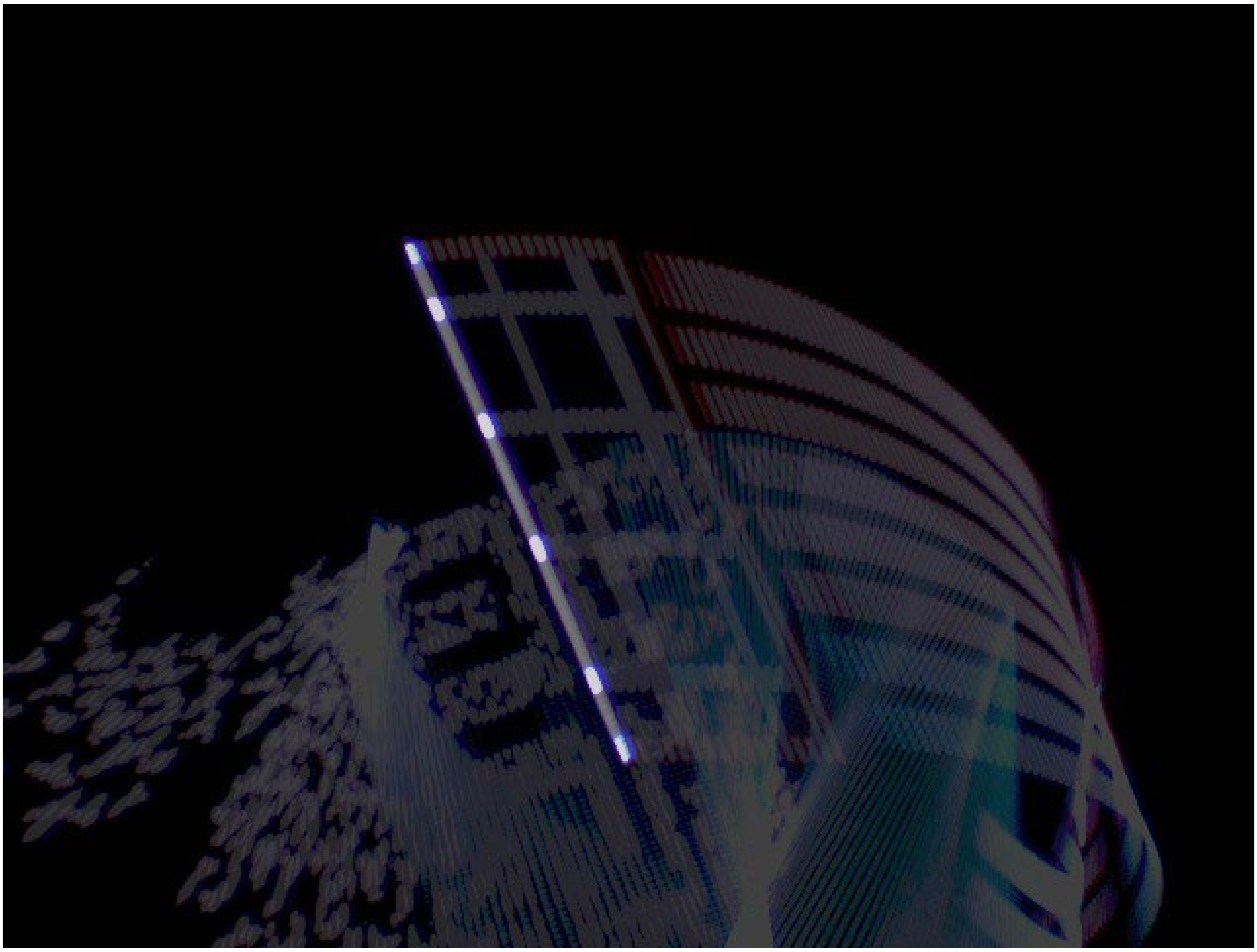
The pixelstick needs a bmp-graphic-picture (Pic. 8) of 100 pixels x the lenght of choice. This loaded picture can be repetativly fired over the 100 LEDs, showing one line after the other of the original picture. The sticks parameters are changeable in speed, repetition-amount, brightness, direction and size. (Pic. 2 left side)
Once loaded on the stick, the robot gives a start-trigger signal to the stick at a certain point.
The pixelstick can repeat the picture continuously.
The difficulty for us was to find the right speed of the pixelsticks screend picture and the speed of the robots movement to have an exactly definable simultaneous movement of both parts.



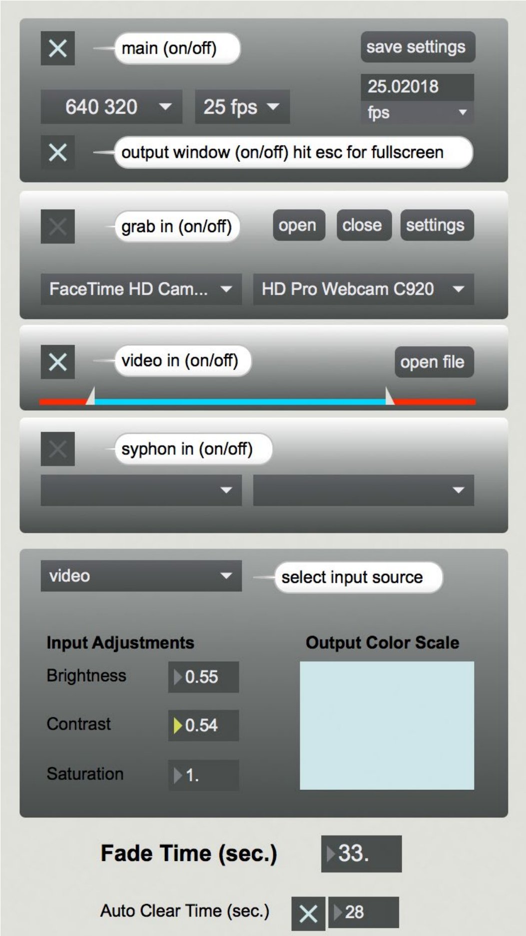
Pic. 2: KUKA KR-16 with a mounted 100 LED-Pixelstick



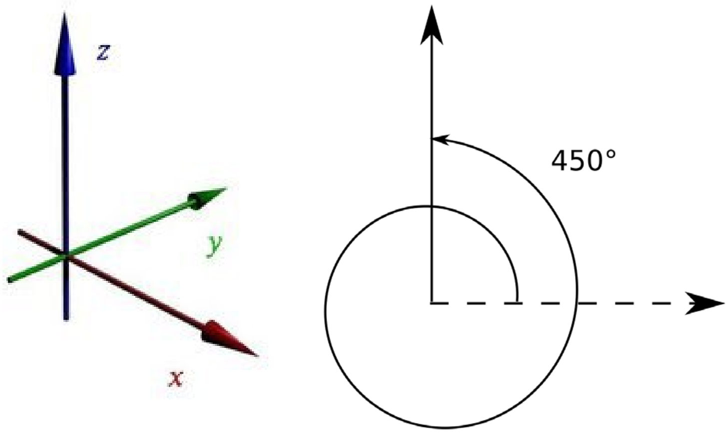

Pic. 3:  Pixelstick-Movement - longtime exposure with worklights in  video software



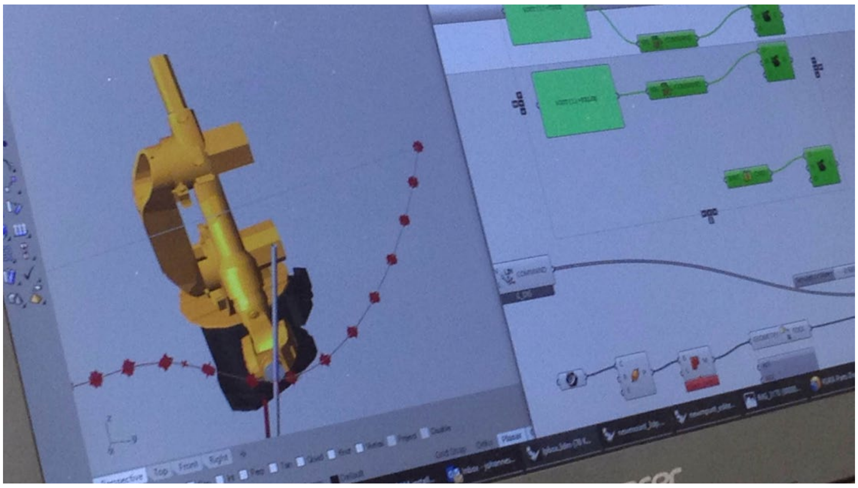
Pic. 4:  Testrun with long Pixelstick-Graphic  loaded on the stick




Pic. 5: MaxMSP livecapture software

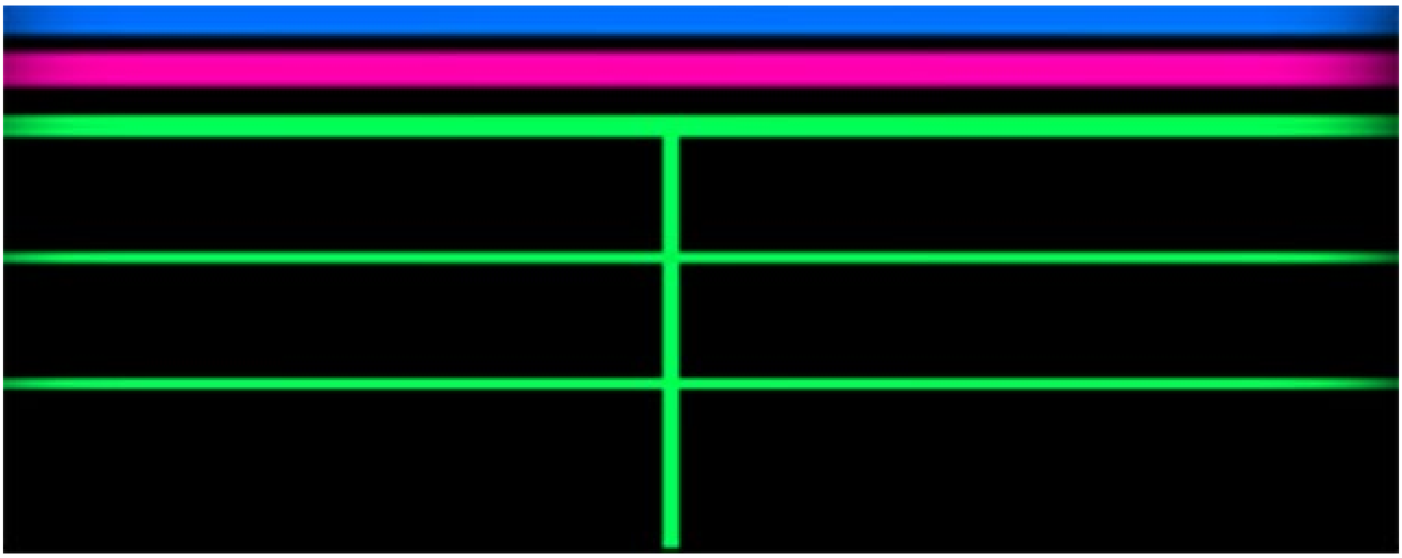



Pic. 6: Variables for the robots motion

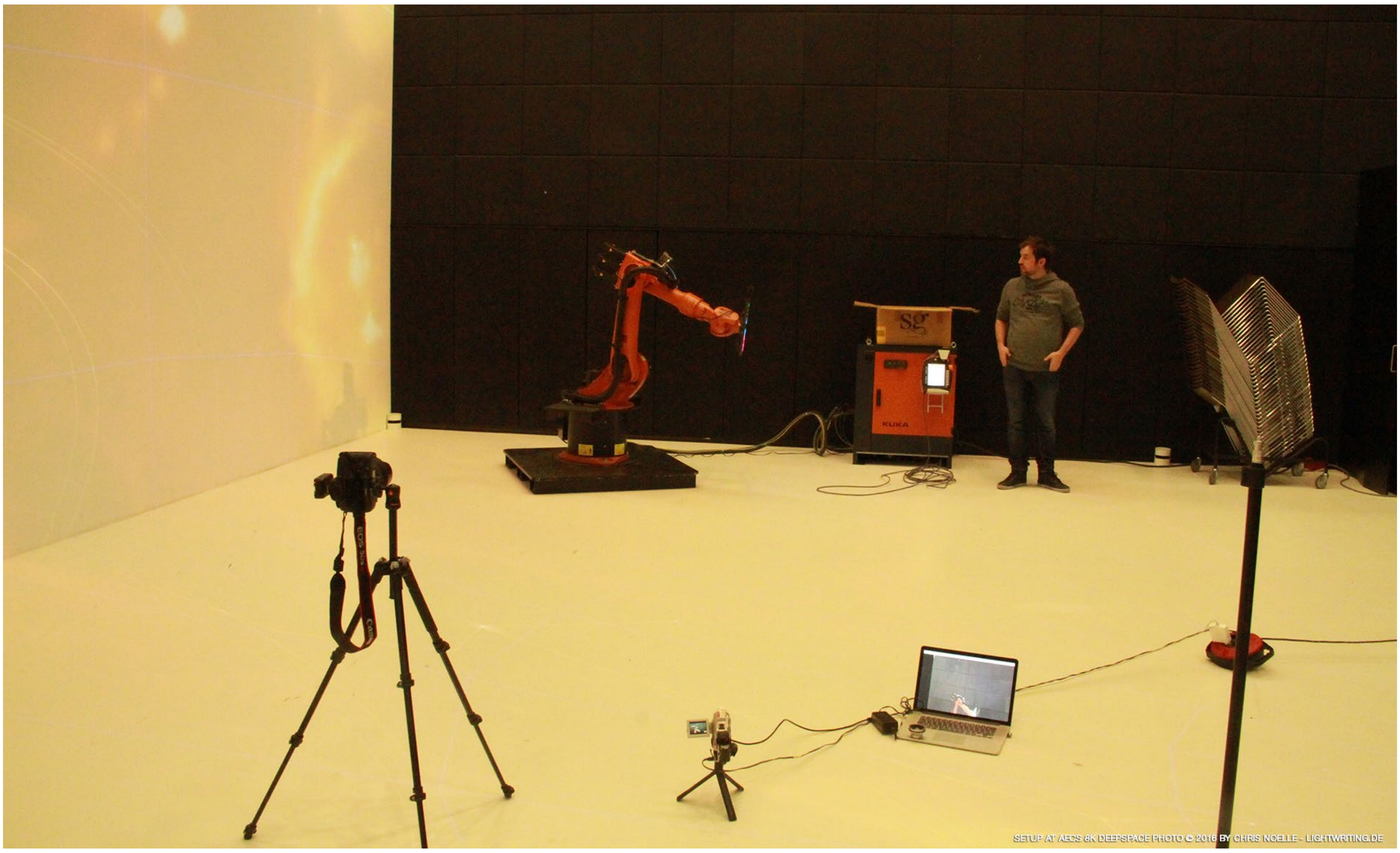


Pic. 7: Programming choreography in Grashopper

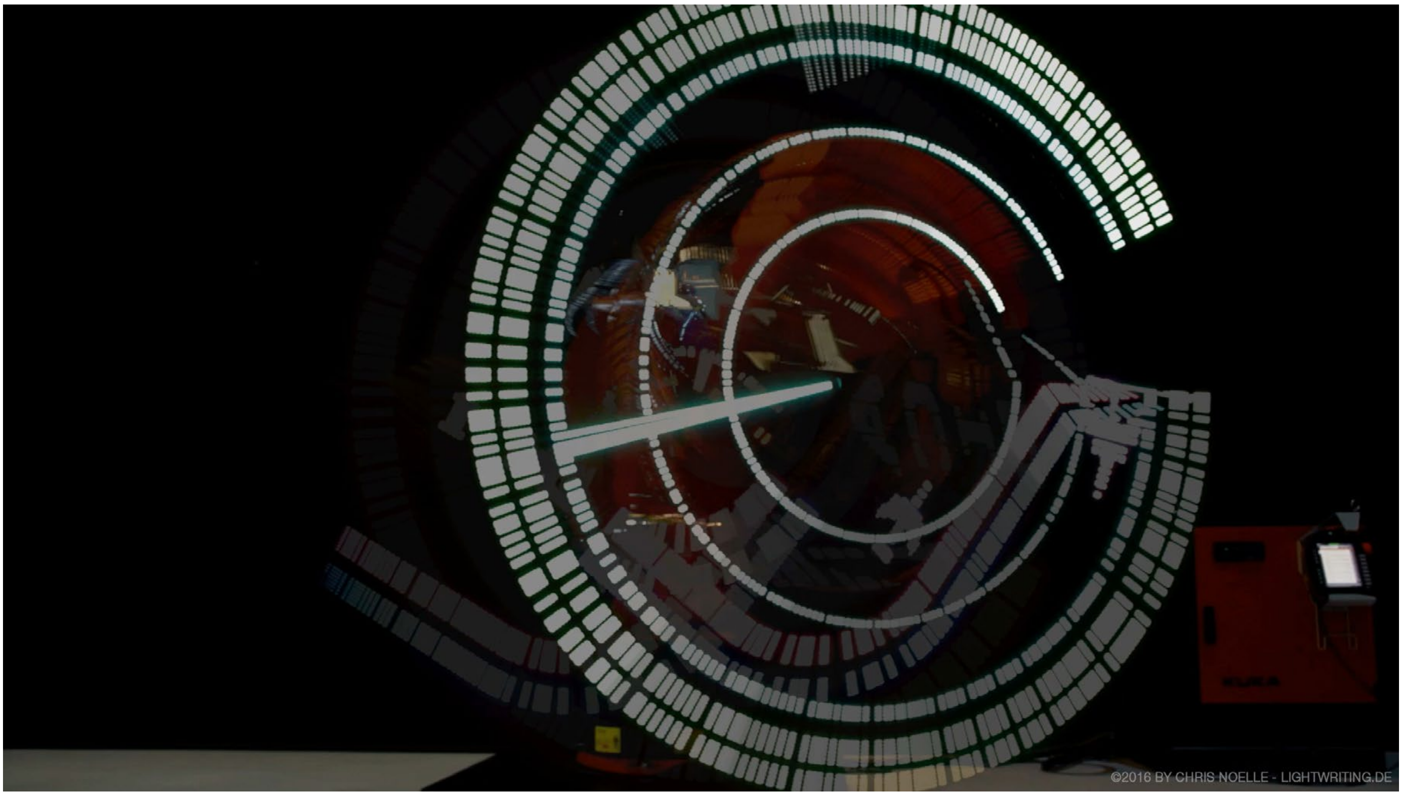
The testruns were originally based on a 3000pxl x 100 pixel long picture as the programmed animationpath of the robot had a full lenght of 03:28min.
For our enhancements we picked out a single part of this graphic-animation which shows pure lines only. By the full circle-rotation of the robot, this graphic turns into an echolot picture. The result is a full circle, the two pictures (pic. 10 & 11) show the difference between the screencapture of the animation created by the MaxMSP patch and a photo of a DSLR camera exposed for more than 25 seconds.



Pic. 8: Pixelstick-Graphic loaded on the stick



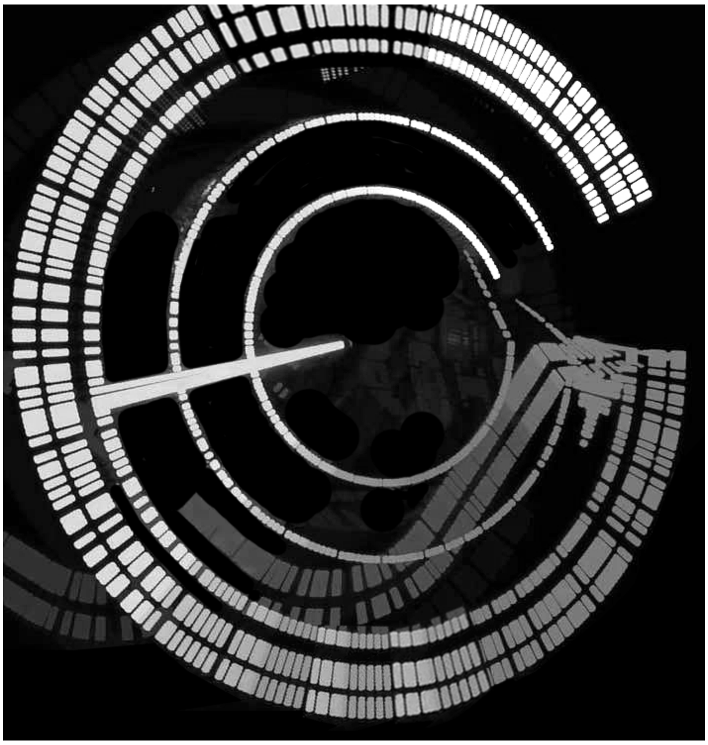
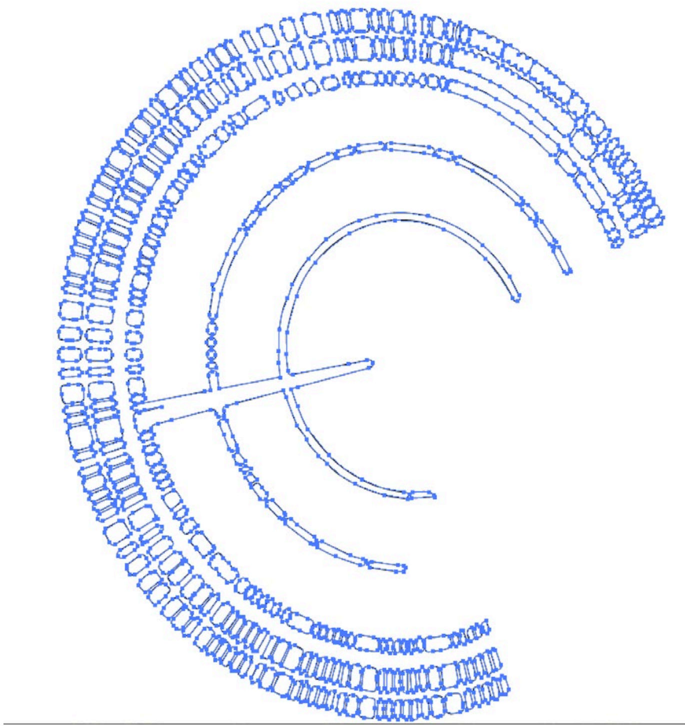

Pic. 9:  Preparation for the Livepresentation at Deepspace 8K/AEC




Pic. 10:  Screencapture of the MaxMSP livecapture software

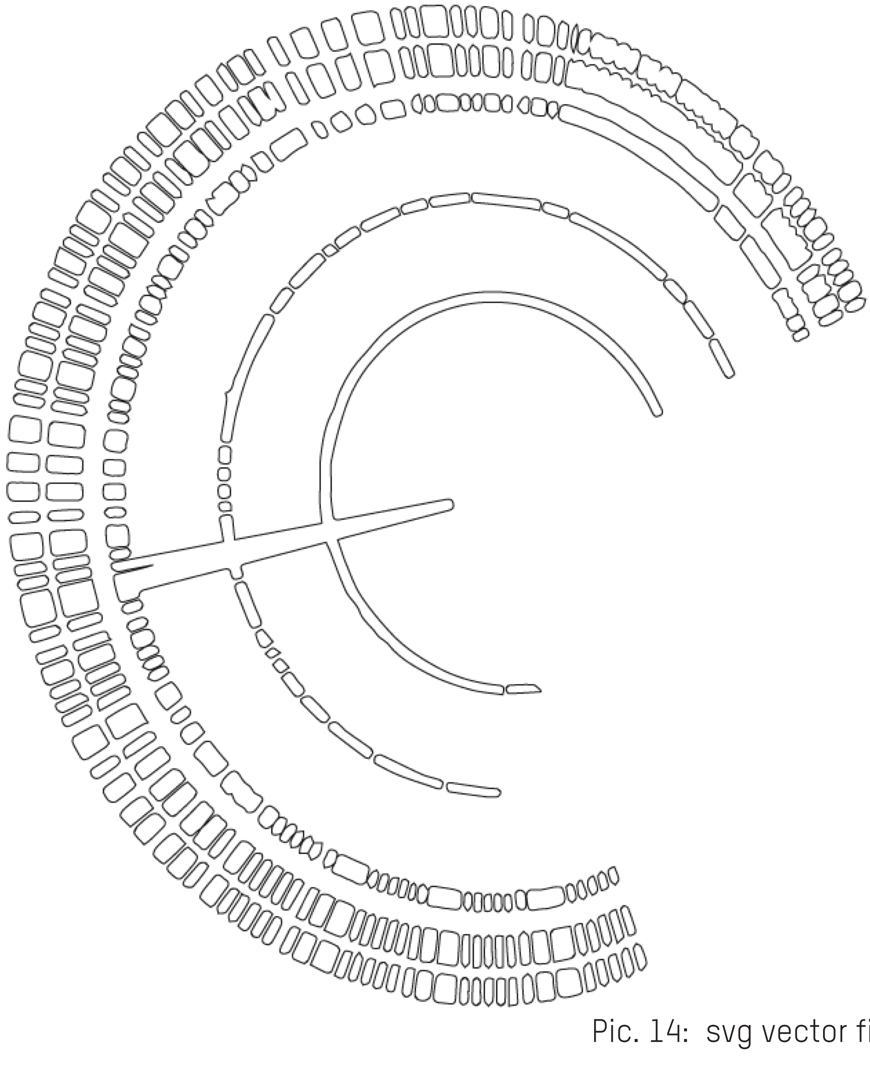
The software captures the motion with 25fps which shows much more single segments of the blinking LED strip than in a lightpainting photo. The human eye can´t see the steps but the latency of a live-camera attached to a computer can.
This disadvantage is turned into the advantage of more detail-informations for our further enhancements.

Pic. 11: DSLR Camera result of a longtime-exposure
Photo by Florian Voggeneder

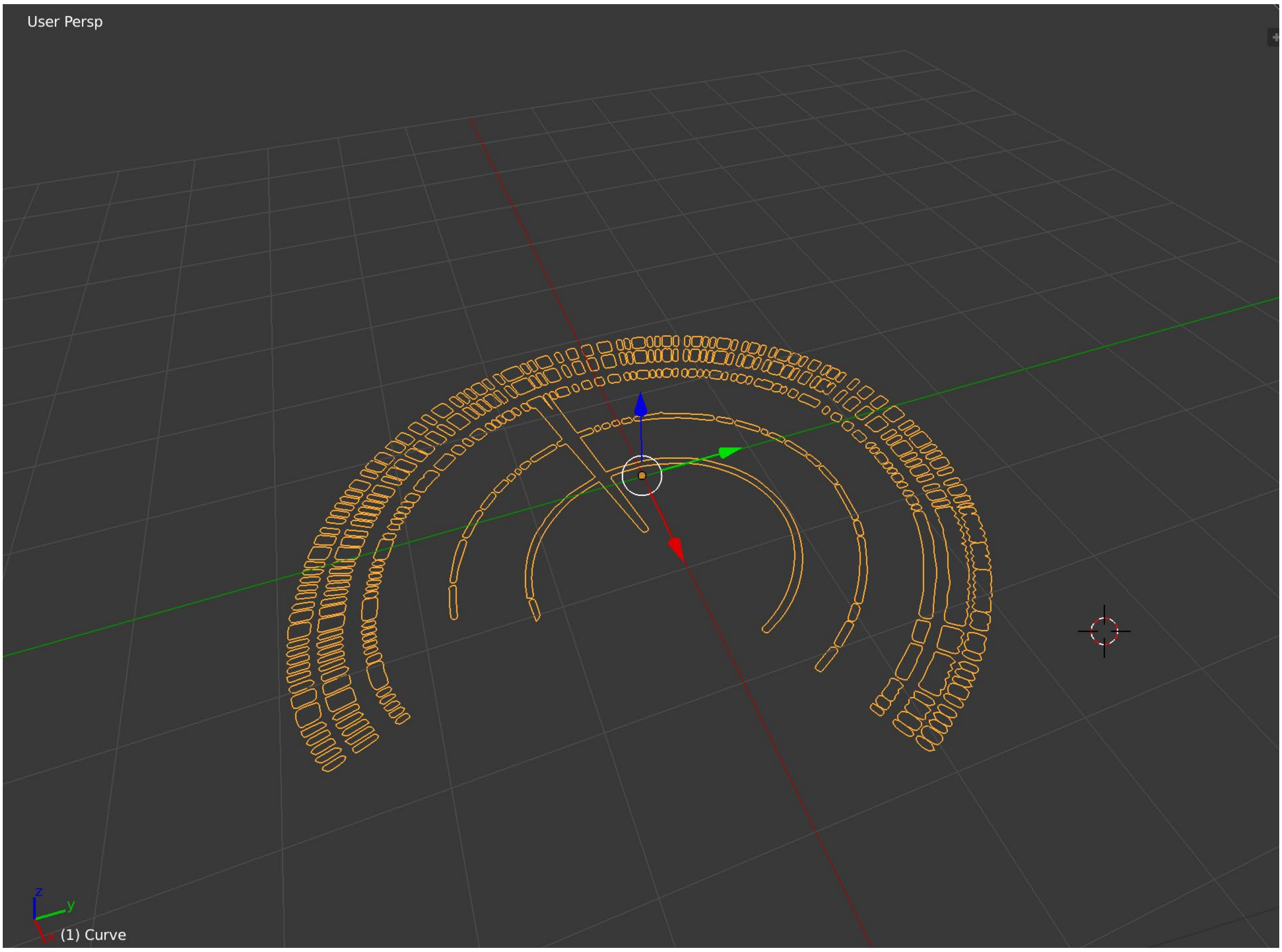
 

Pic. 12 & 13:  screencapture in b/w and vectorized paths

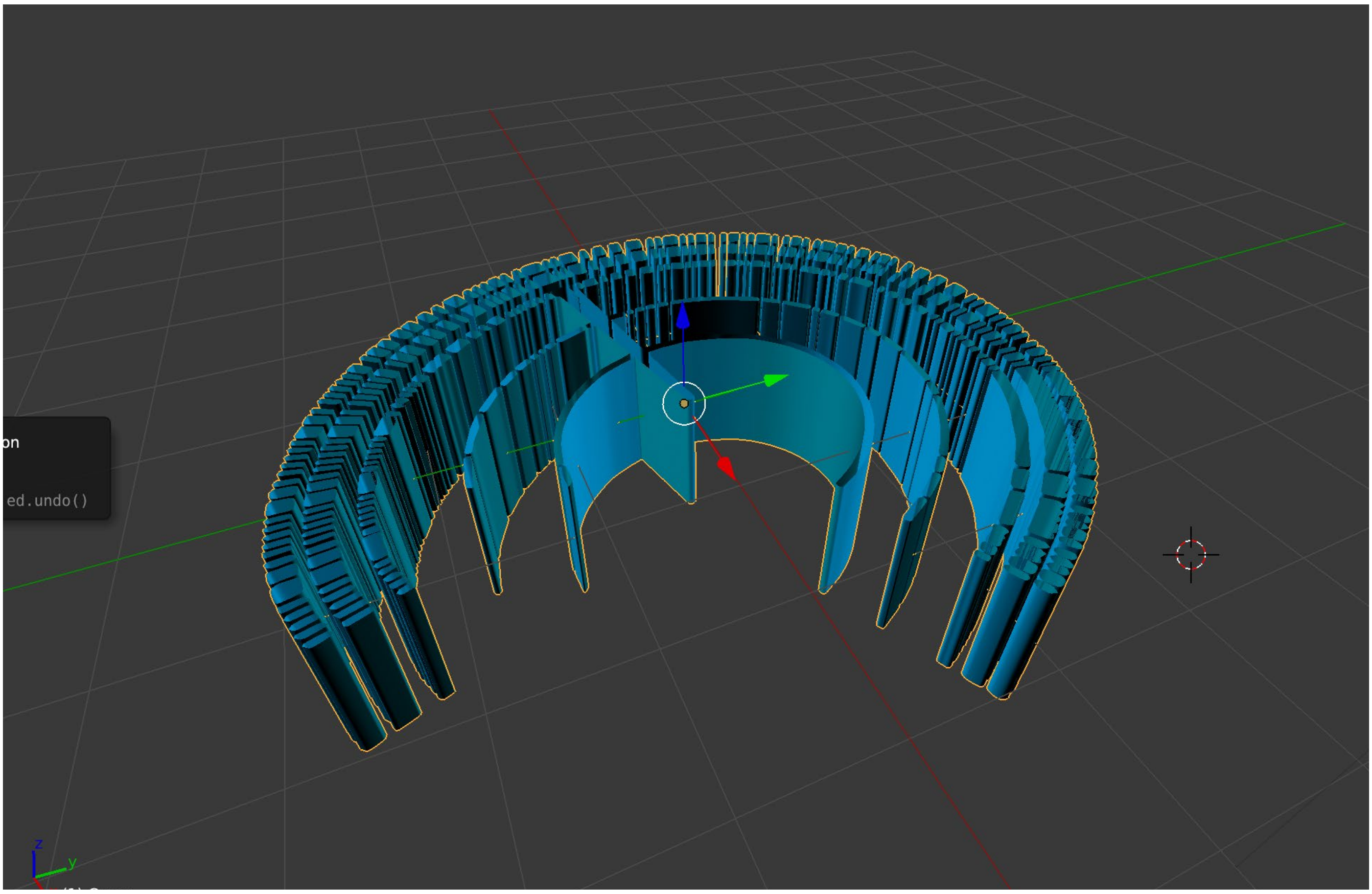
The screencapture of the MaxMSP livesignal is converted to black/white modus and then transformed into a vector in Adobe Illustrator. To simplify the converted file, darker greyscale parts of the picture elements were erased. Now we have a vectorpath that is saved as svg file for further  3D experiments.



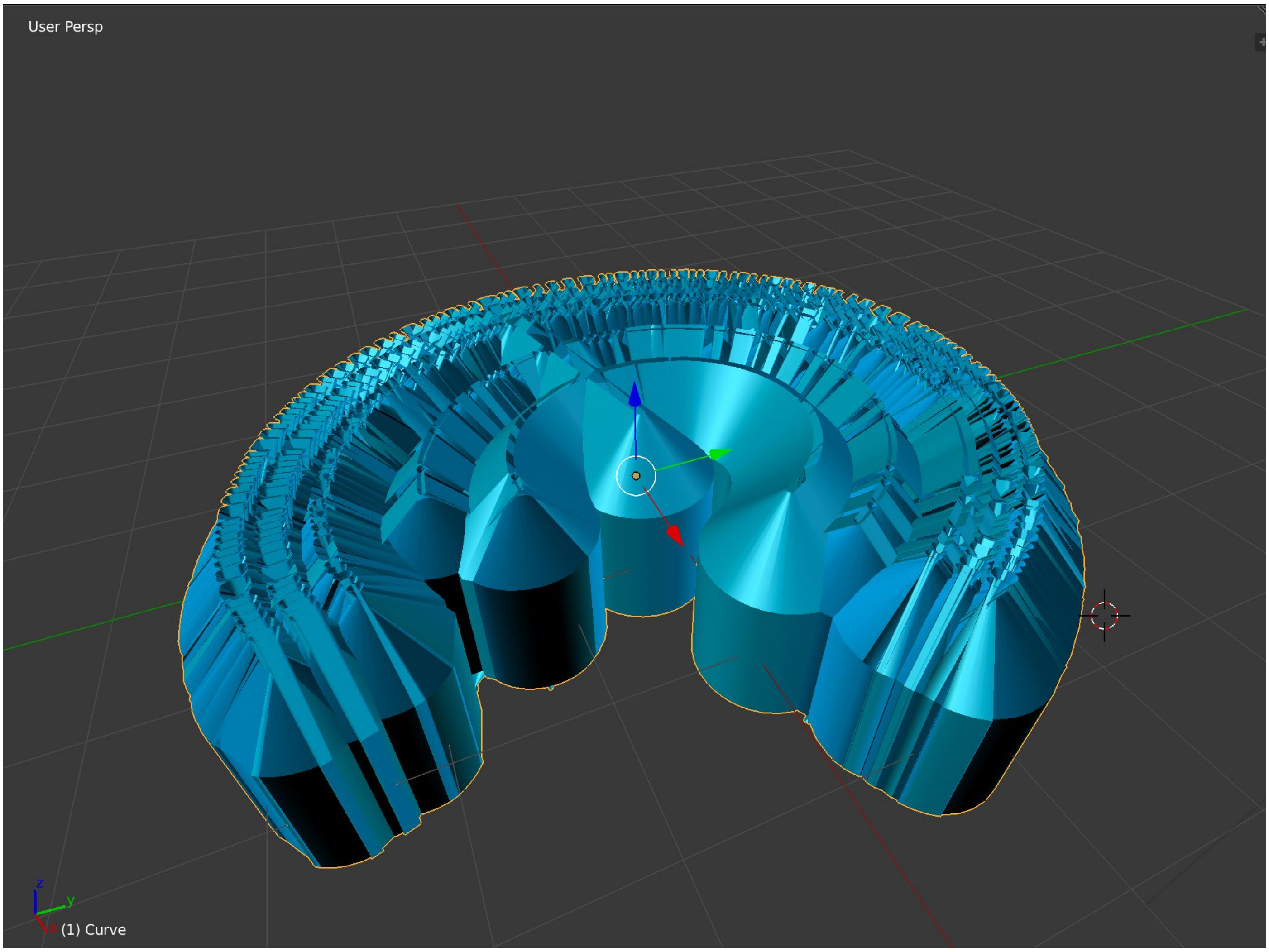
Pic. 14:  svg vector file



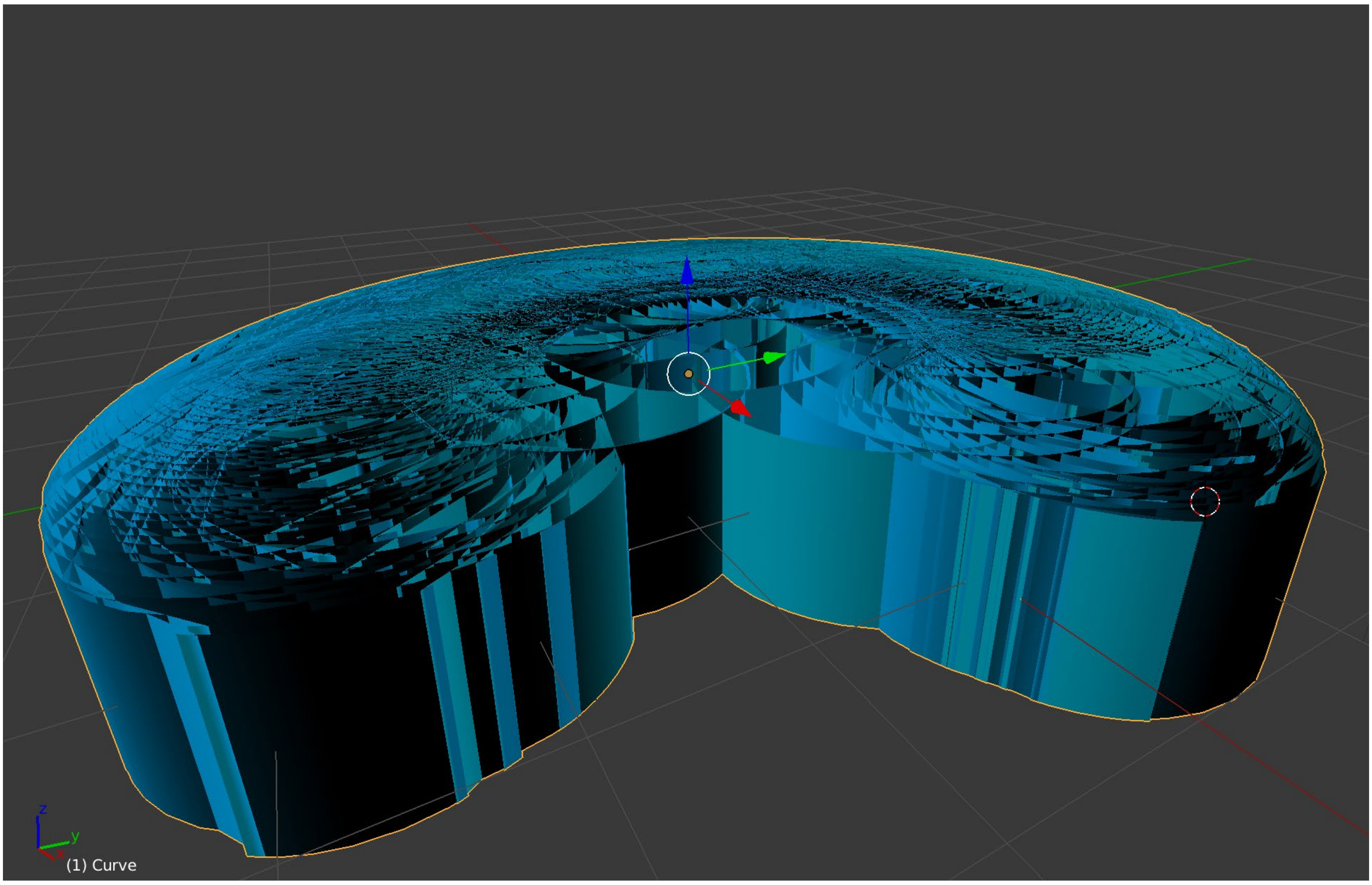

Pic. 15:  Imported svg in Blender 3D software



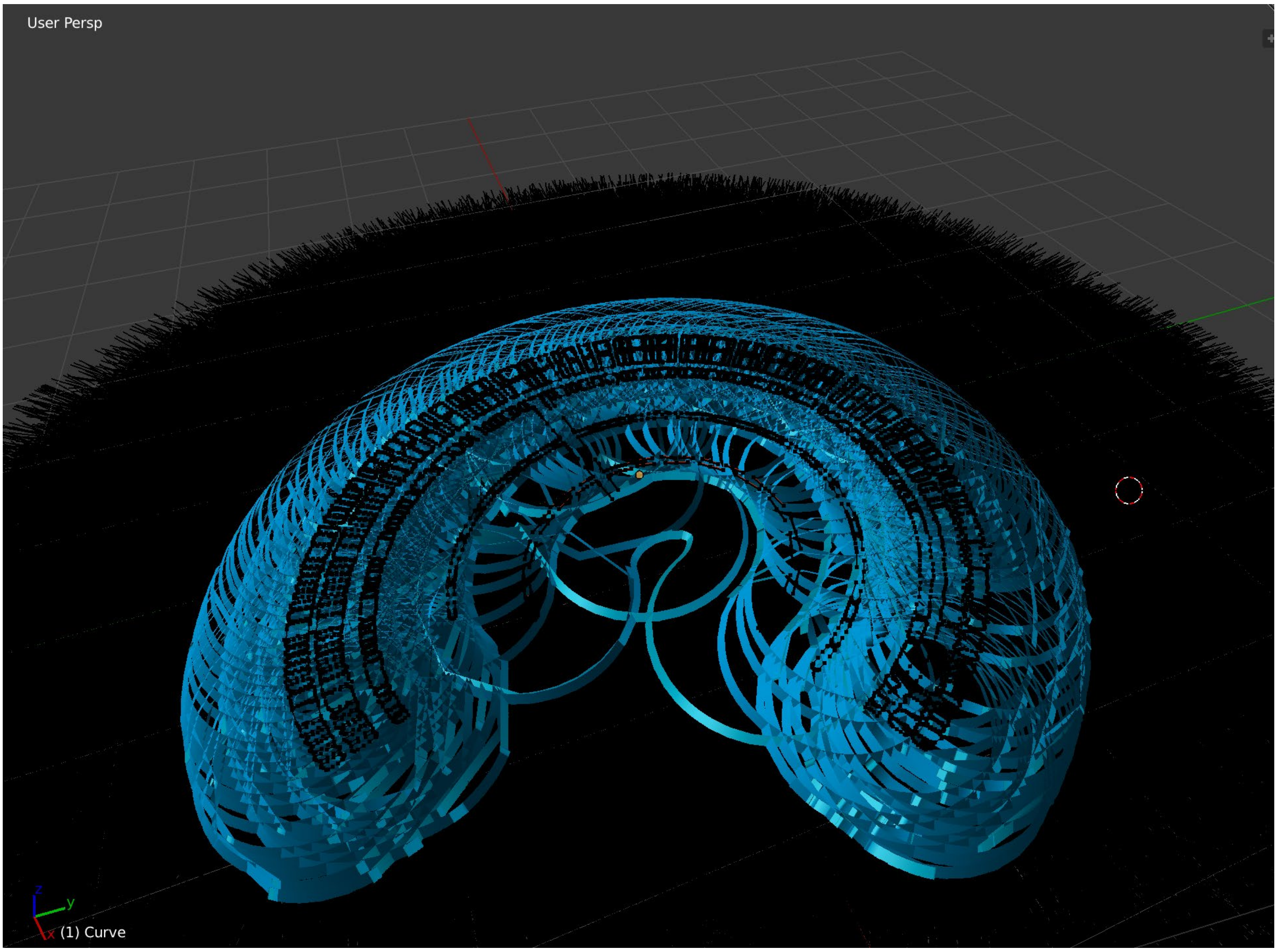

Pic. 16:  Extrusion of the svg file



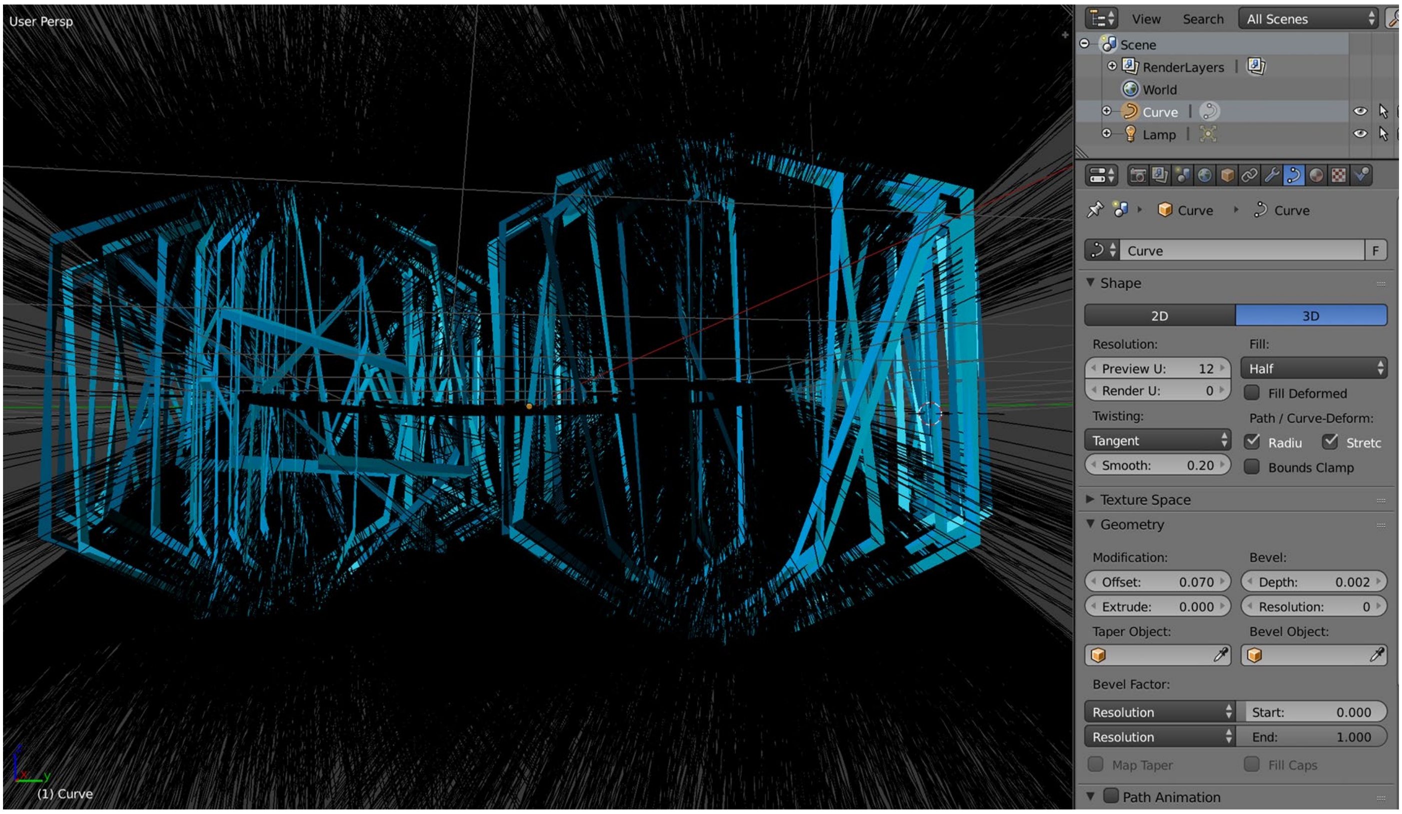

Pic. 17: Bevel modification in Blender 3D software



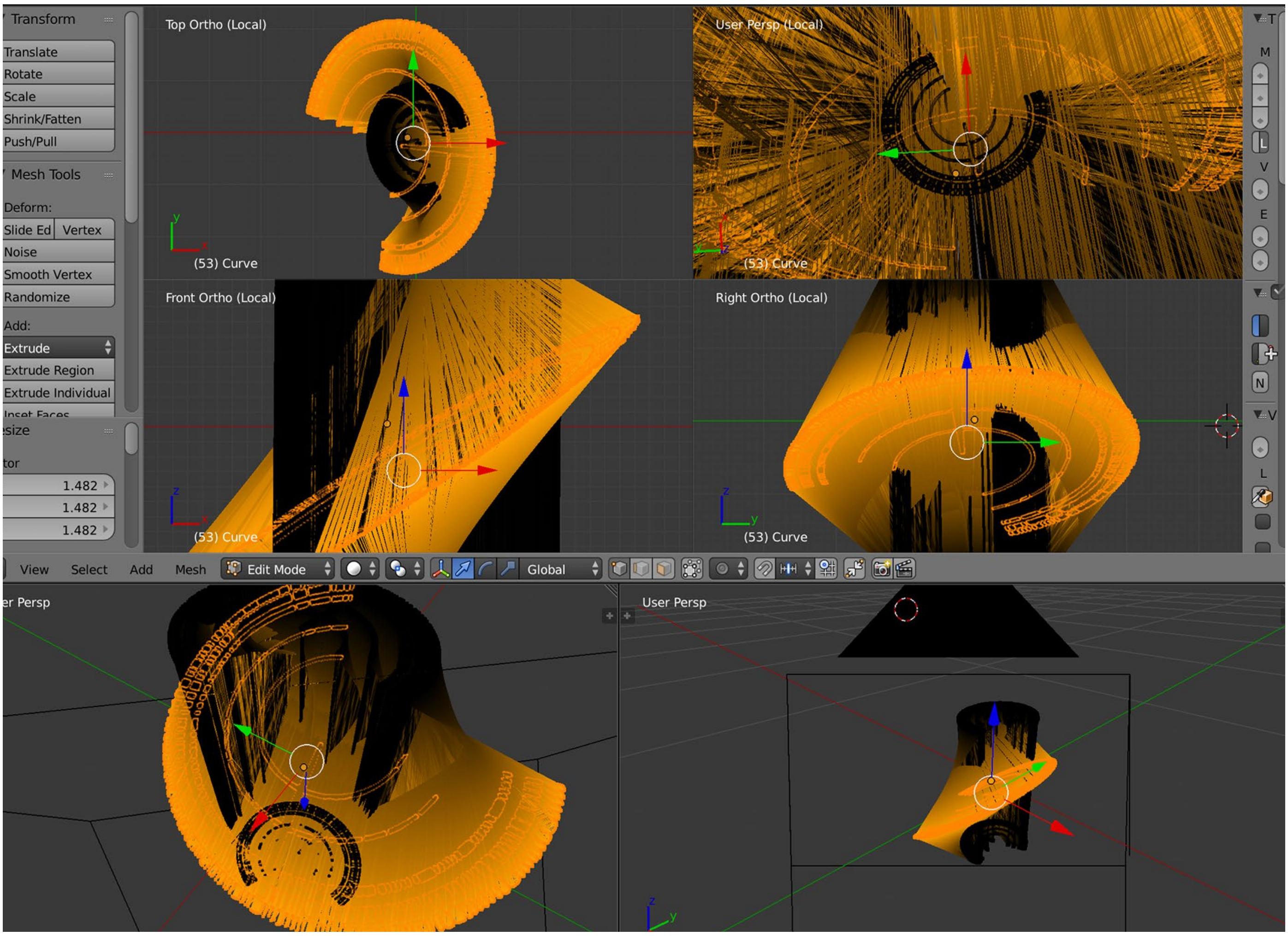

Pic. 18: Offset & Depth change the extruded svg



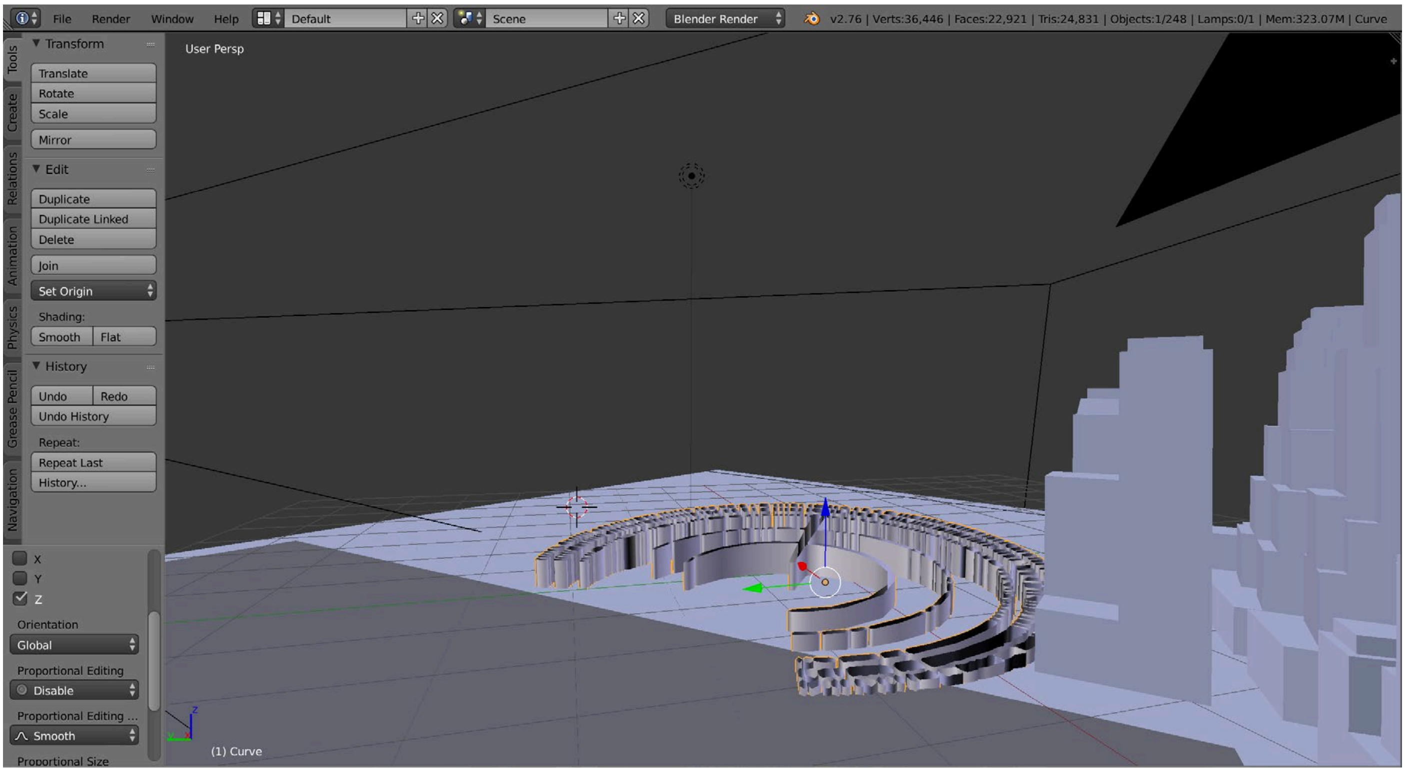

Pic. 19: Wireframe extruded svg



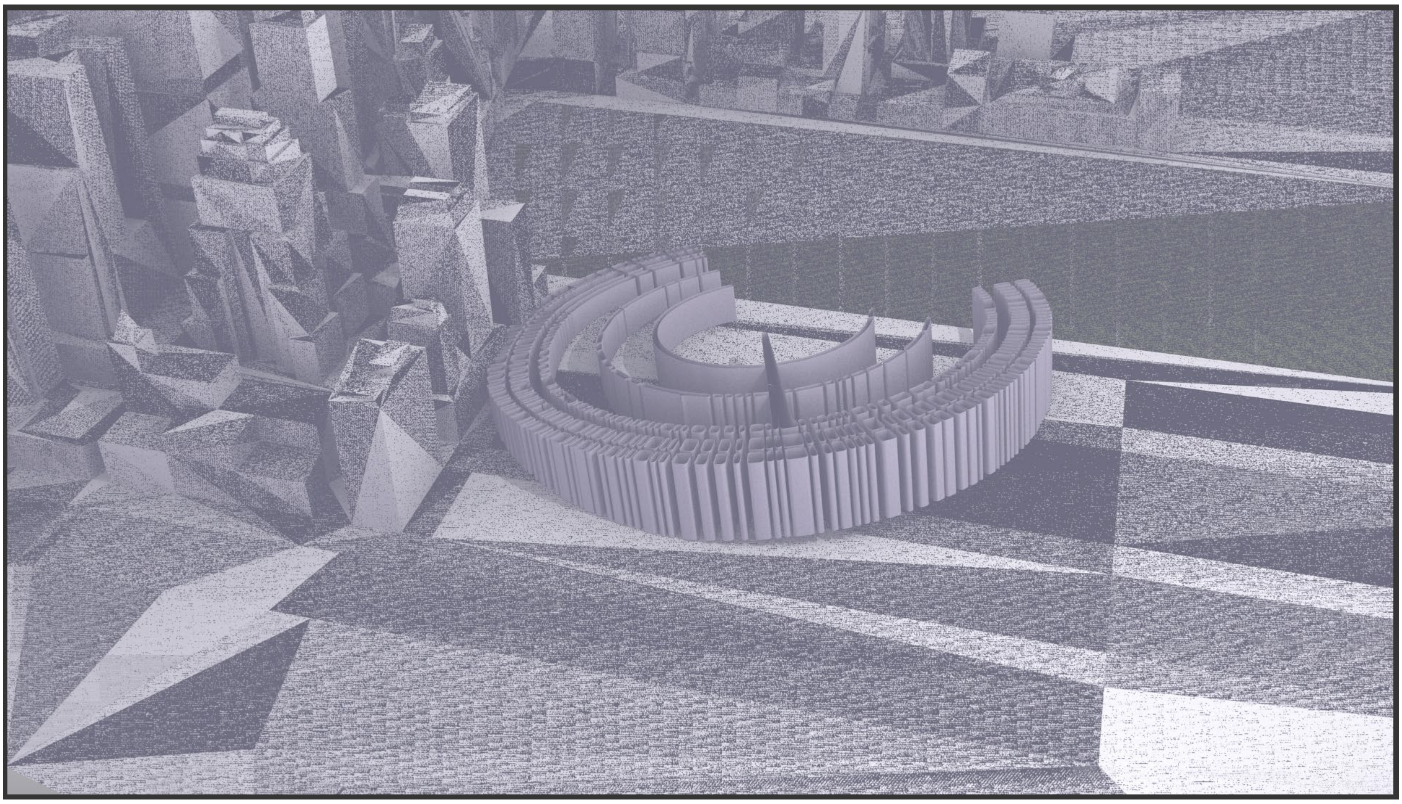

Pic. 20: Close-Up perspective



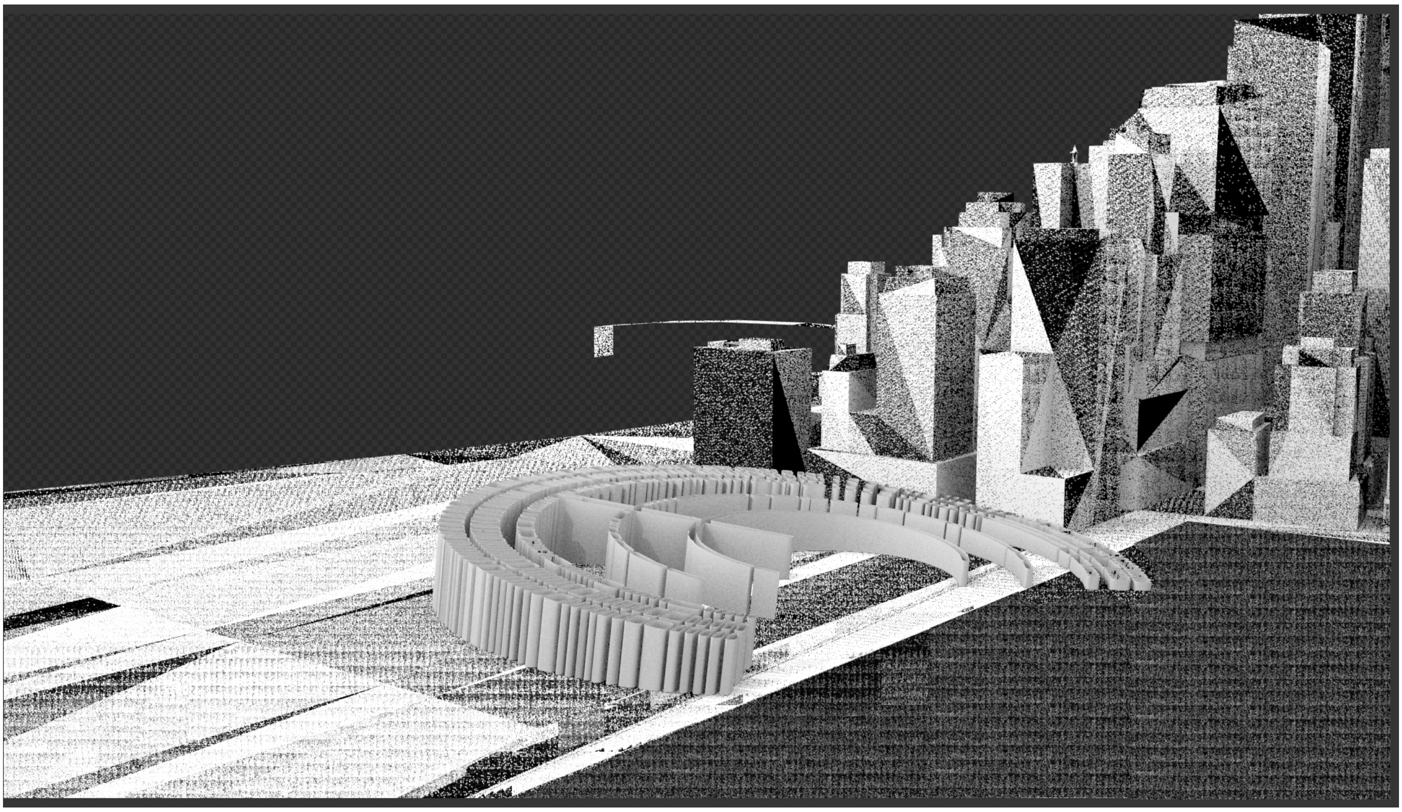

Pic. 21: Experimenting with the svg extrusions perspective



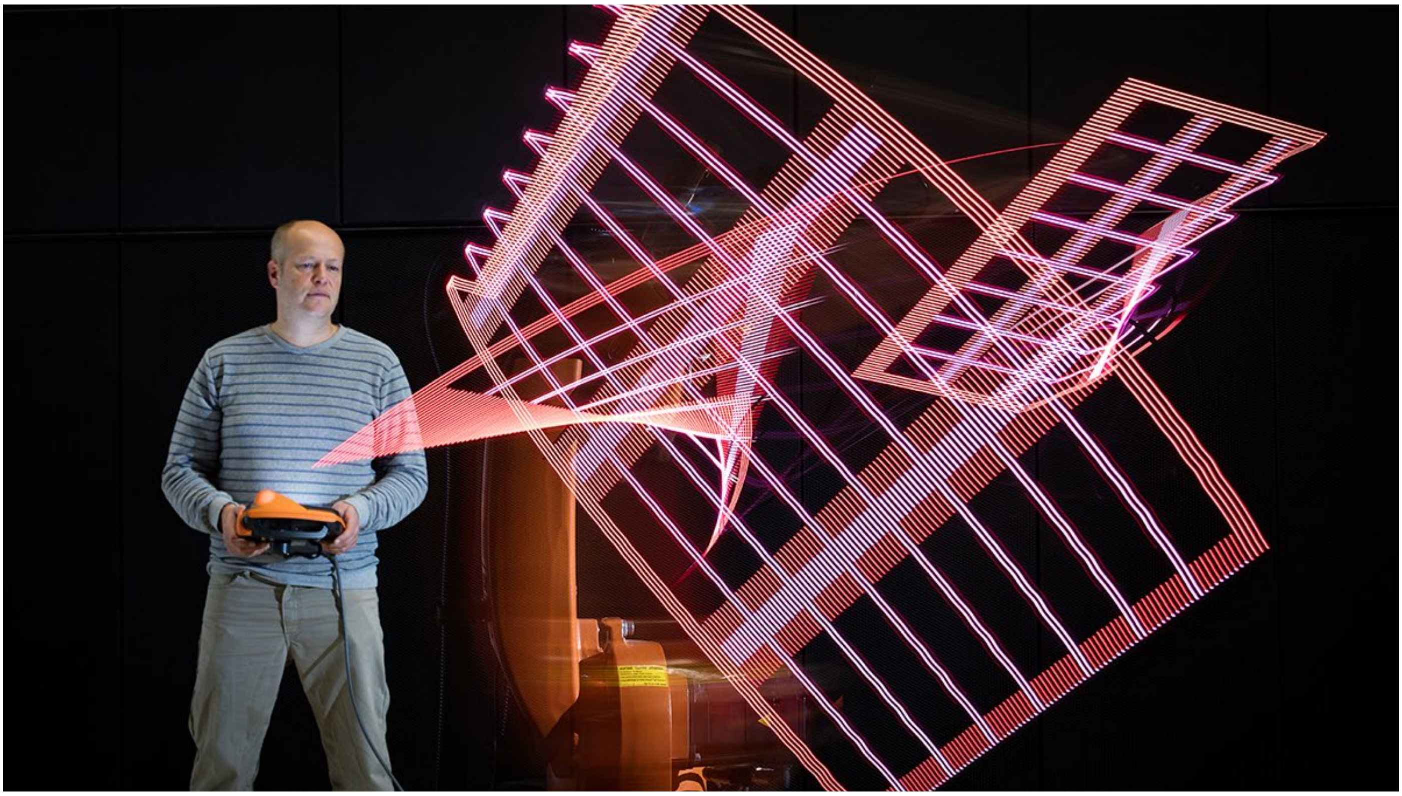

Pic. 22: Adaptation in a realistic city landscape



Pic. 23: Sketched rendering



Pic. 24: Sketched rendering



Pic. 25: Christopher Noelle with hands on the lightpainting Kuka KR-16
Photo by Florian Voggeneder

**THE FINAL STEP**

Development of a workflow based on advancement of our research.

In the final step, the focus comes to parametric urbanism/urban morphology.
With selected students we will develop a series of urban projects with a strong experimental character, an artistic approach, parametric design systems, aiming to develop new urban forms or new urban complex geometries based on our previous researches. The pilot will run as a evaluation project to gather the relevant data and to bundle the essential steps for continuous usage, starting in summer 2016.

With the help of AutoDesk Dynamo, the students will learn how to rapidly generate different design alternatives by simply changing values of a particular parameter and the generation of different architectural and urban scenarios to be evaluated further by facilitating the decision-making and creative-thinking-training during the creation process.

The variables of speed, exposure-time and graphical input create endless variations of the robot-controlled pixelsticks movement. A creative remix of a simple robot-in-motion becomes the core of this scientific research.

With a clear structure and captured content created in realtime, this project can become an inspiration and casestudy for universities, professionals and the creative industry.

Four steps are essential for creating the final project:

1. Creating a motionpath choreography for the robot.
2. Testruns of graphic-design variations which lead to the usage on the robot.
3. Realtime-animation capturing for generating the vectorizeable lightpainting pictures.
4. Development of patches in AutoDesk Dynamo to evaluate parametric design modification-methods which lead to building information modeling in 2D, 3D and 4D.

By the addition of all its ingredients, this project shows the perfect symbiosis of technology, science and art with an outrageous potential.

Due to its potential to incorporate parameters that respond to different disciplinary fields, the parametric model promotes the convergence of all these interests, supports international collaboration and dynamic processes. Thus, conception, design, art, simulation, analysis, detailing and construction can happen simultaneously in a fluid and interactive environment.

**„Fields are full, as if taken by a fluid medium: liquid in motion, structured by waves and streams. They are fields of force.„(Schumacher, 2008)**

## ABOUT THE INVENTORS

**Johannes Braumann** is visiting professor at the artuniversity Linz and leads the robotic laboratory which has a strong connection to KUKA CEE. In 2010 he founded the Association for Robots in Architecture together with Sigrid Brell-Cokcan to unlock robots for the creative industry. He is main developer of the software KUKA|prc (parametric robot control), which allows to program parametric roboterprocesses in a simplified way. This software is used by lots of universities, research laboratories and industrial partners for research, education and production.

Chartered engineer and professor **Michael Holze** finished his studies in architecture in Munich back in 1991 and is the major person responsible for the branch of architecture study  with a focus on 3D-design and presentation at the Beuth University since 2008. He´s member of the international architecture comitee „ArbeitsKreisArchitekturInformatik (AKAI) - an umbrella corporation working on international exchange university researchers

**Christopher Noelle** is a passionate multimedia artist. His skills involve lightpainting photography and realtime-animation aswell as filmediting and hugescale mapping projection. He started his lightpainting research back in 2003 and is today one of the leading pioneers within this genre. He has teached multimedia-presentation courses for architecture students at Beuth University in Berlin between 2009 and 2012 before he settled down in Linz to work on his personal art.

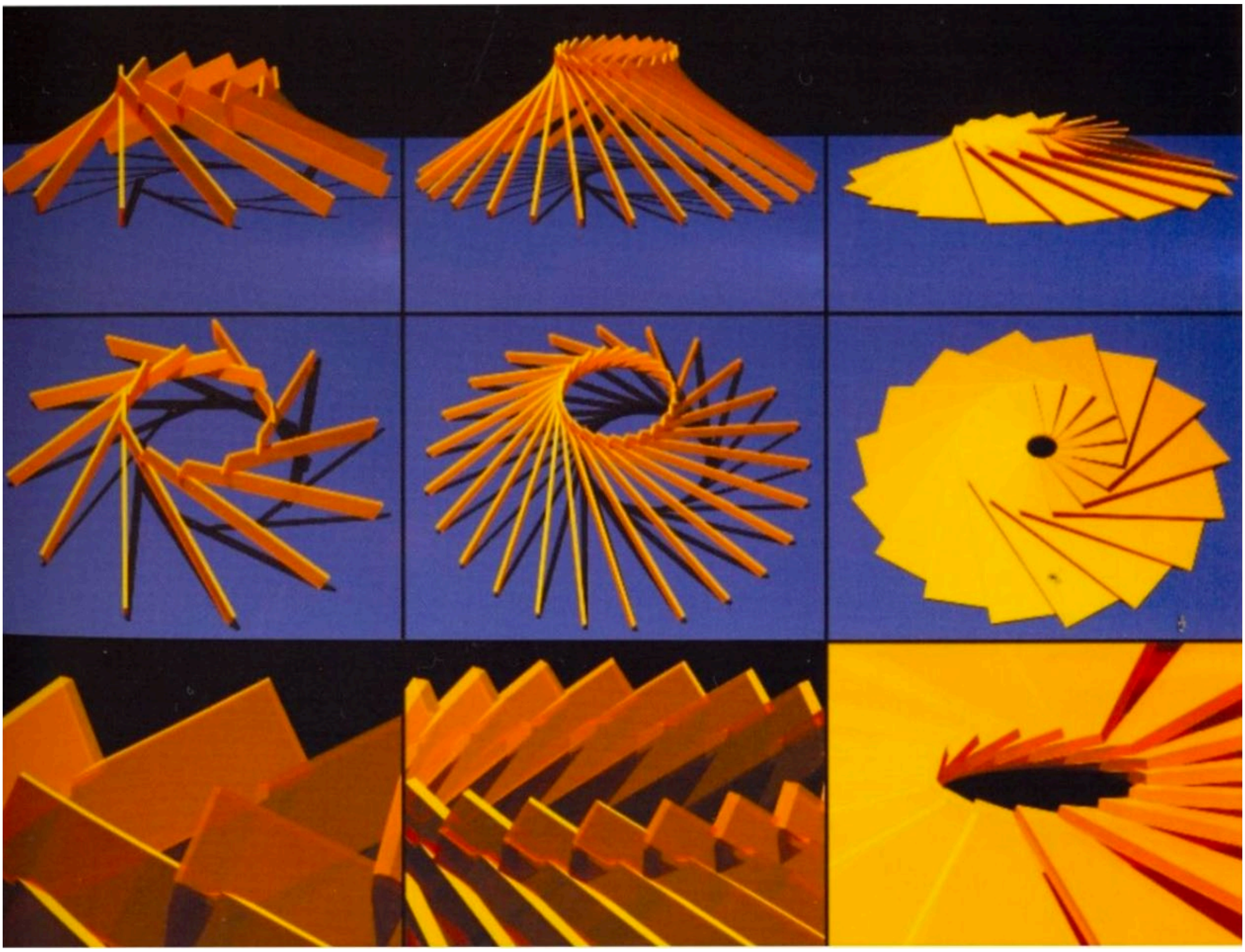
**MOODS**

Bird and fish swarms show one of the most complex paramteric behaviours in nature.
A single change causes its complete look and behaviour. This permanently evolving paradigm stands as archetype for our project and its endless variations of a new creative process.

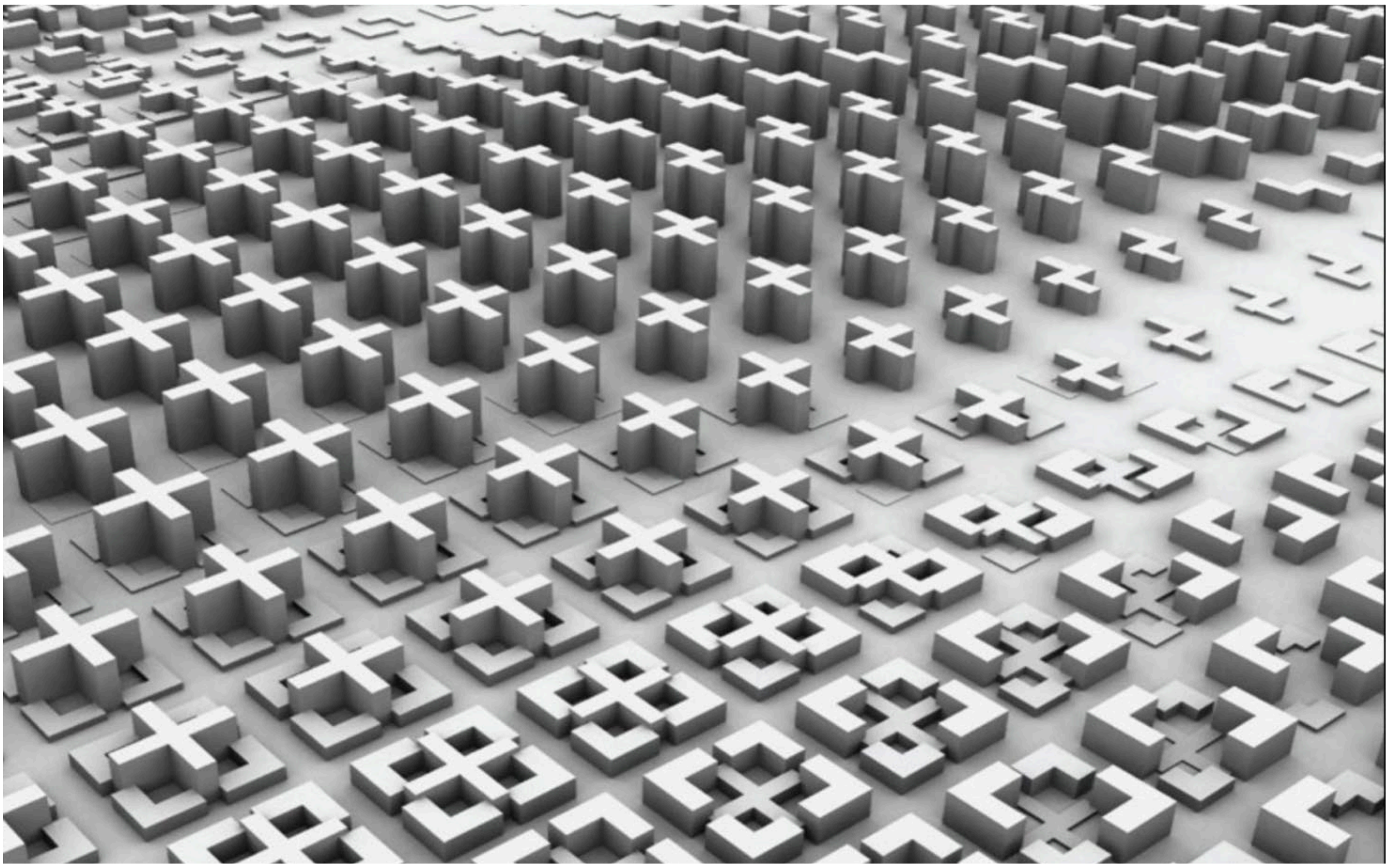
To show the full potential behind the „new parametric thinking" project, we have made a selection of previous projects developed by international leading architects which are all based on parametric design.

Pic. 26: permanently evolving paradigm - a bird swarm

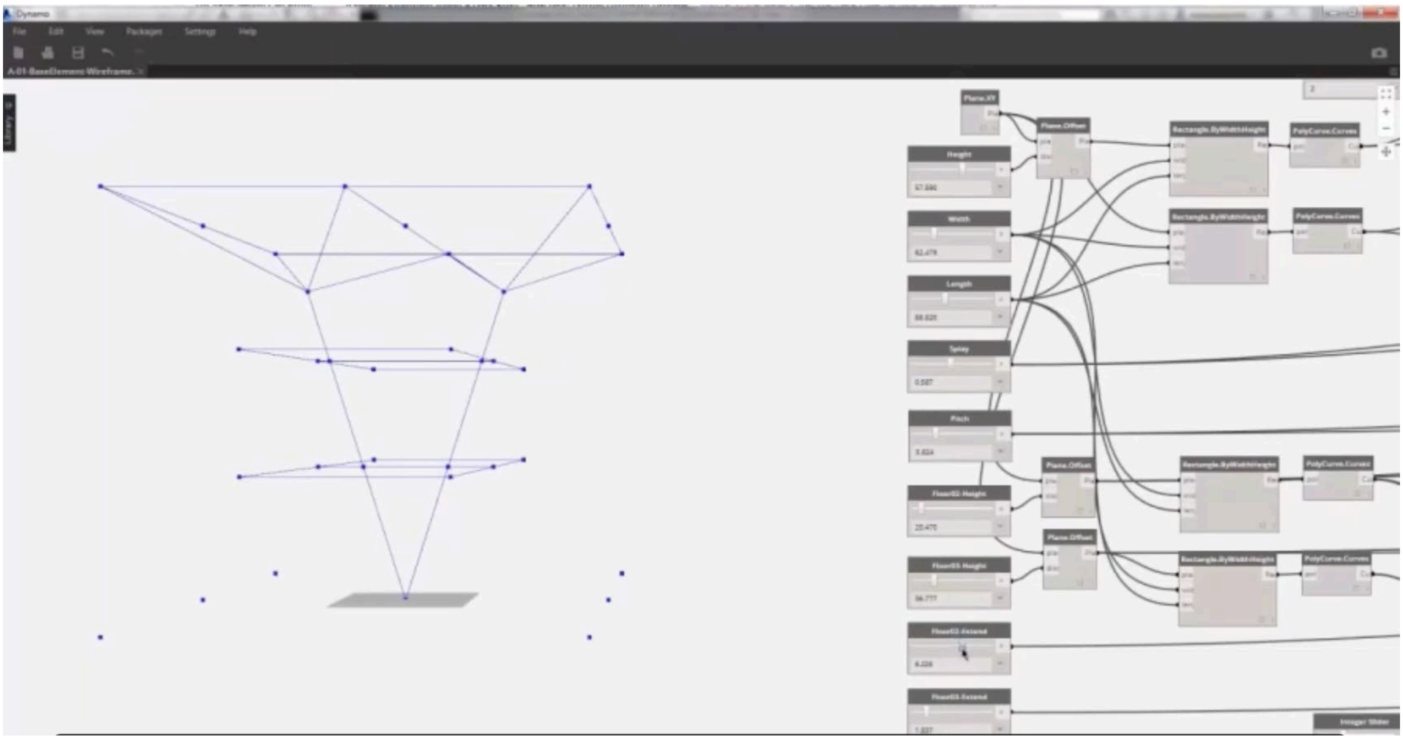
Pic. 27: permanently evolving paradigm - a fish swarm



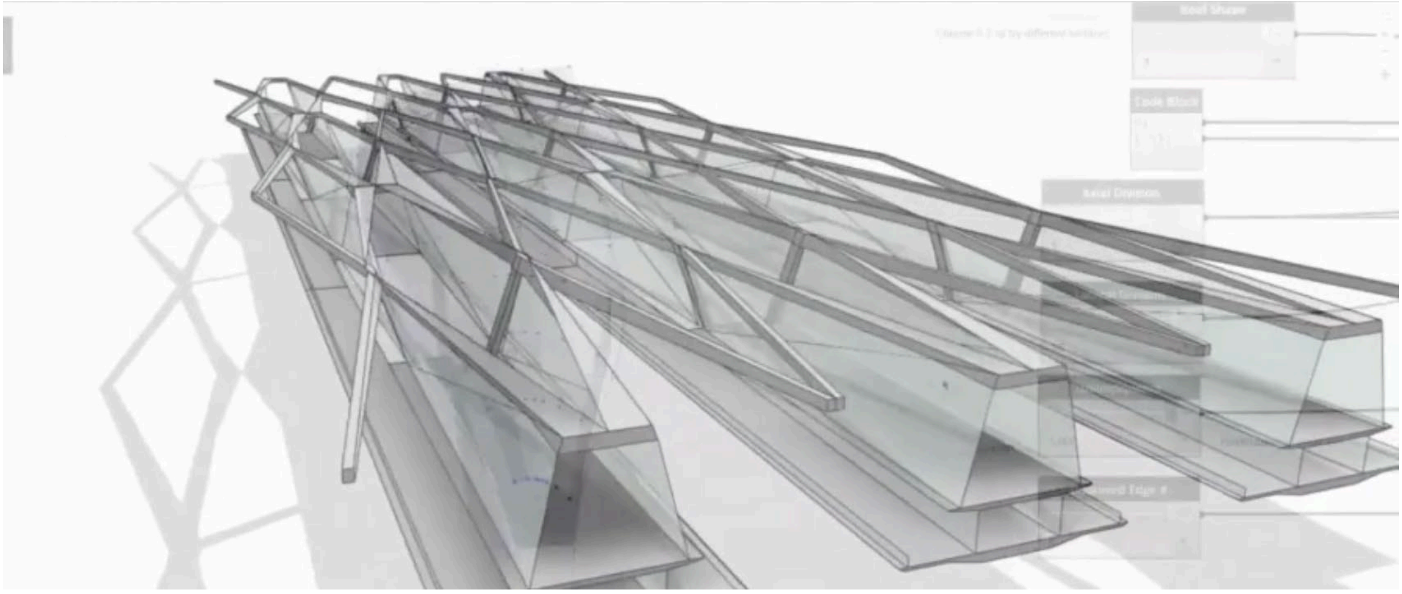
Pic. 28: Variations on the same parametric model, distinguished by changing parameter values
Source: KOL AREVIC, 2005, p.153



Pic. 29: Applied technique of parametric design WERZ, WEWORK|4HER, 2009

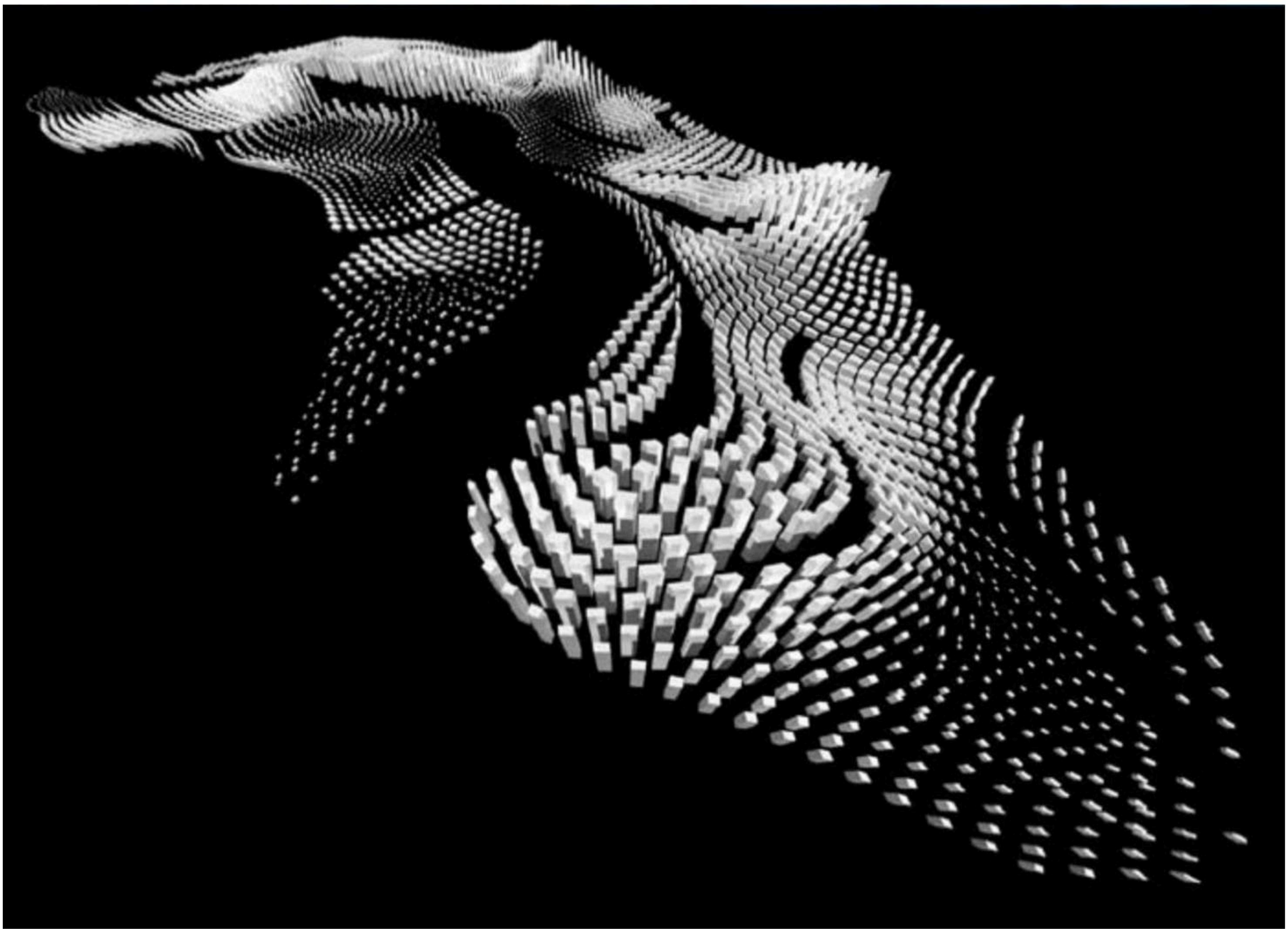


Pic. 30: AutoDesk Dynamo showing the parametric value faders

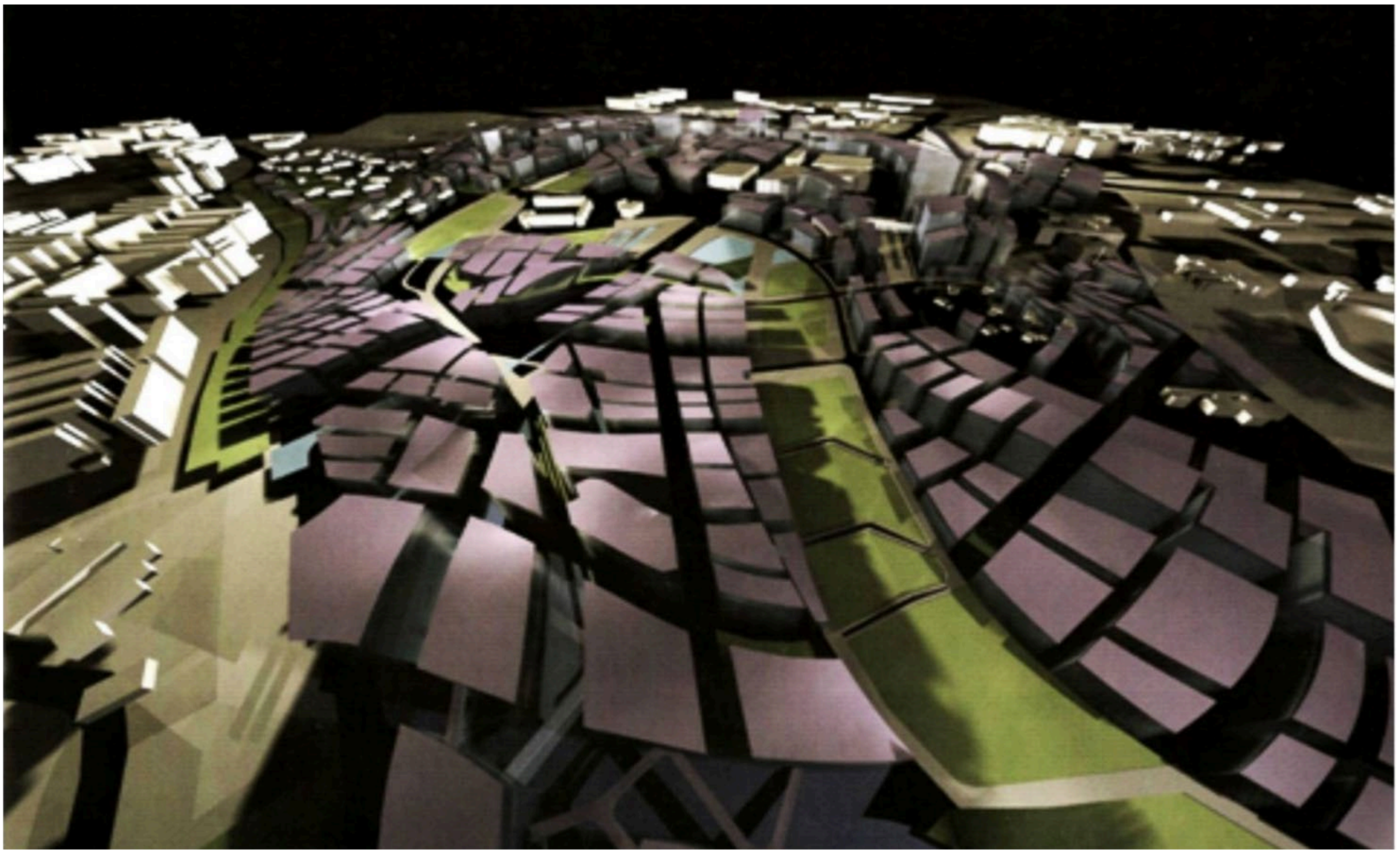


Pic. 31: AutoDesk Dynamo - applied technique of parametric design based on Pic. 30

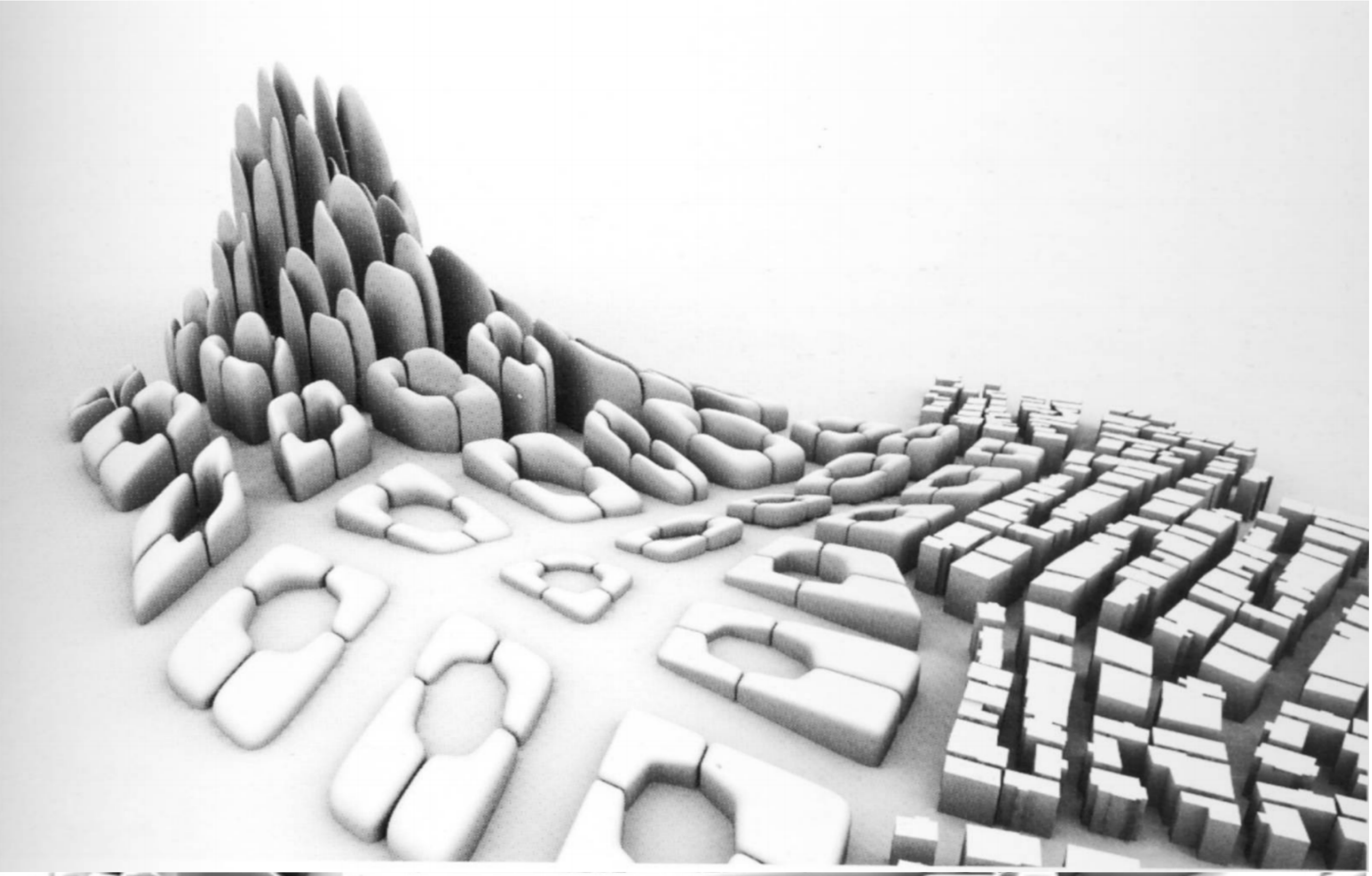
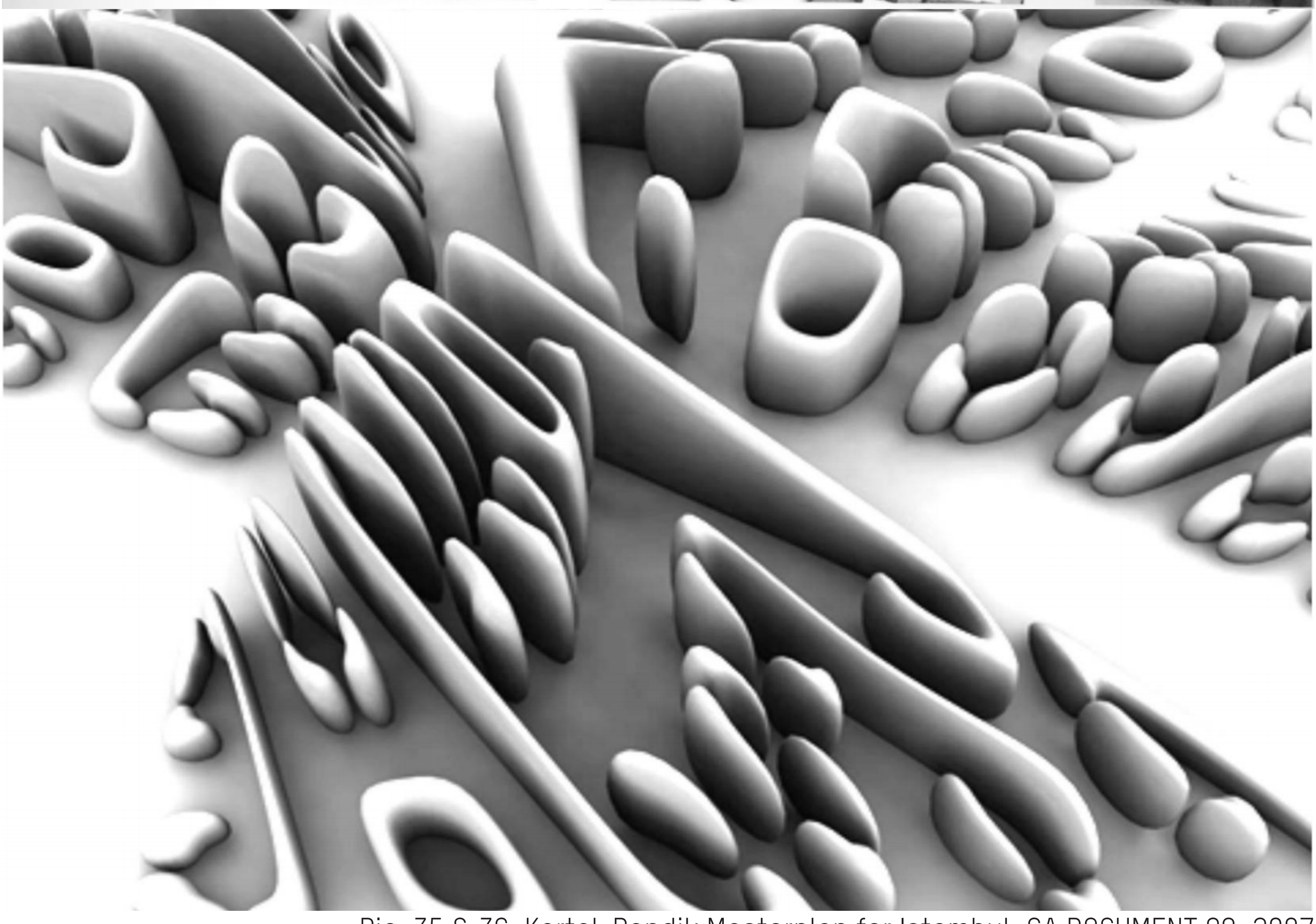
Pic. 32: 3D Rendering of parametric design by 3dmetrica.com

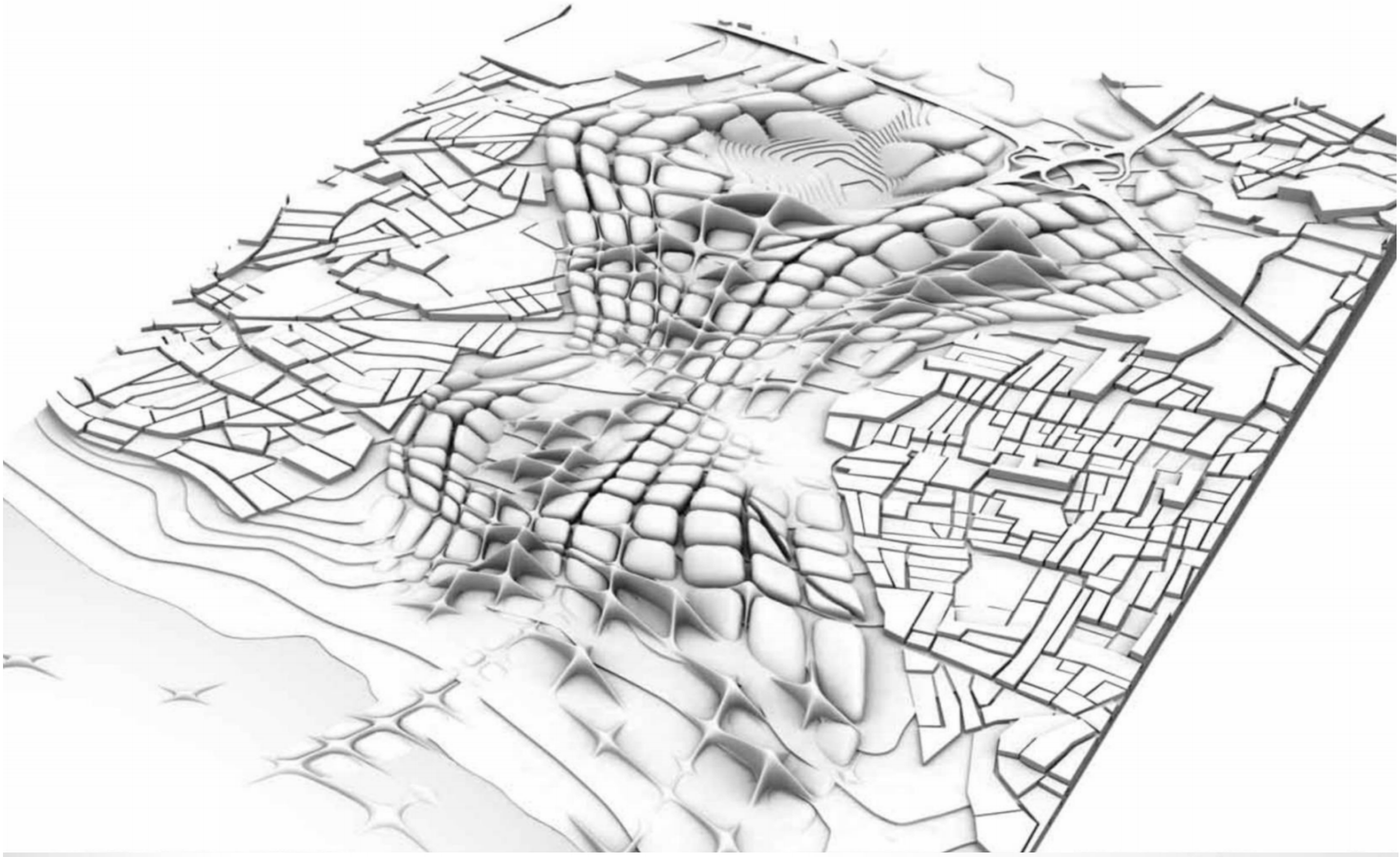
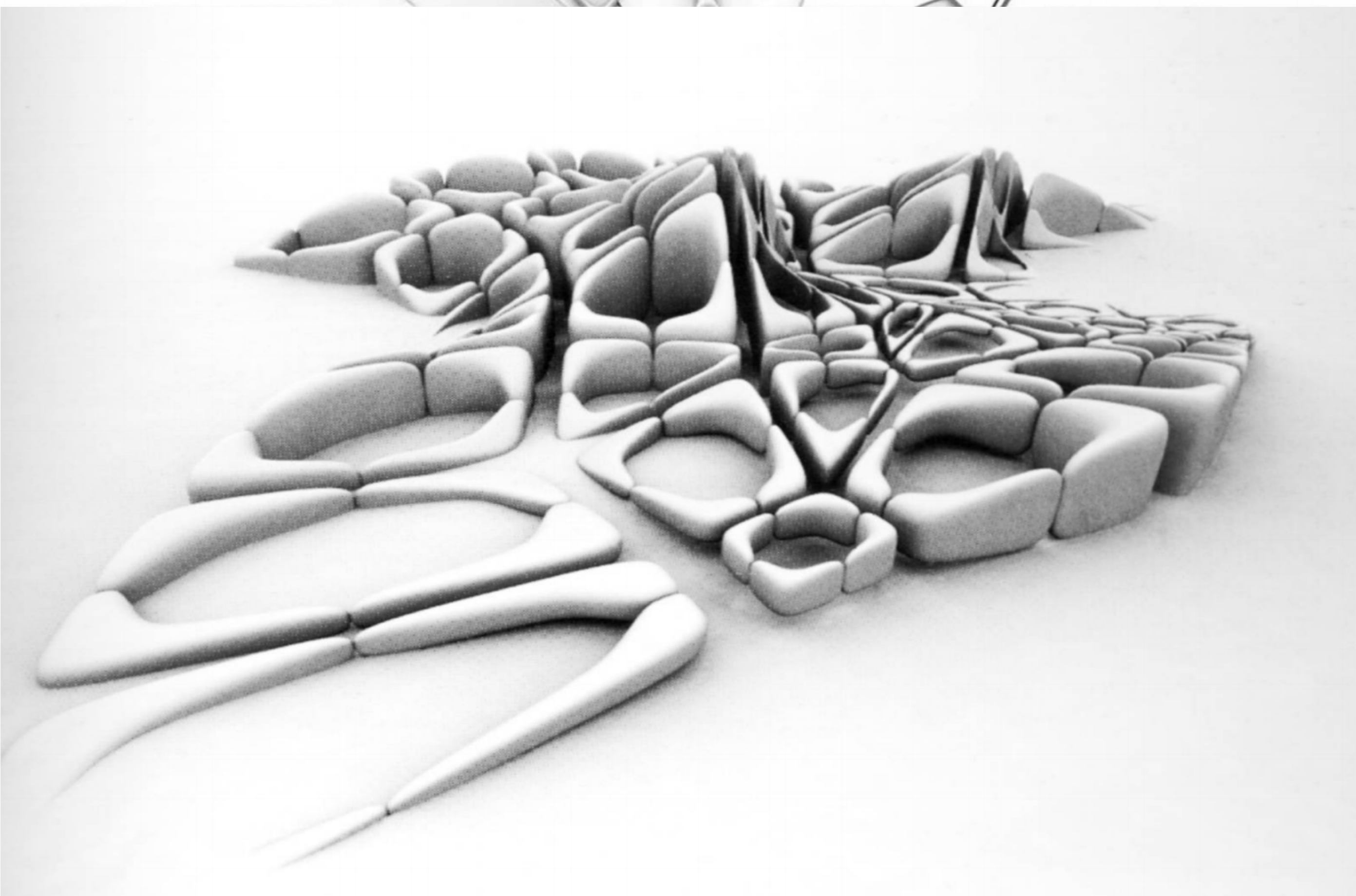


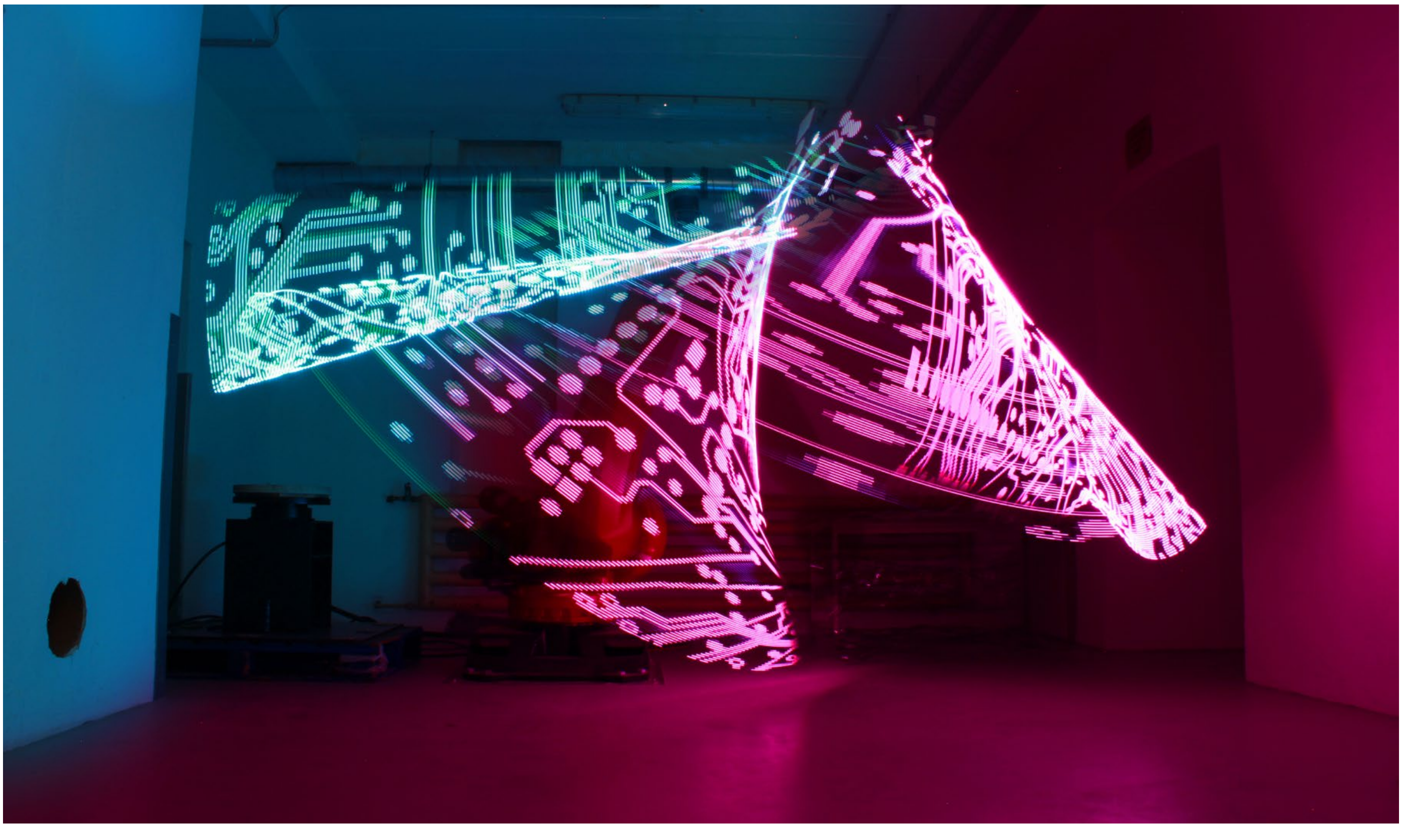
Pic 33: Urban model by Zaha Hadid for Thames Gateway, London, HADID ARCHITECTS, 2009



Pic 34: One-North Masterplan, Acima - urban morphology by Zhad Hadid, HADID ARCHITECTS, 2009

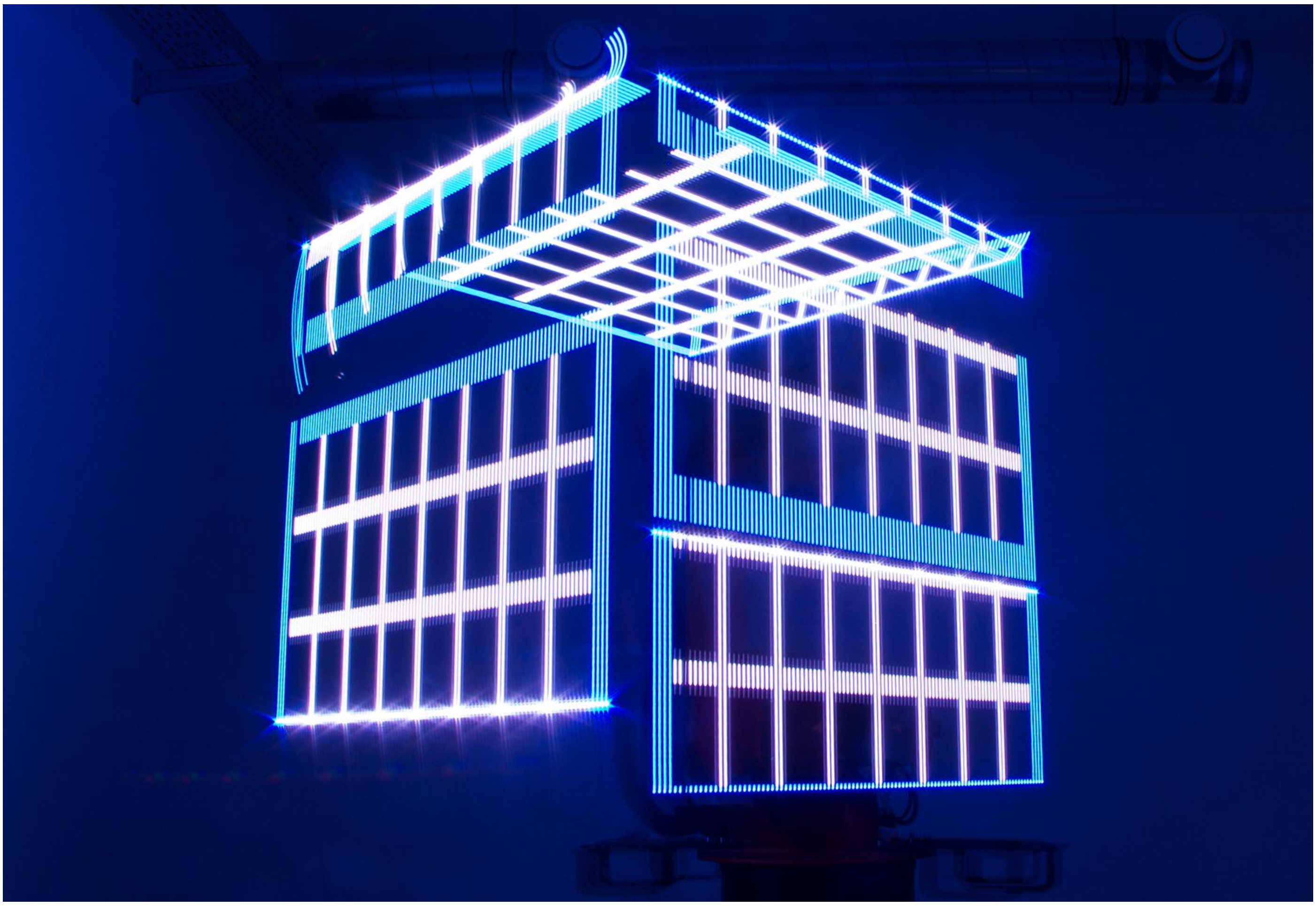


Pic. 35 & 36: Kartal-Pendik Masterplan for Istambul, GA DOCUMENT 99, 2007



Pic. 37 & 38: Kartal-Pendik Masterplan for Istambul, GA DOCUMENT 99, 2007

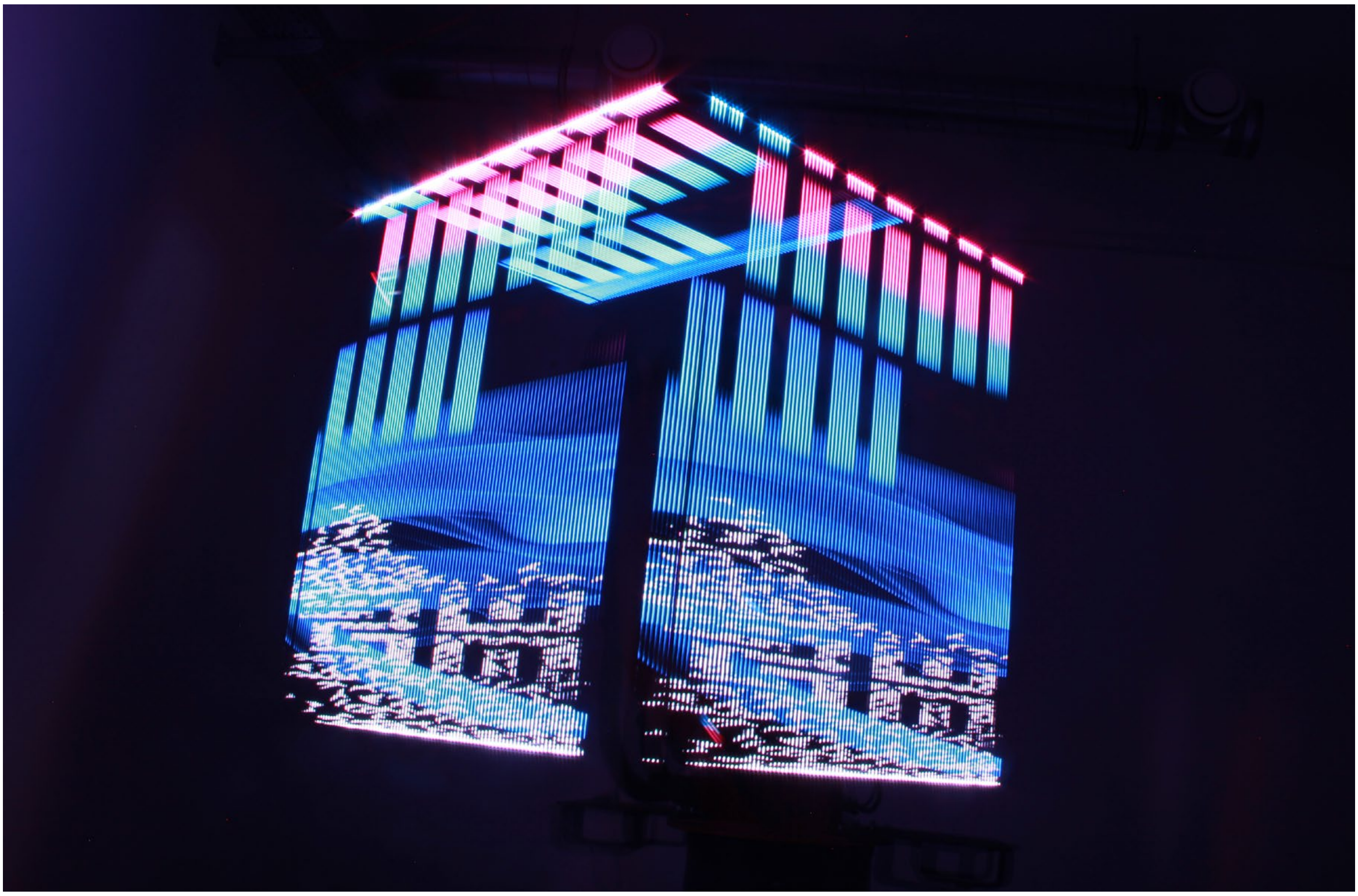


Pic. 39: First Lightpainting Test with Kuka robot at the Robotik Labor KU Linz
Photo by Christopher Noelle


Pic. 40: First Lightpainting Test with Kuka robot at the Robotik Labor KU Linz
Photo by Christopher Noelle



Pic. 41: 3D Cube test with Kuka KR-16 at the Robotik Labor KU Linz
Photo by Christopher Noelle



Pic. 42: 3D Cube test with Kuka KR-16 at the Robotik Labor KU Linz
Photo by Christopher Noelle

Pic. 42: Lightpainting Kuka KR-16
Photo by Florian Voggeneder

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