digital design
in urban environments
fall 2018
Exercice 1 : Lists

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CHAPEL IN THE PARK

The idea was to create a little pavillion facade, with a woven structure to create an interesting light and shadows pattern inside the pavillion.

outside the dynamic structure hides the people inside the pavilion but still let the light go in.
This publication is the fifth edition in a series of booklets presenting a selection of architecture students’ design explorations undertaken during the *Digital Design in Urban Environments* course, at Tampere University of Technology (now Tampere University).

The objective of the course is to introduce and familiarize the students with the possibilities of computational design and parametric modelling. The course explores the use of algorithms in architectural design processes with a focus on their applicability in the context of urban environments.

Various design methods and analytic strategies were presented in weekly lecture sessions, during the last seven weeks of the term. Additionally, the students had to accomplish five design tasks chosen out of seven different assignments. These assignments aimed to encourage the students to investigate and implement these new possibilities in their design processes and allow for flexibility regarding the students’ own initiative and individual application.

As the teacher, it is astonishing to observe the learning development of the students and the broad utilization possibilities the students discover in that very short time period and mostly without any former experience in that field. Fortunately, we once again have the pleasure to show and share some of the discoveries within this booklet. The selection of projects represented, follow the order of the given assignments.

I want to thank all the students who were involved in creating this publication as well as Professor Panu Lehtovuori and the Department of Urban Planning for their support. Special thanks to SungBok Song for his assistance during the lectures and Toni Österlund, Partner of Geometria Architecture Ltd, for sharing his expertise and supporting the course as the assistant teacher this year.

Lisa Voigtländer
The assignment is based on a tutorial by MODE LAB. It demonstrates how to create and manipulate a repetitious pattern of a geometry. The aim was to draw and test repeatable geometries and manipulating the pattern of repetition to achieve a new design and aesthetic solution, for example for a three-dimensional facade.
The aim was to generate a tool to fill a facade with a variety of pieces. The algorithm will shuffle and randomly place them. Some of them are opaque and some others let light through. In this way, it is possible to experiment with several facade arrangements and see how permeable they are to light or not.
The idea was to create a facade for a small pavilion with a woven structure to create an interesting light and shadow pattern inside the pavilion. While preventing visual exposure to the interior from the outside, this dynamic pattern structure allows a natural illumination of the pavilion.
This assignment requested to solve a design task through the usage of mathematics. Different mathematical expressions and functions can be employed to create geometrical figures, such as curves and surfaces. These can provide the basis to design a roof structure, urban plan or landscape architecture among others.
The operation of diverse numeric tools defined this trigonometric roof structure. A perfect canopy was imagined, moving according to the time of the day based on irregular and broken-waved shapes.

Firstly, I wanted to experience different ways of treating the waving shape we created during the lecture. So I had to explore some new tools like Population, Delaunay Mesh, or Delaunay edges. First step was to create different points I wanted to be randomly managed but following the shape. Afterwards, Mesh and triangulation were used to create this new form. Finally I imagined it like a trigonometric roof covering a flat concrete floor. It might create some interesting shadows thank's to its moving disposition. Moreover, this structure might be able to change itself according to the time of the day and the position of the sun thank's to its irregular form.

First step corresponds to create waving parametric shape. Second step aims at disposing some points in a randomly way on the shape with Population tool. In addition to it, it was necessary to have some point all along external edges of the form in order to add kind of a filter of columns on two sides of the structure.

The Delaunay Edges tool allows all the point to be reached by edges. As we can see, the external edges of the shape are stil waving whereas the entire structure in the center is designed thank's to the triangulation.

Final step consists in pre-modeling the structure by applying cylinder form to each points. Moreover these cylinders are set to be attached to points situated above a certain high. The goal of that parameter was to support only higher altimetries of the shape, and to have feeling that the shape is attracted by the floor.

In addition to those columns, it is necessary to apply a spline to the Delaunay meshes in order to model it as metal tubes and obtain the whole structure of the project. And finally, just need to bake!
Having decided to construct trigonometric curves as geometry using mathematical expressions, a spiral provided the perfect base. Sine and cosine functions using $x$ value as the variable were used to create this shape.
The geometry is a recreation of the roof from Salone B, Palazzo di Torino Esposizioni, Torino, 1947-1954. It is built in concrete, and uses the shape for structural resistance, with a thickness of just 30 cm.
This assignment explores the usage of attractors. Points and curves are set as attractors to determine geometry transformation. The transformation is based on the distance of e.g. a generated geometry to these attractors. The distances can be used for example, to define an according height development, or a rotation, as well as creating openings through scaling. This process can be iterated and modified to achieve multiple design variations.
A public space was created by a function, using the different possibilities brought by Grasshopper. Once the perimetral and new buildings were set as constrictions, a trial and error process assisted in the completion of the park.

The choice of a structural grid and paths helped with navigation. Finally, a visualisation was done to give the feeling of this cosy new park.
The idea was to generate a roof skeleton pattern using a curve. After creating the roof surface with an adjustable tilt angle the following step was to create the triangular grid and an attractor, dividing the curve and using the distance between the triangles and the curve. This results in different unit types. Then the roof surface was mapped, using the same steps for the gradient colouring in Grasshopper.
The exploration of solar analysis with a solar vector is the core subject of this assignment. The aim is to find a beneficial use of the solar analysis to improve, alter or even generate a design with the influence of sunlight and shadow. The following works are based on the "attractive urbanism" exercise work and individual design projects, demonstrating the utility of this analysis in different scenarios.
This was a study of solar energy received as well as the shadows cast by a garden pergola. This was conducted on the 21st of every month of the year.

% shaded

shade from the pergola different months of the year

shadow calculation

idea

visualisation
This analysis seeks the most suitable corner in the selected area for a celebration event. The criteria to find the best spot was to avoid the casted shadows in the cold month of March on the 20th in Tampere. With the results, not only the location was defined, but the schedule for the celebration had been set.

The party will start at 12:00. There will be a shaded half an hour. For this reason moving to a nearby sunny spot from 15:00 to 15:30 is recommended.

The party will come to an end when the shadows overtake the entire location area, at 17:00 exactly.

The idea visualisation site in Tampere
This was the description of how an automatic shading device was implemented on a tower. In order to function properly, the shading device needed to open whenever the sun was not directly on the panels and then closed when facing the sun.
In this design for an urban installation, created for a previous exercise, the casted shadows strengthen the intention of marking a main path through which directed to the nearby spaces. This effect was perceived while analyzing the lit and shadowed areas: pure serendipity.

I've decided to apply the solar analysis to my attractive urbanism concept. By analyzing the impacts of shadows and lights, I've realized that they were strengthening my first idea of a main path between the amount of blocks. Sun is shining on the smaller blocks and shadows lead people to the urban space. - Elise Mullens
The aim of the following assignment is to familiarise with the creation of patterns. Grasshopper is offering several methods to generate patterns, for example, by different meshes or grids. Very popular is the pattern of the Voronoi mesh, which is based on points that can be set manually or randomly generated. The pattern design allows to explore and develop different options and variations for a design project. These patterns can be used as the basis of a geometry or a reference grid for several design concepts.
The main idea was to redraw the urban street network along a boulevard in Rennes, France. To define the new isles’ frame a Voronoi mesh was projected along the location. The focus was on the creation of different layouts of density, green areas and a variation on height along the boulevard.
This was an intervention in a site in Hervanta to create public benches of different sizes. The goal was to maintain three paths that cross the delimited area. These paths were created by the positioning and morphology of the benches, that were round and they enclosed small spaces for either planting some greenery or placing a pond.
This is a remodeling of a facade created using a curve attractor for a previous exercise. For this new skin, a Voronoi pattern was combined with the old creation process. Many variations and combinations were created.
Here is a proposal for remodelling the street network around the National Library of France in Paris. The intention of it was to give a new fresh atmosphere to the appearance as well as provide a structure to bring order within it. The four main buildings were kept as they are nowadays, as a central main area. The northern and Southern blocks were organized in order to highlight this important cultural landmark.

**Design and Process**

The idea was to choose a site which is in my home city, Paris. I actually live next to the B.N.F. (National Library of France), so I decided to design new buildings for this area that I see everyday. I thought that it could be a good idea to keep the main existing buildings which are the 4 towers of the B.N.F. and then to create new blocks, more organized, in order to highlight this important cultural place.

I started by selecting an area on the site. Then, I chose one road which is around the B.N.F. to finish, I used 12 points in order to design 12 new buildings which are at the same place than previous buildings.

The new courtyards are now creating a link with the huge green space in the middle of the library.
The purpose of this assignment is to explore and make use of the Isovist-field of view-analysis. Several routines can be generated, to show a graphical representation of the visual range in the analysed area. This is a useful tool to evaluate different proposals of new projects or to contrast perspectives in existing public spaces.
The isovist analysis was based on a competition proposal for an infill in a historical environment in Lappeenranta. It is a walk through the old and the new, using Grasshopper to presenting different urban atmospheres.
The goal was to generate Isovist displays, defined by squares. Initially, it could be done with an animation through a square outline. It became easier to make a definition that builds an Isovist field, coloured by distance to the centre of the square outline.
The following works are various approaches to the bitmap assignment. Bitmap images and their values, such as brightness and contrast, colour tone or saturation, are used as parameters to influence the generation of geometry. Most frequently the image brightness is employed, for example to define the height development of a geometry. Any kind of image can be used or self created for design processes, providing inspiration for architecture, urban design or landscape design.
An aerial photograph of a vacation location in the Finistère in Bretagne (France) gave the foundations and the guidelines for the process of creating this structure. There was an intention to emphasize the difference of heights considering the water’s depth. An interesting point of the design, due to the structure and expressivity given by the caption, is how it represents a certain peak, a goal or an attractive point.

As the topic was about the urban scale and a site that we particularly appreciate, I choose my holiday house location, in the Finistère, Bretagne (France). At first, I wanted to highlight the fact that there must be a huge difference of heights considering the water’s depth and the lands a bit higher; eventhough the drop isn’t that important in there. I liked that it represents a certain peak, a goal, an attractive point.

I used the bitmap depending on the contrasts and the brightness of the pattern. This triangulated floor moving with the most bright units creates cave shelters, in which the oblique walls are mixed with some stalactite pillars. The holes in the middle of the triangles are windows, where you can appreciate the view. The landscape becomes the current covered urban pavilion, and the ocean is now the shaped espanade with some facets to sit on, and rest.
The goal was to design a sun screen façade from an image in an alternative way and to create a special atmosphere for a building.

An abstract photograph of a forest was used as the image source. This was an interesting photo as the brightness itself creates the depth of field. The opening of the screen was also determined by the brightness, having the bitmap as the scale factor.
The idea was to use a bitmap image to generate a pattern and apply it to the roof of a butterfly pavilion created in a previous exercise.

The bitmap generates an artistic-looking structure. The colouring of the roof was taken from different paintings to create various design deviations.

I have tried Wuguanzhong’s painting and Zhuda’s painting. Because I don’t like the structure overwhelmed with colors. So I choose painting with little colors. Because the second one is abstract art so I finally choose the first one.
Tampere’s Keskustori was selected as the site for this bitmap investigation. A green labyrinth was created from a maze pattern. An alternative design was a playground area developed from a different image. Both images were taken from the Image Sampler in Grasshopper in order to explore what that feature could bring to the design process and output.

- ** bitmap gradient circles made in photoshop **
- ** baked design **

** Idea **

- ** the maze **
- ** the playground **
biography

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