Rethinking Eiermann's Horten Tile A new structuralism?

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Abstract. *The structural idea of a universal structure that is valuable for different situations gets new power through new design and manufacturing methods. Genetic evolutionary algorithms can find pheno-typical solutions based on capable geno-typical structures. These design systems need to transform abstract architectural requirements into geometric parameters. In a studio students were asked to apply this structural idea to the redesign of the Eiermann's Horten façade.*

Keywords. *Evolutionary Strategies, Design Methodology, Structuralism, RhinoScript*

Egon Eiermann's facades for Horten

Egon Eiermann designed two department stores for the Horten Sales Company in the fifties and sixties. These designs were previewed to be leading concepts for some upcoming department stores. The "Warenhaus Merkur" for Horten in Stuttgart from 1951-1960, replacing the Schocken department store, designed by Erich Mendelsohn, was followed by the design for the Warenhaus Horten in Heidelberg 1958-1962(Schirmer et al., 2002). Using the so called "Horten Tile" as the main and significant element he developed a memorable façade design. Because of their rigidity and their strong attitude against the surrounding urban situation, today these buildings are discussed ambivalently. Often they are seen as an early attempt to establish a corporate architectural design for the Horten Company. But if other buildings of Eierman from this time a brought into account, another motivation appears. Regarding his designs for the Matthäuskirche Pforzheim (1952-1956) and the Kaiser-Wilhelm-Gedächtniskirche Berlin (1957-1963) (Schirmer et al., 2002), the same idea of the serial use of a single tile spread regularly over the facades is obvious. Comparing these facades more detailed we realise that the structural idea is the same, whereas the shape of the tiles differ in size, shape, material and colour. For the Matthäuskirche for example the size of the concrete tile is 43cm x 43cm x 30cm, and the opening is a single hole with artistic multi coloured glazing, whereas for the Stuttgart Horten store 60cm x 60cm x 20cm monochrome ceramic tiles with convex and concave crossing surfaces are used. Even the tiles of the two Horten stores are different. So these designs seem to base on a structural idea, which is the serial and ordered use of a tile, whereupon the tile is adapted to each situation.

So even if the facade designs are based on the same structural idea the appearance of the buildings differ significantly. This is the reason why the structural concept could be used for so different types of buildings, like churches and department stores are. The link between the two types of buildings and the reason for the same façade concept are functional requirements. The main façade concept of the mentioned works is a repetitive structure of tiles. As the tiles of each building are identical, this leads to a very homogeneous and memorable appearance of the building to the outside. Inside the building this concept leads on the one hand to a very introverted space because there is no direct interaction between inside and outside and on the other hand it allows a maximum of flexibility because the inside structure has no influence on the outside appearance. Walls, storage racks, church pew or other furniture can be arranged very unrestrictedly. The translucency of the walls is determined and controlled by the shape of the tile and its overall use allows the natural diffuse lightning in the whole building. Besides the technical and functional requirements this concept enables a sacral atmosphere in the churches. The architecture at this time is strongly influenced by the need of a big amount of low-budget buildings. So the use of prefabricated mass products is not unique by Eiermann, it is somehow the spirit of time. What is unique is that he discovered that the same structural idea fits to the requirements of different types of buildings.

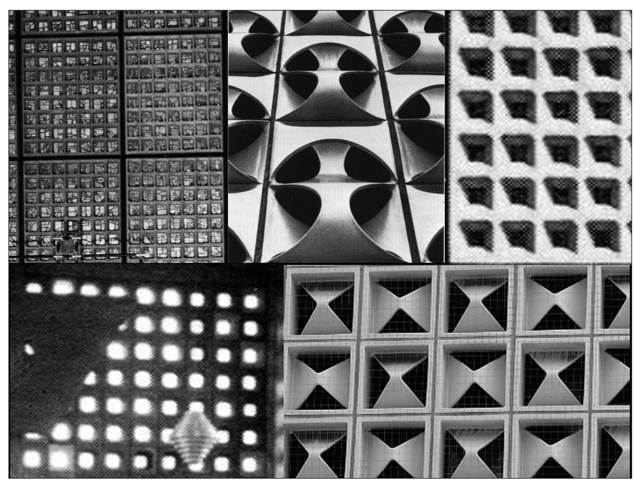

Figure 1. Details of different tile facades

The studio concept: an evolutionary design algorithm

Eiermann is not following consciously evolutionary or genetic design concepts, but his basic idea shows some of their characteristics. So his structural idea can be seen as the genotype of his facades and through the use of parameterised tiles the phenotypes are produced. This is a very simple shape grammar algorithm. New planning methods, a further understanding of artificial evolution and the knowledge of individualised mass production encouraged the idea of a redesign of the mentioned facade designs. Where Eiermann reacts

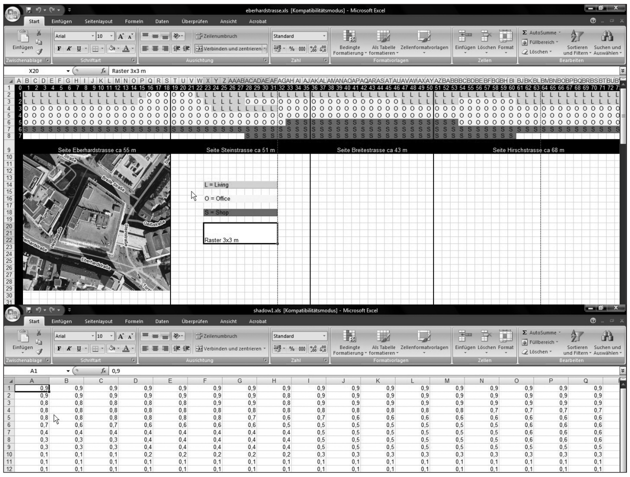

Figure 2. scheme of input parameters function

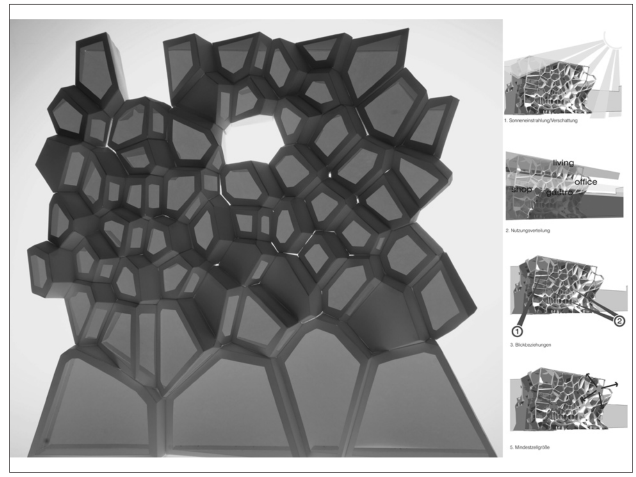

Figure 3. Voronoi model detail with influencing parameters

to the requirements with homogeneity and neutrality new methods allow more individuality. So the students of the studio are asked to set up a design system for the Horten store Stuttgart, which imply the potential to be assigned to other situations or requirements. The main goal is to develop a genotype which is the base for the production of different phenotypes by using specified input parameters. The input parameters for the functionality and the average sun ray information are provided as excel-sheets. The urban situation is described with a common site plan.

The basic concept we are following is to create an evolutionary design strategy. Despite to an evolutionary algorithm where many individuals in a population are in a fitness competition the evolutionary strategy the population consist of a single individual (Bentley, et al. 2002). That means that not many different solutions are produced and a selection function is used, but that a single phenotype is evolved in an iterative and recursive strategy to a valuable design result. So there is no mutation algorithm programmed but a step by step evolution based on the input parameters. The automated production of geometry is an abstract and just formal act. The produced geometry has per se no meaning in an architectural sense. To step into architectural structures it is necessary to assign semantics to the produced geometry (Franck, 2008, p.183). The crucial point is to develop a design system, where abstract and non geometric design requirements like function, sunlight, urban situation are transformed into geometry. The challenging point is where different design tasks step into conflict. Correction or evaluation functions has to be integrated into the design algorithm to make 'decisions' possible or to establish hierarchies. As design tool McNeels RhinoTM and RhinoScriptTM are introduced to the students.

The studio results

Although randomised elements and parameters are not essential for a successful algorithm it seems to increase students' motivation, so we keep it in the rule set. In the following some concepts are shortly explained and discussed.

Voronoi

The design system is based on the idea of a 3-dimensional Voronoi grid. The determine parameter for the grid is a specified point cloud. The algorithm creates a random point cloud over the façade surface. This cloud is 3-dimensional. In the next step this point cloud is adapted to given requirements by different modifications. The sunlight is considered by extracting the ray direction at specified daytimes which are brought into account by assigning them to grid points being a direction vector for the Voronoi 3D grid. The design systems integrates also the orientation of grid cells as vector to defined relevant view points. These view points are i.e. urban landmarks or important traffic directions. From several vectors on one grid point in the Voronoi grid the arithmetic middle of the vectors defines the resulting vector. The third parameter being considered is the building program. Based on the given program scheme the grid points are moved as far as a defined minimum or maxim Voronoi grid size for the cell is reached.

Umbrella

This design system picks up Eiermann's idea of a tiled façade. Starting form a regular hexagonal structure which is divided into 2 regular sets of 3 triangles. For each set the tops of the triangles meet in a centre point. Three parameters are introduced into the design system. Different distances between the two centre points of the sets control the shading effect of the tiles. The value from the given sunlight scheme determine the relative distance of the centre points of each tile. The second parameter to influence the tile is activated by moving the centre points out of the centre. This manipulation is used to allow direct views through the tile to the surrounding, or to let pass direct sun light. The base size of hexagonal grid defines the third parameter of the system. Bigger tiles a previewed for the selling parts of the building and smaller tiles a used for office or housing parts. A major problem in this design system was the continuous transition from bigger to smaller hexagonal base tiles. As geometric solution it is proposed to fix the biggest hexagons and to decrease the resting tiles in correspondence to their distance to the fixed size hexagons. The centre points of each tile are fixed through a regular point grid. The resulting gaps between the hexagons are now filled with irregular hexagons.

Figure 4. Umbrella model detail and possible grids

Horten Web

The basic idea of this design system is to draw a grid of lines on a surface defined through two given outlines. The outlines are the boarder lines of the façade of the building. Each line takes the shortest distance on the created surface. To create the grid lines one random point is generated on each outline. With an evaluation function the created line is proved if it fits to the requirements. If not the line is deleted and a new line is created and evaluated. The validation of the line is determined from void areas and minimum and maximum crossing point distances. With an extrusion function related on an evaluated function considering the values from the given sun scheme, the cell size and the façade height, the resulting grid structure for the façade is generated.

Conclusion

Regarding the three students' works we have to realise that these design systems are not genetic algorithms. These algorithms are evolving design elements driven by random elements and by some restrictions. An essential characteristic for genetic algorithms are the creation of different populations which get in competition to each other. The algorithms here are missing a competitive selection based on a fitness function. Although the Voronoi and the Horten Web are using a selection strategy of elements, this selection is just a validation selection for single elements to proof if they fit to the essential requirements. Although at the end we get different results which are all valid results, the results are not distinguishable in terms of their quality. Without any doubt Architecture is a question of quality (Franck, et al. 2008). If algorithmic design systems want to enter into an architectural dimension they need to define evaluation values which can be integrated into a fitness function. With such fitness function and meaningful arguments integrated, it is possible to assign semantic denotation to the created geometry. The first step towards architectural impact, the transformation of abstract architectural requirements to geometric parameters is done in the mentioned works. It overtakes the status of a simple geometric game.

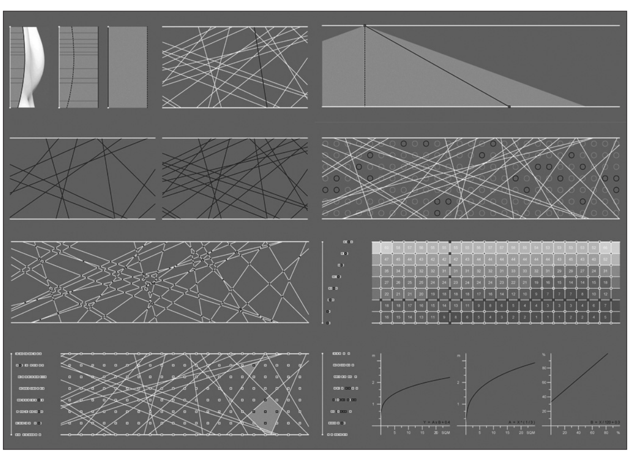

Figure 5. steps of the algorithm

Figure 6. visualisation of the result

Acknowledgments

The studio was held by Fritz Mielert, Matthias Rippmann and A. Benjamin Spaeth

The works mentioned in this paper are works from the following students. Thank you very much for your effort.

Voronoi: Frederik Ernst, Michael Schnell

Umbrella: Hamid Dulovic, Marco Iannelli

Horten Web: Peter Abele, Christian Seelbach

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