FROM RESEARCH TO DESIGN BY COMPUTATION

By Olav van der Doorn (4076974) for the course Architectural and Media studies

One of the big advantages of computationally generated architecture is the connection between context and the architecture by means of information. At first there is a difference between computational research and computational drawing of geometry. Research derives as much as possible from real-life phenomena, not with the primary goal of building. Computational drawing is closely related to complex manifolds, the definition of geometry according to nodes and their connection (Huybrechts, 2005). In a design process both design and research play a big role, the research determines the design and vice-versa (Avermaete, n.a.). Something to aspire is an information based direct link between research and design for that means that the research conclusions can be updated after certain design progress, without breaking the link. Working parametrically makes from two separate design steps in time, two integrated parallel processes. Mayor factors to take into account are the feedback loops between design on macro, meso, micro scale and the link to the production. What the role of the architect and what is the role of the algorithm in this context? How to deal with the relation between research and design in parametric architecture?

DATA DRIVEN DESIGN PROCESSES

On the GSM3 symposium in November 2016 several speakers talked about the design process. Some speakers such as Sander Boer saw the design process mainly as computational drawing with variable inputs, but other speakers such as Han Feng and Jia Ray Cheng saw the design process increasingly as an conversation between computer and human. Hang Feng describes the 'traditional' computational design process in three steps, the *designer* that designs an *algorithms* that generates a *design outcome* (Feng, 2011). Most of the influence on a design project, in a parametric framework, is on the first part of the design, the design of the algorithm. Afterwards it's a matter of adapting and changing it by changing variables (Boer, 2016). Both the design of the algorithm and designing with the algorithm are tasks for the architect.

A key factor in generative design is the combination of top-down and bottom-up approaches. Top-down approaches grant an integral design – a rather linear process –, while bottom-up approaches grant a way to come to new design solutions by means of complexity. In a bottom-up design process the design is taken into its components and these components are granted certain intelligence. The design is approaches from its topology and iterative processes (Biloria & Chang, 2013). The topology that is used is based on its nodes, the building blocks, and its connections . The feedback loop between these newer bottom-up processes and more traditional top-down processes form an integral design process.

DESIGN PROCESS IN DESIGN PROJECTS

In the Echosphere project (Fisher, Kattermölle, Kemper, & van der Doorn, 2016) different ways of information mapping from research to the design were found. For the project, among other things, sound optimization research and structural analysis was done to inform the project. The sound optimization, to conclude a shell shape of the stage, was done in a 2-dimensional way, while the final geometry had a 3D outline. The sections that the sound optimization gave us, were imported and approximated by building 3D splines on top of it. There was no direct information link between research and architecture. In the same project on meso scale, there was a more direct relationship between the structural analysis and the porosity of the project. Structural analysis gave a pattern of curves that was interpreted by a script that generated the strived for porosity. In the first case there was a mismatch in data between a 3D object and a 2D analysis, while in the second case the planes of the analysis and design object matched and made it more easy to link the geometry to the research.

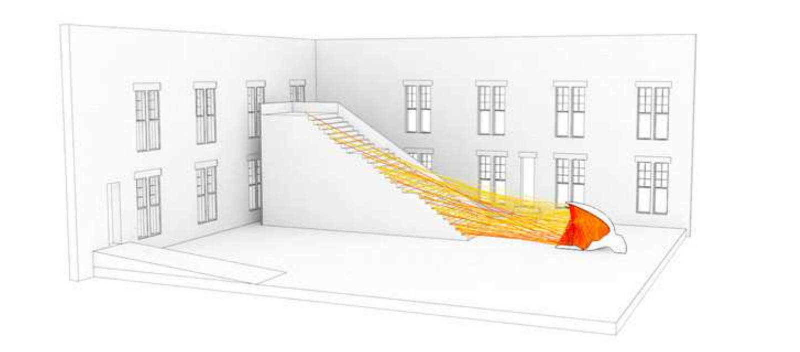

Figure 1 2D section results from shell optimization for sound

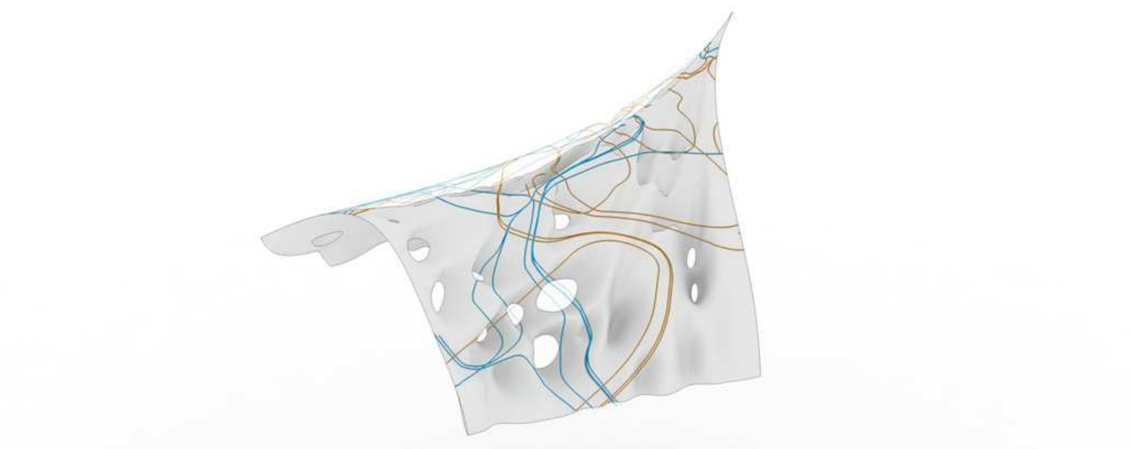

Figure 2 Structural analysis to porosity on meso scale

In the GSM III stage project a more direct relation was achieved between the design and analysis. A folding lectern was developed as a new component for the stage. The outline of the component was determent by the shape of existing components. The folding behavior and the production files were to be designed in a coherent framework. The design was drawn according to folding lines that separated the component in four sub-components. The way these sub-components fold over their folding lines determent the outcome of the folded geometry and the production files for all the parts. The feedback on both design outcome and production made a workable feedback loop in which the designer had the task to check and control the system by changing input lines. The feedback from the design script made it easy to generate design options in a playful way.

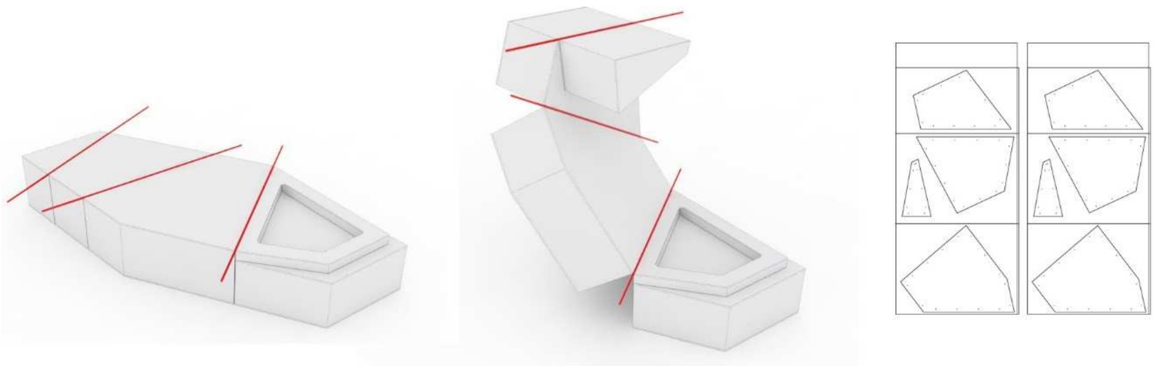

Figure 3 Folding lines as link between architectural outcome and production

In the graduation project a factory of the future is being designed. The design is located at quite an interesting spot near the center of Amsterdam, where public and private transport comes together with both living and working functions. A location that in short could be describes as complex. The function of the building is a combination of offices, workspace and exhibition space. The approach now mainly focusses on the macro scale, the interface between the building and its urban context. Both computational and architectural ways of form finding are combined and used as input towards architecture.

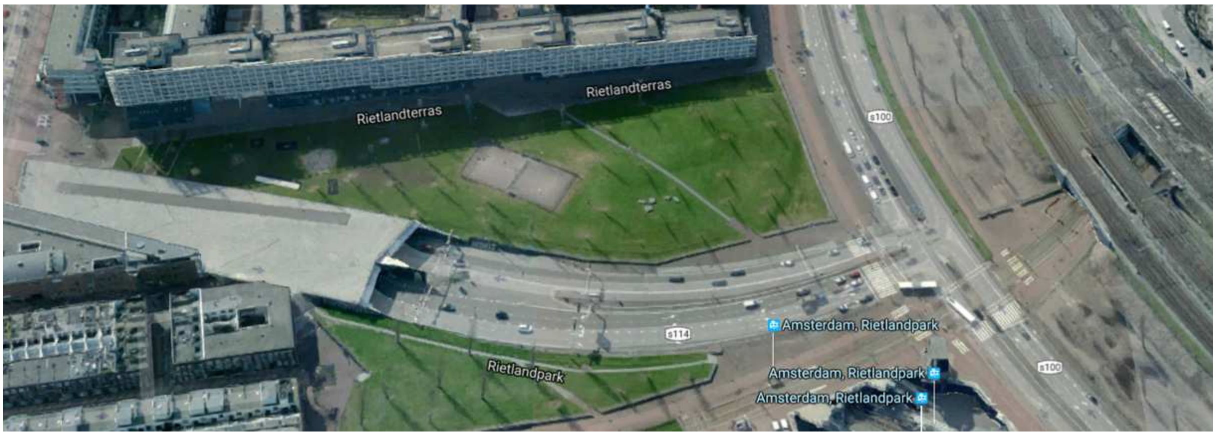

Figure 4 Rietlandterras, Amsterdam – urban context

One computational way of looking at the buildings functional layout is by a space syntax. Functions are defined as nodes and their relations, influenced by urban characteristics such as the site and the external connections of certain functions. Another way of looking at the urban context is the integration of the urban context with the building, the idea of an urban network defining the building. This is approached by defining the streams of different kind of transportation – e.g. cars, public transport, pedestrians – and using the relation of these streams to attract the space syntax. The last performed operation is an iterative process linking site to building by mapping paths by attraction, both internal attraction forces are taken into account as external forces. The paths flock together, grow on the surface of the space syntax to avoid cutting spaces thoroughly and avoid streams of different kinds of transportation such as roads. All approaches should come together in an architectural approach. A space syntax is a useful tool to use in an indirect way to the design, it merely generates options that inspire the functional layout. The analysis of transportation streams and iterative generating the connectivity on site is also a process that generates multiple design options that can be seen as an inspiration for design.

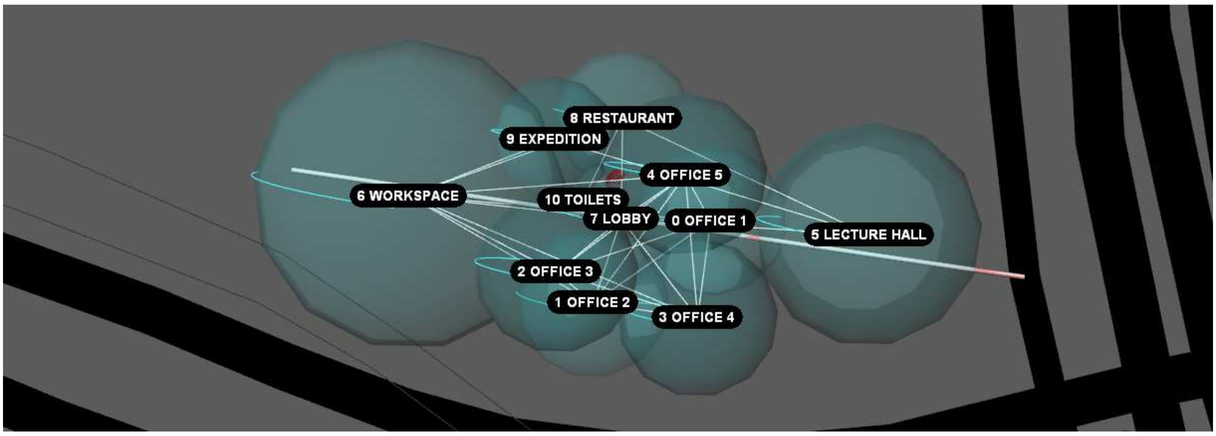

Figure 5 Space syntax on location, attracted by mesh shape

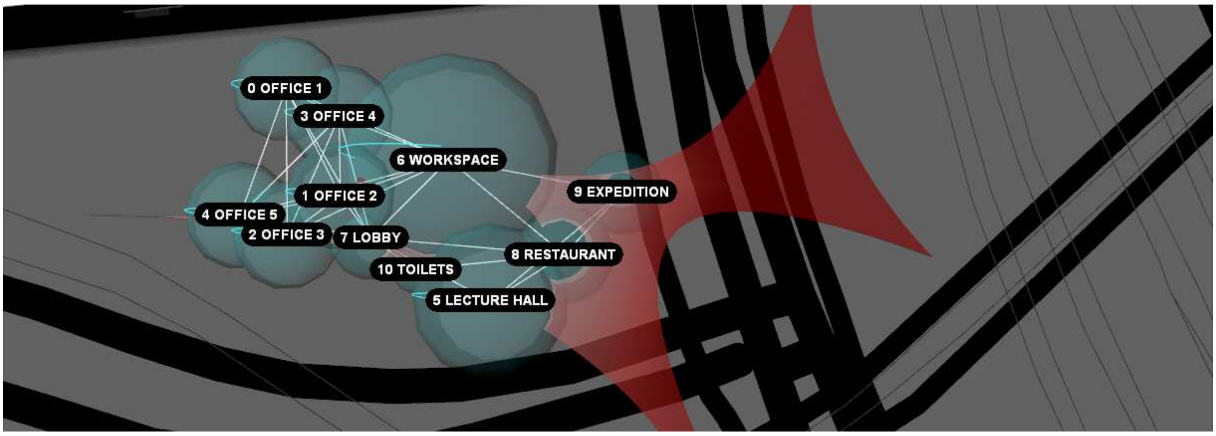

Figure 6 Space syntax attracted to urban context, in the shape of a mesh

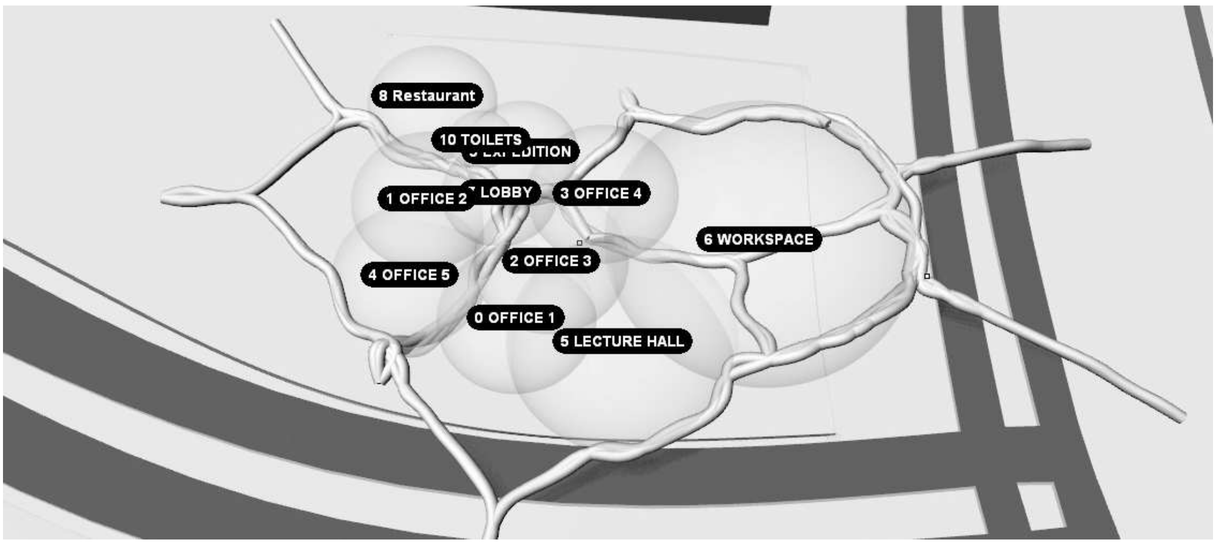

Figure 7 Result of iterative attracting curves to syntax

CONCLUSION

How do these research and design systems link to each other? The easiest, but rather rigid, way is to synch the grids of the analysis and design. This means that the analysis typology and the drawing topology match up. The information is lossless transmitted to the design, but design freedom is lost in rigidity. Less rigid methods might be useful, such as attraction based systems. A point cloud that needs to inform a mesh can look for the closest points on this mesh. Here the disadvantage is the loss of topology connection, so this works mostly for single sided geometries or more rougher estimations. Another way is a manual step in between computational processes, this grants maximum control to the designer, but breaks the information link between the analysis data and the design outcome.

The way we draw architecture is the interface between designer and design outcome, in our field this is done by computation. The interpretation of research into the design is not purely a computational matter, though the establishment of an information links between analysis and design is something to strive for. The way to deal with integration of analysis and design is largely dependent on the kind of information links that can be established. The combination of both traditional top-down processes and newer ways of bottom-up computational working grant a combination that allows the designer to use both to the full potential for the design process.

BIBLIOGRAPHY

Avermaete, T. (n.a.). *Architecture and its epistemes: lecture notes for students*.

Biloria, N., & Chang, J. R. (2013). *Hyper-Morphology: Experimentations with bio-inspired design processes for adaptive spatial re-use*. Paper presented at the eCAADe.

Boer, S. (2016). *Design to production (lecture at GSM3)*.

Feng, H. (2011). Quantum Architecture, an interministic and interactive computational design system. In K. Oosterhuis, H. Feng, & X. Xia (Eds.), *ia#4*. Heijningen: Jap Sam Books.

Fisher, D., Kattermölle, A., Kemper, B., & van der Doorn, O. (2016). Echosphere. In A. Conway, L. Boelens, I. Hemmings, F. Hoogenboezem, M. de Man, & L. Peng (Eds.), *Architecture Anual* (Vol. 1, pp. 136-137). Delft: ARGUS.

Huybrechts, D. (2005). *Complex Geometry: An Introduction*. Heidelberg: Springer.