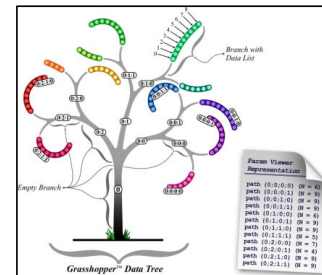
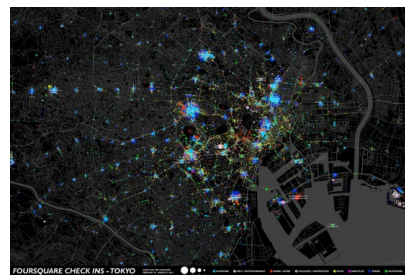
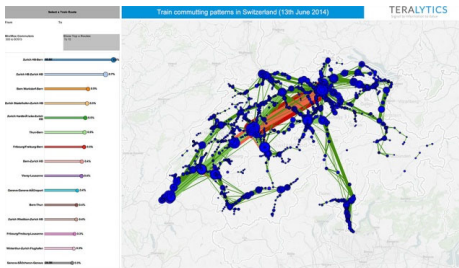
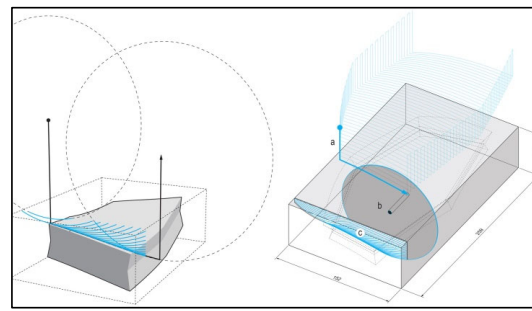
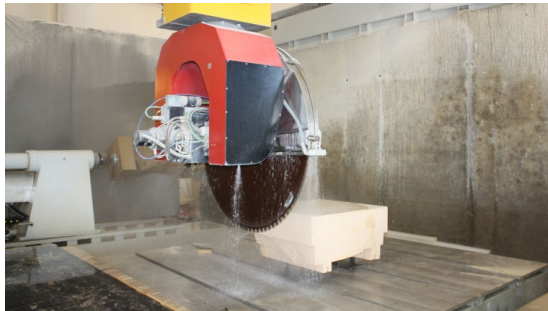
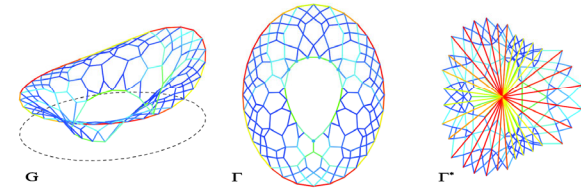
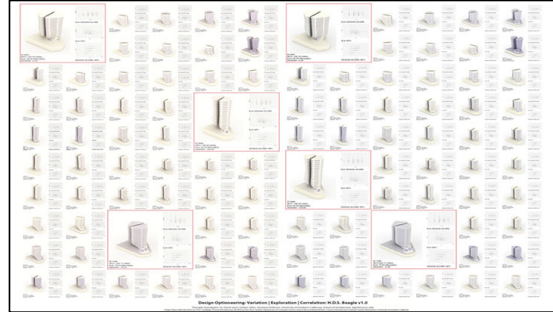


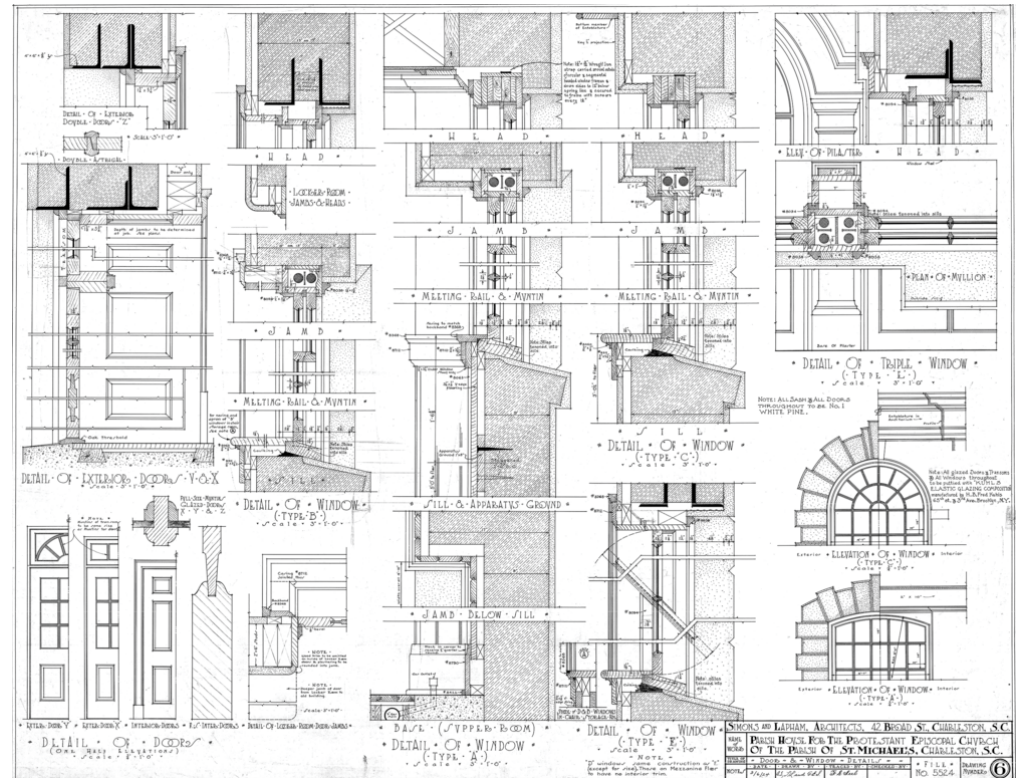
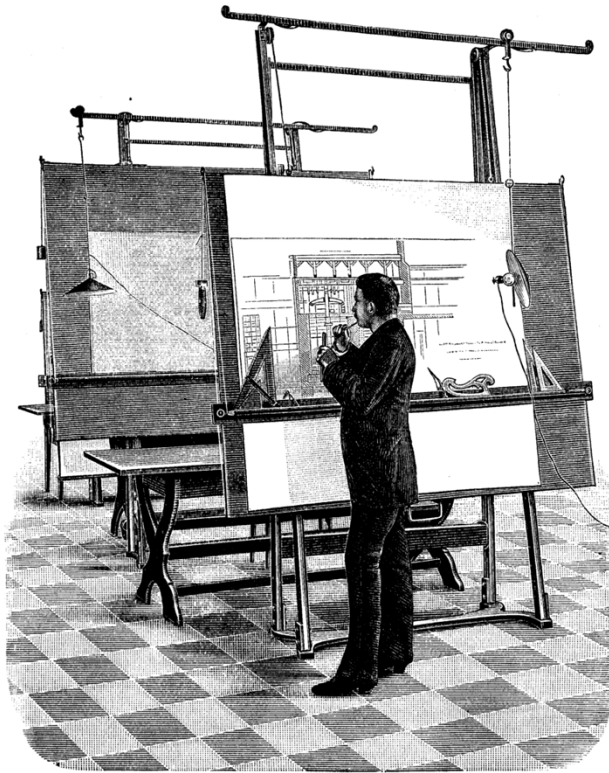


L01: Computational design in architecture

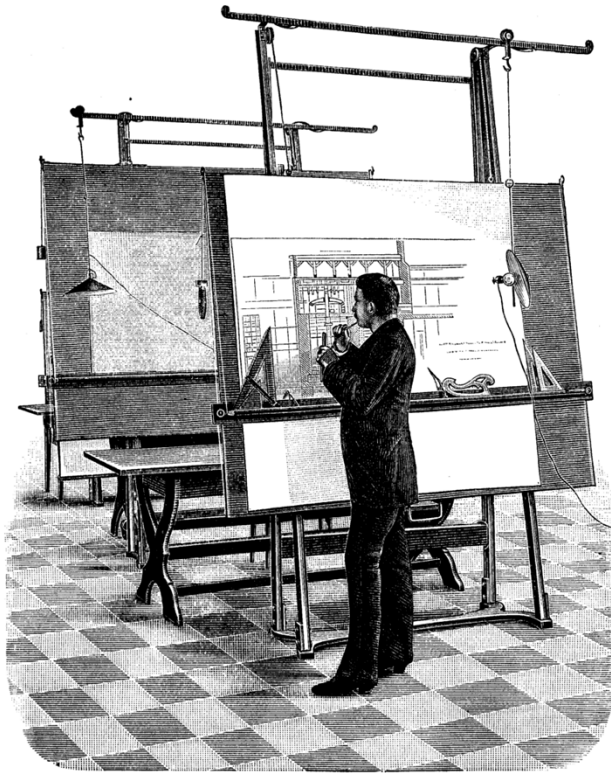
Computational design in architecture



Computational design in architecture

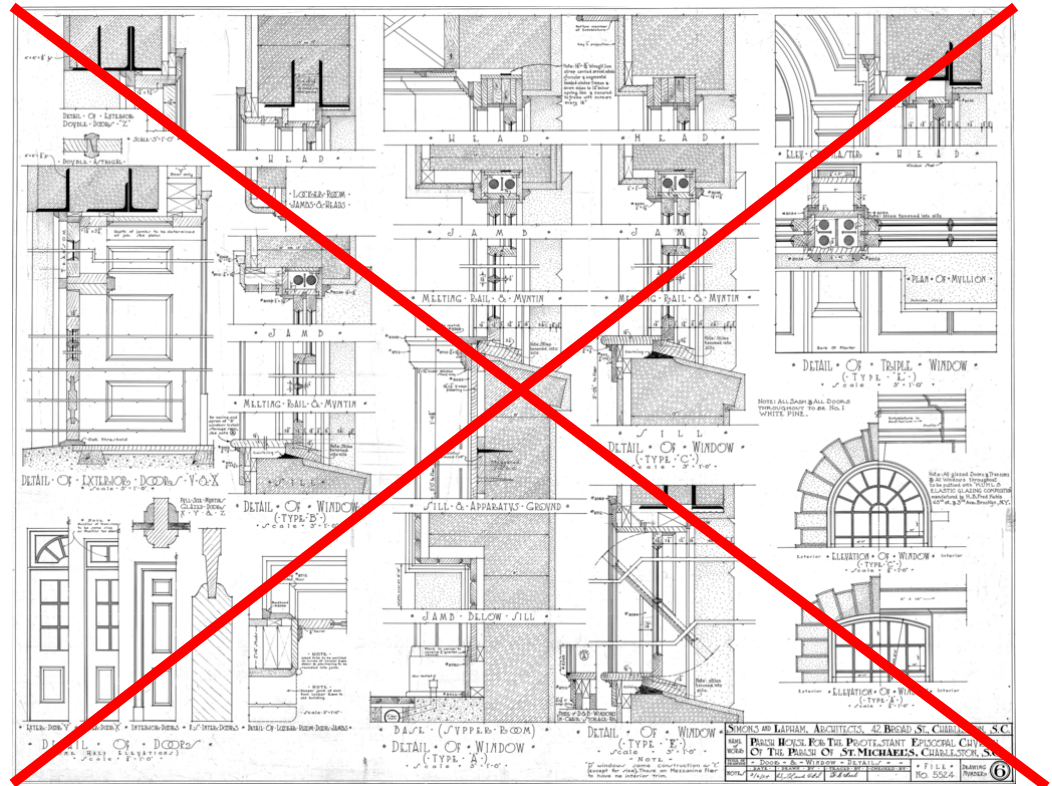
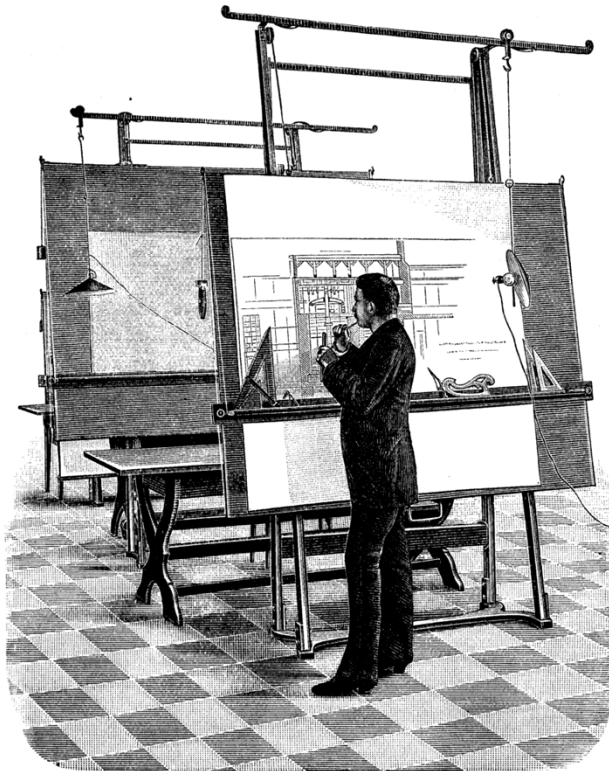


Computational design in architecture

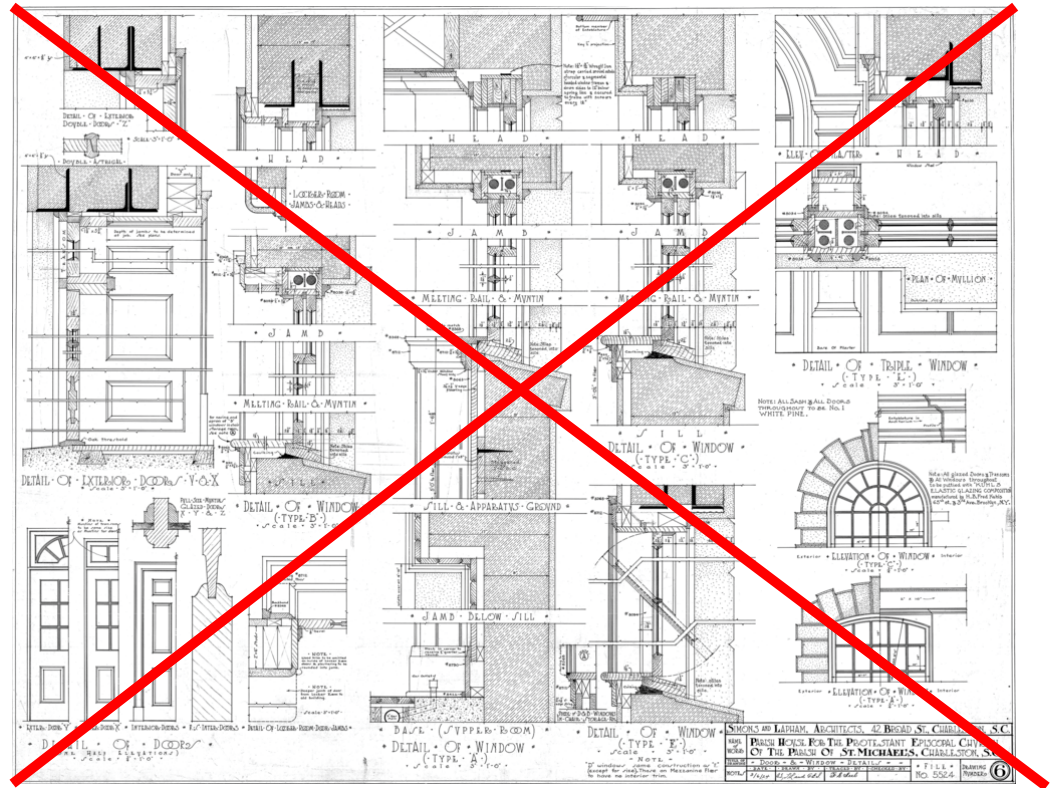
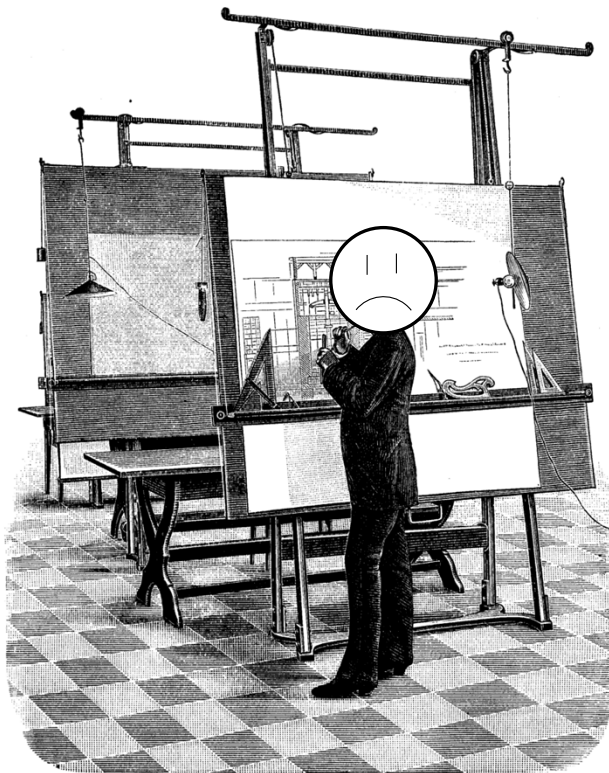


- What happens if someone changes something fundamental?
- How set up is this process to iterations?

Computational Design and Architecture



Computational Design and Architecture



Computational Design and Architecture

But wait, iterating and changing the design is usually what makes a good project. There **MUST** be a way of having a more DYNAMIC Design Process that can handle changes.



Computational Design and Architecture

But wait, iterating and changing the design is usually what makes a good project. There **MUST** be a way of having a more **DYNAMIC** Design Process that allow changes.

Ever heard of parametric Design?!

I build my design based on parameters, giving geometry defined properties and relations to other objects. That is the basis of what is called "Parametric Design". This makes the design process much more dynamic.



Parametric Design

Parametric modeling = **Associative** modeling

Modeling where the relation between objects control how they behave.

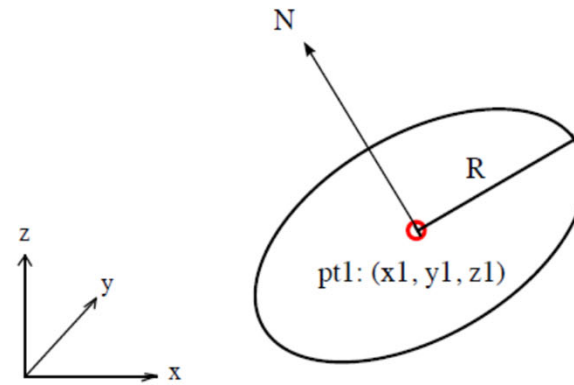
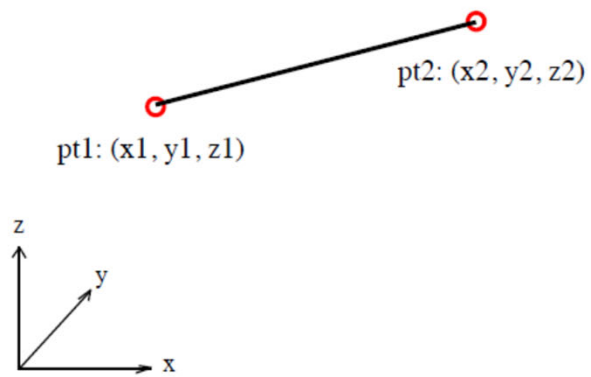
When building an associative model the emphasis is put on describing these **relationships** between objects.

These relations are controlled by **parameters**

Parametric Design

What is a parameter?

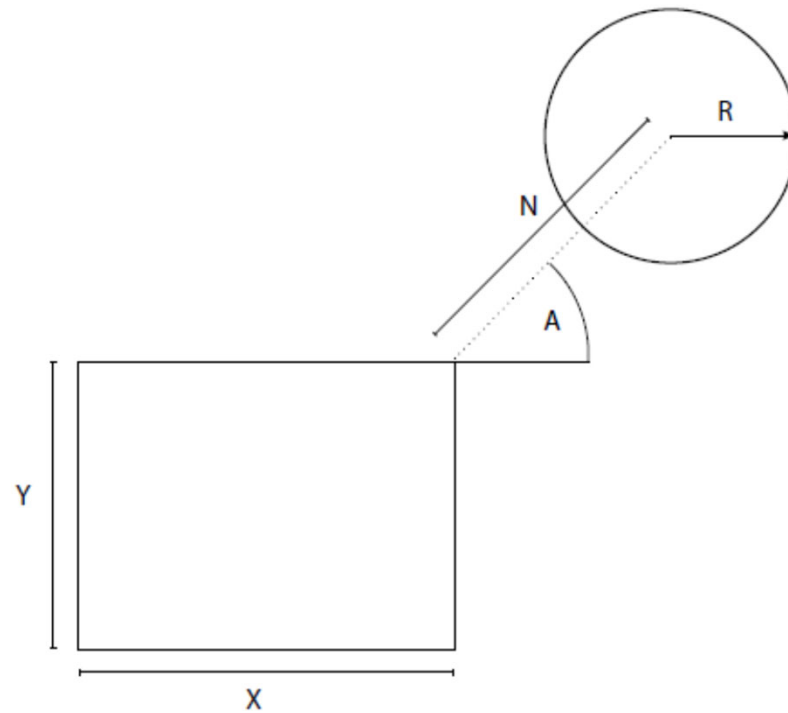
- Point - can be described by a x, y, z values in space (3 parameters)
- Line - can be defined by two points (2 parameters, or 6)
- Circle – can be defined by a point, radius and normal vector



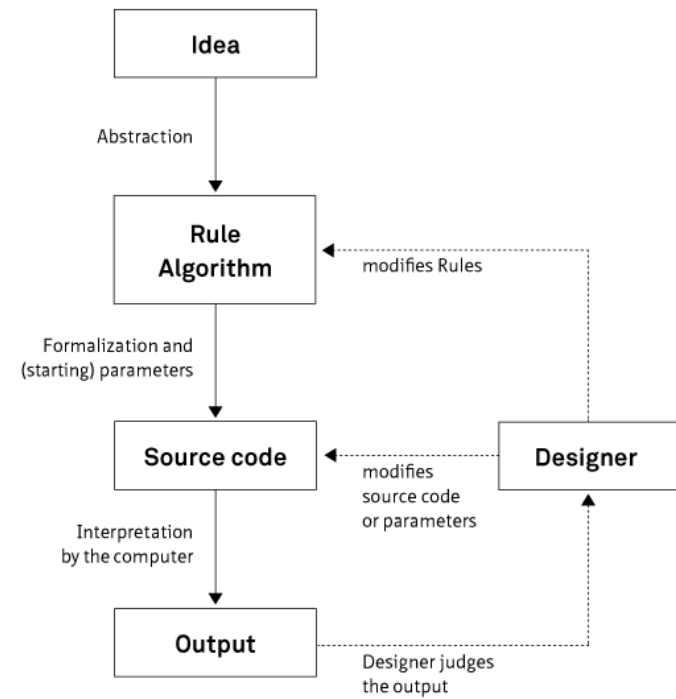
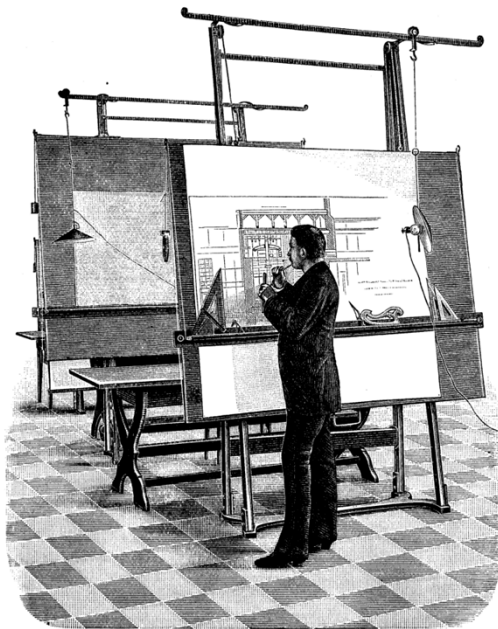
Parametric Design

Two categories of parameters:

- Property-parameters (R,X,Y)
- Relation-parameters (N,A)

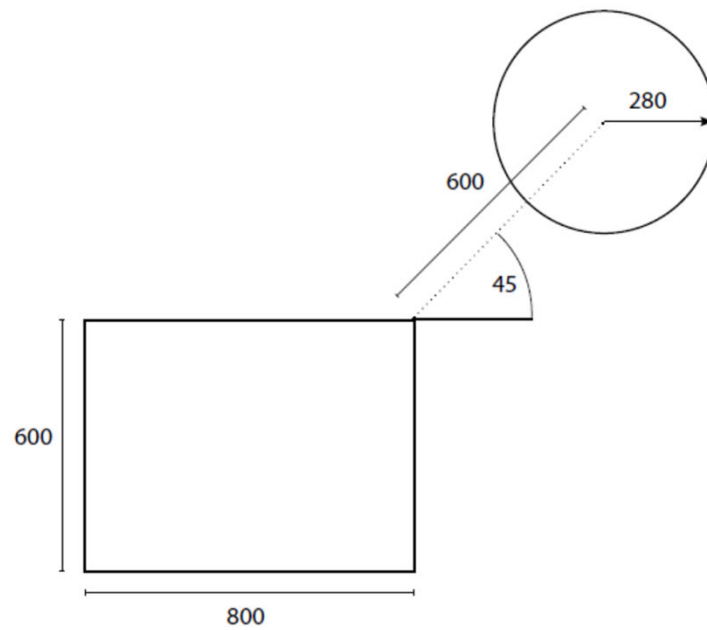


Parametric Design

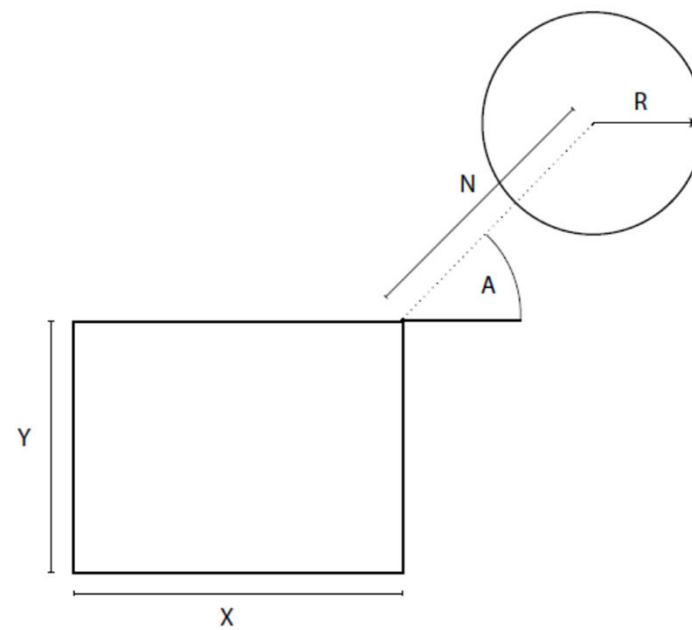


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Book „Generative Gestaltung“, www.generative-gestaltung.de

Parametric Design

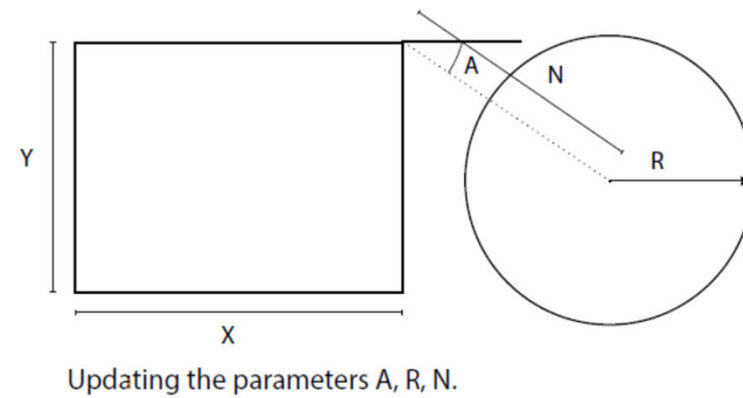
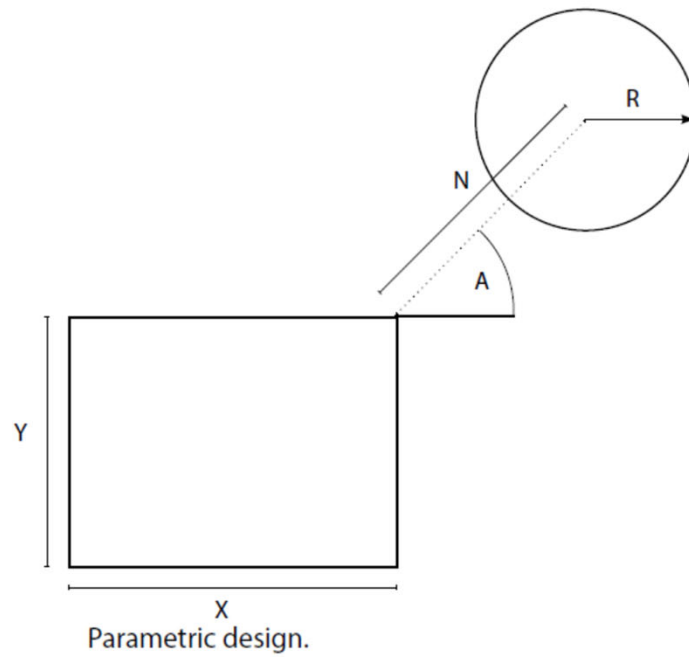


Explicit model (non-parametric)

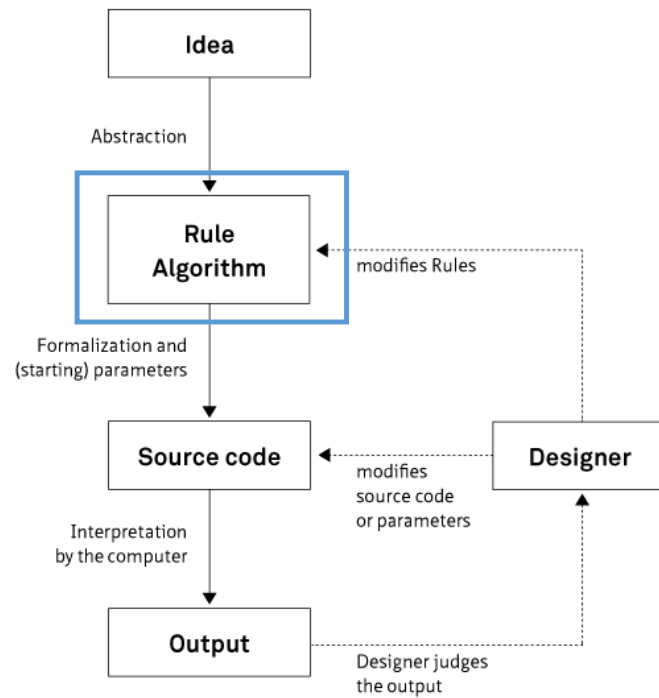


Associative model, where the circle is related to the corner of the rectangle based on the parameters N and A.

Parametric Design



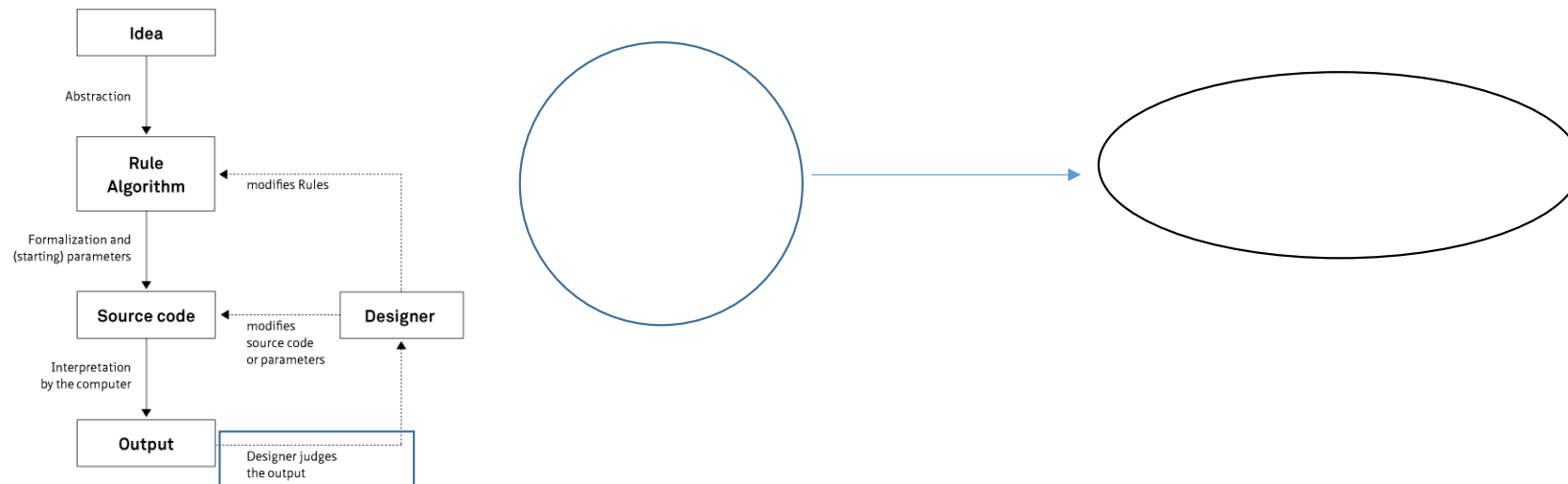
Parametric Design



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Parametric Design

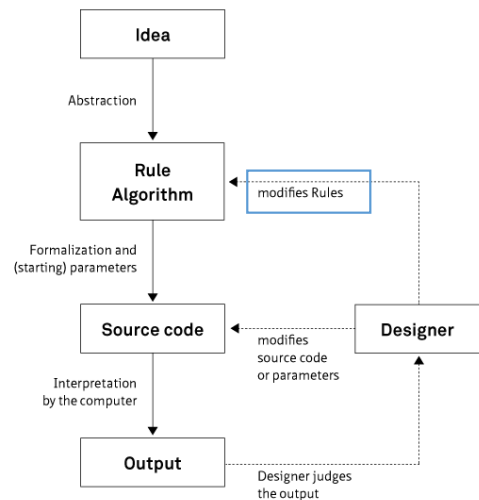
That sounds great, but what if I am not satisfied and would like to change the circle to an ellipse?



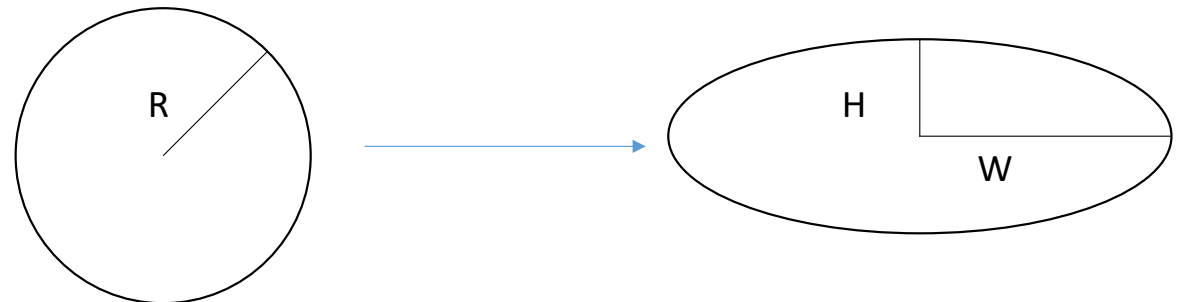
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Parametric Design

Yeah sure, but we need to update the parameters/modify the rules.



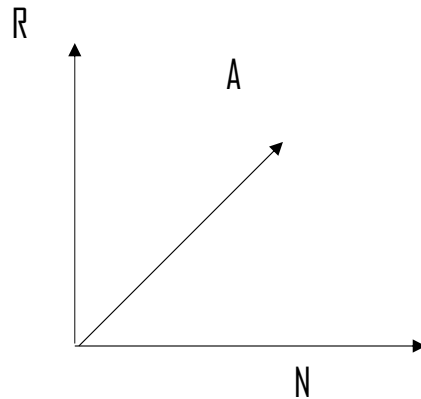
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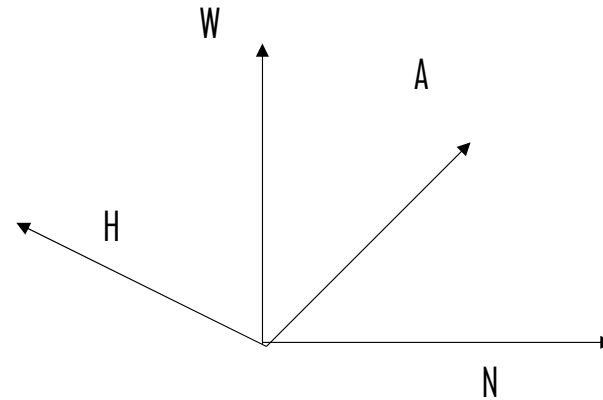
Parametric Design

IMPORTANT: A parametric model is defined by a "solution space" which is based on the parameters describing the model.

3 dimensional solution space



4 dimensional solution space
(I do not know how this looks, but you get the point)

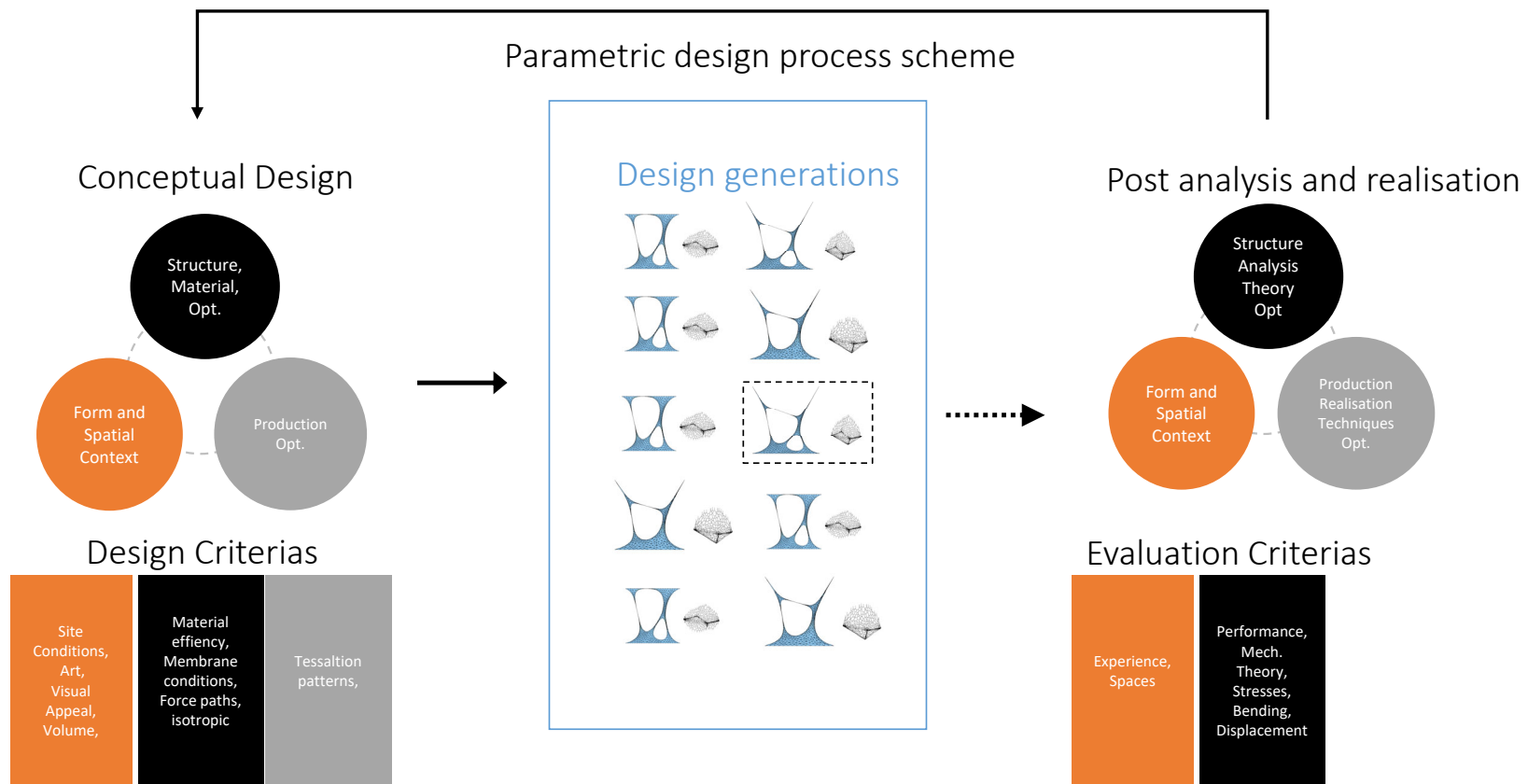


Parametric Design

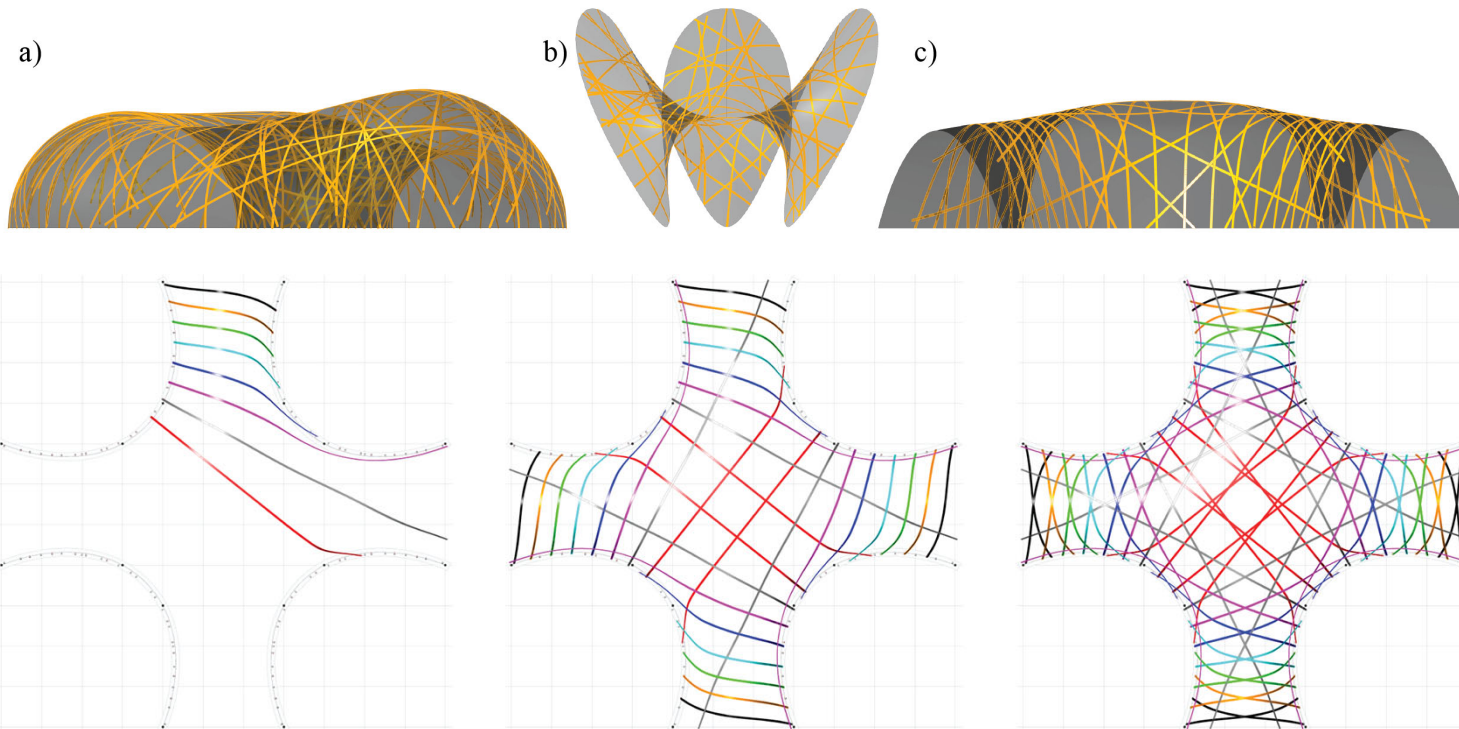
What features and concepts are available for me as an architect and engineer?

- Iterative Design Process
- Automation
- Design tool
- Performance driven design

Iterative design

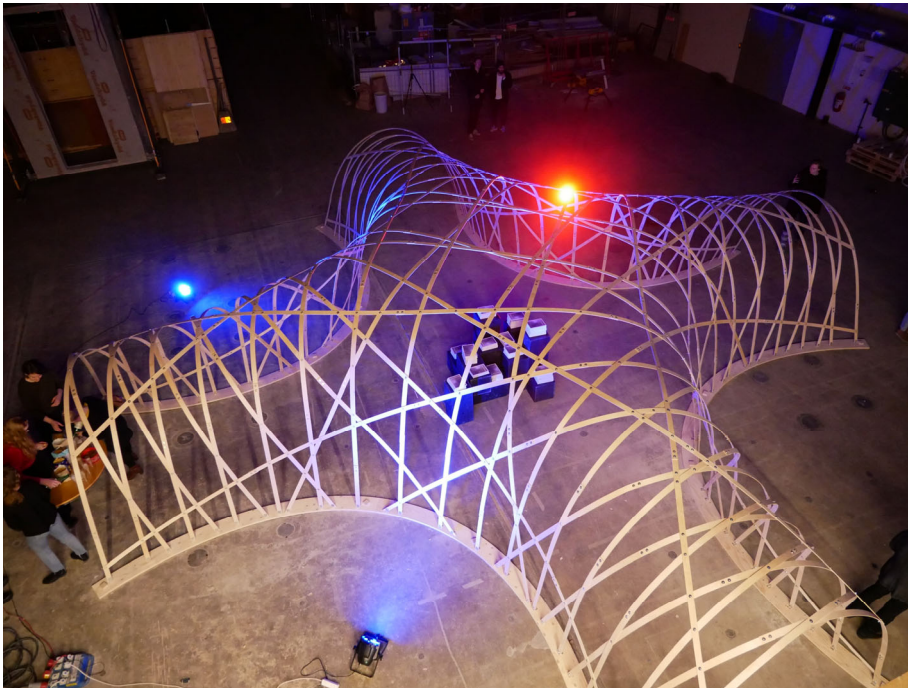


Iterative design



Adiels, E., Bencini, N., Brandt-Olsen, C., Fisher, A., Näslund, I., Otani, R. K., Poulsen, E., Safari, P., & Williams, C. J. K. (2018). Design , fabrication and assembly of a geodesic gridshell in a student workshop. *IASS Symposium 2018 "Creativity in Structural Design,"* 1–8.

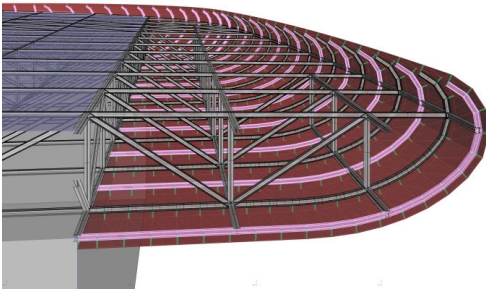
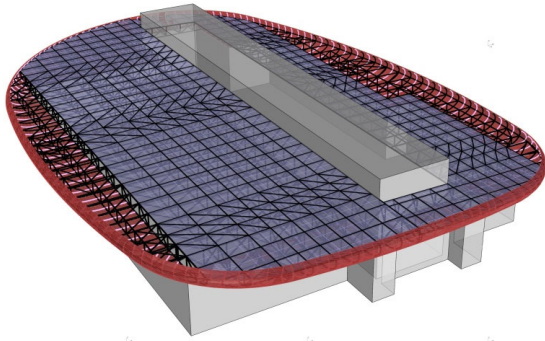
Iterative design



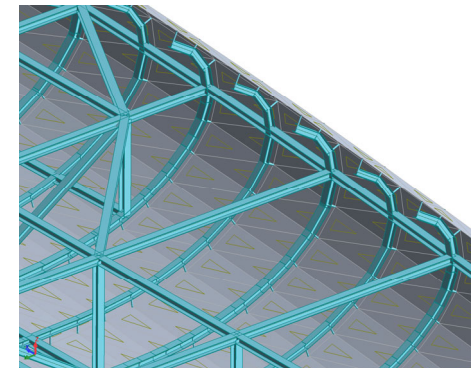
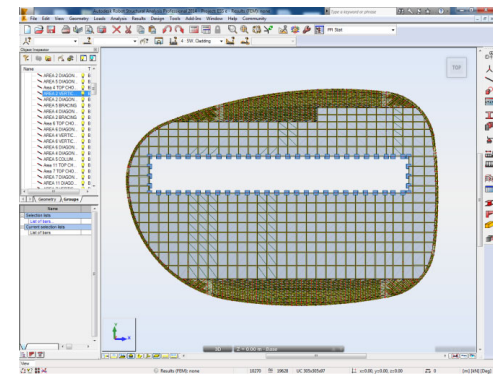
Adiels, E., Bencini, N., Brandt-Olsen, C., Fisher, A., Näslund, I., Otani, R. K., Poulsen, E., Safari, P., & Williams, C. J. K. (2018). Design , fabrication and assembly of a geodesic gridshell in a student workshop. *IASS Symposium 2018 "Creativity in Structural Design,"* 1–8.

Automation - Interoperability

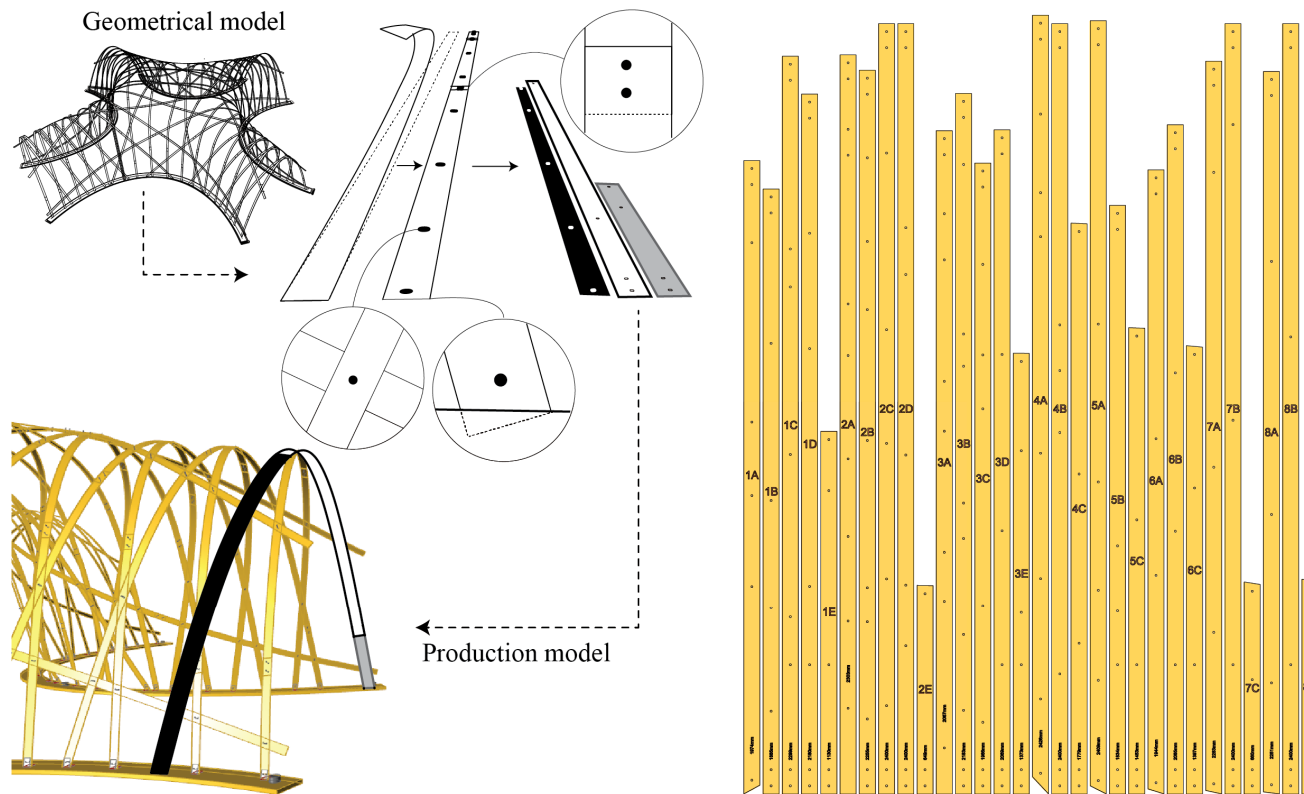
Parametric modell



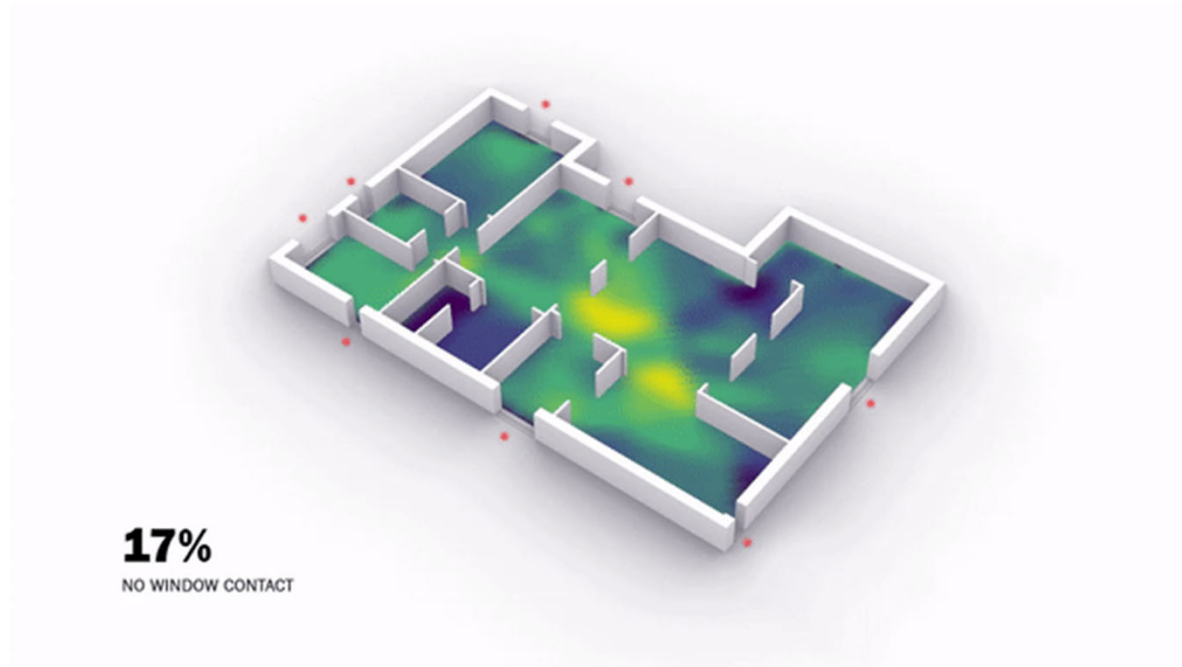
Structural Analysis in ROBOT



Automation - Production drawings

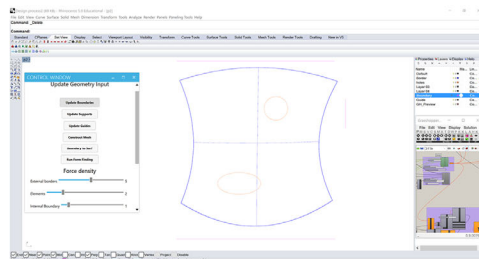


Design tools – “Simple tools”

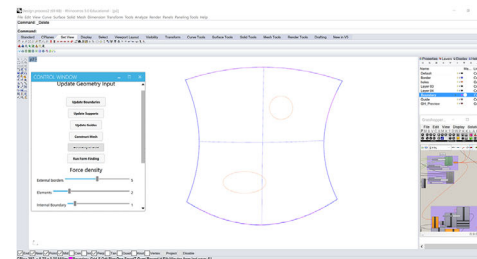


https://twitter.com/Andre_Agi/status/1148535099736174593/photo/1

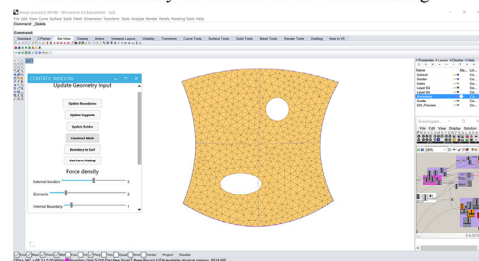
Design tools – “Simple tools”



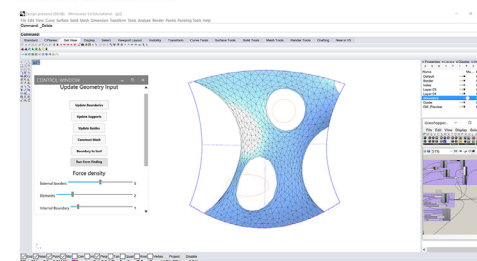
Generate external and internal boundaries for the model and the boundary conditions for the form finding



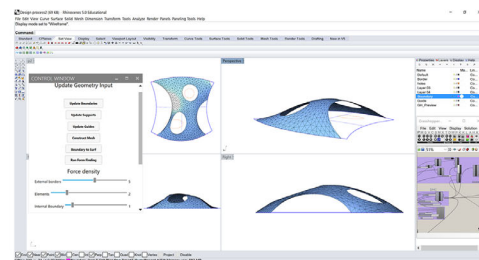
Apply the drawn boundary conditions on the external surface boundaries



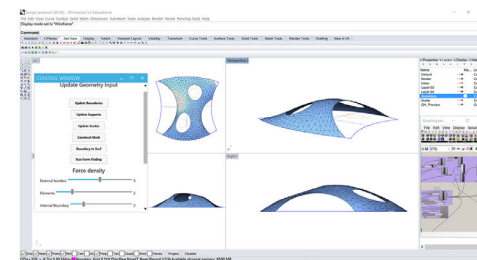
Perform meshing on the surface boundaries



Perform form-finding with generated mesh and the boundary conditions along mesh edges.

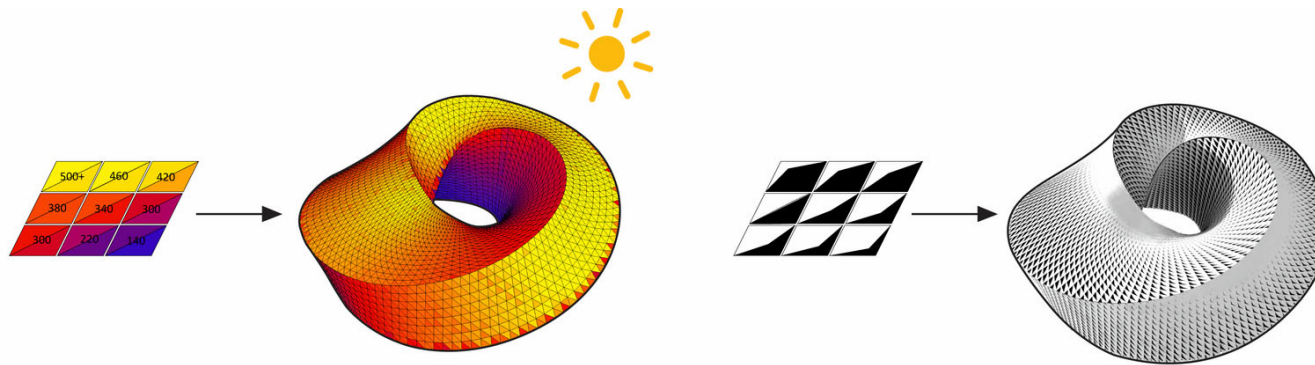


Adjust the force densities or stiffness in the members to generate a form that fits context and is appealing.



Performance driven design

Solar driven design - National Library in Astana, Kazakhstan / BIG



Pattern as climate screen

By using state of the art technology and simulation capacity we have calculated the thermal exposure on the building envelope. Due to the warping and twisting geometry the thermal imprint on the façade is continually varying in intensity. The thermal map ranging from blue to red reveals which zones do and do not need shading.

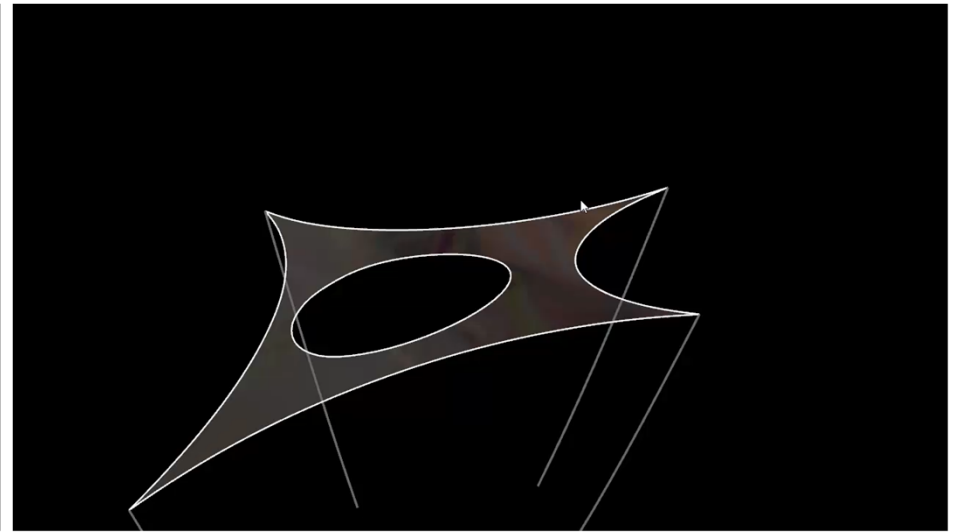
By translating the climatic information into a façade pattern of varying openness we create a form of ecological ornament that regulates the solar impact according to thermal requirements. The result is a contemporary interpretation of the traditional patterns and fabrics from the yurt. Both sustainable and beautiful.

https://www.archdaily.com/33238/national-library-in-astana-kazakhstan-big?ad_medium=gallery

Performance driven design

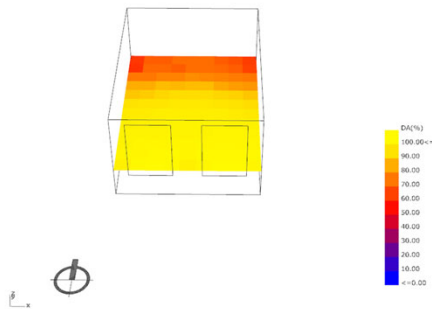
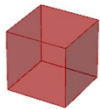


Real soapfilm models in a workshop from 2018



Soap film modelling by Daniel Piker
<https://vimeo.com/380131960>

All combined



<http://tt-acm.github.io/DesignExplorer/> CORE studio | Thornton Tomasetti

Parametric Design

-Is this useful?

Parametric Design

-Is this useful?

-YES!

Parametric Design

-Is this useful?

-YES!

-Does it mean that everything will be better?

Parametric Design

-Is this useful?

-YES!

-Does it mean that everything will be better?

-Not necessarily, it depends on how we use the tools. Though, it will probably be a necessary competence in the future. E.g. FEM Analysis among structural engineers.

Parametric Design

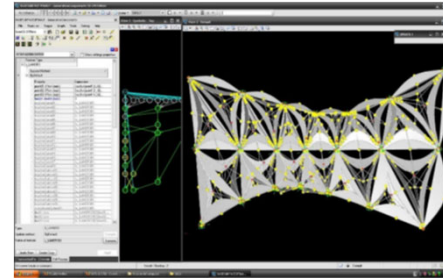
"Historicly" been a specialist diciplin

Usage growing rapidly

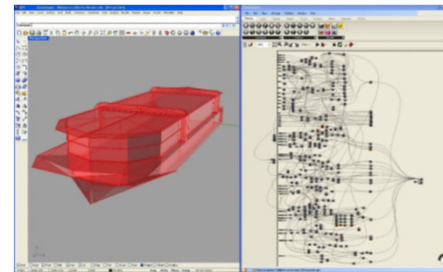
Now seen as a core competency at Buro Happold

Parametric Design - Environment

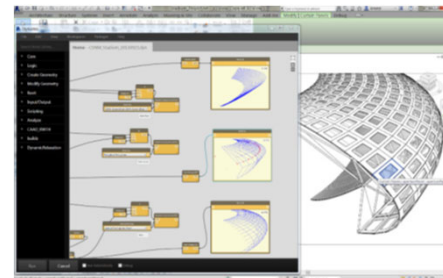
Generative Components for Microstation



Grasshopper 3d for Rhinoceros

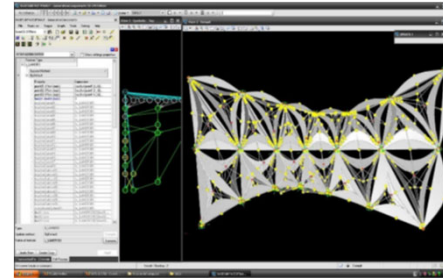


Dynamo for Revit

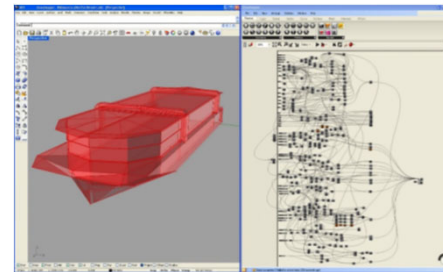


Parametric Design - Environment

Generative Components for Microstation



Grasshopper 3d for Rhinoceros



Dynamo for Revit

