THE HUNDRED YEAR BAUHAUS PAVILION, A RESEARCH BY DESIGN

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I Robotic Building and the hundred year Bauhaus pavilion

Weimar Germany 1919, the as what we now describe as the First World War has ended. Henry van der Velde director of the Weimar Saxon Grand Ducal Art School had been searching for a successor. The man he found to replace him was Walter Gropius. As the new director he made the decision to merge his school with the Weimar Academy of Fine Art into a singular design academy. This academy was named the Bauhaus. (Trachtenberg & Hyman, 2002)

Gropius set up the Bauhaus as a design school which merged fine arts, crafts, industrial design and architecture as an all-embracing aesthetic discipline; a Gesamtkunstwerk. Since the industrialization caused by the second industrialization a barrier between craftsman and artist began to raise. It is this barrier that Gropius wants to break down with teaching on the all-embracing discipline.

With breaking down this barrier the Bauhaus aims to create a new machine-age environment. The school's teachings pursues creative exploration of its design in laboratories and workplaces. It is there where experimentation with materials takes place, it is where design and technology gets integrated and prototypes are being made. These integral designs are formed in such a way that they can be produced through means of mass production. In the end this should form the new machine-age environment as Gropius envisions. (Oxman, 2008; Besgen, Kuloglu, & Fathalizadehalemdari, 2015; Chen & He, 2013; Frazer, 2016)

This year celebrates the hundred year anniversary of the Bauhaus existence. Even after hundred years the legacy of the Bauhaus is still present in contemporary design. The ideas have evolved since these past hundred years. One of which is the advancement of mass production of products to an extent that at the moment robots are being used to create complex mass customizable designs as gesamptskunstwerks. (Jiao & Tseng, 2004)

It is this Bauhaus legacy which is central to the Robotic Building studio. A year ago the chairs of Architectural engineering and Robotic Building merged into one. As a result robotic building became a studio within the larger umbrella of architectural engineering chair. While the other architectural engineering studios write a thesis, Robotic buildings on the other focuses on research by design. It is in spirit of Bauhaus that this research is done through experimentation, prototyping, scripting and programming with the aim of the integrating art and technology into a single design.

This semester's research is focused on the Design-to-Robotic-Production-Assembly and –Operation, often described as D2RPA&O, of the Hundred Years Bauhaus Pavilion in Dessau. Since this course did not provide enough time to design the pavilion itself, a pavilion of last semester was provided. The D2RPA&O approach was also scaled down to a research focused on D2RP, Design-to-Robotic-Production, with the predesigned pavilion.

The predesigned pavilion was segmented into three parts which where consequently distributed among four groups of students. It was up to the groups to design the segment and produce a fragmented part of it. The produced fragment had to be materialized with the usage of wood. Which than had to be robotically produced through subtractive ways.

It is for this fragment that the questions were raised of how we facilitate the users of the pavilion? Like how does it facilitate its desired function, and what requirements are needed for that specific function? While on the other hand the research explored its practical requirements as its structural, acoustical design and how this can be efficiently produced from a single material by usage of a robot, capable of mass customization, into a single holistic design.

II The Robotic Building approach, research by design

The end goal of the research was clear from the very beginning, the development of a pavilion's fragment. It was this manner of research which enabled the tutors to test our current knowledge of parametric design and prototyping. To start the research the macro scaled model of the pavilion had been distributed along the students. This 3D model is only suitable with the modeling program Rhinoceros 6. Rhinoceros offers the usages of a unique plugin, Grasshopper. Grasshopper is a parametric design tool which generates geometries by creating scripts based on parameters.

Just like Grasshopper is a plugin for Rhinoceros, there is a wide range for plugins to add to grasshopper, each offering different additions. Since the exercise was to explore through a series of practical requirements, this requested the investigation of various grasshopper plugins able to provide for the needs.

For the environmental needs Ladybug was selected due to it's elaborate range of possibilities and its user friendly interface. Ladybug converts environmental datasets, like weather datasets, into design parameters. This enables the user to project environmental data like radiation, shadow, rain and view onto the pavilion. Which than can be used as parameters for the design.

Karamba on the other hand had been selected as a plugin to analyze the forces flowing through the structure enabling the user to see the stress and compression lines mapped onto the geometry. In turn a user can then redevelop the geometry accordingly to for example reduce material usages.

In order to create an acoustic analysis regular grasshopper scripting was used. Basic acoustic reflection behavior was recreated by scripting lines projecting from a single origin and reflection onto a surface. The reflection is than based on the income angle according to the normal of the surface.

With these digital tools in mind we explored the properties of the manufacturing tools and materials. The tutors of this course had arranged that we could use the Hogeschool van Amsterdam their five axis ABB Robot. This could be mounted with a milling tool in order to achieve subtractive production. Besides the arrangement of the robot they acquired wooden beams in order to glue together into a bounding box for the fragment.

In order to line up the physical and the digital, precise measurements were taken from both the Robot, the milling tool and the wooden piece. These measurements were translated into digital geometries. This in order to run test subtractive toolpath simulations to avoid physical collisions.

When the model is ready for prototyping the model gets simulated digitally to avoid errors and mistakes. When the simulations and improvements are done the design is once again simulated. When the simulation show no faults a trial was run with a low cost disposable material like eps in order to do physical test. If the results are satisfying it is time to start export data and program the ABB robot in order to follow the toolpaths. When this is finished the process is analyzed to see what went well what went wrong so the next process can be better and more efficient.

III From Bauhaus to Robotic building, art and technology in a new age

The teachings of the Robotic building studio find their origin in the Bauhaus methodology from a hundred years ago. It is in 1923 that Gropius and the Bauhaus hold an international exhibition in request of Thuringian state government. Gropius uses this opportunity to show of all the Bauhaus achievements. The exhibition started off with an opening lecture by Gropius himself. Here he presents one of his most well know Bauhaus quotes: "Art and Technology: A new Unity". (Findeli, 2001)

But this quote is actually not the original idea of the Bauhaus. Gropius his original idea when he started the Bauhaus was to create a threefold unity where students were taught in craft, art and science. Even though that might have been the case in 1923 as well, the focus had shifted more towards art and technology unity with a smaller role for science. It were these aspects that were taught until the closure of the Bauhaus in 1933 due to the German National Socialism.

That did not mean the methodology and pedagogy of the Bauhaus were lost. The various teachers and students fled the countries in fear of the Nazi political party and ended up in other countries around the world, including the United States. It was one of the former teachers, Moholy-Nagy who on the advice of Gropius founded the New Bauhaus in Chicago. In his effort to establish this design school he tried to remain faithful to the original Bauhaus philosophy. But rather than having a focus on Art and Technology, Moholy-Nagy his new school focused on more on the aspects of Art and Science. (Findeli, 2001)

In the early 50s another another school continued on the Bauhaus legacy. The hochschule fur gestaltung in Ulm Germany. While the school continued to grow and develop itself the emphasis on Art and Technology began to shift towards Science and Technology. But the underlaying idea of epistemological structure remained the same. (Findeli, 2001)

This brief evolution of Bauhaus epistemological shows that there has been a threefold of aspects revolving in and out of main focus, art, science and technology. In the image below the result is visualized. The reason one of the circles is smaller than the other two is mainly because of the relative weight in the relative epistemological structure. (Findeli, 2001)

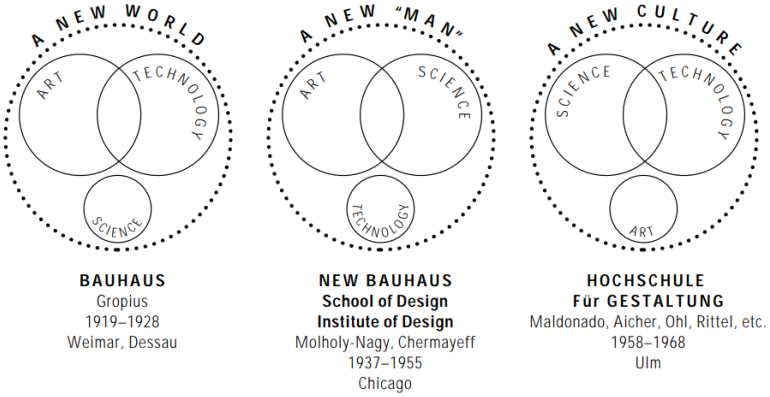

Illustration 1, A overview of epistemological structures. (Findeli, 2001)

While the threefold combination of art, technology and science did not change in the current teachings within Robotic Building. What did change is the advancement within the respective aspects of which the technological advancement is the most important for the Robotic Building studio. In the time of the Bauhaus two industrial revolutions had taken place. While in the hundred years past since than a third and fourth industrial revolution has taken place. With the introduction of computers and telecommunications in the third and later with the fourth the internet of things and virtual and physical intercommunication. (Bloem et al., 2014)

Where the Bauhaus focused on the production of designs through means of mass production. At Robotic building we now focus on mass customization, by the use of virtual parametric design tools. It is these tools that enable us to create complex geometries and do complex calculations. But that same tool raises question.

As designers who use computational parametric tools we basically have some sort of input, an output geometry and a script connecting both ends. But it raise the question where the architectural knowledge to generate the geometry comes from? In the literature it is stated that architectural knowledge is a combination of design knowledge and instrumental knowledge. But where can the computer and it's parametric tools be positioned? The same literature describes two separate groups. (Witt, 2010)

The first group sees the new digital as formalism, characteristically connected to complex geometric forms. This group sees design knowledge as architectural knowledge while the instrumental knowledge is just a means to produce is.

The second group views design knowledge and instrumental knowledge as equal dimensions to architectural knowledge. It is this group that looks beyond just the creation of form, it focuses on the professional and practical fields domains of power and control over design creation and realization. Designers that fit within this group seek to become and regain the role of the architect as master builder. They see the computer as a way to access and use domains of knowledge pragmatically and to extend and organize the capacity of architects. It enable designers to use embed knowledge into design through means of programming, scripting.

It is this group where the robotic building studio can finds its place. With its ideals of the Bauhaus and the contemporary use of technologies. It has been the embedded knowledge in the various computer programs that have enabled the designers to create holistic designs and design wide range of alternatives based on the same input parameters.(Frazer, 2016)

IV Art and technology, ingredients for gesamtkunstwerks

One of the main reason I signed up for the graduation at the Robotic Building studio is the fact that I

see importance in creating design as gesamtkunstwerk. Therefor it becomes necessary to tackle design with a holistic perspective and thus look at the various different disciplines for solutions. One of the ways to achieve this is the use of parametric design tools. But as our field of knowledge in each respective discipline grows larger so does the difficulty, complexity and time required to get skilled in these disciplines. Therefor it becomes increasingly more difficult to become an independent expert in multiple disciplines as a designer. But it is the parametric, computational and instrumental skills taught within this studio that could provide the knowhow of these disciplines to create design as gesamtkunstwerk.

However by using tools it is worth wondering whether or not the designer that uses the tools knows all the knowledge embedded within the tools themselves. Or is it that the user just has can tap into the embedded knowledge and use this tapped knowledge within the design. But this would mean that the user barely makes use of the full potential that these tools can offer.

On the other hand could it mean that the designer has become a manager of data streams and their flow? Than it would mean that the designer uses their computer as a central hub for data processing. It is this way of working that could provide the designer control over the process. That would mean the designer could once again assume the role of master builder.

But the management and usage of these digital tools also require specific knowledge. It requires the user of course the basics of extracting information. Not only that but it also requires knowledge about programming, scripting and various types of software and connect them all. The challenge hereby is that they themselves are very complex and with the fourth industrial revolution unfolding right in front of our eyes it will become even more challenging.

What would it mean when upcoming when upcoming technologies like artificial intelligence are introduced to the field of design? How would that shift the balance between the knowledge from the designer and the embedded knowledge from the computer? Will it than still be us who is creating the gesamptkunstwerk and will it be the artificial intelligence that becomes the master builder and the designer just the mere manager of the potentials the artificial intelligence can create?

Even though the robotic building provides me the knowhow to create a gesamptskunstwerk I feel like the strategy of design taught within the studio more or less results into familiar visual design geometries. I believe this to be a result of the way that data processing is taught within scripting and programming education.

Nonetheless the parametric tools provide plenty of wonderful possibilities but it also poses risks. Since these tools provide control over data on a logical and structural basis, a designer could get the feeling he is working with fixed entities. It could mean that the designer while creating these scripts could get some form of confirmation bias on the end result, believing it to be truthful to their own intentions. While the end result might be erroneous due to the errors during the scripting and programming of the design.

While these design tools provide great opportunities for the use of embedded knowledge of exact disciplines, e.g. structural, environmental and acoustical disciplines. But are these parametric tools also able to embed and capture knowledge from the social disciplines like psychology, anthropology and sociology. Of course we can scale aspects of these disciplines down to certain parameters. But can we with the technology we have now capture feelings and emotion into scripts? At the moment I don’t think so but these scripts provide the opportunities for creating many variations and these could be tested for the social impacts.

The final question is whether or not the prototype we created succeeds in the predetermined research goals we set up to explore and if the result ended up being a gesamptskunstwerk. I would argue that this it is hard to determine with such a small piece from a larger whole. But what I do know is that through the parametric research and design exploration the predetermined set of design aspects are integrated into a unified design, therefor proving to be a gesamptskunstwerk.

V References

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