Reflection

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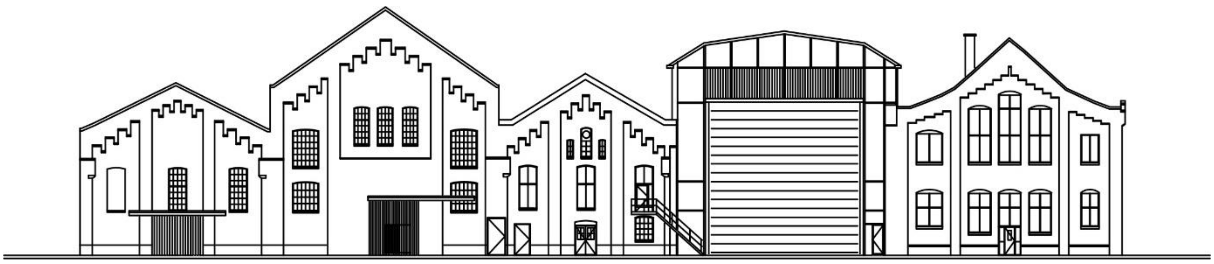

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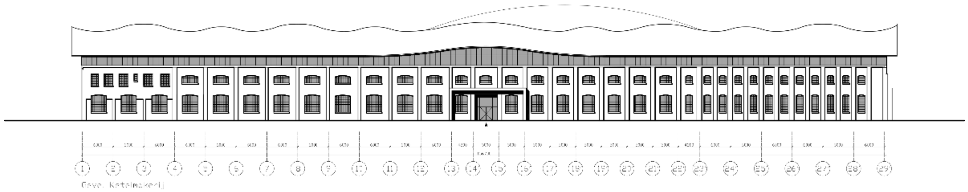
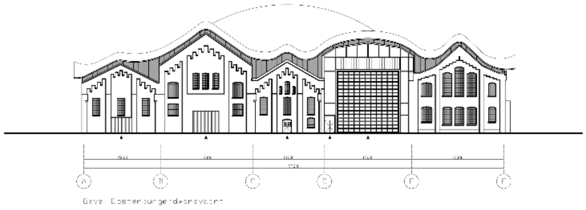
MSc4. Reflection

This is a short reflection on the topic of my design proposal for an architectural intervention in the Van Gendthallen in Amsterdam. This design proposal is made as part of my graduation from the Delft University of Technology, faculty of Architecture at the studio of Architectural Engineering and Technology.





Design Proposal

The Van Gendthallen are a collection of 5 factory halls which were built, rebuilt and transformed between 1898 and 1959 on Oostenburg island in Amsterdam. The halls were built to manufacture train and ship engines. The building fell in disrepair after the production process stopped in 1959. In 2011, new owners decided to make it possible for small creative companies to temporary rent space at low cost, while they are formulating a concept for the future of the building. At this moment in time the building needs a complete renovation and transformation to make it suitable for any new function.

When the Van Gendhallen were built, Oostenburg was a part of a larger industrial zone surrounding the city of Amsterdam. Today almost all (heavy) industry has left this zone and it has been transformed into high density residential areas. The non-transformed Oostenburg therefore has an uniquely low density compared to its surrounding areas.

With my design proposal I want to make use of this low density of the area and the large volumes of the building in comparison to the surrounding residential areas. One function distinctly missing in the eastern part of Amsterdam, which makes use of large volumes, is a multifunctional sports centre. My design intervention is to design a new roof for the Van Gendhallen. With this new roof the building will be transformed into one cohesive design, is able to accommodate the new sports function and will be brought to contemporary technical standards.

The relationship between research and design

The roof is made as a series of concrete shells of various sizes. The advantages of shell structures are numerous, while there are also some drawbacks. The first advantage is the reduction of stresses in the structure and reduction of volume of material needed for the structure. By shaping the roof (almost) according to the force trajectories through its volume, the stresses in the structure are reduced greatly when compared to more linear slabs. Shell structures are almost exclusively loaded in compression, whereas linear slabs are also loaded in tension and with bending moments. The more closely the shape follows the force trajectories the lower the stresses in the structures, hence less material is needed.

Noticeable difference between thickness of the structure:
- true shell, designed by Felix Candela (http://www.imagejuicy.com/images/plants/m/mexicoa/5/)
- curved slab, design by SANAA (https://beautifulrough.wordpress.com/2013/01/24/the-rolex-learning-center/)
- between shell and curved slab, designed by Toyo Ito (http://openbuildings.com/buildings/meiso-no-mori-profile-2819)

A second advantage is derived from the first advantage; the low stresses in the structure makes it possible to create larges spans. This gives more internal spatial freedom for the design and creates the possibility to a fluid architectural language. It also reduces the need for new columns and foundations extensively. The existing structure cannot be used for the new roof. Partly because of its unknown structural capacity and the lack of fire safety built in the structure, but mainly because officials have already reported their concern about the foundation under specific parts of the building. By creating a new large span structure only 56 new columns are needed, the original structure has about 4 to 5 times as many columns.

A shell structure design can bring a drawback to the design process. You have to be aware of the structural implications with every change in shape with each design iteration. Otherwise you can end up with a design that becomes thicker, structurally weaker and architectonically less elegant.

Another thing to keep in mind is the thermal expansion of the structure. Shell structures derive strength and stiffness from their shape. Deformation through self-weight and external loads are minimal compared to traditional structures. However, the Van Gendthallen are 157m long and 82m wide, a concrete structure of that size will expand massively due to thermal variation. This can build-up high peak stresses and can cause cracks and other failures in the structure. Therefore the roof needs to be designed as multiple segments, divided by expansion joints.

The main drawback of shell structures is the actual way they are physical built. To create a multiple double curved structure you need an one-off hand built mould for the entire roof. This way of building is too costly in this day and age (for almost all clients). Due to high labour costs all elements need to be standardized to keep costs down.

My research in the Architectural Engineering studio has been focused on the topic of flexible moulds and the structural application of the panels made with these kind of moulds. With this technique I want to overcome the need for an one-off hand built mould, thereby making it again possible for more architects to design shell structures. Flexible moulds are a relatively new technique and are still researched by start-up companies and researchers at universities. Panels made by flexible moulds are already being used in architectural designs. For example Zaha Hadid used panels as cladding in her design for the Heydar Aliyev Cultural Centre in Azerbaijan.

Prefab double curved panels are fitted to the underlying structure at the Heydar Aliyev Cultural Centre
(http://www.gizmag.com/zaha-hadid-heydar-aliyev-center-baku-azerbaijan/32783/)

The advantage of flexible moulds compared to traditional moulds is the possible re-use of the mould. By a computer controlled driven mechanism it is possible to change the shape of the mould. This makes it possible to create uniquely shaped geometries with the same mould. This eliminates the need for unique moulds of each uniquely shaped element. The designer can design as many differently shaped elements as needed for the design without the cost of the structure spiralling out of control.

The process is as follows:
- the designer makes a design with 3D modelling software
- this design is cut into (digital) panels, in a size that can be handled by the flexible mould
- the (digital) panels are send to the mould
- concrete is poured on the flat surface of the mould
- actuators under the flexible surface of the mould change the shape of this flexible surface into the desired shape while the concrete is still wet
- after the concrete has hardened sufficiently the panel can be removed from the mould, this panel can now be stored until it is completely dry and is needed on the building site
- the actuators flatten the surface of the mould

From digital model to physical concrete panel (http://adapa.dk/)

This process can be repeated until all desired panels are made. For a large building like the Van Gendthallen, 157m by 82m, a multitude of flexible moulds are needed to speed up the production of the panels. However these moulds can be used at following projects.

The limits of the size and shape of the panels is determined and limited by the size of the flexible mould. Experimental flexible moulds mentioned in research papers are often able to produce panels around 0,8-1,2m by 0,8-1,2m. This size is mostly chosen because it is small enough to be easily manageable and large enough to be able to perform tests with the panels. Theoretically flexible moulds can size up to any size demanded by the customer. Accurate data from commercially available moulds is hard to come by. Companies are highly secretive about their products, because flexible mould technology is still reality new, therefore production details are scarce and hard to come by. Requests made by me have all been ignored by all companies and researchers. However, if we look at the Heydar Aliyev Cultural Centre in Azerbaijan again, we can see panels used ranging from roughly 1m by 1m to roughly 5m by 3m. The maximum panel size used in my design proposal is 3m by 3m.

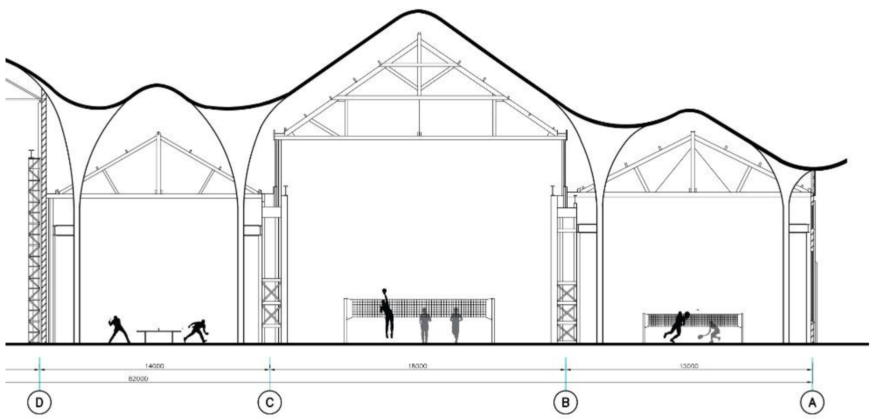
At the building site these panels will be held in place by a temporary structure. On top of the panels a layer of concrete is poured. After the concrete is hardened the temporary structure can be removed and the shell structure is standing. The panels created with the flexible mould are now integral part of the shell. This building process is similar to the broad slap floor process (in Dutch: breedplaatvloer). Then a layer of thermal insulation and a top finish can be applied.

The advantages of this process are numerous. Firstly, the lack of moulds to be made on the building site. All panels can be made in a controlled factory, this ensures smaller production tolerances and higher surface quality of the panels due to greater production control. The process of the production of panels with a flexible mould can largely be computer controlled. Also the time needed at the building site decreases, because all the panels can be prefabricated. Most important is the reduction of manual labour.

In my design proposal concrete still needs to be poured on top of the panels, to create a continuous shell surface. Maybe in the future when the flexible mould technique is developed further, manual labour on the building site can be reduced by only using prefab elements. The used technique is to new at this moment and therefore this is not possible yet.

The relationship between the graduation studio and the design

The mission of the Architectural Engineering and Technology graduation studio is making architecture with a fundamental relation between Design, Engineering and Technology. This vision is strongly interwoven in my design proposal for the Van Gendthallen.



Part of the building section showing the new sports function, with the new roof structure creating a new spatial quality.

The engineering and technology is not only essential in making the roof, it is also is an integral element in the design language used throughout the building. The whole design intervention is strongly tectonic, all columns and the roof are visible in the building. The placement of these new columns, compared to the placement of the existing columns, creates a dynamic new rhythm through the building. The multiple double curvature of the new roof, separated from the façade with a strip of glass, is in strong contrast with the linearity of old trusses. Another directly observable difference between old and new is the use of materials. The existing building is made from brick, steel and wood, whereas the new structure will be concrete. All these contrasts and similarities are deliberately chosen to create an interesting, but cohesive, architectural design.

A bold design like this for an intervention project fits with Architectural Engineering and Technology studio, while it probably doesn't fit with the Heritage & Architecture studio. A more subtle intervention design can fit both studios.

The methodical line of approach of the graduation lab and the chosen method

Like all prior projects, the design process in this project has been iterative and had many feedback loops. During the process four methods have been used; site and building analysis, literature study, case study and research by design. These are all relatively standard design tools for any project. There are a couple elements that are more specific for this project.

The project consists of a design intervention for a large existing building. Normally, for a new building project, the site and building analysis can be done relatively fast. In this case it was important to keep analysing the site and building throughout the whole design process. At first glance the building is easy to read, but at numerous occasions building details or sections needed for design progress were lacking from the provided documents. The easiest way to determine these building details or elements was by simply revisiting the building and amending the building analysis.

The size of the building is another specific essential part of the project. While making sketches digitally or on tracing paper it is easy to loose perception of the (human) scale. In previous projects I have worked on large buildings, but not with continuous volumes of 157m long.

The program also provided some unique challenges. A sports centre needs to house sports fields, which have to be a certain size. It is not possible to make these fields a little smaller just to fit them better in the building volumes. They also need to be completely free of building elements. This had great consequences for the interaction between program, spatial design and structure.

The integration of the technical research into the design, is the most prominent feature of the chosen graduation studio. Materialisation is of course always an integral element of the design, but during this design process it has been in the design from day one. The idea of making double curved surface(s) from concrete panels is the backbone of the project.

The relationship between the project and the wider social context

The relation between the design proposal and the social context is found on multiple layers in this project. The sports program is specifically chosen because there is a lack of sports facilities in the centre and eastern part of Amsterdam. The design intervention provides the citizens of Amsterdam directly the facilities they need. The influx of people to the building also reactivates Oostenburg, which is now either underutilized or completely abandoned during large parts of the day.

There are many more abandoned industrial sites and factories in Western Europe. The proposed design intervention, made by double curved concrete panels as a roof, may also be a solution in these other formerly industrial contexts. Transformation of existing building in cities in Europe is an important aspect of contemporary architecture. The outcome of the research may also be applicable to design interventions for other types of large scale buildings or for completely new structures.