Proceedings of the International Association for Shell and Spatial Structures (IASS) Symposium 2010, Shanghai
Spatial Structures – Permanent and Temporary
November 8-12 2010, Shanghai, China

Textile Techniques and Tectonics in Architectures

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Abstract

This paper discusses the various strategies for micro techniques and tectonics with macro variants to design and construct ephemeral architectures. As a starting point the work of Gottfried Semper is revisited to reveal the different qualities and characteristics of textile techniques and tectonics. To create an oversight of this content a matrix is used. From there, this diagram is evolved; state-of-the-art techniques and applications are added to create a contemporary overview. As part of the research several studies and case scenarios have been executed by the authors with a focus on the following topics.

To make ephemeral use of the architectural skin possible, second-skin facades are created by using textile techniques. Just as men change apparel from time to time, within a certain interval, the architectural dress or skin can be changed as well. By separating the art-form and the core-form, architectural facades can adapt to the change of use, fashion and trends without harming its structural body.

To provide sculptures with an appropriate structure, volume patterning techniques are developed. Unlike surface patterning, volume patterning is placed perpendicular to its virtual surface. By generating extruded ribs the structures are materialized.

1 Introduction

New techniques bring new architectural possibilities and new architectural possibilities bring new techniques. Of course this is nothing new and maybe too obvious to mention in the context of many symposia on advanced architectures, but in the line of architectural research it can be helpful and refreshing to open this vicious circle by providing new insights.

In his essay “What is a thing”, Heidegger(1968) mentioned that it takes more than a change of position for one thing to come to us as a thing. Trapped in boundaries related to a certain profession a change of position doesn’t leave the field itself. In this respect a step back from the chosen standpoint be the answer. By leaving a point of view at first, subjectivity makes way for objective thinking which may open or stretch the boundaries of the specific field. In an educational system which sets for specialization this isn’t easy. Studying a profession for many years can narrow outlooks. This is why things don’t come to us as things. We keep objects on a distance by re-membering ancient objects that perhaps were becoming things or had become one. [1]

In this respect, rethinking a certain matter in the same context can never reach further than its boundaries because it’s limited to the same framework. This way a certain matter is trapped in subjective judgment and predictive thinking. Heidegger(1962) calls a part of this phenomenon enframing. Like more abstract philosophical compound words, enframing can not directly be translated. In this context enframing has nothing to do with a structural framework. It is not an activity nor is it in itself something

technological. It's meaning consists of all ways having to do with things which let things show themselves in some way. But the thing with matter that let things show is that they don't show themselves and are thus hard to pin down.

Taking the theory of enframing into account and architectural techniques for example we can conclude the following. By "deframing" or disconnecting architectural techniques from its current background and enframe or implement it into another framework or field it is subject to a different context or set of rules. The subject is somehow freed from predictive thinking in which it can develop on different soil.

Few researchers in architectural design and geometry intentionally or unintentionally already work following a similar model. Papers and publications in this field take place in a different framework than architecture itself. Ranging from origami and paperwork to nature and morphology, researches try to implement a certain subject into an unfamiliar framework to stretch the boundaries of the architectural one. The framework used in this research is the one of Textile Techniques and Tectonics.

2 Possibilities of textile techniques in architecture

For arts like architecture and sculptural arts which traditionally need a notion of eternity to exist, fashion and temporality are natural enemies. Nevertheless the lean of general design towards commercial fashion and retail purposes resulted in a shift from eternal quality to a form of temporal satisfaction. Adapting to brands, fashion and retail design, these forms of design forced some interesting developments and settled in the crowd easily due to recognition and adaptability. "Sub-cultural relativism" leaves little space for discussion on the quality of these designs, but it can be useful to adapt some of its characteristics instead.

One of the characteristics in contemporary design is the acceleration in styles and trends. Where it took a style like baroque and the gothic more than 150 years to be followed up by the next, it took more contemporary styles like pop-art about ten years. Since the acceleration to a great extend has to do with developments in transportation and communication, it is not very likely this increasing speed comes to a hold soon. With people being part of several physical and digital networks today, trends change style and taste rapidly. [2]

Architecture as well as fashion are non-verbal media. Both communicate in an own language and a different vocabulary. Compared to fashion, architecture communicates much more subtle. Certain ornaments used in a trend or fashion would be absurd or even grotesque to be used in architecture. Scaling up these ornaments to an architectural scale can result in a non-satisfying results. Apart from commercials, architecture leaves little space for the use of print and figurative design.

Secondly for a language to communicate it has virtually to become a cliché. People have to recognize it in comparison to other likewise structures with likewise atmosphere and communication. With contemporary architecture being fragmented and widely spread and architectural magazines having a circulation of nearly one percent of its fashion counterparts, for common people clichés are hard to recognize. As a result the architect's vocabulary to communicate with isn't as accessible as the one used by fashion designers and design which narrows it's interacting audience to a small group of enthusiasts and critics. [3]

The rapidly changing style and taste together with the need to changing apparel with the trends to come, demands adaptability of both the designer, the product and its user. With architecture being a classical media, its lifespan endures several trends. When it can't compete it is to be demolished. Inspiration from fashion, textile techniques and textile formwork can force some change. Separating architecture's core-form from its art-form like posed in "Style in the Technical and Tectonic Art" by Gottfried Semper leaves space for adaptability through time.

It's needless to say that changing apparel through seasons and trends is far more easier than replacing a part of a building. Still, the characteristics like the lightweight characteristics and broad variety of textile techniques fit well in a tendency like mentioned. By the use of textile techniques, the vocabulary of architecture can be enlarged and more accessible by a broader audience. The use of lightweight Textile tectonics can enforce a more ephemeral use of architecture.

3 Discussion textile tectonics and textile techniques

In reaction to the late modernist architecture the discussion on Tectonics revived by the end of last century with, among others, the work of Kenneth Frampton. In the center of all discussion on the use of tectonic and first of all the meaning of it, is the work of Gottfried Semper. In his works “Der Stil” and “Die vier Elemente der Baukunst” he gives rise to the technical arts of textiles, ceramics, carpentry and masonry with which he tries to unfold art-form to its origin.

For Semper, Tectonic is the art of assembling stiff, planklike elements into a rigid system. This rigid system is, as he said, indisputably the most important art for the theory of monumental style. [4] In *Der Mythos der Konstruktion und das Architektonische*, Kollhoff reacts to this notion by posing Tectonic as a unity of the, at first sight, opposite pairs of construction and representation, art and technique. [5] Frampton related this distinction to the representational and the ontological (the symbolical and technical) aspects of tectonic form. [6]

Through this discussion and different interpretations, the definition of “Tectonics” has become as diffuse as the definition “Design”. Discussing these definitions will become a paper in itself. To make things for this paper more clear a logic of Techniques and Tectonics is set. In the tectonic discussion the material itself, the way it is handled and the craftsmanship in the joining of parts has to be in balance. This is why in this paper a distinction of Tectonics and Techniques has been made. Textile Tectonics are ways to make the material itself. Textile Techniques are ways to process the Textile Tectonics.

Revering to the education of textile formwork a distinction between fabrication, processing and application is used. Translated to architecture, the fabrication of textiles is the Tectonic aspect of materials. In other words, Textile Tectonics are certain assemblies of small elements to fabricate textile building material. Textile Techniques on the other hand are ways to process the Textile Tectonics. Using Textile Tectonics or other materials, the use of Textile Techniques in architecture result in building components. Finally an application of Textile Techniques can result into Architectures.

A framework of Textile Techniques and Textile Tectonics relevant to architecture

As a result of the distinction of Textile Techniques, Textile Tectonics and its subdivisions, a framework is created and presented through a matrix. The model embodies a research and educational guideline for techniques and tectonics applicable for architecture and structural use. The matrix can grow horizontally to give a broader view, it can grow vertically to give more depth in a certain subject.

Like mentioned a separation between Textile Tectonics and Textile Techniques is made at first. Both subjects are vertically separated into main groups. As a pad for Tectonics, the separation in treatment of materials as stated in “Der Stil” by Gottfried Semper is used. [4] A translation to architectural use is made by a subdivision in direction and one in structural and non-structural use.

For a pad for Textile Techniques, not much technical and philosophical material is available. In "*Le pli*" by Deleuze a broad field of folding is discussed. Technical use is discussed more in mathematical use than in a technical one. Therefore the subjects on Textile Techniques is lifted form technical books on Textile Formwork in general. In contrast to the Tectonics, division in techniques is mostly made horizontally, only patterning has a division vertically.

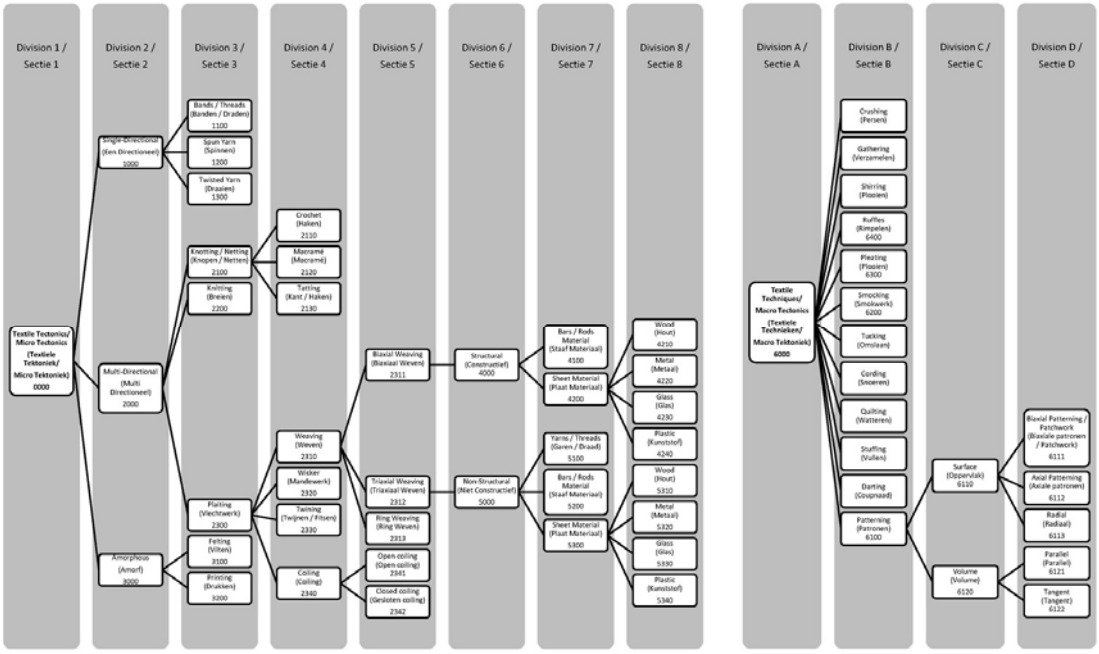

Fig. 1: Matrix Textile Techniques and Tectonics

Textile Tectonics and Textile Techniques are placed in horizontal order. In the matrix the two are not connected, in application most Tectonics can be processed by Textile Techniques. These main groups are placed in first division, respectively "1" and "A". From here a division into subdivision is made. This way every subject in the same subdivision refers to a likewise evolution in a different field.

The first subdivision and the most visual one used in the diagram of Textile Tectonics is that of direction. Considering all Textile Tectonics, three directional groups stand out the most. Consecutive the Single-Directional, the Multi-Directional and the Amorph.

Single-Directional Tectonics result in a line-like product or a positioning of threads parallel to each other. All Single-Directional Techniques are situated in an X or a Y direction and don't interfere.

Multi-Directional Techniques result in a surface or volume assembled by Single-Directional elements in multiple directions. By interlocking line-like elements in a certain way, Multi-Directional Textile Tectonics are produced.

Amorphous Tectonics don't have a assignable direction. By a illogical interlocking of elements, the material is produced.

The second subdivision is structural use. With this quality not often used in everyday fashion, it is of great importance to Architectural and Structural use. Non-structural Textile Tectonics result in cladding material. With a structural frame as a Core-Form, the dress together with the frame encloses the inner space. Structural Textile Tectonics can exist structurally without any framework. By its materialization and geometry, it is able to stand by itself.

Cutting patterns have a long history in clothing and fashion. Carefully formed and fitted round a body, the patterns are placed in line of the contour its covering. Unless well designed structurally, surface patterning needs pretension or rigidization to be scaled up to architectural scale. To stay in line with patterning, a body has to be applied by volume patterning.

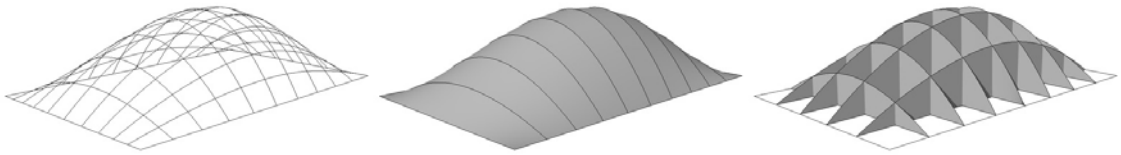

Fig. 2: Grid, Surface-Patterning, Volume-Patterning

In patterning a subdivision into two main groups is made. The first group represents the group of surface patterning. The group of surface patterning contains all patterning techniques that form a surface in line of its outline or contour. The axial, bi-axial and radial pattern direction posed in Division D all form the surface in line of the surface itself, only the direction itself differs.

Volume patterning is a surface structure describing its surface by patterning on an angle to it. In contrast to surface patterning, volume patterning describes a surface incidentally. The pattern isn't situated in line of the contour but perpendicular or angled to it.

According to surface patterning, three divisions can be made. The first division contains all axial patterning. This division holds all pattering parallel to one another. The second division contains all radial patterning. This division holds all patterning with a form generation from a centre point. The third division holds all biaxial patterning. This division holds all form generation by patching, tiling and panelization.

According to volume patterning, also three divisions can be juxtaposed. Like surface patterning the first two divisions hold all axial and radial patterning. These forms of patterning start from patterns placed vertically, describing de surface in a radial or axial direction. The third one contains all tangent patterning. Tangent volume patterning is subject to the surface it's projected to. The patterns are placed perpendicular to the surface's tangent. This results in a sum of axial and radial patterning.

4 Textile Techniques and Tectonics; geometry and application

To describe the way Textile Techniques and Textile Tectonics can be used in architectural practice, a case study is used. The study represent a sculptural use conceptually designed by Maarten de Reus. Structural design and engineering of the Puma is done by Mark Feijen (i-Saac) and and Ivo Vrouwe (WorkShop IV).
The Beacon, a sculpure by artist Maarten de Reus, is placed in the Noordoostpolder, the Netherlands. The sculpture serves as a landmark and marks the boundary of a landfill. The concept of the design is based on the ancient fire beacons that used to stand in this area. The structure itself is not one of temporal nature. It is used as a case study because of several textile techniques used to form and construct it. Parallel Volume Patterning is used to construct the body, bi-axial weaving is used to create its infill.

The overall shape of the structure is formed by lofted surfaces between doubly curved border lines. A precondition was the generation the surface by a mesh of steel elements. This way the underlying structure remains visible. During engineering the challenge was to keep a balance in both structural behaviour and the expected sculptural form.

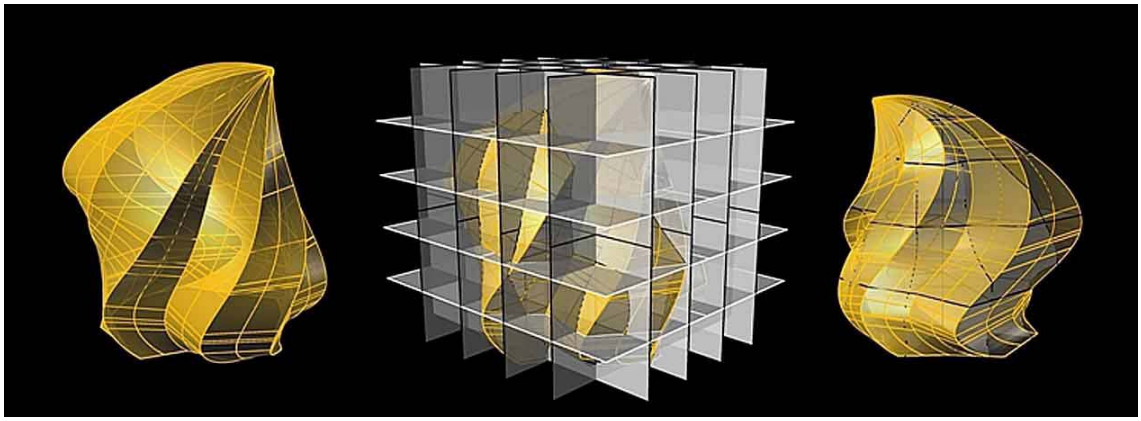

Fig. 3: Surface Sectioning

After considering several alternatives a structure of steel plate work was chosen. By cutting the global form in orthogonal sections the outlines for the surface-patterning was created.

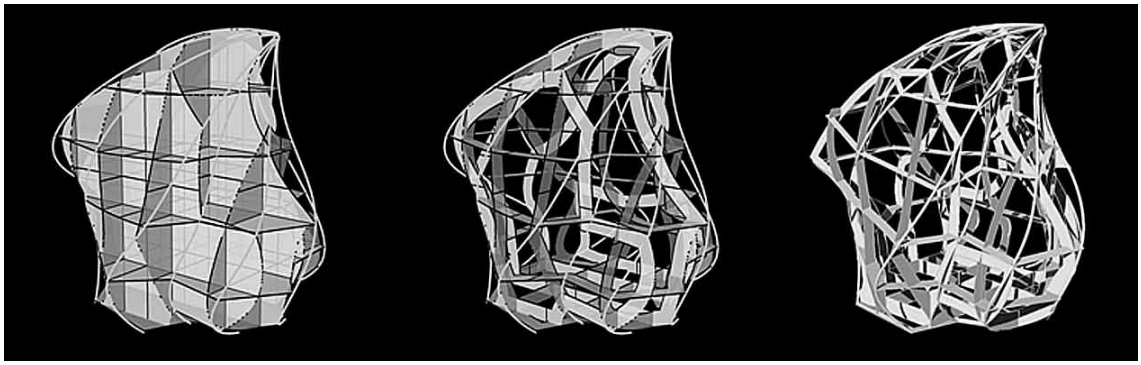

Fig. 4: Volume Patterning

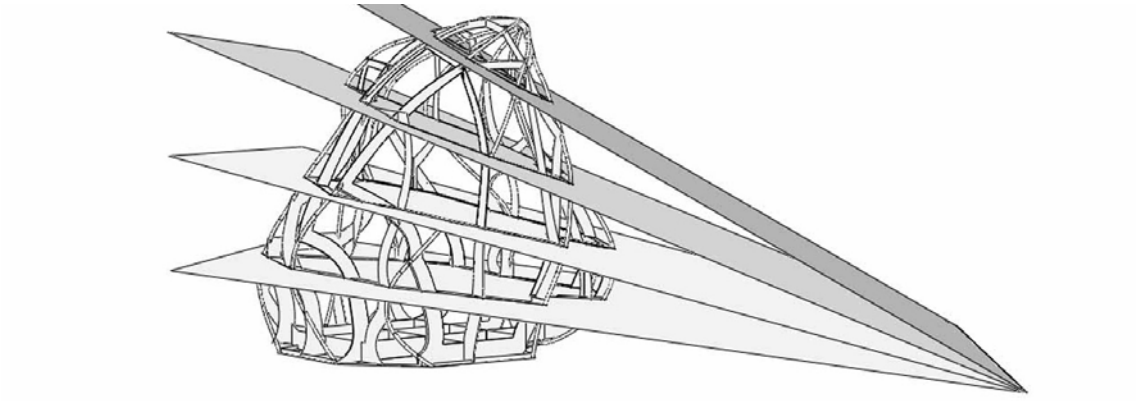

Fig. 5: Sloped Sectioning

The main structure consists of vertical closed framework which are interlocked by a horizontal one. To break up the orthogonal sectioning the horizontal sections became sloped. With a combined secant on a 15 meter distance a 45 degree was filled evenly.

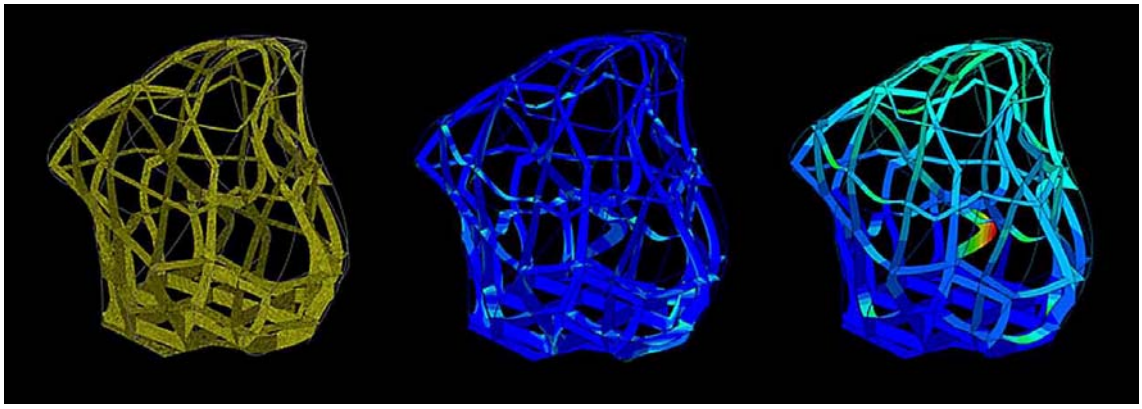

Fig. 6: FEM Analysis

The structure outlines, formed by tubing, is guided by the steel plate work. Next to the outline of the lofted surface-patterning, the tubing provides the structures torsion stability. Because of the absence of information about the surface mesh, the surface stiffness of this material wasn't taken into account during calculation.
The structural analysis is performed by importing the Rhino geometry in the FEM Software ABAQUS. All loads are applied and the stress distribution and the deformation are analysed.

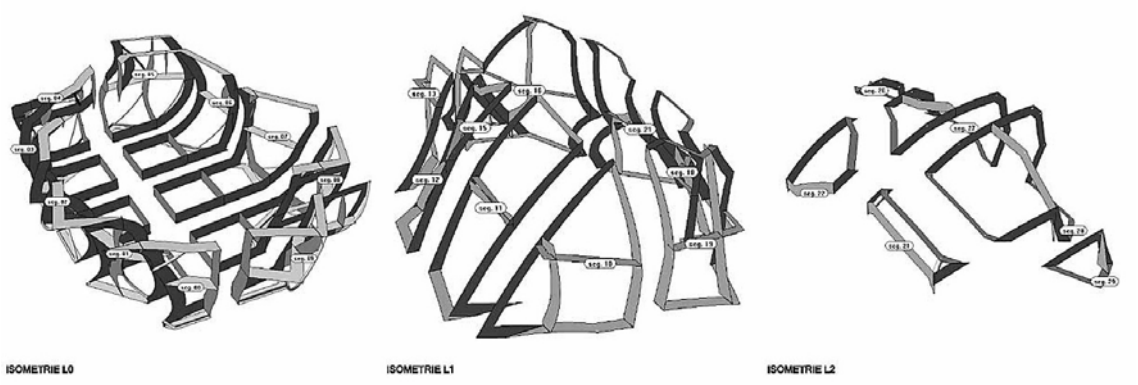

Fig. 7: Segmentation per level

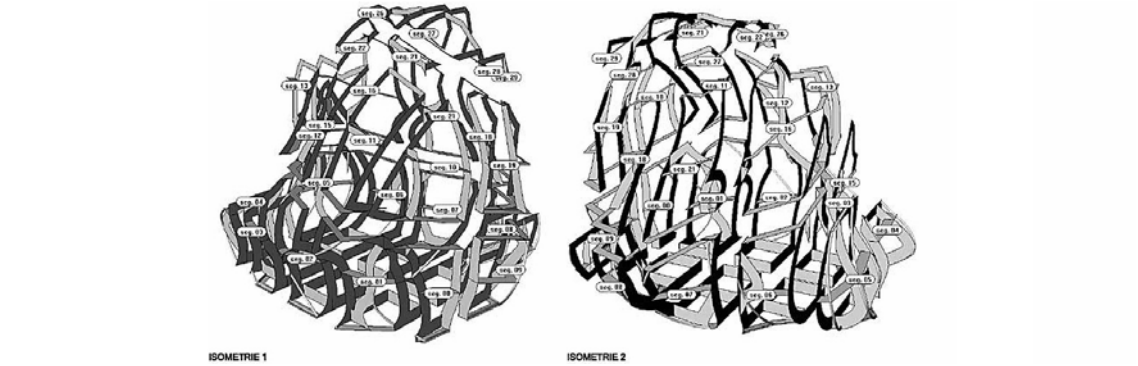

Fig. 8: Segmentation Structure

Due to the size of the structure, a second segmentation had to be carried out. Every segment should be build, transported and constructed separately to make realisation possible logistically.

Fig. 9: Pipe Segmentation

Steel strips ranging from 200 to 500 mm width, are cut and numbered directly from a RhinoScipt output. Every strip containing a segment and a component number could be constructed to a whole by corresponding drawing. The outer tubing geometry consisted of splines. Having difficulties bending the spline geometry, all were converted into arc segments an numbered digitally. Connecting all in strict order under right angles resulted in a flaming outline.

Fig. 10: Construction Structure

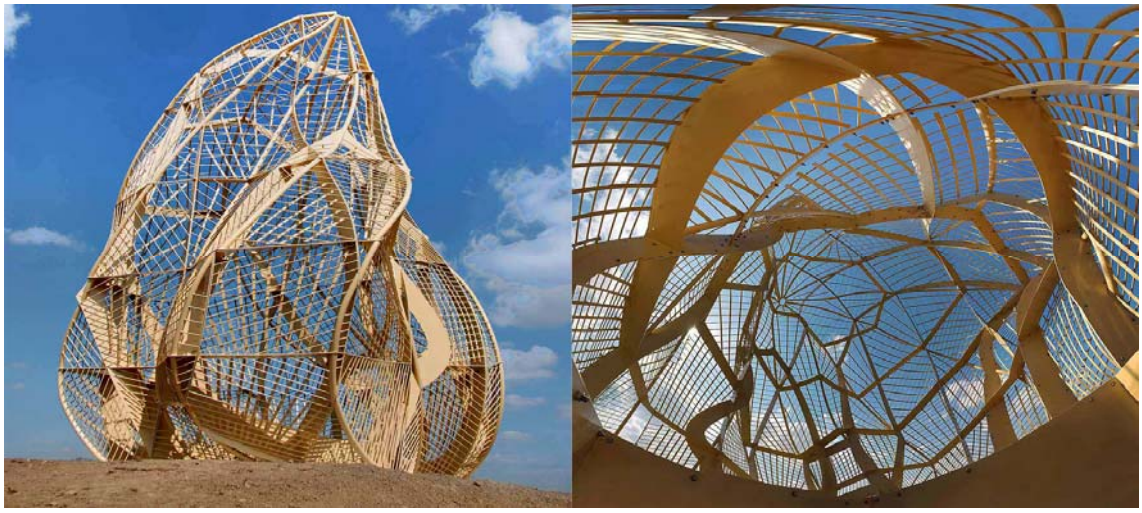

Fig. 11: Result Structure

5 Conclusion

Textile Techniques and Tectonics can be of great importance to Contemporary Architecture and Structural Design. Not only by its structural and dressing qualities it opens a new spectrum of possibilities but also by providing new medial capacity and a different framework to work with.

Several case studies attest to the fact that progressive use of these techniques can result in remarkable structures. The challenge through this research remains the evolution of Textile Techniques and Tectonics from a micro scale to a macro variant without harming its original nature.

References

[1] Heidegger H. Over, denken, bouwen, wonen. Uitgeverij SUN. Nijmegen, 1991.
[2] Vejlgaard H. Anatomy of a Trend. McGraw-Hill. New York, 2008.
[3] Barnard M. Fashion as Communication. Routeledge. Abingdon, 1996.
[4] Semper G. Style in the Technical en Tectonic Arts. Getty Publications, 2004.
[5] Kollhoff H. De mythe van de constructive en het architectonische. Oase 47, 1997
[6] Frampton K. Studies in Tectonic Cultures. The MIT Press, 2001