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Newsletter of the European based Network for the Design and Realisation of Tensile Structures

REPORT

TEXTILE ROOFS 2018

PROJECT

LIGHT ETFE FILM ARCHITECTURE SAVES 1.500TONS OF STEEL

LONG LIVE THE MEMBRANE

Light ETFE film architecture saves 1.500tons of steel © Dyneon ▲
Membrane canopies enrich a public space © Andras VanQuaille ►

TensiNews INFO

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contents

Edito

Dear Reader

I am glad to present TensiNews 35. It is again full of information about recent projects and research results.

The championship has led our eyes towards Russia this year. Some of the stadiums have been done with structural membranes. One of those, the façade for the stadium in Nizhny Novgorod is presented here. In St. Petersburg a large ETFE roof structure for the Laktha Centre has been finalized. And Textile Roofs was held this year in Russia. Joseph Llorens was one of the speakers in Moscow, and again he was so kind to prepare the summary for us.

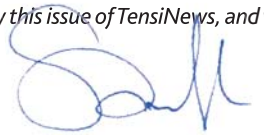
Two projects with coloured ETFE are presented. One single layer façade varying between white and different grades of blue has been realised in Mexico. And also far from Europe, a cushion façade in white, yellow is protecting an urban library from the western sun.

Other topics in this issue of TensiNews are recent research results and actual membrane projects. The 20 year old retractable roof in Tecklenburg has received a new membrane, and a public space in Belgium has been enriched with a light membrane canopy. The research topic knitted membrane structure has been applied for the Danish pavilion on the Biennale this year, and students and teachers from Madrid have finalized within the last eight years the sails under the skylight of their patio. This has already been published twice in our TensiNews.

With large steps we approach our next TensiNet Symposium 2019 "Softening the Habits" in Milan. We have received 65 abstracts in a wide range of interesting topics. The organising committee is working on the final program which will be distributed soon.

I hope you enjoy this issue of TensiNews, and will be glad to meet you soon.

Yours sincerely,
Bernd Stimpfle



Working Group EUROCODE SPECIFICATIONS

Work in progress to broaden the use of lightweight structures Up to the publication of the second generation of the Eurocodes

The final objective of the WG EUROCODE SPECIFICATIONS is to establish a Eurocode for "The Structural Design of Tensile Membranes Structures" as there exists for more conventional materials like steel or concrete. The development started in 2010.
Meanwhile the CEN/TC 250/Working Group 5 made quite some progress. After the European Commission published the JRC Science and Policy report (2016) the focus was laid on the development of the Technical Specifications. To organise the work several subgroups were created and responsible coordinators were appointed: 1. Materials + Durability (Natalie Stranghöner, Heidrun Bögner-Balz); 2. Basis of design (Marijke Mollaert, Bernd Stimpfle); 3. Basis of structural analysis (Nick Gibson, Bernd Stimpfle); 4. Ultimate Limit State + Serviceability Limit State (Bernd Stimpfle, Jörg Uhlemann) and 5. Details + Execution (Alessandra Zanelli, Rogier Houtman).
The Working Group, with Marijke Mollaert as Convenor, will cooperate with a newly established Project Team for the work programme of Phase 3 & 4: Bernd Stimpfle (leader), Peter Gosling, Jean-Christophe Thomas, Ramon Sastre and Jörg Uhlemann are the expert members. They have the specific task to develop the Technical Specifications for the Structural Design of Tensile Membranes Structures.
The Eurocode will not only assist and support the industry and engineering offices but will also encourage potential clients to choose for these sustainable applications.

Forthcoming Events

TENSILE INTENSE - Overview in membrane and lightweight structures | *15–22/09/2018* | IMS e.V. Archineer® Institutes Dessau-Rosslau, Germany | **https://www.membranestructures.de/overview-academic-programs-2018/tensile-intense**

SLTE | *11-13/09/2018* | Lima, Perú | **www.slte2018.com**

Essener Membranbau Symposium 2018 | *28/09/2018* | University of Duisburg-Essen, Germany / Glaspavillon Campus Essen | **www.uni-due.de/iml/**

13th International Conference on Advanced Building Skins *1–2/10/2018* | Bern, Switzerland | **https://abs.green/callforpapers/**

Aachen-Dresden-Denkendorf International Textile Conference 2018 - Turning Fibers into Value | *29–30/10/2018* | Aachen, Germany | **www.aachen-dresden-denkendorf.de/en/itc/**

TECHTEXTIL 2019 | *14–17/05/2019* | Frankfurt am Main, Germany | **https://techtextil.messefrankfurt.com/frankfurt/en.html**

TEXTILE ROOFS 2019 | International Workshop on the Design and Practical Realisation of Architectural Membrane Structures | *20-22/05/2019.* | **http://www.textile-roofs.de.**

6th International TensiNet Symposium "Softening the Habitats: Sustainable Innovations in Minimal Mass Structures and Lightweight Architectures" | *3-5/06/2019* | Politecnico di Milano, Milan, Italy | **www.tensinet2019.polimi.it/**

FORM and FORCE 2019 Joined International conference IASS SYMPOSIUM 2019 & STRUCTURAL MEMBRANES 2019 | *7-10/10/2019* | Barcelona, Spain | **http://congress.cimne.com/formandforce2019/frontal/default.asp**

TensiNet Meetings

TensiNet Annual General Meeting & Partner Meeting 2/2018 | *at Essener Membranbau Symposium 2018* | *28/09/2018*

TensiNet – Eurocode TC 250/WG 5 meeting | *5/11/2018* | Afnor, Paris, France

Oran Park, Australia

ORAN PARK LIBRARY & RESOURCE CENTRE

A COLOURFUL ETFE FAÇADE AS AN ARTISTIC SOLAR BARRIER

Context

Oran Park Library celebrated its grand opening ceremony on Saturday 30th June, 2018! The new Oran Park Library & Resource Centre is now home to a distinctively colourful ETFE façade that was designed to be an artistic solar barrier from the heat of the Western sun.

Now, this structure is part of a pretty exciting project for the Oran Park community! The South-West Sydney suburb of Sydney has seen some tremendous economic, social and residential growth in the last 5-10 years, so it was exciting to be a part of the suburbs' development. The new Library & Resource Centre underwent an AUD$13.8million development in late 2017 as part of a voluntary planning agreement between Urban-Growth NSW, Greenfields Development Company, and Camden Council.

Concept

Fabritecture was contracted for the design & construction of the ETFE façade at the front of the library. The structure incorporates 2-layer ETFE cushions in a tessellating triangular pattern in red, yellow, white & translucent foils, on a uniquely designed folded plate structural steel framing system that completes with backlighting which makes the structure come alive at night.

Design & Planning

The development plan had an artwork requirement specified, so the client was after a functional façade that also satisfied the criteria of structural artwork. A structure such as the Oran Park ETFE façade is considered a piece of architectural artwork as it includes elements of creativity amid the constraints of a functional piece of engineering. Designer & architect Brewster Hjorth came up with the design for the unique façade. Engineering was completed by Wade Engineering & Seele.

Apart from offering architectural aesthetic, the façade also provides an effective solar barrier for the library to help regulate temperature behind the glass. It was installed 3m in front of the main glass wall of the library as a barrier from the Western sun (Fig. 2). The purpose is for the ETFE Façade to block a majority of the heat before reaching the main façade of the library and any redundant heat would disappear within the 3m gap. This still maintains high light levels in the building whilst keeping the library cooler.

Name of the project:	Oran Park Library
Location address:	Central Avenue, Oran Park NSW 2570, Australia
Client (investor):	Urban Growth NSW & Camden Council
Function of building:	Community library & resource centre
Type of application of the membrane:	Artwork façade
Year of construction:	2018
Architects:	Brewster Hjorth
Multi-disciplinary engineering:	Wade Engineering
Structural engineers:	Wade Engineering
Consulting engineer for the membrane:	Seele
Engineering of the controlling mechanism:	Wade Engineering
Main contractor:	ADCO Constructions
Contractor for the membrane (Tensile membrane contractor):	Fabritecture
Supplier of the membrane material:	PATI Films
Manufacture and installation:	Fabritecture (steel and installation of complete system); Seele (manufacture of ETFE)
Material:	ETFE
Covered surface (roofed area):	199m²

Figure 1. Colourful ETFE façade as a huge lampshade © Kevin Chamberlain
Figure 2. ETFE façade as second layer installed 3m in front of the main glass wall © Kevin Chamberlain
Figure 3. Installation of the colourful ETFE façade as an artistic solar barrier © Kevin Chamberlain

Although functionality was the primary motive of the structure, the architectural intent was to be a distinctive piece of artwork that the local community would be proud of.

Installation

The installation for the façade was quite unique. A plan was developed to assemble the whole steel structure/frame and ETFE cushions at ground level, then install it using one crane lift (Fig. 3). Some of the ETFE cushions were inflated before the lift which allowed for faster installation.

Obtaining specialised ETFE colours for the yellow-gold and red pillows was complex due to the small amount of each foil required for the design. There is a lack of symmetry along the façade, meaning most pillows have custom dimensions and complicated nodes where they all meet.

The ducting system for the cushions has been designed so that each cushion is connected to its predecessor, so that the air works its way vertically down the façade through each cushion. This removes the need for an aesthetic large ducting system. The plenum sits neatly and discreetly along the top of the structure. None of the pillows sit independently.

The steel framing was adapted to lighten the overall weight of the structure with a custom folded plate profile, and RHS steelwork around the outside. The custom steel profile allows for connection details and specialised central node connections. Each connection where the corners of the ETFE cushion triangles meet are all different because the geometry of the triangles is different.

The project is approximately 189m² and took the team 497 man hours to complete.

The Result?
An Award-Winning Structure!

Everything went according to plan for the Oran Park Library project. The façade looks incredible, and the client was very happy with the result. The Oran Park Library project took home the 2018 Specialised Textiles Association Award for Excellence Winner (Category 13)!

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ARTICLE

END OF THE RAINBOW SEQUENCE COMPLETED

SCHOOL OF ARCHITECTURE, MADRID (ETSA-UPM)

After eight consecutive years, the sequence of "sails" under the skylight of the central patio of the School of Architecture, Madrid (ETSA-UPM) has been finished. This has completed a teaching work, which had already been announced in TensiNews, in the numbers 19 (09/2010) and 25 (09/2013)

The "sails" have been designed and executed as part of a practical workshop in the Seminar on Textile Architecture, directed by professors Juan Monjo-Carrió and Javier Tejera Parra, with the direct participation of the students of each year and the sponsorship of DCTA·UPM, Serge Ferrari and BAT SPAIN.

The main objective of this work is all the students to explore and understand the basis of design, detailing, fabrication and erection of these "sails", and to understand and solve the problems that may appear in the process of a tensile roof project.

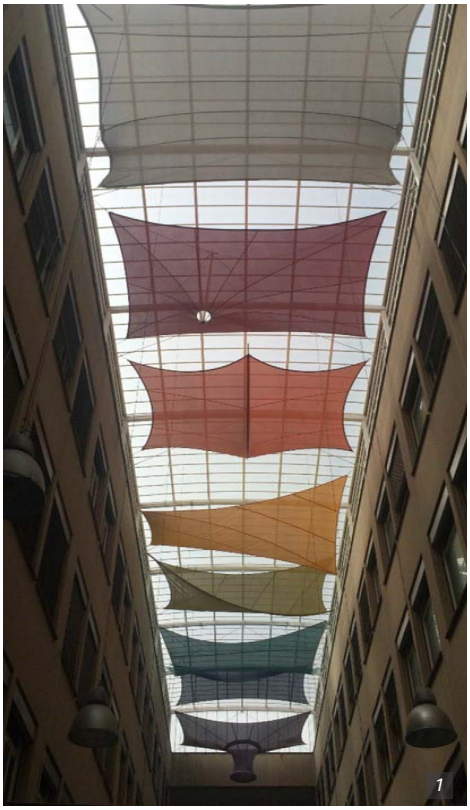
In order to contribute with some colour to the patio, the sequence of the rainbow has been followed, starting with a "sail" in white followed by the Soltis 86 range of colours.

Every year, a "sail" has been designed with different shapes, using anticlastic surfaces, which allows the students to play and verify the great variety of "organic" shapes that can be obtained in textile architecture.

The students have participated in the design of the "sail" and its formfinding with MPanel. Then, they have carried out the cutting of patterns, manually, to have a better understanding of the necessary curvature of the edges of each one in order to obtain the geometrical anticlasticity.

During the course, several built projects are visited, to show the students the real execution of this kind of architecture. A specialized workshop is one of the visits, in which the sail is welded.

Finally, the students have helped to erect it in its place, checking the need for prestress during its hoisting, to ensure the proper geometry.



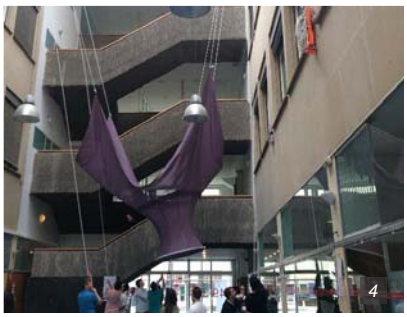


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Figure 1. General view
Figure 2. Cutting of the patterns
Figure 3. Rigid ring assembly
Figure 4. Hoisting the sail

TEXTILE ROOFS 2018

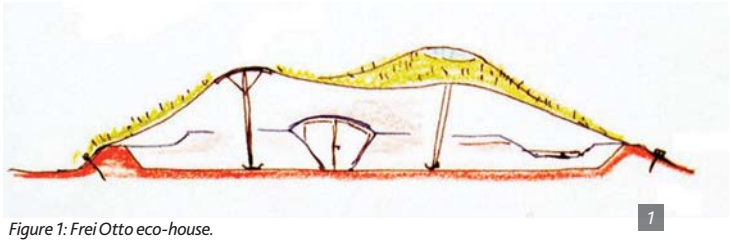

Figure 1: Frei Otto eco-house.

Textile Roofs 2018, the twenty-third International Workshop on the Design and Practical Realisation of Architectural Membranes, took place on 26–28 May, 2018 at the Moscow Architectural Institute (State Academy), and was chaired by Prof. Vladimir Ermolov (Verteco Co.ltd.) and Dr.-Ing. Bernd Stary (Academus). It was attended by 74 participants from 6 countries covering two continents. Once again, the attendance demonstrated the success of the event, which has become firmly established since it was first held in 1995.

Figure 2: Two lightweight design approaches (O.Myskova).

Introduction and overview

Jürgen Hennicke in his lecture "Membrane structures" illustrated with an enriching sequence of slides that lightweight structures include much more than textile roofs. He started with the history to show that it is not a new issue at all, looking not only at human constructions, but also at the contributions of nature. A parade of Bedouin and Middle-Age tents, radiolarian, Roman velum roofs, nets, suspended bridges, nomadic shelters, primitive constructions, cantilevers, arches, shells, grid shells, bubbles, balloons, trees and much more exemplified the different concepts on which light structures are based to reduce the self-weight. Professor Frei Otto's works and schemes were also worthy of mention, because they explored the available solutions as well as the possibility of improving them (Fig. 1).

Some outstanding achievements completed the demonstration of principles, ways and possibilities of the lightweight design approach. They included the peak and hump tents for the Federal Garden Exhibitions, the Bad Hersfeld open-air theatre, the threatened Mannheim Multipurpose Hall, the historical Montréal and IL Pavilions, the Nimes Arena inflated cushion, the Munich Olympic Stadium and aviary, the Pink Floyd USA Tour umbrellas, the Hamburg Tennis Court and the Frankfurt Pavilion among many others.

The lecturer ended up issuing his favorite message regarding lightweight and membrane structures as "everyday architecture which can satisfy all our needs as living beings in a built environment, increasing our physical, mental and social quality of life in harmony with the natural environment as a reconciliation between man and nature and with himself".

Olga Myskova went also into general concepts with her "Architecture of tensile constructions. Form and perception" conference. She presented an international wide selection of tensile constructions to show their main architectural characteristics and possibilities. They ranged from pavilions, stages, stadiums, sport halls, railway stations, airports, sunshades, umbrellas, awnings, tents, parking lots, coloured interior decoration, urban furniture, sculptures, covered squares and streets. She demonstrated that tensile constructions offer a wide range of possibilities, although some of them do not correspond exactly to the lightweight design approach mentioned in a previous presentation (Fig. 2).

Materials

In "Tensile wraps for two FIFA World Cup Arenas in Russia", Katja Bernert mentioned two important issues that play a role in decision making when designing a textile roof concerning the material and its company. The material could be PVC coated polyester, a performing long lasting material as it has been found when replacing the Mercedes Benz Arena roof and the Elspe Grand Stand canopy. The membrane roof of the Mercedes Benz Arena in Stuttgart has been in place since 1993. Estimated lifespan was 20 years, 25 maximum. Local authorities decided in 2016 its replacement. During the 2017 summer break, the Pfeifer cable construction team equipped the first-division stadium for VfB Stuttgart with a completely new membrane roof (Fig. 3). The project involved removing and replacing all 40 segments of the delicate roof structure, measuring more than 38.000m². Made of a special dense woven fabric coated with a fluoridated nano-topcoat which makes it easier to clean the MEHGIES® Valmex® Mehatop® membrane was pre-produced, shipped to the site and erected directly saving valuable time.

Figure 3: Replacement of the membrane roof of the Stuttgart Stadium.

The membrane roof of the Karl May Festival in Elspe was erected in 1978 and replaced in 2015 because the Festival company wanted a bright new colour impression. Mehler Texnologies developed a membrane as close as possible to the original material bearing the same colour and adapted to the requirements of the new directive for chemicals. It has been an opportunity to measure the longevity under real life conditions such as heavy snow loads during winter time, better than any artificial weathering tests: the measured loss of tensile strength of the dismounted fabric was 20%.

The second issue concerns the company, in this case Mehler, founded in 1837, with a long experience in a large number of projects, including F.Otto's early works such as the retractable roof over the open-air theatre in the monastery ruins in Bad Hersfled. Mehler stands out for the capability of customizing products and providing Life Cycle Assessments and Environmental Product Declarations. Recent achievements include the Nizhny Novgorod and Volgograd Stadiums in Russia.

The manufacturing of PVC materials for tensile architecture was approached by Irina Grigoryan

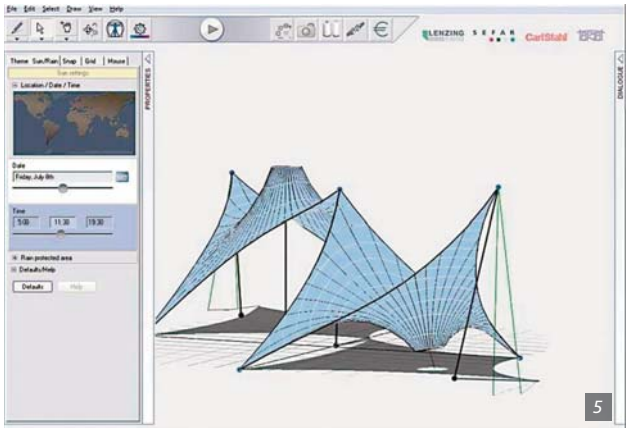

Figure 4: Three innovation stages undergone by Ruchaika.
Figure 5: Screenshot of "formfinder".
Figure 6: The interaction between membrane and stiff elements is taken into account by the software "easy.technet" because it tends to be significant.

from Ruchaika, a modern developing enterprise in the Republic of Belarus, specialized in the manufacture with the mixed yarns ring spinning process of technical and decorative fabrics with PVC impregnated composition.
Ruchaika has undergone three innovation stages (Fig. 4). In 2007 the modernization was launched with the purchase of modern weaving and spinning equipment made by «SmitTextile» (Italy). In 2009 old equipment was replaced by the newest weaving machines and in 2010 the third modernization phase was launched with the acquisition of the most effective technology in terms of performance, energy saving and sustainability. Following the modernization, the new equipment made by «ISOTEX» Italy, was put into operation, which allowed to produce textile fabrics impregnated PVC composition. The ability to produce textile base for any PVC material densities, widths and weaves allows the development of a wide range of products.

Design

Professor Robert Roithmayr introduced the initial phases of the design process with the assistance of the software "formfinder" aimed to the design, plan and estimated cost-effectiveness of tensile membrane structures (Fig. 5). He mentioned three main steps: get inspired, be creative and make it real. To get inspired, "formfinder" provides a data base with an extensive typology and the description of 2.000 projects collected over decades. To be creative, the powerful "Membrane Design tool" is provided to encourage designers in the creation of beautiful and quality membrane architecture checking different proportions, curvatures and sags. And to make it real, the results go to the engineer and the "easy.technet" software to proceed with the structural analysis and cutting pattern generation.

In addition, the Lightweight Membrane Structures Master of Engineering course held at the Danube University in Krems was announced. It combines the state of the art in building materials and the latest fabrication technologies with the highest engineering knowledge provided by leading experts in the field in order to provide skills and applied knowledge translating these elements into creative designs and actual project implementation and recognize and exploit the full commercial and environmental potential of Lightweight Membrane Structures.

Dr. Dieter Ströbel introduced step by step the procedure of designing tensile surface structures with the software easy-technet. After highlighting the requirements of modelling, he went into the computational form finding based on the force density method, summarizing its fundamentals and advantages. The combination with stiff elements was also taken into account as the interaction tends to be significant (Fig. 6). It was illustrated by two examples: the pneumatically stressed galets of the 2002 Swiss Expo in Neuchatel and the optimization of textile halls supported by aluminium frames.

After obtaining the form, it was the turn of the non-linear static analysis, starting from approximate values, membrane, cables, struts, material properties and external loads. References were made to the influence of the material direction, the application of the gas law (for pneumatic structures) and the effects of the incorporation of stiff bending elements.
The third step was the patterning needed to manufacture a doubly curved and prestressed surface from rolls of plane material. The doubly curved surface cannot be represented on a plane without distortion. It is not developable. In addition, the planar strips have to be as straight as possible (in order to keep the cutting out waste as low as possible) and the width of the 2D strips should be as wide as possible (in order to minimize the amount of work, considering that the maximum strip width depends on the roll width). Moreover, the developed surface has to be corrected to allow for the deformations caused by the prestressing and the corresponding seam lines must have the same length to avoid problems by joining the strips. The patterning ends with the cutting drawings, welding marks and the checking of areas, widths and lengths.

Research projects were also mentioned such as biogas storage systems, together with special applications including the automatic form finding and patterning of ETFE cushions and the fast patterning of cones, saddles and textile halls.

Okeanov Gennady Vadimovich, architect, addressed the situation of standardization in Russia. He presented the regulations and recommendations for the design and calculation of buildings and structures containing membranes starting with the procedures developed for the 2018 FIFA Championship stadi-

ums. Currently, the Central Scientific Research Centre of Industrial Construction is developing regulations and recommendations for textile construction structures which are expected to be available next year.

"Detailing" was presented by Professor Josep Llorens who alluded to his usual remarks regarding their relevance as a significant part of the design process. He listed and illustrated the requirements emphasizing the needs of the installation process (Fig. 7). A typology of details was presented including seams, edges, corners, high and low points, ridges and valleys, base plates for masts and cables, fittings, and anchors. And finally, two conclusions were highlighted: 1) Details cannot be directly transplanted from a repertoire, since they have to be adapted to the requirements of each case. Solutions are successful when they meet the specific requirements of every application. *Changing the requirements means that the design must be changed.* 2) Detailing has to be taken into account from the beginning of the design process. It is not an independent step, because it is also essential to the general requirements of the whole structure. *Details are not an afterthought.*

Figure 7: Ice Skating Ring, Montafon. Attachment of holding devices and tensioning equipment (Courtesy of R.Off).

Realizations

The lectures that usually bring the latest news are those devoted to recent works such as the Volgograd Arena presented by Dip.Eng.Ivan Uroshlev (Fig. 8). The Volgograd Arena is one of the stadiums for the FIFA 2018 world cup. Its roof consists of a tensioned spoke wheel system cable structure supporting 76.800m2 of PVC coated membrane and ETFE panels. The inner tension ring consists of two cables that support a steel platform which in turn supports the ETFE panels. The outer roof of the foyer consists of structural steel trusses. They act as

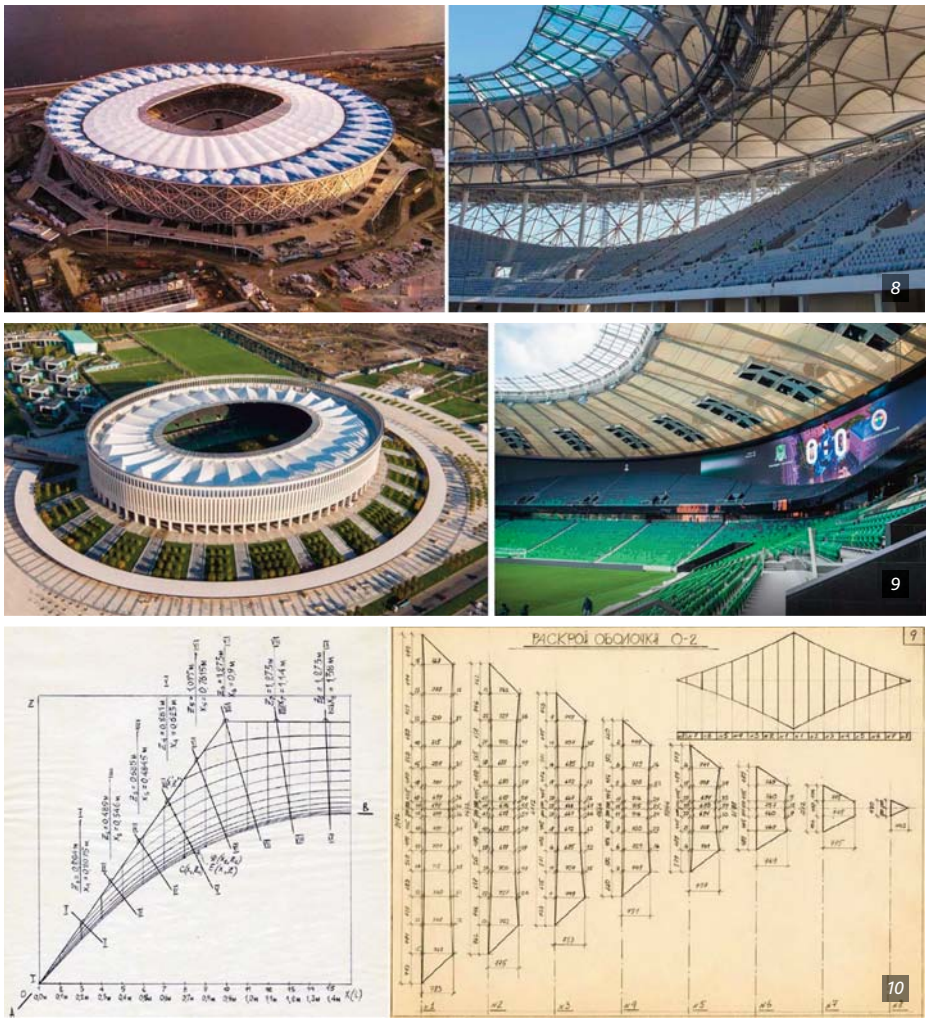

Figure 8: Volgograd Arena.
Figure 9: Krasnodar Arena for 34.000 spectators, equipped with heating.
Figure 10: Patterning by hand.

the compression ring of the spoke wheel system. The final arrangement looks like a gmp & sbp stadium but excessively complex to accommodate only 35.000 spectators after the FIFA 2018 World Cup.

The group Kurganstalmost, a holding that offers services in the field of design, fabrication of metal structures, construction, installation and delivery on a turn-key basis, took an active part in the design, supply and installation of 10 football stadiums, such as Krasnodar (Fig. 9), Volgograd, Nizhny Novgorod, Novgorod, Yekaterinburg and Rostov-on-Don in cooperation with Maffeys and Kubantent, a company that works in the field of membrane tension construction, design, production, and installation. Thanks to these successful projects, membrane architecture is gaining popularity in Russia. Costumers and designers appreciate the advantages of this technology, speed of installation, quality, durability and aesthetics.

Membrane architecture in Russia was the topic of Vladimir Ermolov, from Verteco Co.Ltd. He presented a parade of textile roofs made in Russia from the 16th century to the present day starting from icons and chronicles. He mentioned, before 1917, fairs, markets, tents and patents. Vladimir Shukhov deserved special attention corroborated by the technical visit made during the workshop. Air supported structures began in 1936 with military purposes and mechanically stressed structures are recorded from 1961. From 1981 to 1989 attempts were made to quantify snow loads, stress relaxation, shear modulus and testing. Efforts were also made to develop form finding and patterning (Fig. 10). Minimal surfaces were adopted in 1983 for a tennis court. Verteco Co.Ltd. began in 1991. His record of achievements covers a wide variety of types and sizes, both utilitarian and decorative. Finally, the lecturer referred to some problems derived from snow loads, drainage and lack of maintenance.

Future trends

Professor Natalia Saprykina astonished the audience with the first part of her presentation for


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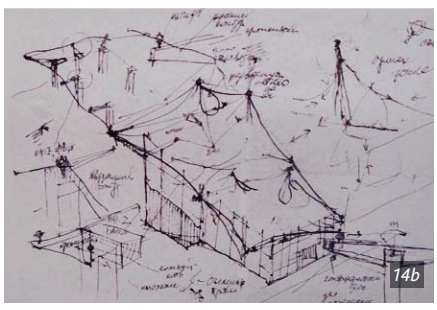
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dreamers. She began with the "flying city" project by G. Krutikova 1928, of the Soviet avant-garde, for the construction of new flying cities and flying agglomerations. More futuristic proposals were the flying gardens, skyscrapers and parks together with air purifiers to manage acid deposition in the atmosphere that have been proposed recently (Fig.11).

Professor Natalia Saprykina kept looking to the future in the second part of her lecture but she tended to be more realistic focusing on the use of airships for touristic purposes in the North of Russia due to the difficulties derived from the climatic conditions, relief and small population that require training, skills and tourist knowledge. The use of airships for touristic purposes was initiated by the Graf Zeppelin in 1931 that traveled to northern Russia. The contemporary aerostat technology for the tourism market, advertising and special tasks was shown with Zeppelin NT, Skyship, Airship/Lightship, Voliris, Mineseeker and Aeroscraft.

The closest examples to the purpose of the lecture were the Aeroscraft Hotel (that moves at a speed of 280 km/h with 250 passengers including casino, restaurant and comfortable cabins), the Air hotel Stratokraiser for a new type of tourism (air cruises along the whole globe with restaurant, spa, beauty salon, swimming pool and views. Filled with helium. It generates electricity with photovoltaic cells) and the Flying house "Wolke 7", a new concept of habitat including everything essential for permanent residence (Fig. 12).

"Harmonizing urban spaces with architectural membrane (tent) constructions" was presented by Anwar Khairoullin, from the Association of Creative Laboratories of Forms. He showed the newest technological capabilities of his company dedicated to the use of modern tent structures for solving a wide range of social problems, including the harmonization of the architectural and spatial environments (Fig. 13). The interventions were based mainly on the application of a variety of shapes and colours to create ludic and festive environments. He illustrated them clearly with many designs and summarized as "Making beauty!".

Figure 11 a: Left: Flying gardens with living quarters and offices, laboratories and plantation of microalgae to obtain bio hydrogen as the main fuel for the airship.
Figure 11b: Flying park and facilities in a large balloon with helium and propellers who work with solar energy to collect rain water for irrigation and purify the air of the city absorbing carbonate gas.
Figure 12: The Flying House "Wolke 7".
Figure 13: Coloured tents to harmonize architectural and spatial environments.
Figure 14a/b: The students exposed their designs that were commented by the participants.

Student designs review

In a room next to the conference-hall, the students exhibited their designs that were commented by the attendees (Fig. 14).

Technical visits

The top of the 2018 Textile Roof Workshop was the technical visit focusing on the figure of the architect and engineer Vladimir Shukhov. Vladimir Grigoryevich Shukhov, 1853-1939 was a Russian engineer, scientist and architect renowned for his pioneering works on new methods of analysis for structural engineering that led to breakthroughs in industrial design of the world's first hyperboloid structures, diagrid structures, gridshells, tensile structures, oil reservoirs, pipelines, boilers, ships and barges. He is also the inventor of the first cracking method. (His patent was used to invalidate Standard Oil's patents on oil refineries).

The GUM State Department Store was designed by A.N.Pomerantsev and V.G.Shukhov and constructed in 1894 in a Russian style to harmonize with the surrounding architecture of the Kremlin and the Historical Museum. It stands out for the lightness of the original steel structure of the roof (Fig. 15).


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Figure 15: The GUM State Department Store, 1894.
Figure 16: The Petrovsky Passage, 1906.

The Petrovsky Passage was designed by S.Kalougine, B.Freidenberg and V.Shukhov and opened in 1906. Vladimir Shukhov designed an arcade with two wide three-storey galleries covered with extremely light high-pitched semi-cylindrical glass vaulting taken over that of the GUM Department Store. The second floors of opposite galleries are connected by exquisitely designed ferroconcrete catwalks (Fig. 16).

The Shukhov Tower is a landmark in the history of structural engineering (Fig. 17). Known as the Shabolovka Radio Tower, it was built between 1919 and 1922, rising to the height of 148m. It was originally designed to be 350m high but steel shortage made it impossible. It consists of six stacked hyperboloids, which have the property of being constructed out of entirely straight segments. For the construction Shukhov employed his own original method of telescopic assembly. Today, the structure suffers from corrosion and, in addition, it sits close to the center of a growing Moscow, and demand for land, coupled with its poor condition and lack of public access, have led to the looming threat of demolition. In 2014, architects, preservation groups, and members of the local community, rallied to protest against a plan to dismantle the tower and re-erect it at a new location. The 2016 World Monuments Watch joins their voices in calling for continued vigilance in the fight to save this icon of modern Russian history.

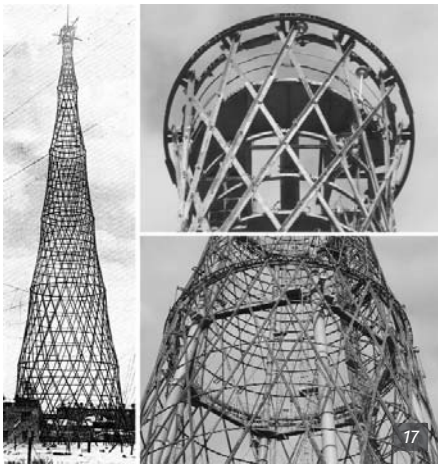

Figure 17: The Shukhov Tower or Shabolovka Radio Tower, 1922.

Figure 18: Manufacturing & erection of the "Joint participants' project".

Joint participants' project

The "Joint participants' project" was led by Stev Bringmann, 3dtex GmbH. A four point sail was designed and erected with the participants and the following contributions: supplier of the fabric: Low & Bonar (Valmex Mehatop F1). Form finding, structural analysis and patterning: technet GmbH. Physical modelling: Jürgen Hennicke. Membrane manufacture: Verteco. Foundations, set out anchoring points and tent pegs, preparing the masts, finishing the membrane, corner reinforcements, pulling in the edge cables, assembly of corner plates, installing the masts, erection of the membrane and tensioning and discussion: the participants (Fig. 18).

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The Twenty-fourth International Workshop on the Design and Practical Realisation of Architectural Membrane Structures will be held on 20-22 May 2019. Its format will be similar to that of TR 2017, with seminar-style lectures and hands-on activities and it will be preceded by the student seminar. More information will be available at http://www.textile-roofs.de.

7th IMS International Textile Architecture Symposium in Miami

From May 17th to May 19th 2018 the IMS e.V. Archineer® Institute held its 7th IMS International Textile Architecture Symposium. This year the symposium was hosted at the very prestigious School of Architecture at the University of Miami. About 90 people interested or involved in the membrane building business attended and made it a successful event.

Within the three days of the symposium, concentrated lectures were provided regarding planning, design and increasingly frequent inclusion of high-tech membrane structures within the modern architecture. The symposium was a didactic and academic event counting on the experience of great professionals in the field. Keynote speakers Nicholas Goldsmith, Prof. Dr. Günther Filz, David M. Campbell and many other specialists shared their expertise with the participants. At the same time the attendees took advantage of the symposium for networking. The event turned out to a great meeting occasion between professionals, students and craftsmen currently involved in the industry and the world of membrane or tensile structures especially during the two evening cocktail parties.

On its last day, the symposium was concluded after an interactive panel discussion where the specialists answered questions regarding education, future trends and development in the field of membrane and lightweight structure building.

Upcoming programs IMS Institute

The next educational events organized by the IMS e.V. Archineer® Institute are the **2nd TENSILE intense** in September (15.-22.09.2018) and the **14th Master Program Membrane Structures** at the Bauhaus Campus of the Anhalt University in Dessau-Rosslau, Germany, the home of the institute. TENSILE intense is a one-week focusing on membrane- and lightweight structures, addressed to architects, engineers, managers, salesmen and others interested and/or involved in the membrane business. More information is available at www.membranestructures.de or contact heike.kleine@ims-institute.org.

LIGHT ETFE FILM ARCHITECTURE SAVES 1.500TONS OF STEEL

Estadio Cuauhtémoc, Puebla, Mexico

The world's largest façade made of single layer ETFE film is gleaming in the club colors of the Mexican first division club, FC Puebla. The freshly renovated traditional stadium Cuauhtémoc in the Mexican highlands rises to a height of around 40m. The extravagant façade made of more than 30.000m² of film was built in a sophisticated way. The film was extruded from the high-performance material 3M Dyneon Fluoroplastic ETFE. The lightweight film makes it possible to build the stadium with 1.500tons of steel less than for a comparable glass façade.


1

Context

The sports complex, built in 1967, had already hosted suspense-packed competitions at the Summer Olympic Games in 1968 as well as being the venue for the FIFA World Cup in 1970 and 1986. The stadium was completely modernized in the years 2014/2015 and furnished with the first ETFE façade in Mexico by Dünn Lightweight Architecture.

Mosaic of panels

The façade seems extremely lightweight in its curved shaped and incorporates pre-Columbian design elements with its mosaic character. It consists of 124 vertical segments, about 40m in height. A total of 5.952 ETFE film sections in the three shades were welded to one another for the segments. In the daytime the club colors of blue and white as well as the transparent sections continue to be visible. By night the film sections are illuminated in various colors by LED lights.

ETFE resists nearly all chemicals

Especially important in the hot and humid climate: In the production of films made of 3M Dyneon ETFE no plasticizers are required, which evaporate over time and thus could promote algae or fungal growth. ETFE films are so smooth that rain showers are sufficient to clean the façade to the greatest possible extent. They are so resistant to other chemicals that they are also able to withstand environmental influences such as exhaust emissions for decades. Originally, parts of the façade of the stadium in Puebla were made of glass panels in various colors. Dünn Lightweight Architecture chose to design the complete façade with ETFE film instead. One significant advantage: The weight per unit area of ETFE is around 95% lower than that of glass. As a result, stress analyse were able to build the supporting structure in a much lighter way. Instead of the 2.500tons of steel required for a glass construction, 1.000tons are sufficient for the ETFE façade, a saving of 60 percent.


2

Extrusion in any color you want

Nowofol Kunststoffprodukte GmbH & Co. KG extruded the films from high-performance material 3M Dyneon ETFE. The company manufactured the NOWOFLON ET 6235Z film for the project in Mexico in three shades and with a thickness of 200µm. The 160cm wide films were welded in such a way that a mosaic with 80cm high fields results in the panels up to 6m wide. Nowofol produces ETFE films in nearly all RAL shades and in an infrared absorbing design, in order to minimize the solar heat gain. The films comply with fire classification B1 (in accordance with DIN 4102), an important criterion for stadiums.

Helmut Frisch
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Figure 1-2: General view new lightweight façade © Dyneon
Figure 3: Finishing the installation © Dunn Lightweight Architecture


3

Name of the project:	Estadio Cuauhtémoc
Location address:	Puebla, Mexico
Client (investor):	City of Puebla
Function of building:	stadium
Year of construction:	2015
Architect:	Dünn Lightweight Architecture
Structural Engineer:	Dünn Lightweight Architecture
Supplier of the membrane material:	Nowofol Kunststoffprodukte GmbH & Co. KG
Manufacture and installation:	Dünn Lightweight Architecture
Material:	NOWOFLON ET 6235Z
Covered surface:	98.425m²

LONG LIVE THE MEMBRANE

Tecklenburg, Germany

THANKS TO THE ENGINEERING OF FORMTL THE OPEN-AIR THEATRE HAS BEEN EFFICIENTLY AND SWIFTLY REFURBISHED.

Introduction

Membrane structures are often used as an interim measure and therefore rarely survive longer than 20 years or so. Textile structures in particular stand out in this context due to their special aesthetics and their demolition often means that some true engineering works of art are lost. One exception is the roof of the open-air theatre in Tecklenburg – it is a fine example of just how durable lightweight constructions can be showing the potential inherent in such structures. 25 years ago, Freilichtbühne Tecklenburg e.V. wanted a rain canopy for its annual summer festival. A retractable roof was developed by consulting engineers IPL, from which the formTL engineering office emerged in 2004 (Fig. 1).

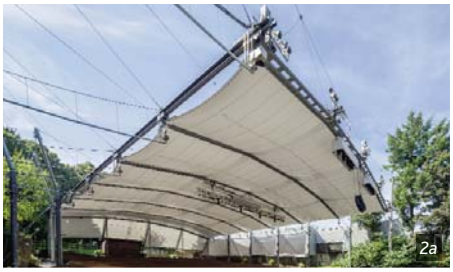
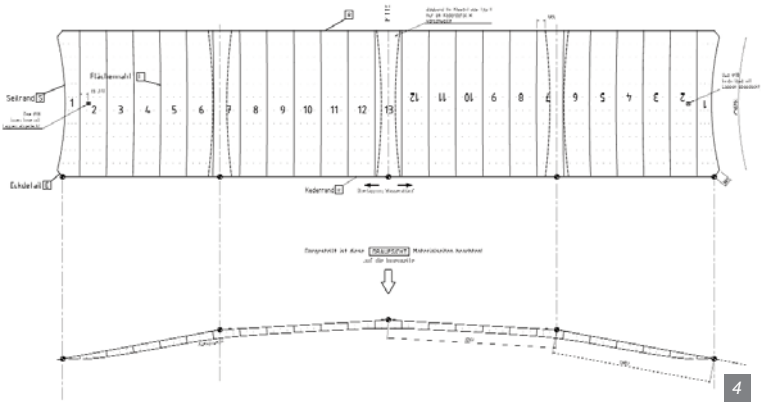


Figure 1: Before the refurbishment © Freilichtbühne Tecklenburg
Figure 2a/b: After the refurbishment © R. Borgmann
Figure 3a/b/c: Connection details © R. Borgmann
Figure 4: Cutting pattern layout of a membrane cushion © formTL



Unique structure & systhem

In poor weather the roof can be extended to shelter both the audience and the stage while in dry weather it allows a clear view of the sky. The structure consists of six filigree cable girders from which five longitudinal rails are suspended. Six steel arches with a carriage to which the double-layered membranes are attached move along these rails. As soon as the roof is extended, the membranes are inflated into cushions, so making them wind-resistant, covering an area of 29x40m. When retracted, the membranes become parked in a type of garage which protects them from bad weather. This unique structure – there are only a few comparable structures of this kind – continued to win over the clients even after over 20 years of operation with its timeless design and high functionality. The society therefore decided to maintain and renovate the cushion canopy. Membranes age at different rates: fixed structures usually have a service life of between 15 and 30 years. In the case of mobile structures, a service life of around 10 to 15 years may be expected as movement wears out the coating and fibres, so reducing the strength of the fabric more rapidly.

Refurbishment

An inspection carried out in 2010 revealed that only the membranes needed to be replaced. Together with CENO Membrane Technology, who had already constructed the canopy in 1993 under the company name of Carl Nolte, formTL developed the refurbishment. One big advantage was that the project had already been designed 25 years before in 3D and all the documents, from the drawings to the analysis, to written correspondence, were kept in formTL's digital archive. This meant that all that was necessary was to carry out a comparison of the measurements of the disassembled membranes and fittings with the old plans. As only a few discrepancies were found, formTL produced the cutting patterns which were adapted to the new folding membrane material within a month.

An optimized material was used for the highly stressed cushions which withstands more than 100.000 folds. The correspondingly manufactured membranes were transported to the site and were easily and quickly installed. During the course of the refurbishment, not only the service life of the structure was extended but also the process of opening and closing the roof was accelerated with more powerful suction and pressure blowers (Figs 2-3).

Design and cost efficiency

The Tecklenburg open-air theatre is a remarkable example that is well worth the maintenance and refurbishment of membrane structures, also from the point of view of design and cost efficiency. Tecklenburg can certainly rest assured that it now has 20 years of dry summer festivals to look forward to!

Bernd Stimpfle, formTL ingenieure für tragwerk und leichtbau gmbh
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www.form-TL.de

Client	Freilichtbühne Tecklenburg e.V.
Design	IPL, Radolfzell/DE
Refurbishment	formTL ingenieure für tragwerk und leichtbau gmbh, Radolfzell/DE
Construction and manufacture	CENO Membrane Technology GmbH, Greven/DE

CITA - CENTRE FOR INFORMATION TECHNOLOGY AND ARCHITECTURE - KADK COPENHAGEN

ISOROPIA

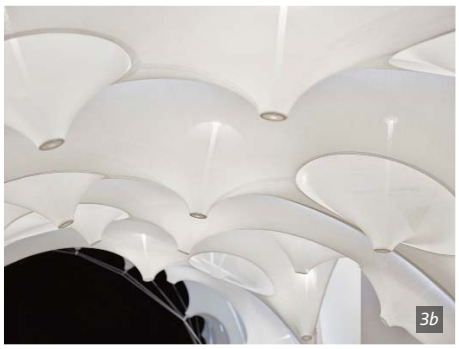
ACHIEVING BALANCE, EQUILIBRIUM AND STABILITY

Knitted membrane structure

CNC (Computer Numerical Control) knit was used for the first time in a large scale morphing textile structure for the Danish Pavilion in the 2018 Architectural Biennale. The installation 'Isoropia' – Greek: meaning balance, equilibrium and stability - is more than 35m long and made of more than 40 custom CNC knitted membranes of up to 7m length. These are set in structural equilibrium with bend glassfibre rods of varying strength. The structure creates a spatial and structural continuum through the Danish Pavilion, forming differentiated outdoor canopy structures on the two outer sides and a vaulted space in the interior. Similar to the spatial expression the structural system morphs from a cablenet system, which prestresses and stabilises the structure to one, which uses tensegrity like compression elements to prestress the knitted membrane (Fig. 1-2).

'Isoropia' explores new territories in terms of Fabrication, Material, Detailing and Assembly, as well as simulation and possible spatial and aesthetic expressions in Form Active Hybrid Structures. The installation uses knit as a textile membrane. Knit is softer and less homogenous than traditional laminated membranes and can therefore be used at very different scales. Isoropia' is knitted in Dyneema®, a high performance fibre with practically no stretch. The material performance of the knit - its ability to stretch and deform is therefore uniquely down to the structure of the knit. In 'Isoropia' we vary the knit structures to compose areas of more or less stretch. By building our own interfaces between the computational design environment and the digital knitting machine we are able to control fabrication at stitch by stitch level. The textile are bespoke produced as one-off custom patches and detailing such as the channels, the protrusions and perforations are controlled directly from the design environment (Fig. 3).

The ambitious project, which went from design sketch to assembly in only 4 month, builds on an interdisciplinary collaboration between CITA, Centre for IT and Architecture (design and computation), str.ucture (engineering), AFF - A. Ferreira & Filhos, SA (knit fabrication), DSM Dyneema B.V (fibre) and alurays lighting technology GmbH (lighting). It extends here the established workflows and introduces a new level of design integrated simulation with a tri-fold simulation strategy in the work flow from design in Kangaroo 2 engineering, fast structural assessment of dynamic loads with the Isogeometric Analysis in Kiwi (str.ucture) and a detailed FEA of details in Sofistik.



'Isoropia' is an example of collaborative innovation. It is the product of a broad interdisciplinary collaboration crossing academia and practice exploring methods for developing light-weight simulation tools and workflows for active bend and hybrid structures.
As such, 'Isoropia' showcases how small distributed groups, who meet over internet or loose networks as the COST action "Novel Structural Skins" are able to innovate industry. This grassroots innovation is community led and open source, creating a free-space for imagining what the material practices of architecture can be. The community forms around the development of Kangaroo and similar software tools and contributions which led to Isoropia came among others from members of: CITA, Department for Structural Design and Technology (KET), University of Arts Berlin, Fosters + Partners, Robert McNeel & Associates, Technical University of Denmark, Format Engineers and Mule Studio.

The project is kindly sponsored byToppglass Italy (GFRP tubes),Sofistik (FE analysis) and SIKA (Glue), Kunstfonden Denmark and Danish Ministry of Higher Education and Science - Complex Modelling - Sapere Aude: DFF-Starting Grant

Figure 1. The outdoor canopy structure.
Figure 2. The indoor canopy structure.
Figure 3. Detailing the knit structure.

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https://kadk.dk/en/CITA

Isoropia can be visited in the Venice Biennale until November 25th, 2018. More information: https://kadk.dk/en/case/isoropia

THE 6TH TENSINET SYMPOSIUM 2019

TensiNet POLITECNICO MILANO 1863 TEXTILESHUB

SOFTENING THE HABITATS

SUSTAINABLE INNOVATION IN MINIMAL MASS STRUCTURES AND LIGHTWEIGHT ARCHITECTURES

Dear all,
we are glad to report the advancements regarding the next TensiNet Symposium 2019. The 6th TensiNet edition, **Softening the Habitats. Sustainable Innovation in Minimal Mass Structures and Lightweight Architectures** will take place from the 3rd to the 5th June 2019 at Politecnico di Milano, in Milan, Italy.
The symposium will open a reflection on current innovations, trends and strategies in the field of lightweight membrane structures and mainly on the future of those technologies, namely tensile and pneumatic structures, textile architecture, membranes and foils, ultra-lightweight constructions and structural skins. Since it was launched, the symposium has reached a promising. More than 60 abstracts from 26 different universities, international companies, practitioners and students have been sent so far. A very nice number of contributions allowed for a proper reviewing and selection process: we want to thank the Scientific Committee, made of reviewers who have contributed to the relevance of the conference with their competences and professionalism.

Concerning **the publication**, an e-book with all of the conference proceedings will be Open Access. Moreover, the best outstanding full papers will be published on a Special Issue of the Architectural Engineering and Design Management Journal, Taylor and Francis ed., after a peer-reviewed selection process by the Scientific Committee together with the Editorial Board of the journal.

A **call for exhibiting** will be launched soon and we are approaching it as a natural counterbalance to the conference with very high visibility in the university campus, to get into the minds of the next generation of designers. A selection of innovative lightweight projects by leading companies in the field of tensile architecture will be showcased within the main entrance pavilion of the symposium, in addition to a dedicated exhibiting installation hall. Projects coming from the academic research will also be displayed by mock-ups scattered around the campus of Politecnico di Milano. Contact us or make sure to visit the official conference website in October if you are interested in participating in the call. Sponsors will not need to apply for the call, as we will guarantee them an adequate spot, with varying degrees of visibility.

We are also finalising **the agenda of the symposium**: three plenary sessions – Soft Structures (June the 3rd), Softening the Environment (June the 4th), and Soft Skins (June the 5th) – plus five parallel sessions will open new ways up for softening the habitats. In particular, the second afternoon a panel session will be devoted to an IASS joined session on the WG 18: Environmental Compatible Membrane Structures seminar advancements.
Furthermore, an Open Talk will be the chance to spread and take feedback from sharing the advancements of the TensiNet Working Groups. It will complete the afternoon of the second day when the social dinner will take place in a relevant place in the centre of Milan.

We are also thrilled to announce that some important **keynote speakers** have accepted to contribute to the conference with their inspiring lectures. To name but a few,
on Soft Structures (June the 3rd):
- **Christoph Paech**, Schlaich Bergermann Partner GmbH;
- **Julian Lienhard**, str.ucture GmbH;

on Softening the Environment (June the 4th):
- **Maibritt Pedersen Zari**, School of Architecture, Senior Victoria University of Wellington;

on Soft Skins (June the 5th):
- **Mette Ramsgaard Thomsen**, Royal Danish Academy of Fine Arts, Centre for Information Technology and Architecture research group;
- **Jan Knippers**, University of Stuttgart, School of Architecture and Urban Design, Institute of Building Structures and Structural Design.

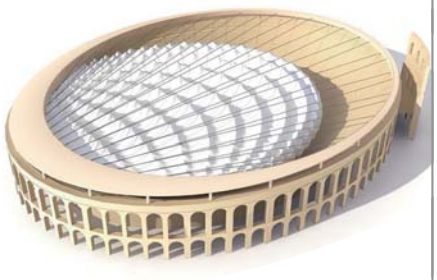

Figure 1. Deployable canopy for the Arena di Verona - Christoph Paech from SBP

We are looking forward to hosting such a heterogeneous community, and we feel honoured to contribute in such a way to the achievement of the mission of the TensiNet association to enlarge and facilitate the exchange of information and joint working, to increase the quality of tensile architecture. A very near action in this sense is that the symposium is going to be presented in the upcoming SLTE 2018 congress – Congresso Latinoamericano de Tensoestructuras, in Lima (Perù).

In conclusion, we would like to thank the TensiNet association for this opportunity, and especially Evi Corne, Marijke Mollaert and Bernd Stimpfle for sharing their efforts in the organisation of the symposium. We would also like to thank the administrative staff of the Politecnico di Milano and the local organising committee for their support.

We all look forward to welcoming you in Milan!

TS2019 organizing committee
Politecnico di Milano
Alessandra Zanelli, Carol Monticelli
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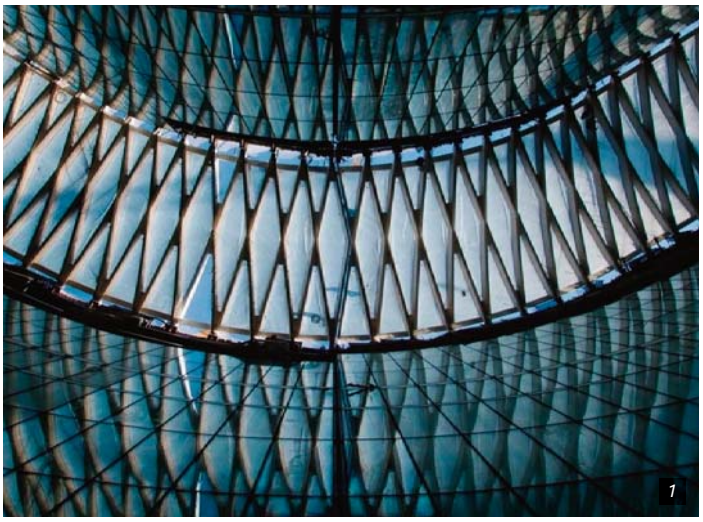
www.tensinet2019.polimi.it

Figure 2. Close up of research project Hybrid Tower in Portugal - Mette Ramsgaard Thomsen

ROOF MADE OF FOUR-LAYERED ETFE CUSHIONS

LAKHTA CENTRE

Saint Petersburg, Russia



Laktha Center is a multifunctional complex located in Saint Petersburg, Russia, which includes two boomerang-shaped buildings and the tallest tower of the European continent, with its 462m of height standing in front of the Baltic Sea. Construction started in 2015 and is about to be finalized.

FOUR-LAYERED ETFE CUSHION

Maffeis Engineering developed the full design of the steel-ETFE skylight in between the glazed façades of the buildings. The roof is composed by steel arches with trapezoidal section, crossing in couples and sitting at a variable height that goes from 38m to 60m, being the profile of buildings inversely sloped. The resulting layout is a mesh of triangular and romboidal voids covered with four-layered ETFE cushions which protect the plaza from the extreme temperature outside, while bringing a huge amount of natural light to the ground floor. All insulating details have been developed in accordance with Russian norms to satisfy the strict requirements of the project, both from an aesthetical and a technical point of view.

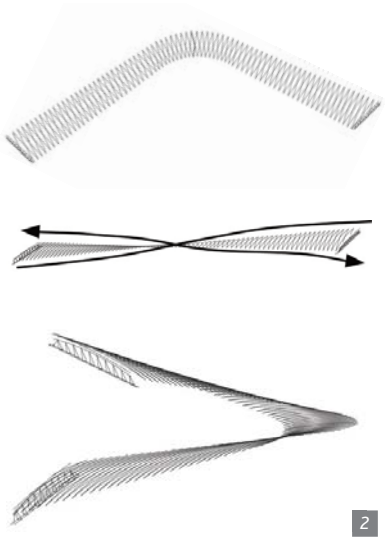
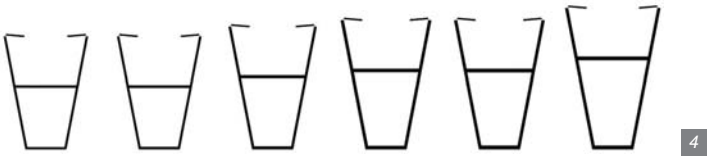
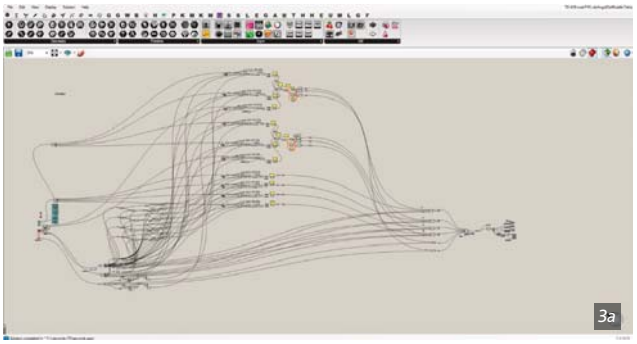
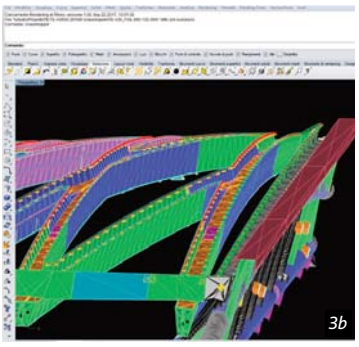


Figure 1. ETFE roof covering the atrium
Figure 2. Concept scheme of twisted roof
Figure 3. Parametric modelling
Figure 4. Steel arches sections







Giulia Paramento
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Antonio Diaferia
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Structural analysis

The whole geometry has been studied with parametric softwares to control intersections between arches with different radiuses, inclinations and sections. Basing on a FEM model to perform the structural analysis, arches have been grouped in five types of trapezoidal shapes, according to the span which increases from the center to the end of the roof. On both ends, the structure is closed by two steel trusses made of CHS profiles, supporting the spider brackets from which two inclined glazed façades hang.

Cutting patterns

All the ETFE parts (ETFE cushion, clamping profile, insulated gutter) has been detailed and studied using parametric approach. A detailed control of the work line of cushion was mandatory to achieve for every cushion the correct shape.

Name of the project:	Mixed-use complex "Lakhta Center"
Location address:	Bld3/2, Lit A, Lakhtinsky prospekt - St. Petersburg, Russia
Client (investor):	Samsung C&T, Gazprom
Function of building:	multifunctional complex
Type of application of the membrane:	three layer cushions
Year of construction:	2017-2018
Architects:	RMJM
Structural engineers:	Gorproject
Main contractor:	Renaissance Construction Company
ETFE roof contractor for steel and membrane (Tensile membrane contractor):	Taiyo Europe GmbH
ETFE roof consulting engineer for steel and membrane:	Maffeis Engineering
Supplier of the membrane material:	Taiyo Europe GmbH
Manufacture and installation:	Taiyo Europe GmbH
Material:	ETFE
Covered surface (roofed area):	4090m^2
Total Steel weight (including all secondary steel)	792tons

NIZHNIY NOVGOROD STADIUM

Russia

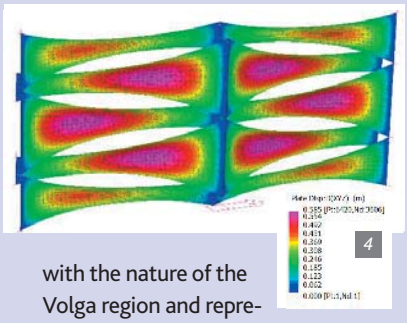
FAÇADE MADE OF BLUE AND WHITE MEMBRANE PANELS

The stadium was designed by gmp architects from Germany for the 2018 World Cup. It lies at the confluence of the rivers Oka and Volga. The circular stadium provides seating for around 45.000 spectators and was opened in 2017. It is located within view of the city center of the Russian metropolis in the midst of a park landscape that opens out to the bank of the River Volga.
The design of the façade creates analogies with the theme of water that is a dominant feature in the city. Behind the colonnade that surrounds the building, a tensile cable structure holds blue and white membrane panels of irregular forms. The mesh

Name of the project:	Nizhniy Novgorod
Location address:	Uliza Dolschanskaja 2a, Nizhniy Novgorod
Year of construction:	2018
Architects:	design by gmp architects, execution by PI Arena
Client (investor):	Sportengineering
Function of building:	FIFA Worldcup 2018 football stadium
Type of application of the membrane:	façade
Multi-disciplinary engineering:	PI Arena
Structural engineers:	PG Maximum
Consulting engineer for the membrane:	Maffeis Engineering
Main contractor:	Stroytransgaz
Contractor for the membrane (Tensile membrane contractor):	Kurganstalmost
Supplier of the membrane material:	Low & Bonar GmbH
Manufacture and installation:	Dovleti/Kubantent
Material:	TF400, >7000 m² white and >7000m² light blue color

Structural analysis

Maffeis Engineering's scope of work was the full design of the fabric panel which encircle the stadium's inner colonnade, respecting the design concept given by the alternating colours: for these, a palette of white, blue and azure has been used, associated with the nature of the Volga region and representing the local football team's colours.



The average fabric modulus (Valmex TF400) is about 16m long and 5m wide, for a total of 11.500m² and an openness of 30%: from one column to the next one, a total of 5 fabric meshes overlap each other, anchored respectively

membrane for these important design features were produced in Germany by Low & Bonar GmbH. The mesh that was used for the stadium's façade in Nizhny Novgorod is Valmex TF400 with an openness of 30%. It serves for the wave - look in blue and white from the outside and at the same time gives an airy impression when seen from the grandstand's perspective at the inside. As it is the case at Volgograd Arena, Low & Bonar coated a specific blue which is not only to correspond to the architect's idea of conveying the water image within the façade. At the same time it matches the color of the club that will use the stadium in the future.

Katja Bernert
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www.lowandbonar.com

Figure 1. Visualisation of the stadium © gmp
Figure 2: The new stadium situated near to the city center © Stroytransgaz
Figure 3a/b: The wave - look made of irregular blue and white membrane panels © Stroytransgaz

Figure 4. Modelling © Maffeis Engineering
Figure 5. Connection detail © Maffeis Engineering

to the outer or inner part of the concrete column, fixed with an aluminium profile and tensioned with a cable system.
The analysis of the fabric panel which is basically flat considered also respect to the flattering effect that typical flat panel cause with a resultant increased value of pretension to the initial design condition

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1

Valmex Systems

Low and Bonar

Developing smart fabrics

Low & Bonar's latest development for the market of technical textiles is called Valmex Systems. It's a vinyl-coated polyester membrane with built-in pockets. The position, width and quantity of the pockets can be varied. The first edition was done with tubes in warp direction. That means that the pockets have a length of several hundred meters. Valmex Systems has already been used with integrated LED lights – an application which is most suitable for tents or pergolas.

One of Low & Bonar's Turkish customers, SunTech, needed a width of more than 5m for the erection of a prototype pergola. 3,20m long tubes in weft direction were not long enough for this application (Fig. 1). This is why the weavers in Fulda went for the challenging option of badge-long pockets in warp direction. However long the tubes are, at first they are nearly invisible. As the whole fabric is homogenously coated the tubes will only be activated by opening-up the textile at the respective ends. The easiest way of making the tubes accessible is inflation by air pressure. Once inflated the tubes within the fabric could for example be used as a mixed tensioned/inflated structure. Furthermore heating systems can be installed within the membrane pockets – for example to get rid of snow loads on fabric roofs. Conductor cables as potential filling in the pockets open-up yet another range of applications.

Valmex Systems is the analogue template for using the textile grid as a matrix. Thinking ahead of this analogue version the fabric will once be comparable to the computer's circuit board: open for numerous applications on either an analogue or digital level. The more digital the applications get the smarter will be the fabric itself. Ideally it will be adapting to its environment and hence enlarge the range of interaction with the user. In consequence smart fabrics insert yet another player to the textile industry. The supplier of the fabric will not only be weaver and coater. The coating industry will need experts for smartness within their R&D departments. Whereas nowadays it is mainly chemical and textile engineers collaborating in the laboratories there will be a strong need for IT knowledge in the future. The most important additional player will be in the team of the manufacturer: only the interconnection of the textile matrix with its environment will make it really smart.

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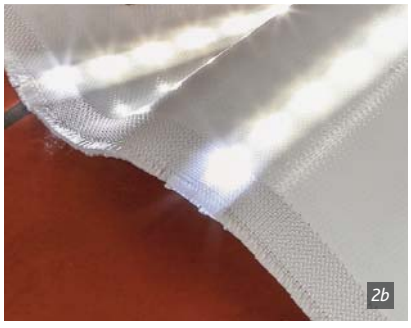
Figure 1: Pergola with integrated lighting © SunTech
Figure 2a/b: Variety of applications © Low and Bonar
Figure 3: Datasheet


2a


2b

Technical datasheet No.: **2133.5**

Product: **VALMEX®** Systems

Article No.: 9262 5342

Type of coating and finish			
Type of coating	**PVC**		
Finish	**Acrylic lacquer on both sides, protected against microbal and fungal attac**		
Burning behaviour	**flame retardant**		
Total weight	**1200**	g/m²	EN ISO 2286-2
Tensile strength warp/weft	**7000 / 6500**	N/50 mm	EN ISO 1421/V1
Tear strength warp/weft	**1000 / 1000**	N	DIN 53363
Adhesion	**25**	N/cm	PA 09.03 (intern)
Cold resistance	**-30**	°C	EN 1876-1
High Temperature	**+70**	°C	PA 07.04 (intern)
Light fastness	**>6**	Note, Value	EN ISO 105 B02
Base fabric			
Material	**PES**		DIN EN ISO 2076
Yarn count	**1100**	dtex	DIN EN ISO 2060
Remarks	**with blockout inner layer, preliminary datasheet, Abstand zwischen den T Taschen ca. 3,4 cm. Die Taschen müssen vorher mit Druckluft geöffnet we einschieben zu können.**		

3

Gooik is mentioned as belonging to the Abbey of Saint Gertrudus as from the 9th century. The church of Gooik is a registered building. In front of the church the parking space is in fact the centre of the village, which had in previous times a much more prominent meaning in the settlement. With input from the inhabitants a reconversion was planned.

Gooik, Belgium

Figure 1. The Saint-Niklaas church in Gooik © Heemkundige Kring Gooik/JP De Loecker
Figure 2. Parking in front of the church, © RING TV, Geert Vanhassel

MEMBRANE CANOPIES ENRICH A PUBLIC SPACE

Context

It was the aim that this central location of Gooik should have again its prominent role in the life of the community: covering friends and families at weddings when accessing the church, allowing the emplacement and linking the individual market stalls during the annual market, sheltering the benches, designed for this location, to allow the villagers to sit and talk together…

It was the aim of the architect Amandus Van-Quaille to preserve the view from the church to the beautiful landscape in the west direction. By designing two similar canopies, one in front of the church and a larger one on the main place, the architect also created a beautiful perspective towards the church.

The design

Both canopies have 4 high boundary points, supported by struts. The low points in between are tied down by two cables. In the larger canopy an eye-shaped opening is oriented to the west view. The material … has been chosen for its high translucency.

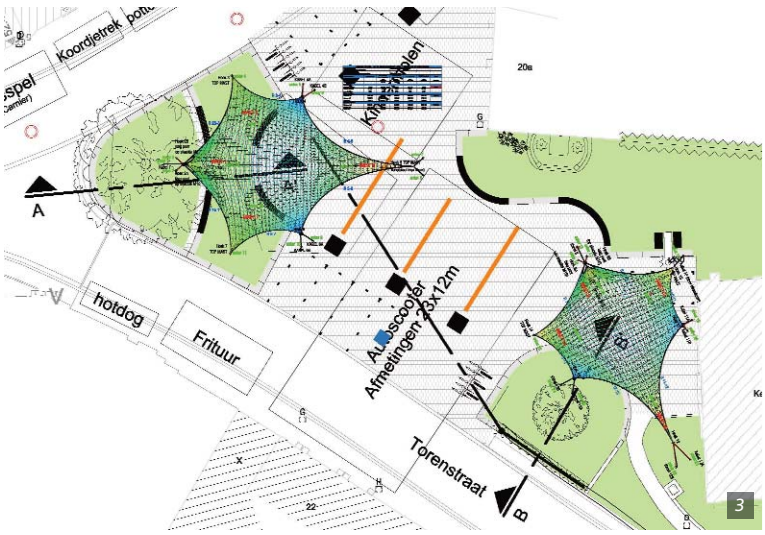
Set-up

The drilling of the anchors and precise verification of the positions was done in advance. The screw anchors have a length of 3m and 4m. The anchors were checked by pulling with the design force for about 10 minutes (a non-destructive testing, see Figure 3 and Figure 4) and the displacements were measured afterwards. The final position of the anchors was measured with theodolite and GPS. Any small difference was taken care of by adjusting the length of the cables. In this case, the production of the membrane and the placement of the anchors were parallel processes. The confection of the cables was done after the execution of the foundations to be able to incorporate differences observed on site.

Both canopies were set up by a team of 5 workers, and the help of a telescopic crane. There was no wind at all when installation took place (2/8/2018).

The membrane was laid on the ground, connected to the high points of the struts as well as to the tie down cables. Cables were also connected to their anchorage points. High points were lifted, fixed immediately by the cables, and the base points of the struts were moved to their position and fixed.

The process was smooth, it was clear that the workers understand their job. They looked at every cable and corner to avoid damage while moving to the final position. Every handling



was done softly. Within 8 hours the set-up of both canopies was completed.
Pictures below are taken during the set-up, before the final adjustment of the pre-tension.

Final comments

As new parking lots have been arranged in the neighbourhood of the main place of Gooik, this place becomes car free and is given back to the villagers. Besides the canopies, the place will be enriched with benches, a playground for children and plants. Inhabitants are still invited to inform about proposals and initiatives.
As other installations already proved to be used by the inhabitants of the neighbourhood, a similar evolution is expected for Gooik.

Report by Marijke Mollaert, who attended the set-up
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Figure 3. Drawing as built ©Amandus VanQuaille

Figure 4. Checking a screw anchor ©Amandus VanQuaille

Figure 5. Verification of the position ©Amandus VanQuaille

Figure 6. The membrane laid on the ground

Figure 7. The smaller canopy in front of the church

Figure 8. Lifting of the 1st high point of the larger canopy

Figure 9. Lifting of the 2nd high point of the larger canopy

Figure 10. Before the lifting of the 3rd high point

Figure 11. All high points lifted, view to the west

Figure 12. membrane enlightened at night ©Andras VanQuaille

Name of the project:	't Plosj (local dialect word for 'The Place')
Location address:	Main place Gooik, Belgium
Client (investor):	Municipality of Gooik
Function of building:	open canopies
Type of application of the membrane:	shelter for rain and sun
Year of construction:	2018
Architects:	arch. Amandus VanQuaille
Structural engineers:	The Nomad Concept
Consulting engineer for the membrane:	The Nomad Concept
Contractor for the membrane (Tensile membrane contractor):	The Nomad Concept
Supplier of the membrane material:	HIRAOKA & CO., LTD.
Manufacture and installation:	The Nomad Concept
Material:	Hiraoka 212T-II E (SAC)
Covered surface (roofed area):	220m²

Figure 1. Engraving of the Mehler company in Fulda, founded in 1837.

The brand Valmex® turned 80

February 23rd 1938: registration of the brand Valmex®

It was registered on February 23rd 1938: one brand of the weaving mill Mehler that was founded in 1837 in Fulda. After 80½ years that is still worthwhile mentioning to the Tensile Architecture community. Right from the start the brand Valmex® stood for coated fabrics. Whereas at first the textiles were mainly used for raincoats it was in the late 1940s that the scale of the fabrics became larger and larger. Vinyl-coated polyester table cloths for example were a great relief for post war households after millennia of starched linen.
With the re-invention of modern textile architecture by Frei Otto in the 1960s the Valmex fabrics were first choice for tensile projects – as for example the retractable roof in Bad Hersfeld. Nowadays Valmex® stands for technical textiles that are far more elaborate than 80 years ago. Nonetheless they still have the appeal of the fabrics that Mehler started with in the 1930s.

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Figure 2. Valmex fabrics for the retractable roof of the Open Air Theatre in Bad Hersfeld by Frei Otto.

Figure 1a. Current frame tent.

Students of the third bachelor architectural engineering were asked to design a tensile structure to replace the current frame tent at the VUB (Fig. 1). The current state of the frame tent is not the best example to show that at the Department of Architectural Engineering one of the research topics is the design of lightweight structures.

Figure 1b. Current frame tent.

Design for a new VUB-tent

by students of the 3rd bachelor Architectural Engineering, as final task for the course Form-Active Structures (2017-18)

Sarah Fontaine – Permanent wall at one side and internal high points.

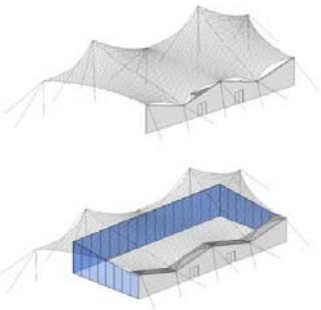
The technical department of the VUB has set a brief with requirements for the new VUB-tent. The tent should, as the current tent does, host parties for the students, but in addition the new tent should offer the possibility to rent the space for other events and exhibitions. Furthermore, the brief listed a demountable structure with a covered area of 37m by 18m, incorporation of a bar, sanitary blocks, the use of fire proof materials and two entries/exits. During the design, students were encouraged to think also about vandalism prevention and ways to (partially) close the tent as part of the architectural concept.

At the end of the task, students had to hand in architectural sketches and drawings illustrating their concept, a physical model of the tensile surface structure they designed and a preliminary numerical model using the software EASY.

Based on the architectural and functional quality of the designs, several 'inspirational' ideas were presented to the technical department.

Finally, the technical department selected the project of Noam Kalai for further elaboration. During a short summer workshop, the numerical model was updated. The curvature was improved, and some separate models for walls and facades were made.
The final design composes 10 frames in a radial configuration. The tensile structure has two times three roof segments covered by membrane connected to two times two segments covered with a cable-net. The covered zones are closed by membrane walls and facade elements.

Pablo Racourt – Logitudinal ridge cable with removable wall system.



Salomé Oliveira Loureiro – Ridge and valley cables and removable glass wall panels.

Helen De Weser – Three internal high points by pivoting poles.

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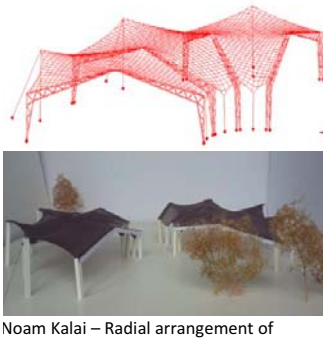
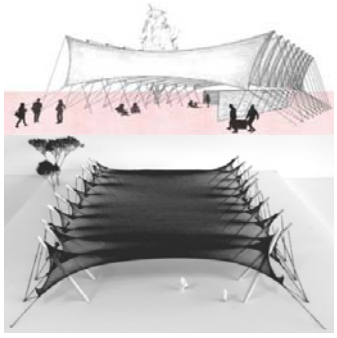


Noam Kalai – Radial arrangement of internal frames of the existing tent.

Figure 2a. Students designs.



Ester Geboes – Articulated ridge and valley.

Figure 2b. Students designs.

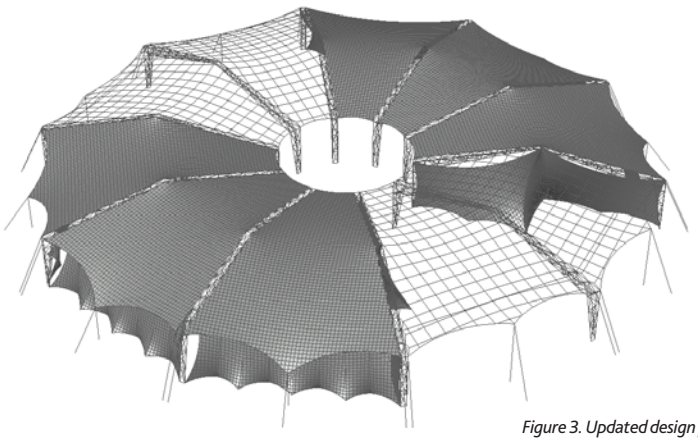


Figure 3. Updated design proposal.