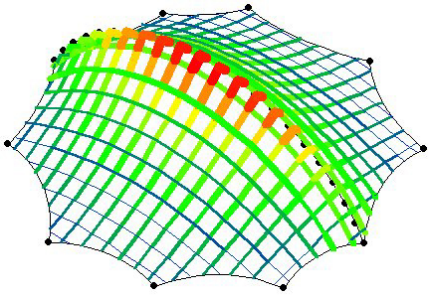


Textile Roofs 2005

May 26th - 28th 2005

Prof. Dr.-Ing. Lothar Gründig
Technical University of Berlin (TUB)
Berlin, Germany

Report

Prof.Dr.-Architect Josep Llorens
Technical University of Catalunya (UPC)
Barcelona, Spain

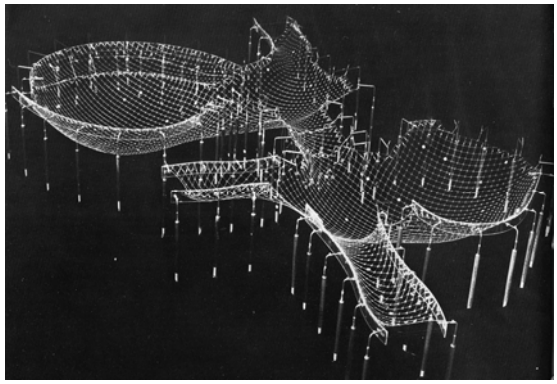
Introduction

Textile Roofs 2005, the Tenth International Workshop on the Design and Practical Realisation of Architectural Membranes, took place from 26 to 28 May at the Technische Universität Berlin and was chaired by Prof. Dr.- Ing. Lothar Gründig.

It attracted 71 participants from 22 countries and four continents who celebrated its 10th anniversary, once again demonstrating the success of the event, which has become firmly consolidated since it was first held in 1995.

Student seminar

This year, the workshop was preceded by the first international student seminar “De-light and air”, which was organised by Dr. Lothar Gründig (Berlin), Dr. Rosemarie Wagner (Munich) and P. Michael Schultes (Vienna) and supported by Dr. Joachim Bahndorf (Minden), Prof. Peter Sassenroth (Minden) and Arno Pronk (Eindhoven). A short summary is available in the 9 Sept. 2005 issue of the TensiNews electronic newsletter.



Main lectures

1. “About Lightness in Form and Structure” by Jürgen W. Hennicke, Institut für Leichtbau, Entwerfen und Konstruktion, Universität Stuttgart

Experimental ways of finding forms were presented: naturally occurring shapes inspired by tree structures, hanging cable nets upside down to obtain grid shells, and soap bubbles, soap films, rubber membranes and plaster and their use in pneumatic structures.

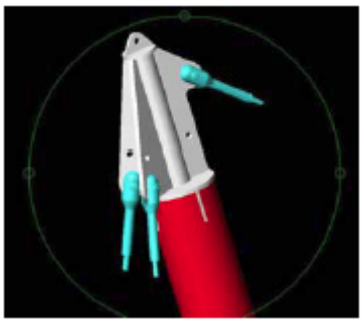
Examples included cushions, pneumatic tubes, meshes, cable nets, wire meshes and tents. Using translucency, sunlight and cutting patterns were some of the methods pointed out for interpreting shapes.

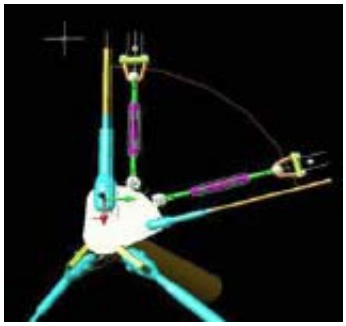
The need for keeping light, air, water and earth was emphasized.

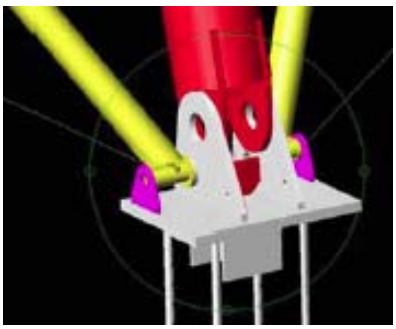
2. “Design” by Dr. Josep Llorens, School of Architecture, Technical University of Catalunya, Spain

In order to design textile roofs, several interrelated requirements must be taken into account. The problem can sometimes be tackled using computer-aided approaches, but at other times there is no substitute for a qualitative approach based on knowledge and experience.

All of the requirements were described in detail: basic principles, processes, site, visual expression, geometry, structure, environment, materials, installation and cost. They were illustrated with a wealth of examples.

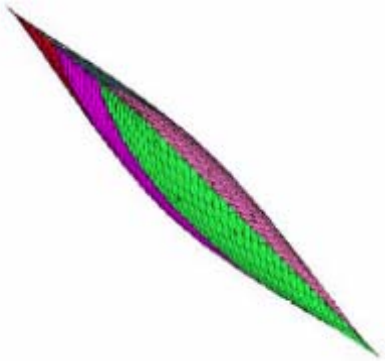






3. “Membrane Structures: From Design to Installation” by Reiner Essrich, IF Ingenieunrgemeinschaft Flächentragwerke, Reichenau, Germany

The complete project sequence for designing and installing a membrane structure was described. It focused on the organisation of those involved, familiarisation with the project, draft construction design, initial calculations, establishing dimensions, structural calculations, working plans, workshop drawings and erection planning. A step-by-step case study was presented.

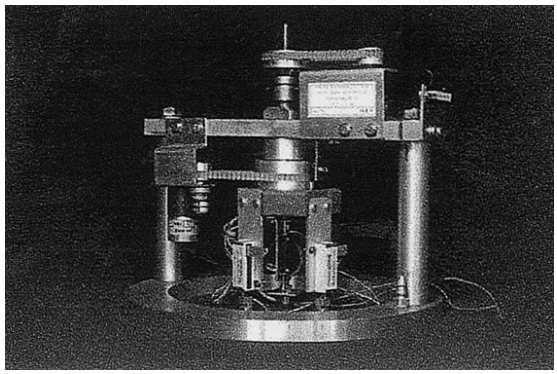


4. “Computational Modelling Concepts”, by Dr. Dieter Ströbel, Technet GmbH, Stuttgart

The task of determining appropriate forms for stressed membrane surface structures was considered. An explanation was given of general concepts common to all equilibrium modelling systems prior to a more detailed description of the force density method extended to geometrically non-linear elastic analysis. Planar cutting patterns were then introduced and the combined flattened and planer sub-surface regeneration strategy used in the Easy design system was presented. The lecture was rounded off by various examples that illustrated the capabilities of Easy tools for form-finding, static analysis and cutting pattern generation.

5. “Multi-layered Tensile Forms”, by Prof. Marijke Mollaert, Vrije Universiteit, Brussels

A thorough introduction was given on the use of layers as an improvement on the architectural quality of buildings that focus on form-active constructions. Adaptable layers made of different textile materials and membranes can be combined to obtain the appropriate weather protection, shading, thermal, ventilation, acoustic, lighting and structural properties. There are numerous possibilities for combining structural and non-structural layers. There are also many different ways of interconnecting the layers and attaching them to the primary structure. This is clearly illustrated by the use of adaptable elements, multi-layered textile forms and adaptable tensile membrane systems, the “Clam Roof Emergency Domehome”, the “Sierra Designs”, the “Minnesota Concept Houses” and insulation materials.



6. “Material Properties of Fabrics and Films: Theory and Measurement” by a representative of Dr. Rainer Blum, Laboratorium Blum, Stuttgart

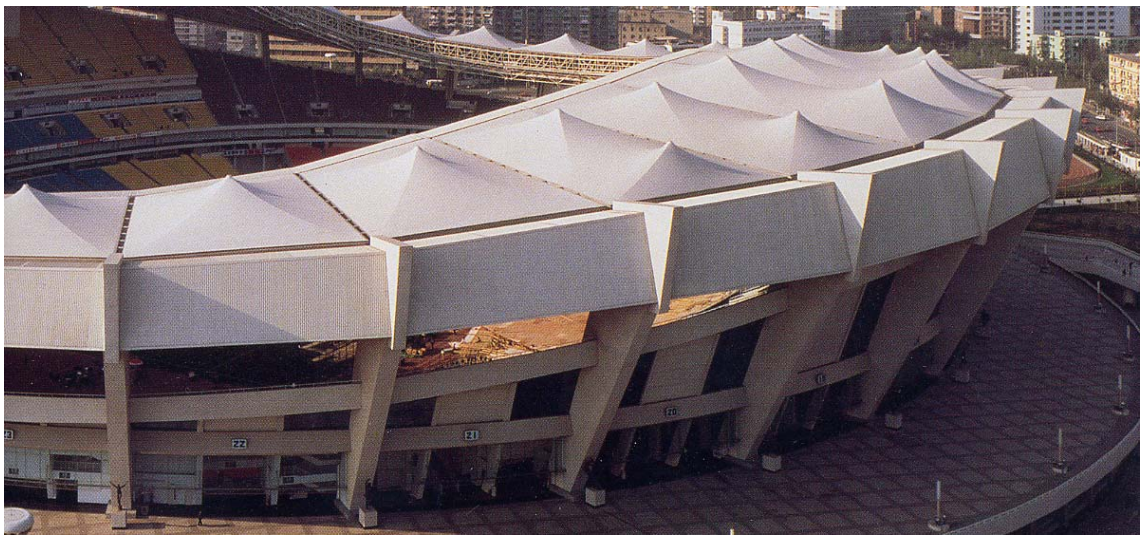
Research on material configuration and properties of fabric and films for textile roofs was presented. The evaluation of translucency, heat transfer, acoustic properties, strength, stiffness and biaxial tear propagation were mentioned. In addition, a description was given of the tools that are required to measure the latter properties, such as the folding apparatus to determine the influence of folding on the foldable umbrellas in Al Madïnah. The pre-stress of the membrane was measured on site in the Berlin Olympic Stadium and the cable stress was measured non-destructively on the façade of the new Cologne-Bonn airport terminal.

7. “Textile Materials for Membrane Structures” by Françoise Fournier, Ferrari, la Tour-du-Pin

The properties and applications of PVC-coated polyester and glass/silicone fabrics were described, together with “Precontraint” and “Texyloop” techniques for improving protection, stiffness, uniformity and environment. The thickness of the coating, fire safety, thermal behaviour, emissivity and recyclability were discussed in detail with the aid of figures and comparisons. The latest advances are focused on applications for interiors and textile façades.

8. “New Membrane Materials with Thermoregulation Properties for Fabric Structure Applications” by Dr. Barbara Pause, Textile Testing & Innovation, Longmont: www.textile-testing.com

Research on a Phase Change Material (PCM) for overcoming the low thermal insulation capacity of membrane materials currently used in fabric structures was presented. During the day, the PCM starts to absorb latent heat and its temperature remains almost constant. Overnight the PCM releases the latent heat stored. Improvement in the thermal performance, savings in costs and extended service life are the major benefits of the PCM application in fabric structures. Product design properties, technical data, thermal insulation values, temperature development inside a model building, light transmission and additional features of PCM were provided.



9. “Recent Development of Membrane Structure Engineering in China”, by Dr. Chen Wujun, Shangai Jiatong University

The development of membrane structures in China since 1995 has been impressive. A fairly fast but more rational development is expected in the near future. The domestic industry possesses sufficient know-how for the manufacture of large PES/PVC membrane structures, but it is somewhat lacking for GF/PTFE and non-existent in the case of ETFE.

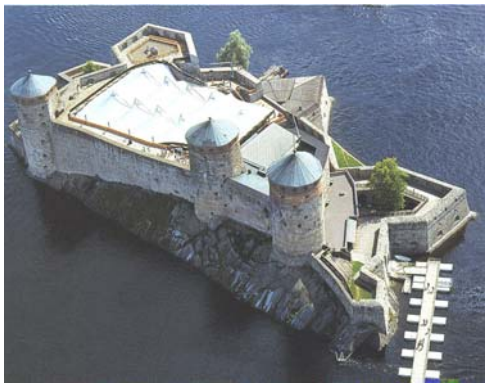
Theoretical research has resulted in software applications for form-finding, static analysis, cutting patterns, computational fluid dynamics and dynamic analysis. Pneumatic structures have not been studied. Prices are dropping. PES/PVC costs approximately €100/m^2 and GF/PTFE €260/m^2, which includes the cost of the fabric, manufacture, erection, steel design fee and taxes.

The speaker made the following shrewd observation from his experience in design: “Designing involves intellectual effort, not just running software. One should not only be proficient in the design of membranes, but also have a firm grasp of structural design and a knowledge of architectural requirements.”



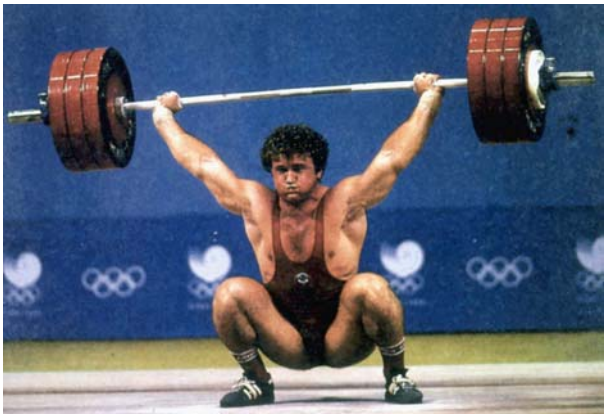

10. “Pneumatic Constructions” by Matti Orpana, Tensotech, Kokolla

A 180x72 m air-supported hall was built in Finland as a sports facility. It measured from 7.2 to 23 m in height, was manufactured as a single piece and taken to the site by lorry and trailer. The snow load was 2 KN/m^2 and pressure ranged from 250 Pa to 600 Pa, reaching a maximum of 800 Pa.




The roof for Olavinlinna Castle was also shown. It is a 1800 m^2 pre-stressed opaque membrane made in a single piece and designed according to strict requirements: new fixtures could not be attached to the old wall and the whole structure had to be erected and dismantled efficiently and not be seen from the outside. This placed limitations on the structure’s height. The result amply overcomes these difficulties.

Finally, some comments were made about ice tourist facilities: they need artificial snow to be fairly stiff and the structure collapse comes slowly as a deflation.

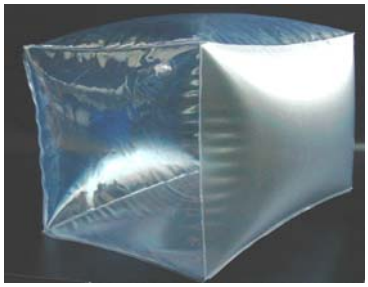


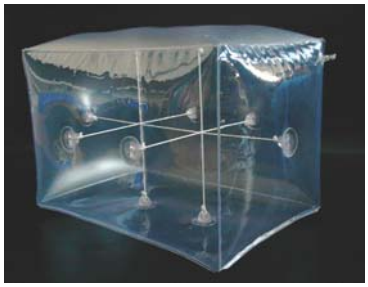
11. “Kinematics in Tensile Structures” by Dr. Rosemarie Wagner, Fachhochschule Munich

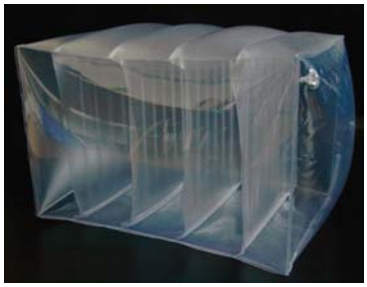
The principles of load carrying based on a high degree of stiffness and flexibility were compared. Less stiffness results in large deformations, low strength, homogeneous stress and less material, all of which are common phenomena in nature. In comparison, a high degree of stiffness means less deformation, greater strength, stress peaks and an appreciable amount of material. This is the usual technique applied to tensile structures.

Kinematic structures were also introduced. They are subjected to large body movements until equilibrium is reached. Each load causes a new geometry to form that is stable but highly sensitive.

The dilemma between stiffness and flexibility affects all aspects of tensile structures, from the material (depending on the yarn and coating), the fabric (the weave and coating process), the structure (curvature and boundary conditions) and the construction (from folded or rolled-up to tensioned). Flexible ellipsoids and redundancies were introduced as a means of characterising kinematic structures, such as cable domes and tensegrities.

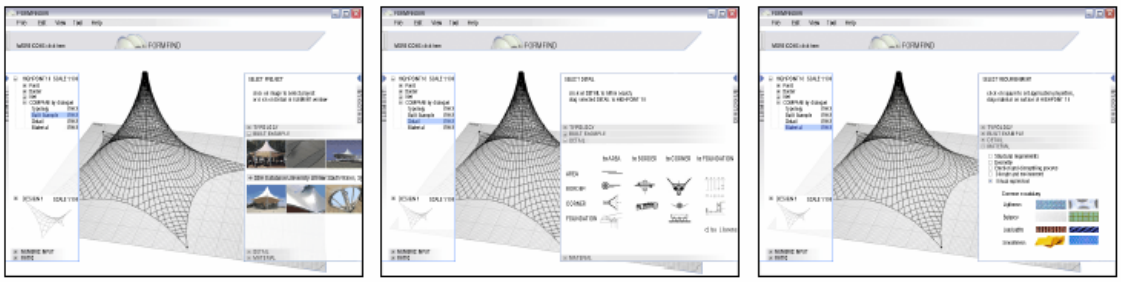






12. “New Developments in Supporting Structures for Membranes”, by Michael Schultes, University of Vienna

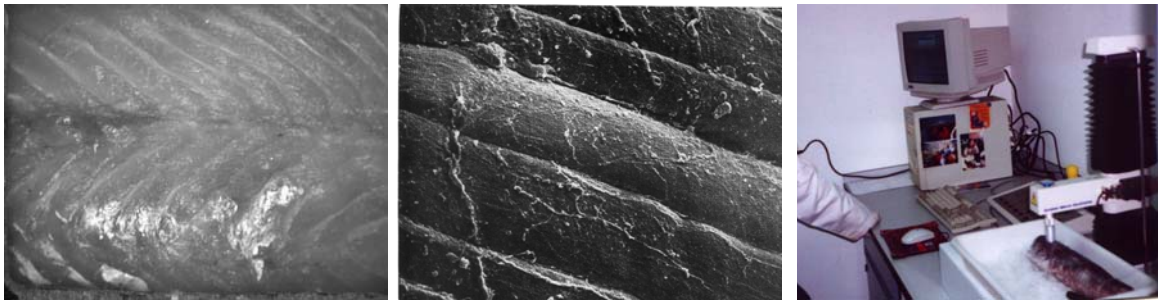
New ideas and applications of steel were shown as an example of the possibilities of cooperation and imagination in design.



Afternoon sessions

13. “Form-finder to Sample” by Robert Wehdorn-Roithmayr, Technische Universität Wien.

Form-finder is a software application aimed at assisting architects in the design of form-active structures. It starts from initial sketches and guides the designer through the next steps to be taken based on analogous information stored in an internal database with online support. Essential fields of knowledge required for the process of designing form-active structures are linked together. “Form-finder” was initially developed as a PhD thesis and is supported by Technet algorithms. It is currently a prototype and will soon be available on the market.



14. “Seafood Quality Control by Means of a Lightweight Structure Approach to Muscle Tissue”, by Prof. Michael Kröger, Hamburg.

Readily accessible information is needed for seafood quality control. Images from fish muscle tissue provide a way of identifying freshness, because the analysis of patterns in the tissue is an indication of the elastic properties of muscle tissue, which are compared to a series of images representing the varying degrees of freshness in seafood. Thus, a lightweight structure approach links up pattern recognition and material properties.

15. “RSTAB: Calculation of Planar and Spatial Structures”, by Walter Rustler, Ing.-Software Dlubal GmbH

Dlubal Engineering Software provides the RSTAB framework program and the RFEM program, which are able to carry out stress analysis, stability analysis, connection design, dynamic design, CAD interfaces, and the design of concrete, timber and composite beams. The Milan Fairground, the Olympic Stadium in Berlin, Graz Airport, the Eden Project, the Scottish Parliament, the Expo 2000 Roof in Hanover and the Allianz Arena are just some examples of structures in which the RSTAB has been used.

The RSTAB takes the geometry, deformation and internal forces computed by the Easy system and develops the steel framework, connections and the design of the foundations, and makes it possible to view the results.

16. “Ice Architecture”, by Arno Pronk, TU Eindhoven

Three different methods of constructing an igloo were presented. The first was the traditional way of building on freezing days or by cooling the air in an insulated room. The second method used an inflatable mould. The third method was developed by the University of Eindhoven. It consists in wrapping tubes around an inflatable mould. The tubes are connected to a cooling system, which pumps glycol at -12ºC into them and sprays them with water. Layers of ice cover the mould, which is deflated and removed, leaving a stable ice structure. This method proved to be a straightforward way of building blob structures.

17. “Mito Type”, by Elisa Gutierrez, School of Architecture, University of Sheffield.

A full human scale toy was installed on the roof terrace of the TU Berlin’s main building. It consisted of a series of hypars that were confined by poles and connected by hinges. The result was an interactive structure that could easily be bent into different shapes. According to the author it is “simple in principle and sophisticated in intention, a sorcerer of ideas for new small-scale architecture”.

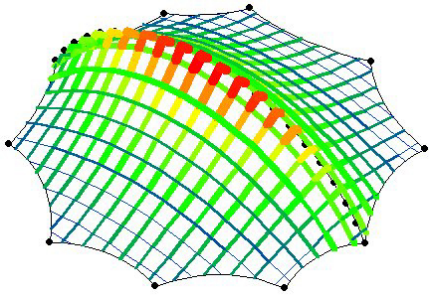
18. Technical visit

On the last afternoon, an optional technical visit was made to the incredible tropical beach installed in the airship hangar in Brand, which is 363 m long, 225 m wide and 107 m high. The central section consists of five four-chord arched steel tubular girders that are 8 m deep at 35 m centres. There are pivoting gates at either end of the hangar, which are made of six movable parts and two fixed elements. The roof is a four-layer membrane of polyester fabric in the form of a double air cushion that has a U-value of less than 1 Wm^2/K.

A cable in the middle of each bay ties down the membrane and prevents it from flapping. Because the initial purpose of the hall was changed to make it a “Tropical Island Paradise”, the polyester on the south face of the semi-cylinder is being replaced with ETFE in order to catch the sunlight and UV rays for plants and visitors.

2005 City Sightseeing Cruise

2005 Workshop Banquet



Textile Roofs 2006

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The Eleventh International Workshop on the Design and Practical Realisation of Architectural Membrane Structures will take place from 25 to 27 May, 2006. Its format will be similar to that of TR 2005 with seminar-style lectures and hands-on activities. It will also be preceded by the student seminar. It will be sponsored by TU, TensiNet, Ferrari and Technet.