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## Concept of Architectural Structure

The authors of this paper are teaching structures and material at the department of Building Science at the School of Architecture of the Royal Danish Academy of Fine Arts in Copenhagen. The aim of this teaching is to stimulate and sustain the interest in **Concept of Architectural Structure.** This is sought to be accomplished by the integration of technology and building science in the concept of architecture through different programs of teaching such as: lectures for 1st and 2nd year students in a series of the history of architecture, seminars in the history of architectural structures and science and analysis of contemporary structures, and studio consultations.

The idea is to give the opportunity to discus the relation between the architectural understanding of the structures and the development of the architectural structures. Obviously the technological development in itself plays an important role, but the basic is, that it only is in relation with the architectural need – or wish, that innovations develops to general architectural technology. The development of reinforced concrete is independent of architectural concepts, - but it was the very strong architectural concept of the modernism, witch opened for a new architectural concept based upon the technical development – that formed concrete into **architectural structures.**

The gab between the architects (and the students) use of the powerful 3-D computer tool, and the technological reality may be seen as immense today, but seen in the view of the historical development, it is natural and necessary.

Before going to the discussion of how to deal with this gab, let us examine some of the characteristics of it.

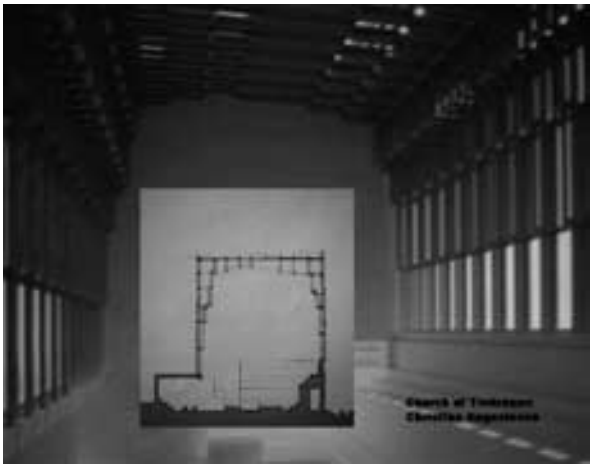
Architectural students have many new possibilities to define shapes and spaces through the computer. They can "manage" a very complex spatial situation, although, they sometimes only understand few dimensions of it. The architects do the same, although they to a certain extent are limited by practical and financial constrains. This gives a gap between the architectural presentation and the real content of the drawings. In that case it may be difficult and less inspiring for the student to have her project pulled apart, and squeezed into well known technological and architectural solutions.
The engineering world has changed at least just as much by the development of the computers as the architect's world. The engineer in theory has a tool enabling him to analyse and understand structures,

which earlier has been left to feelings and very rough check. Calculations of complex membranes, and of structures with large deformations are examples.

The manufacture – the contractor also has a strong tool for product planning and a possibility to deal with non-standardised components by parametric design and manufacturing.

The citizens of the future world also need new environmental surroundings to identify themselves in the contemporary world.

The student of architecture lives with these facts, and tries to find a response within their limits. Their statement must be matched with technological solutions of our time, as been seen in the relation between the eminent engineer Peter Rice, and some very great architects, concerning structures unknown at the time. (Centre Pompidou or the structural glass wall). Neither we, nor our students may be of that calibre, but wee must find methods to deal with the conflicts in a way witch enables a new technological



architecture to develop. One of our experiences from the historical studies is that architectural technology only develops when it is based upon architectural wishes and dreams, and only when these are using techniques of the technological forefront.

So, as technicians wee have to pull upon the latest developments within our field, and to do it in a creative, but responsible way. We need a language between provocative students schemes and the reality. The language seems to be to formulate structural or technological concept. Concepts, which have to match architectural concepts and thereby give guidance in the way the combined architectural and technological development must go.
The need for the use of structural concepts, and conceptual structural design has since some five years, been acknowledge among engineers. At least three international conferences have been held on this topic, and more are planned. It is characteristic, that very few of the papers from these conferences touch the problem, and the subject seem to be better to attract conference fees, than to develop a tool.

It is not our aim to overcome this problem with this paper, but by addressing the network of ENHSA at the meeting here in Athens we wish to present and discuss, the results of the daily work with our students.

The gab between an architectural image and the technological (and functional) problems is on the other hand not only a question of formulations. We believe that there is a need to activate knowledge of how to develop architecture integrated with structures that uses the "hidden recourses of the building" as OV uses to express it. It may be by the use of plate actions of the walls, or by membrane actions in curves surfaces. New spatial concept's seems to call for structural concepts of membrane, or semi-membrane structures designed in a parametric sense suitable for both the architectural computerised control, and the manufacturers use. In this space the engineer's advice of how to handle geometry, supports and curvature need to develop more knowledge, than the common engineering textbooks offers. This is where the impossible demand for some of us to be a "Peter Rice/Ove Arup" raises. Of course this is unsolvable, but the discussion about structural concepts may uncover areas to develop and communicate in a teachers professional forum. At the Architecture School in Copenhagen we try to develop and understand actions and possibility of freely shaped spatial structures. This is a research work, where the focus has changes from minimalize to possibilities of supports and curvature.

Apart from the formulation of architectural, technical concepts, their historical examples, and a development of actual structural systems, it seems very useful to discuss these problems based upon newly build structures with great architectural content. One of our college in Copenhagen a structural engineer Finn Bach scan technological and architectural publications, so that he can give sufficient facts to discuss the new architectural structures and their different concepts with the aim to give the student a more realistic picture of the glossy picture in the magazines.

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Finally wee will like to point out a close collaboration between the specialist teachers, and the generalists. Between the architect and the engineer in some cases. The two authors of this paper are architect Ola and engineer Ole. We often give lectures and courses together, as we do by sharing this paper, in the benefit to reduce the gab of engineering architecture and the gift of provocation and dialogue that links studies, research and practice.