

## **Development of driving technologies of retractable membrane structure – learning from the past**

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### **Abstract:**

During the 60s and 70s of the 20th century, the scientific principles for lightweight tensile structures were elaborated. In particular, Frei Otto and his Institute for Lightweight Structures at the University of Stuttgart advanced engineering technologies of lightweight construction and transformed them into state of the art.

Already at the beginning of this exciting era of lightweight design, early convertible roofs were planned and built. Because of additional requirements in terms of geometry, form finding, material properties and driving mechanism, retractable membrane roofs were regarded as the supreme discipline among membrane structures. As motorized driving systems were used to move and span the textile roofings, building trade and mechanical engineering met; a delicate and often underrated interface to this day.

This paper deals with driving systems for convertible membrane roofs. Initially, development of various mechanisms in the past will be reviewed: Which systems have been developed so far, which have become established, what were the advantages and disadvantages? How design was influenced by technical capabilities and architectural requirements? What has been learned from defeats?

To date, convertible membrane roofs spanning the dimension of around 10,000sqm became established, usually as inner roofs for large stadiums. They all fold to the centre and are driven by well-proven, meanwhile technically mature driving systems. Compared to this category, small and medium sized convertible roofs are surprisingly few. Conceivable applications are numerous and varied: a great many of public open spaces, inner courtyards, open-air stages, pedestrian zones, markets etc. could be meaningfully equipped with convertible textile cover.

In order to achieve technical solutions of affordable costs, less complex and suitable driving systems for smaller sized roofs must be provided. The second part of this paper therefore presents some different driving mechanisms, which have been developed by the author and implemented in his projects over the past years.