

## **Form finding by shape optimization with the Vertex Morphing Method – About the equivalence of sensitivity filtering and standard spline models**

**Kai-Uwe Bletzinger, Majid Hojjat, Electra Stavropoulou**

Technische Universität München, Germany, kub@tum.de;

### **Abstract**

The proper parameterization of structural shape which is suitable for creating structural form and shape optimal design is a great challenge. The demand for large design spaces with large and very large numbers of design parameters is in conflict with the robustness of the numerical model. There is a need for regularization. The currently most successful techniques which overcome those burdens and, simultaneously, are most intuitive and easy to be used are so-called filter techniques. They directly use the coordinates of the discretization nodes as design parameters. Filters are applied to smooth the shape sensitivity fields as the generator of the design update towards the optimum. However, the filters are much more than mathematical means to prevent numerical problems such as mesh distortion or checker board patterns. Even more important, from the point of view of shape design they deal as a design tool to controlling the local and global shape properties. The actual presentation will show that filtering is equivalent to the implicit definition of standard spline models. Impressive applications in the fields of CSD and CFD with problem sizes up to 3.5 million design parameters can easily be handled by this technique.

**Keywords:** shape optimization; sensitivity filtering; morphing; structural optimization; CFD optimization.