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# Multiphysics Topology Optimization

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The topology optimization method [1, 2] has undergone a tremendous development in the last two decades. Starting out as an academic idea of distributing limited material in a design domain in order to minimize structural compliance, the method has grown to be the preferred design tool for structural layout problems in mechanical engineering, automotive and aerospace companies throughout the world. A number of commercial and freeware/web codes are available and the more advanced codes include consideration of manufacturing constraints like extrusion, casting, periodicity and repetitivity constraints.

In parallel to the developments of the purely structural applications, the topology optimization has more recently been applied to a range of other alternative physics and multiphysics problems. Examples are: extremal material design [3, 4], compliant mechanisms and MEMS [5, 6], fluidics [7], optics [8, 9] and acoustics/structural acoustics [10, 11].

The basic idea of the density approach to topology optimization is to introduce one continuous density design variable pr. element in the finite element mesh and use analytical sensitivity and math-programming methods to find the optimal density distribution for given objective functions and constraints. For purely elastic problems the stiffness to density ratio is given by a simple power-law expression and by choosing the power high enough it is possible to obtain discrete solid-void solutions despite of the continuous design variables [12].

Some multiphysics applications of the topology optimization may use the same simple material interpolation schemes as for elasticity but for more complex problems like fluidics, pressure loads, electrostatics, acoustic-structure interaction a.o. the simple interpolation schemes fail and one must come up with more advanced, possibly monolithic, modeling schemes in order to be able to parameterize and topology optimize the problems.

The lecture will summarize recent developments in topology optimization of multiphysics problems cast in a framework that may be called *PDE-interpolations in Topology Optimization*.

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