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BRANCHING STRATEGIES FOR THE APPLICATION OF HEURISTICS TO THE TOPOLOGY OPTIMIZATION OF CRASH LOADED STRUCTURES

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This contribution compares different strategies for the selection and the control of heuristics within a topology optimization procedure of crash loaded structures.
The topology optimization of crashworthiness structures is an emerging field of research. Crashworthiness structures are subjected to nonlinearities with different kinds of sources: geometry (e.g. large displacements and rotations), boundary condition (e.g. contact) and material (e.g. plasticity, failure and strain rate dependency). Usually crash simulations are performed with Finite Element Method codes which can handle the nonlinearities and use explicit time integration. The existence of bifurcation points, the usage of special structural responses like energy absorption and injury criteria, the costly determination of sensitivities (due to the explicit time integration) and the huge number of local optima make the optimization of crashworthiness structures even more complex.
One approach to overcome these problems is the usage of heuristics derived from expert knowledge. The method of Graph and Heuristic Based Topology Optimization (GHT) uses a combination of heuristics and mathematical optimization algorithms for the combined topology, shape and sizing optimization of crashworthiness profile structures [1] [2] [3]. Each iteration of this method consists of a topology change and a subsequent shape and sizing optimization for the new topology class. The topology changes are performed by heuristics and the shape and sizing optimizations are carried out with mathematical optimization algorithms. There exist different heuristics for the topology modification of the structure, which are concurrent to each other because only one topology modification is allowed in each iteration. Therefore the selection of a heuristic for the topology modification is a critical point.
The major disadvantages of the method of Graph and Heuristic Based Topology Optimization are the high risk of getting stuck in local optima and the high computational effort. This contribution compares different kinds of control and selection mechanisms for the heuristics with the goal to improve these weak points. Instead of choosing only one heuristic for a topology change and performing a computationally expensive shape and sizing optimization after every topology modification [1], different design possibilities which are the product of multiple topology modifications performed by different heuristics are tracked simultaneously. The fitness of these concurrent designs is evaluated by function calls. The number of computationally expensive shape and sizing optimizations can be reduced by the more intensive usage of the heuristics

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