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ROBUST PROCEDURES FOR STRUCTURAL OPTIMIZATION

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The overall objective of this paper is to describe the work carried out by the ADOPT (adaptivity and optimization) group at Swansea over the last six years and to pose some questions concerning the future of structural optimization.
Initially work concentrated on shape and sizing optimization for trusses, arches, axisymmetric shells, prismatic structures, models based on 2D continuum representations and free form shells for static and free vibrations situations. In these optimization programs the initial geometry is specified using splines or Coons patches. Meshes are automatically generated using unstructured adaptive mesh generators based on the advancing front method or using structured mesh generators in the case of shells. The loads and boundary conditions are associated with the geometric model not the finite element (FE) mesh so as to facilitate automatic mesh updating. Sensitivities to changes in the structural geometry are then evaluated using finite differences or semianalytical methods. Established optimisation techniques such as sequential quadratic programming, the method of moving asymptotes or the generalised reduced gradient method then make use of the gradient information to produce optimal structural designs using iterative procedures. These were all for linear problems. More recently the ADOPT group has looked at nonlinear problems and has also experimented with genetic algorithms in place of gradient based algorithms.
Other work carried out by the ADOPT group has focused on topology optimization and integrated structural optimisation. Initial structural topologies are either predetermined by design or manufacturing constraints, or must be designed by engineers. Topology optimization is a tool which assists the designer in the selection of suitable initial structural topologies. In topology optimization, at the outset a domain called the reference domain is defined which covers the space of interest. Loadings, boundary conditions and material properties are specified. The aim is to remove or redistribute material from within the reference domain in an iterative and systematic manner in order to arrive at a structural topology which is in some sense optimal. Work is proceeding on the development of ISOP (2D) which stands for **I**ntegrated **S**tructural **O**ptimization **P**ackage and uses adaptive isoparametric FE analysis. Currently, several fragments exist. TOPS and PLATO - for topology optimization using the hard kill and homogenisation methods. IMAGE - for interactive image processing of the results of topology optimization and ADOPT - for the automatic adaptive FE analysis and shape optimization.
The paper will discuss the work of the ADOPT group and conclude by raising two issues: (a) the need for carefully selected, inambiguously defined benchmarks so that research workers can check algorithms and (b) the best methods for interfacing black-box FE simulation tools with conventional optimization (mathematical programming) algorithms requiring gradients of the object function and constraints.