# ICAD - Based Turbine Blade Design Optimization

This article may be found at
http://www.soton.ac.uk/~cedc/posters.html

Mr. Wenbin SONG
Computational Engineering and Design Centre
School of Engineering Sciences
University of Southampton
Southampton SO17 1BJ UK
Tel: +44 (0) 23 8059 5194
Fax: +44 (0) 23 8059 3230
Email: w.song@soton.ac.uk

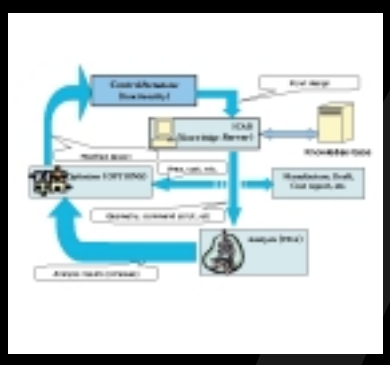
CEDC

UTP for design

## Generative Modeling – More than just Geometry Modeling

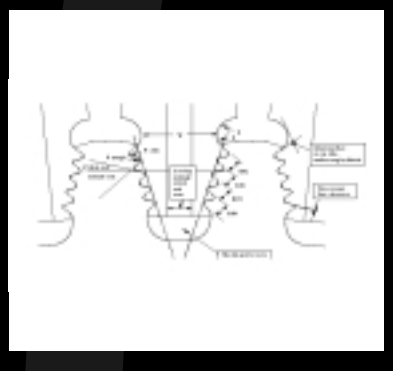
The generative modeling provided by the ICAD system from Knowledge Technologies International gives us the capability to incorporate a geometry-based integrated product model into an optimization process. Here the Rolls-Royce plc. in-house finite element analysis code SC03 is being used to evaluate stress distributions. The OPTIONS Design Exploration System is being used to control the optimization process, carry out jobs starting ICAD and SC03 as separate processes to generate geometries and related information, perform finite element analysis, and retrieve results back to the OPTIONS package.

## Overall System Architecture



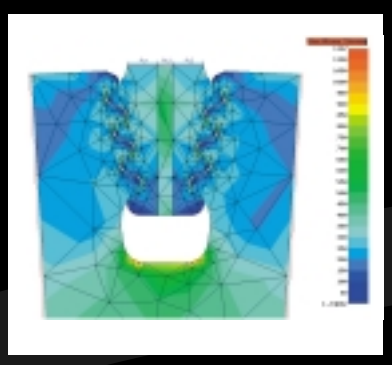
The ICAD system is used to build the geometry from a set of design variables fixed parameters and related information and to construct the FE model in batch mode. The geometry is transferred to the FE code using an IGES file. Boundary conditions and loads are specified as part of the ICAD model and applied in SC03. Full automation is achieved by linking OPTIONS, ICAD and SC03 together.

## Simplified Ad951 Firtree Model



A simplified product model, AD951, is used as the base template for geometry modeling and the starting point for optimization. This consists of straight-lines and arcs only and can be described by approximately 20 quantities, some of which are kept constant, while others are treated as design variables. Care must be taken when there is no feasible geometry that can be produced for a given set of parameters, as this may affect the optimizers, and in particular, gradient based methods.

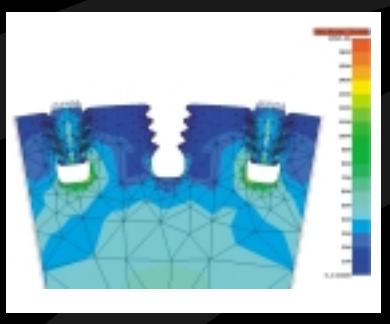
## Stress Contours of One Sector Model



Finite element analysis is carried out using Rolls-Royce in-house FE package SC03 to produce stress distributions for two models. The first examines the peak notch stresses, crushing stresses and section average stresses. The Geometry produced by ICAD is imported into SC03 with boundary conditions/loads applied in batch mode.

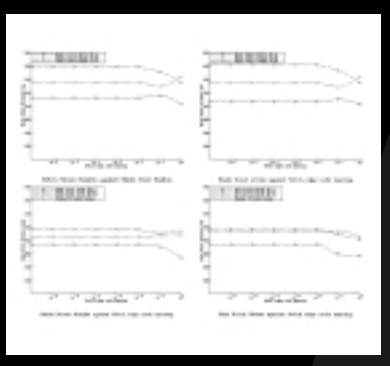
## Stress Contours of 3-Sector Model with Middle Blade Out

The second model considers a three sector model with the middle blade out. This is used to evaluate the unzipping criteria in the design.



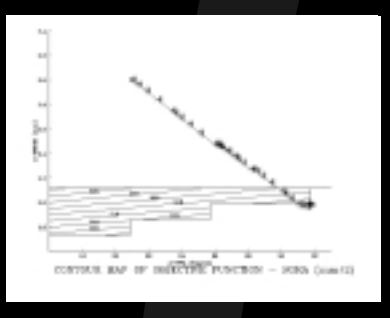
## Effect of Finite Element Node Spacing Along Shortest Edges

Compromises must be made between the accuracy and execution time of the FE analysis as the use of a GA search method involves a large number of loops in the optimization.



This is particularly important for notch peak stress as it occurs along the shortest edges in the geometry.
A parameter study has been performed to find acceptable node spacings before the optimization.

## Trace of Optimization Run



Initial results produced by the GA search show that improvements can be made by searching a large parameter space which would be more difficult for the designer to explore manually without the aid of such an integrated process.
A number of issues such as more complex and robust geometries, impact of modeling of infeasible geometries on the optimizer and different search strategies will be considered in subsequent work.

University of Southampton