ALGORITHMIC ASPECTS OF COUPLED PROBLEM OPTIMIZATION

A THESIS PRESENTED

BY

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ABSTRACT

Title: Algorithmic aspects of coupled problem optimization.

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Summary:

The finite element method is a computer-based design/analysis method generally used to solve field problems. However electro-thermal or magneto-electrothermal problems have rarely been addressed satisfactorily. Moreover the optimization of coupled problem design is especially difficult. In order to eliminate the difficulty, a study was made on the algorithmic aspects with regard to coupled problem optimization and a selected problem was analysed using the finite element method. The algorithms to perform coupled problem optimization were developed.

Where the mesh is generated for a particular problem and electric scalar or magnetic vector potential value at each node is calculated, then the temperature at each node could be computed by using the computed potential values. In order to find the temperature distribution, an additional term has to be added to the matrix equation when the finite element method is applied to it. Also this additional term depends on electrical conductivity (σ_e). Therefore, in tackling coupled optimization problems, the parameter

has to be optimized in one system in which the object function is, while the parameters of design may be in the other part of the coupled system.

There are two major outstanding benefits in this process developed herein. The algorithm provides the means to solve the coupled optimization problem and post-processing capabilities to show how graphs of potential distribution and temperature distribution may be obtained. This is the preferred method of approach.

In the finite element method, we have considered triangular grid for the electric heating of a fuse. Alternatively, the same problem, as shown, can be solved by considering a rectangular finite difference grid using modern spread sheets. The methodology developed couples the graphing and cell-colouring capabilities of modern spread sheets to show how colour maps of temperature distribution may be easily displayed. This easily implementable approach, however, is not suitable for derivate based optimization since derivate computations are difficult. It may however be used in zeroth order optimization methods where no derivates are required.

This thesis therefore has carefully set out the algorithms and their limitations for coupled optimization problems.