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Design Optimization of an Electronic Component with an Evolutionary Algorithm Using the COMSOL-MATLAB LiveLink

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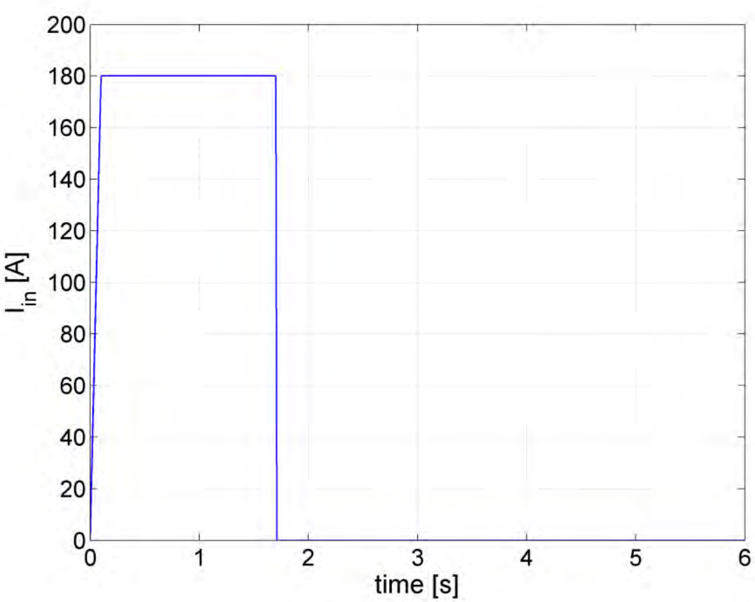
Content

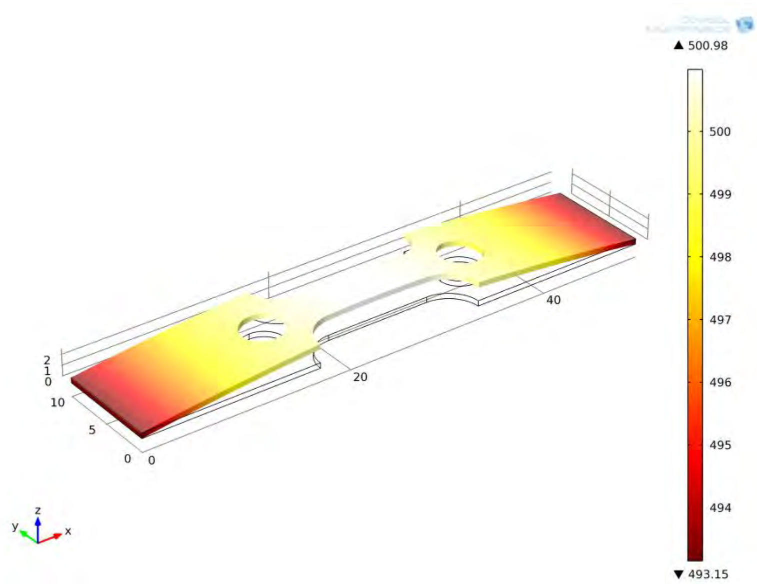
(1) Introduction

- The study shows how to implement a method to use the output from a COMSOL simulation within a optimization algorithm
- The approach is shown by an example of an electronic component, exposed to a high current
- For the optimization a evolutionary algorithm implemented with Matlab is chosen

(1) Introduction

- The geometry is exposed to a current pulse for a defined time
- This results in a temperature rise as well as thermal deformation
- Objective of the optimization algorithm is to reach a desired maximum temperature for the defined pulse while keeping the von Mises stress to a minimum





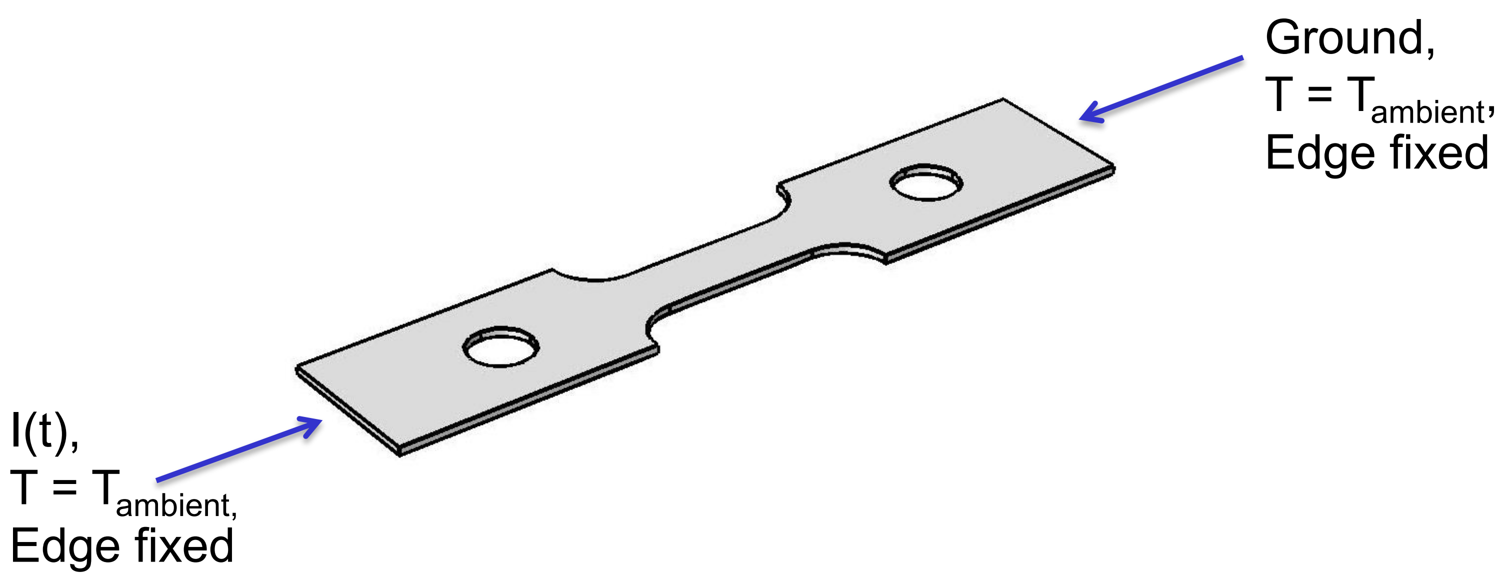
(1) Introduction

(2) Method

(3) Results

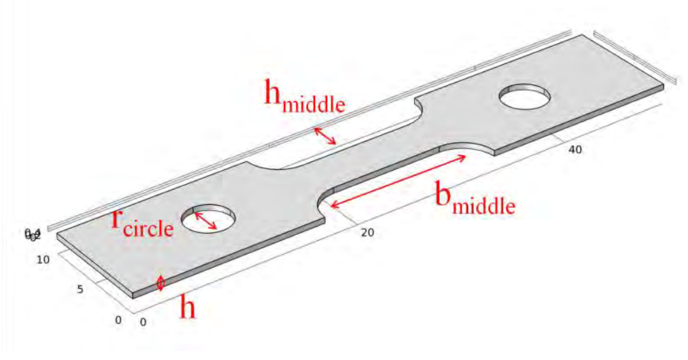
(2) Method: The Comsol model

- The Joule heating model is used to calculate the temperature changes due to the applied current
- To calculate the thermal deformation and resulting stress the structural mechanics model is used
- The geometry is made of copper, material data from the Comsol material database is used



(2) Method: The evolutionary algorithm

- Evolutionary algorithms describe a class of different methods, here a genetic algorithm, part of the class of evolutionary algorithms is used
- These algorithms use methods and operators mimicking biological evolution, such as mutation and crossover
- To judge the quality of each solution a fitness value is introduced, aim is to minimize this value
- During the course of the search different individuals are produced
- Each individuals is made up of different genes, here each individuals represents a geometry with genes being the different characteristics of the geometry



(2) Method: The evolutionary algorithm

- The procedure uses the following steps:

(1) Set $n=1$. Generate N solutions, forming the first population P. Evaluate fitness of solutions.

(2) Crossover: Generate offspring Population Q_t.

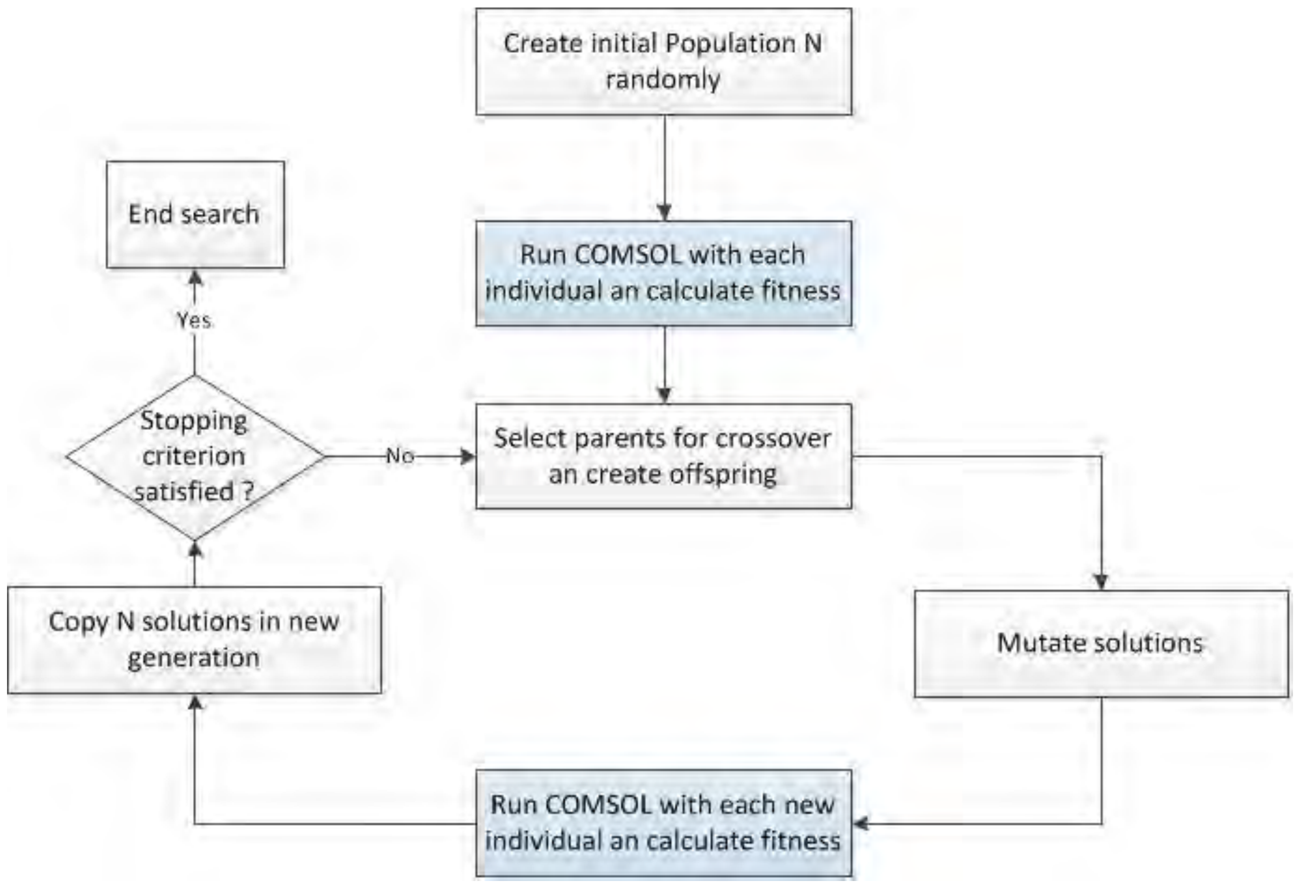
(3) Mutation: Mutate each solution $x \in Q_t$ with a defined mutation rate.

(4) Evaluate fitness of each solution $x \in Q_t$.

(5) Selection: Select N solutions from Q_t considering their fitness and copy them to P_{n+1}.

(6) If stopping criterion is satisfied, terminate search, else, set $n=n+1$ and continue at Step 2.

(2) Method: Linking Comsol with the Evolutionary Algorithm



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(1) Introduction

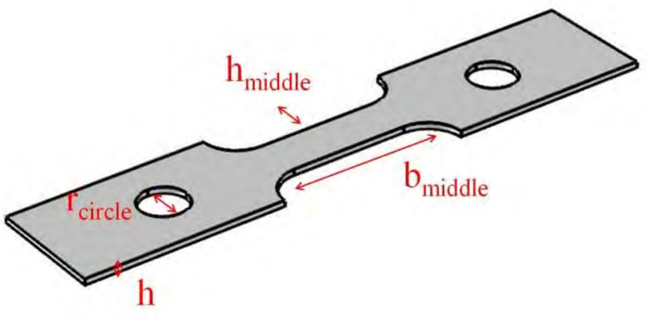
(2) Method

(3) Results

Operator	Value
Population size N	20
Crossover probability	0.25
Mutation probability	0.2
Max. generations	400

(3) Results

- The initial geometry and parameters of the genetic algorithm



Parameter	**Value**
Population size N	20
Crossover probability	0.25
Mutation probability	0.2
Max. generations	400

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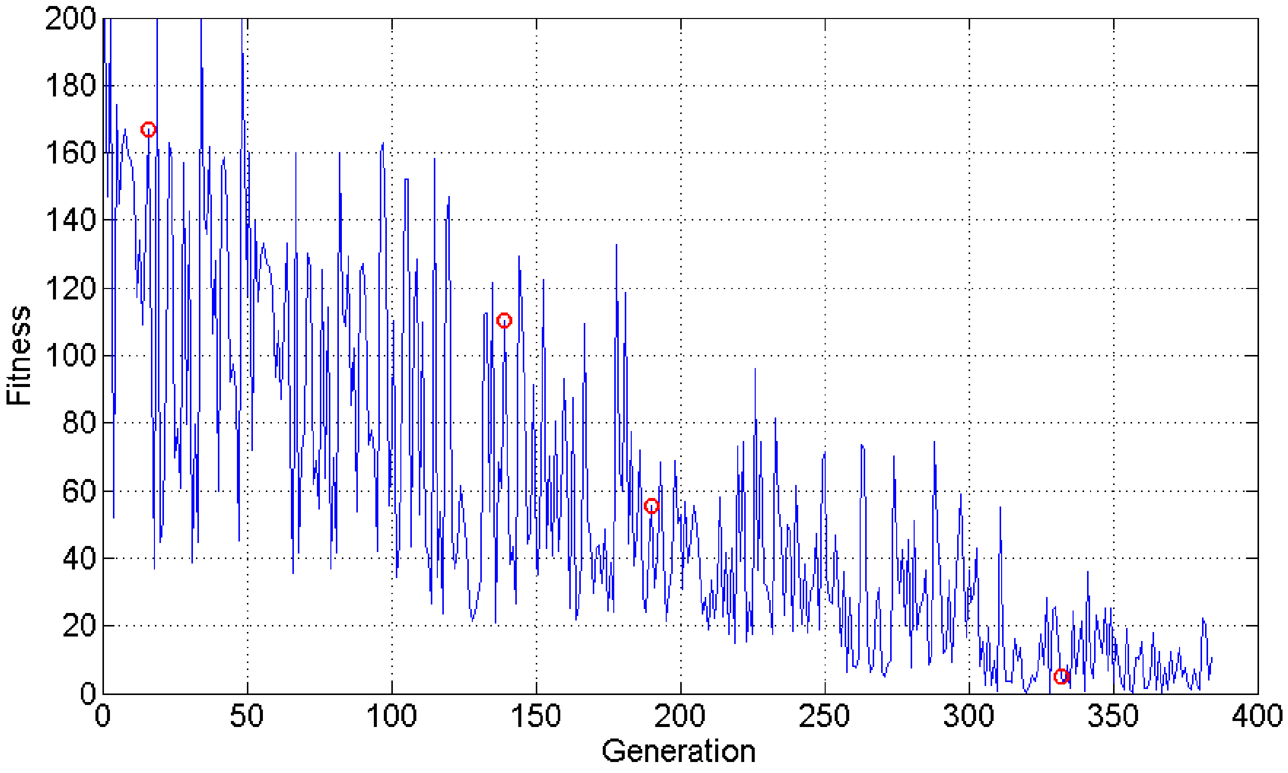
(3) Results

- Stopping criterion is satisfied before the maximum number of generations (400) is reached



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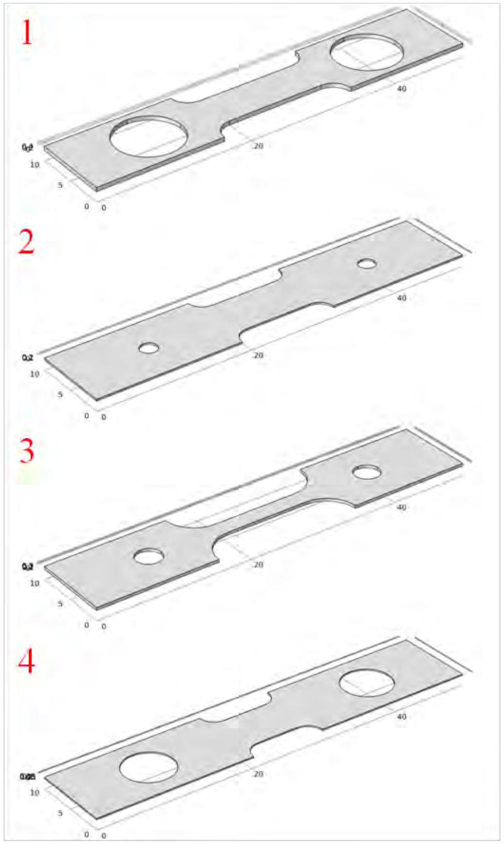
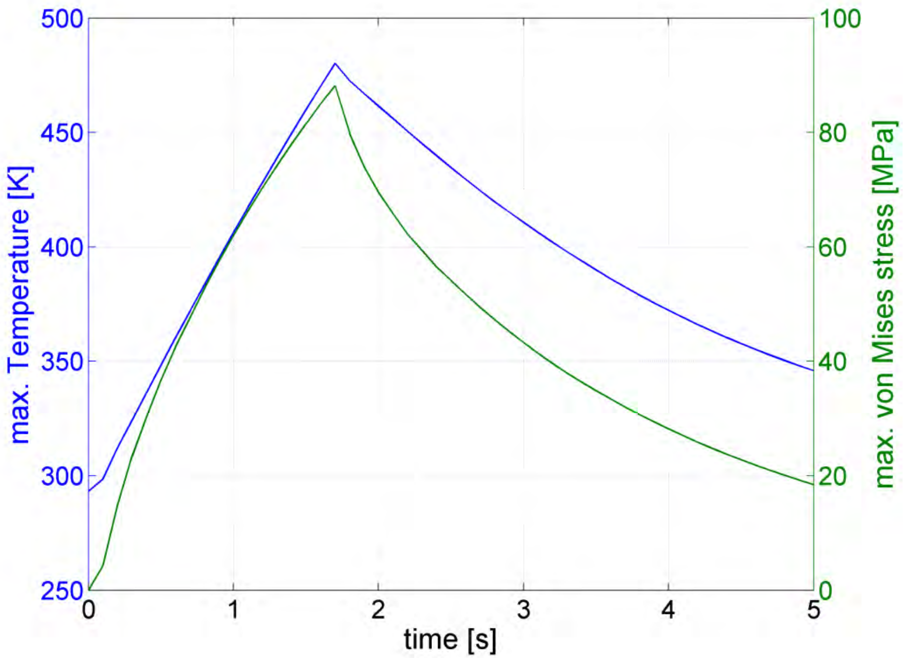
(3) Results

- Geometries at diffferent points during run and output from final geometry





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(3) Results

- Customer was able to reduce the cost of experimental studies
- The geometry shows the desired behaviour while the life cycle due to smaller stress is extended
- This approach could be applicable of a multitude of problems

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