DTU Informatics
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Topology optimization

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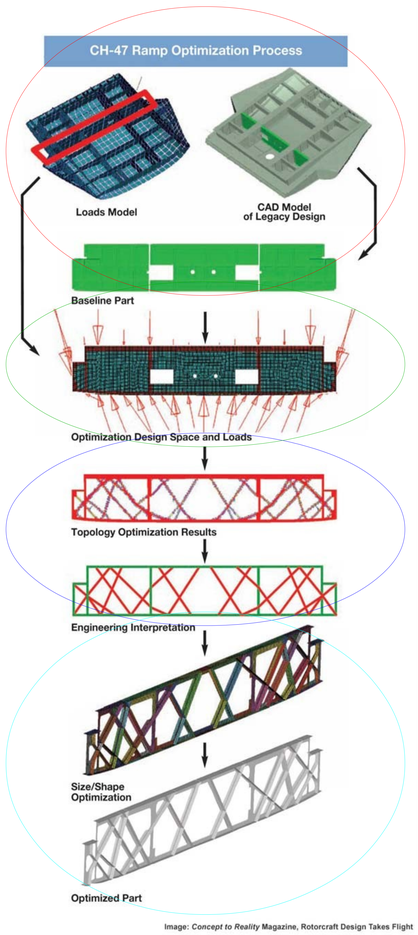
Introduction

Motivation

The idea is to calculate the optimal topology (shape) of a structure with respect to some desired effect (eg. stiffness). For example, instead of making the ramp of a helicopter (see below) entirely solid, we can save weight while keeping the structure stiff by replacing the solid part with a sparse yet stiff structure. Saving weight infers saving fuel and money as well as improving the capabilities of the helicopter. We can calculate the optimal structure for this particular problem as illustrated to the right.

Image: *Concept to Reality* Magazine, Rotorcraft Design Takes Flight

Example



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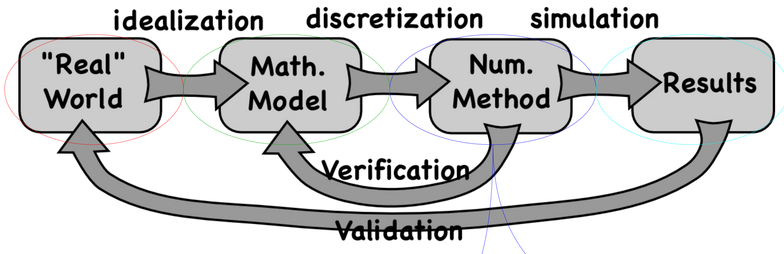


Method overview

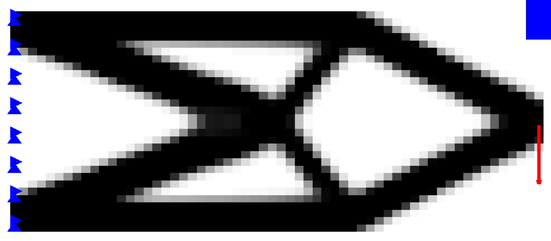
- **Choose design domain, boundary conditions and objective function according to the problem.**
- **Iterate: Calculate the gradient of the objective function wrt. the optimization parameter. Go a step in the gradient descent direction using an optimization method.**

Contribution

Traditionally a fixed grid approach has been used to calculate the optimal topology. The contribution of this work is to utilize a dynamic grid approach called Deformable Simplicial Complexes instead. This has the advantages of explicit interface between material and non-material, it needs only to be evaluated in the interior grid points and regularization is not needed to the same extend.

Fixed grid approach

Optimizes the stiffness by changing the material densitiy of each grid element (black is material, white is no material).



Dynamic grid approach

Optimizes the stiffness by changing the positions of the grid points.