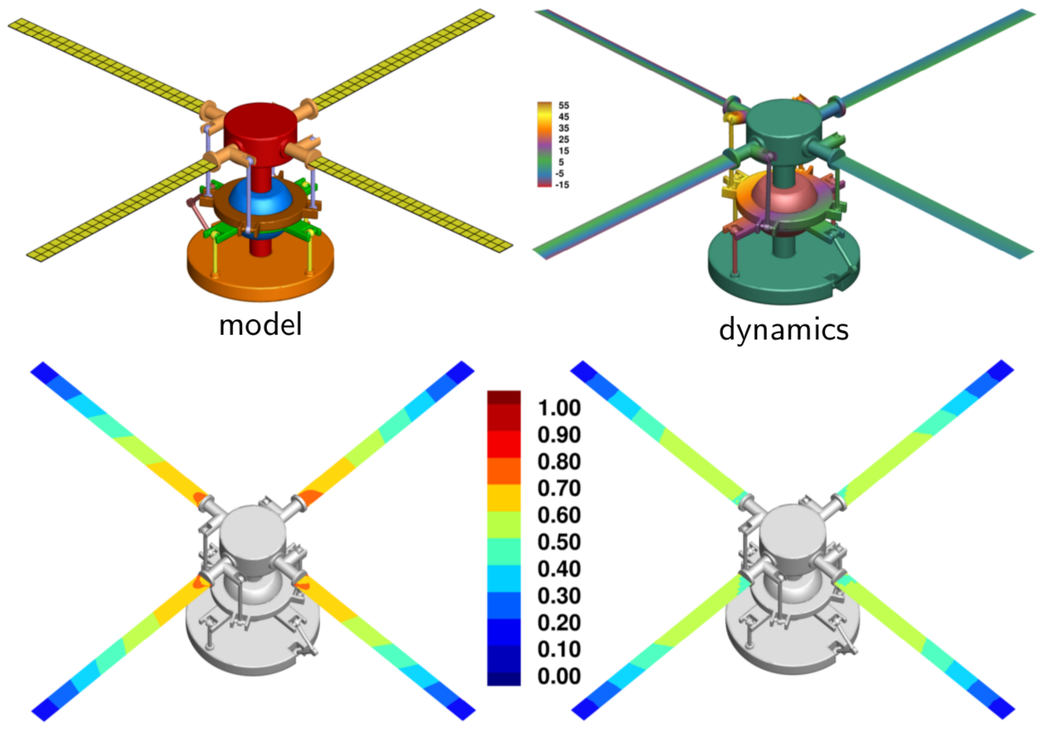
Structural and Multidisciplinary Optimization Laboratory

Graeme J. Kennedy, Komahan Boopathy, Ting Wei Chin, Kevin Jacobson, Jan Kiviaho, Mark Leader, & Jordan Trout
School of Aerospace Engineering

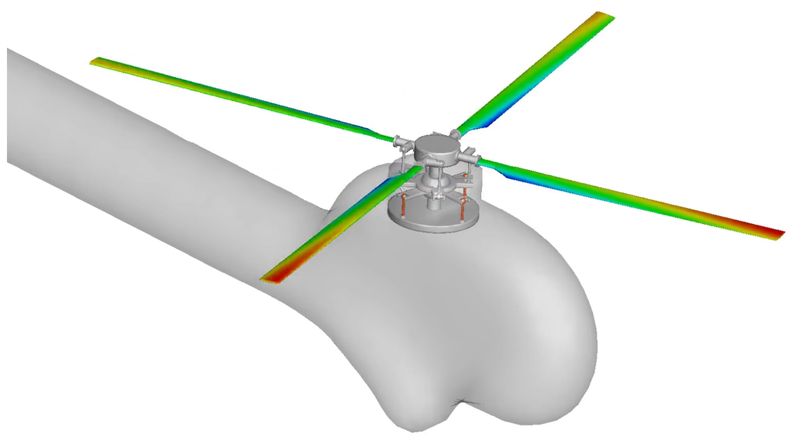
Flexible Multibody Dynamics for Rotorcraft

Adjoint–Based Rotorcraft Design



- Representative fully articulated rotor control chain dynamics model
- Adjoint-based gradient evaluation verified against complex-step computations

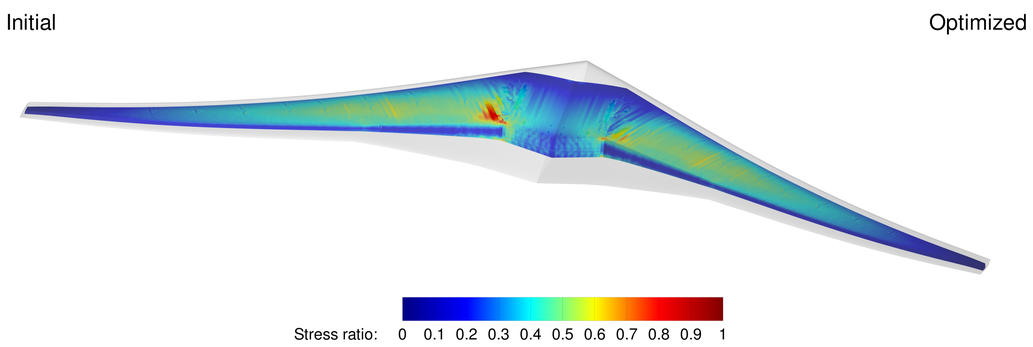
Coupled Aeroelastic Analysis



- Aeroelastic HART-II simulation coupling TACS and FUN3D using the FUNtoFEM framework

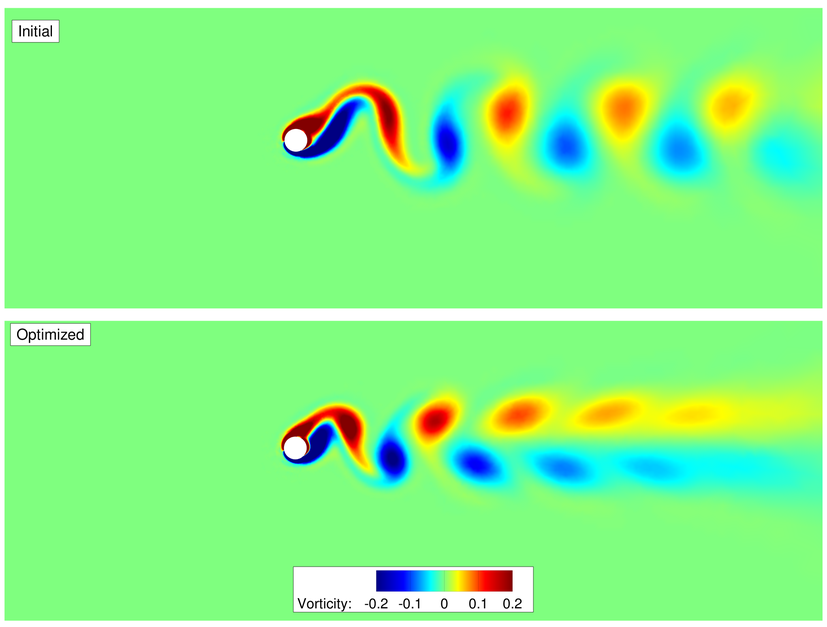
Optimization with Time-accurate Analysis

Undeflected Common Research Model (uCRM) – Wingbox Sizing



- Mass-minimization subject to a stress constraint from time-accurate CFD+FEM gust analysis

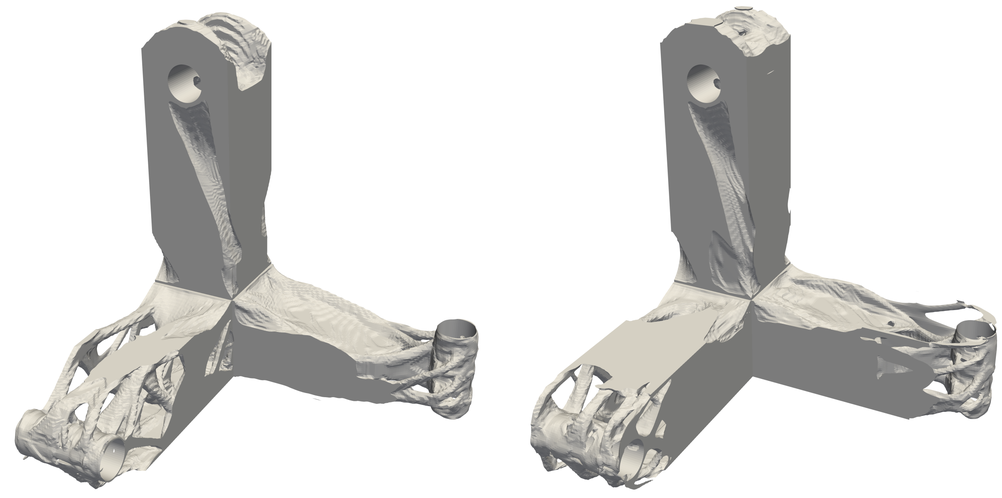
Vortex-induced Vibrations of a Cylinder – Energy Harvesting



- Optimization increased the energy harvested by a factor of 8.7

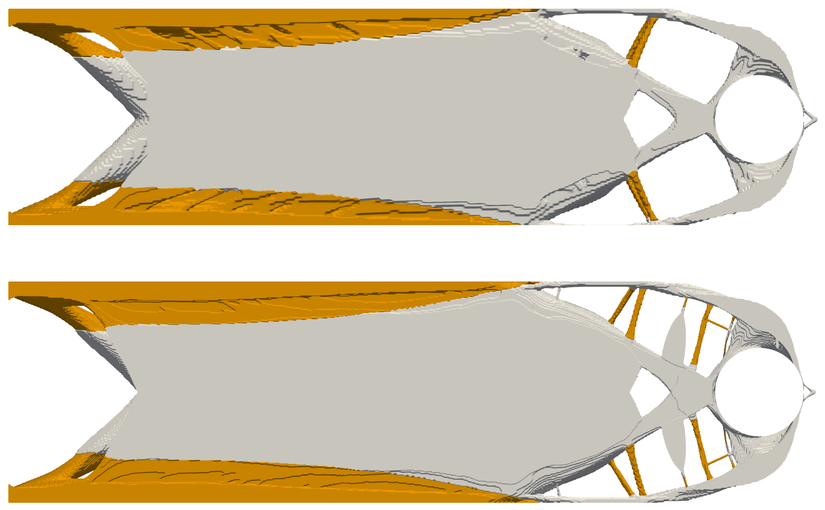
Topology Optimization

Topology Optimization with Stress and Frequency Constraints

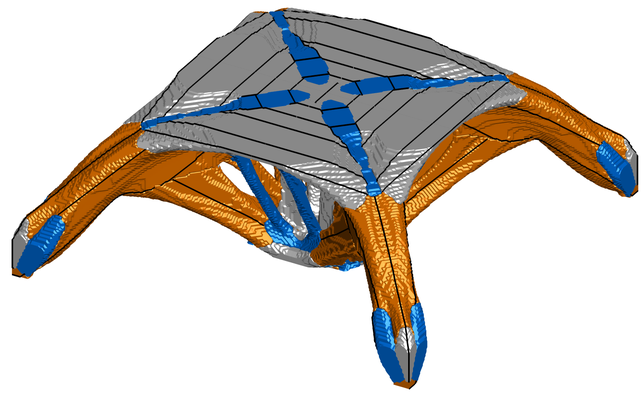


- Mass-minimized design subject to stress constraints (left) and mass-minimized design subject to stress and natural frequency constraints (right)
- Developed a stress reconstruction technique beneficial for solving large-scale stress constrained problems
- Implemented a Jacobi-Davidson eigenvalue solver with eigenvector recycling, reducing the computational cost by up to 73% when compared to the Lanczos method

Multimaterial Topology Optimization

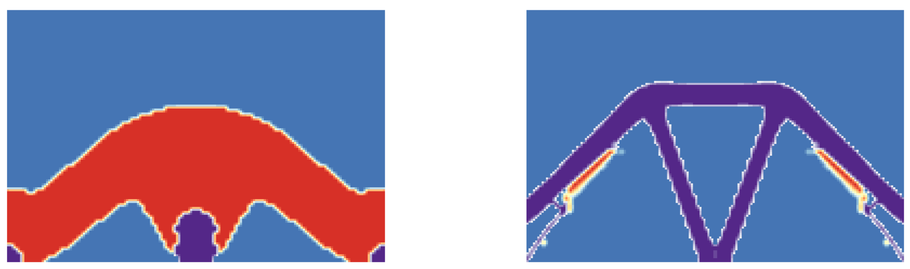


- With Adaptive Mesh Refinement: 81.8 million elements with 31.8 million DVs in 49.2 hours (top)
- Without AMR: 329 million elements with 125 million DVs in 77.0 hours (bottom)
- Identical resolution with only 1.86% difference in compliance objective



- Orthotropic design using AMR: 3.19 million elements with 5.91 million DVs

Multimaterial Topology Optimization with Thermoelastic Effects



- Identical mass but different layout
- Compliance-minimized design subject to mass constraints (left) and mass-minimized design subject to stress constraints (right)

Framework

- TMR[1]: parallel mesh generation and adaptive mesh refinement tool
- TACS[2]: finite element solver well-suited for large-scale problems
- ParOpt[3]: parallel optimizer utilizing the interior-point method

[a] https://github.com/gjkennedy/tmr
[b] https://github.com/gjkennedy/tacs
[c] https://github.com/gjkennedy/paropt

Website: gkennedy.gatech.edu