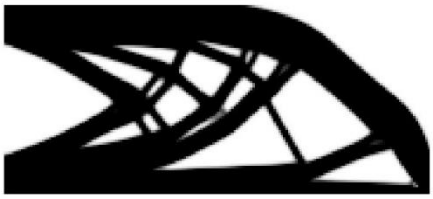
Dr. Jasmin Jelovica
Assistant Professor, Mechanical & Civil Engineering
jjelovica@mech.ubc.ca

MECH 493 project: Computational techniques for topology optimization

Background and research goal



As engineers, we are in constant search for efficient processes, devices and structures. Optimization algorithms can help us immensely in this quest, by finding designs that we cannot imagine ourselves. Very exciting example is topology optimization, where computers generate intricate web of connections between outer surfaces of a structure, as the figure on the right shows. Such designs can be 3D-printed. While minimizing weight, additional features can be considered, e.g. optimal heat dissipation, maximum stiffness, minimal stress, etc. Using novel structures in transportation vehicles leads to reduced fuel consumption and potentially prolonged service life. The framework relies on finite element methodology for structural analysis and optimization techniques to guide the search for optimal designs. This project is part of a research program that aims to provide design tools for a new generation of ships for Canadian Coast Guard.

Although the framework is powerful and versatile, it is limited by the capabilities of the optimization algorithm (OA) as its engine. OAs differ by their computational efficiency and the ability to perform for complex problems. Prominent designs can be overlooked by relying on a wrong algorithm. It is not clear which algorithm provides best performance by being accurate and efficient, and how can the strengths of various algorithms be combined.

Tasks to be performed by the student

1) Survey scientific literature to get familiar with computational techniques for topology optimization and optimization techniques in general
2) Run existing topology optimization code in Matlab (to be provided)
3) Modify the code to consider a complex loading scenario
4) Optimize the structure using prominent optimization algorithms and compare their performance
5) Validate one of the designs using Abaqus software

You are expected to be a fast learner interested in numerical techniques, having at least basic experience with Matlab. You will be trained in using Abaqus software.

Facilities and team:

You will periodically interact with Dr. Jelovica and his research group. You will need to do preliminary work and extend the problem setup using your own personal computer. Longer analyses will be run on a local cluster, with the help from the group.