Topology Optimization Frame Interpreter

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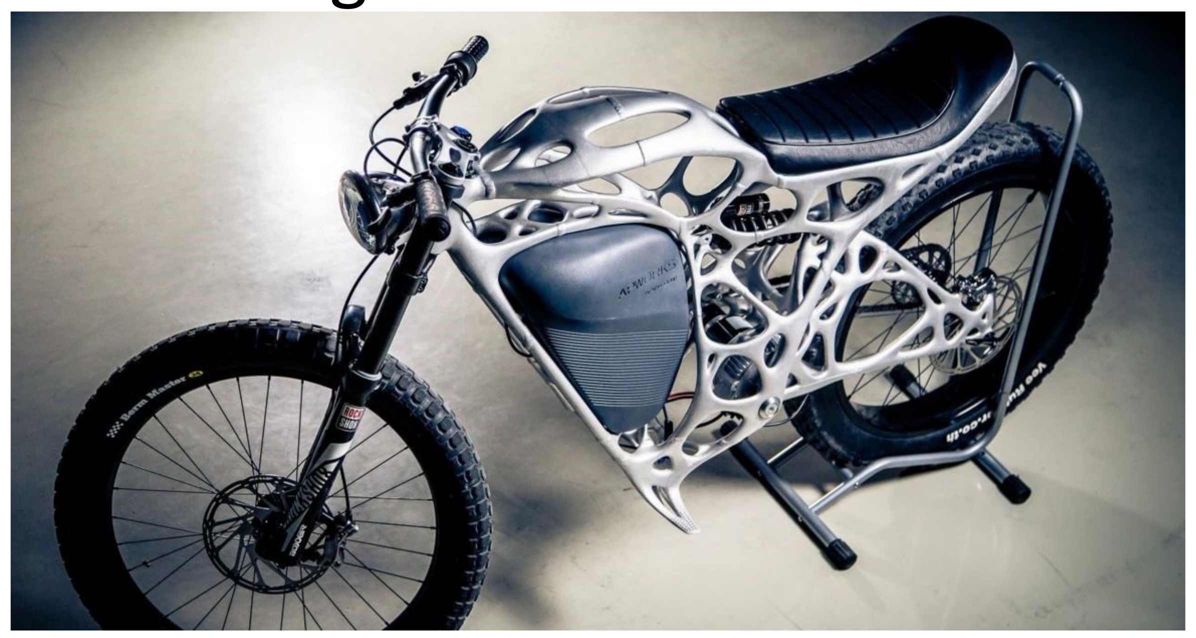
Objective: To leverage the results from topology optimization, create a program able to interpret these results, and create frames that are more easily manufacturable.

Motivation

Frames used in the aerospace and automotive industry must be rigid and lightweight. Modern computers and software are able to generate optimized structures using Topology Optimization (TO), a numerical method that optimizes a structure in a given workspace. These shapes are optimized for stiffness with respect to weight. Manufacturing these shapes almost always requires the use of advanced manufacturing methods such as additive manufacturing. Creating an interpreter allows these designs to be manufactured more readily and removes bias from a human interpreter, giving a more repeatable result.

Topology Optimization

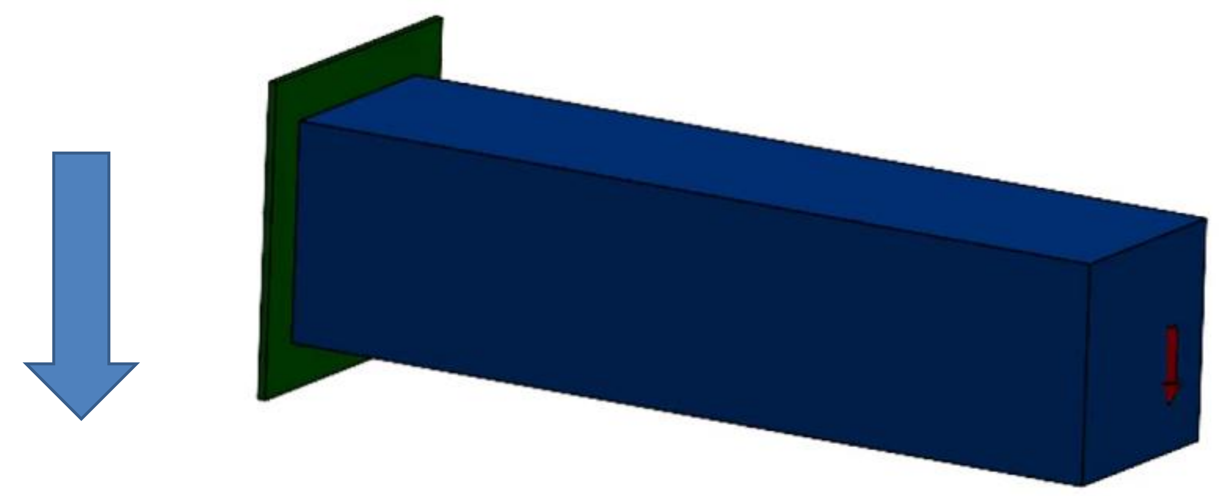
TO is a numerical process based on finite element method that removes material from a design space to optimize the stiffness with respect to weight



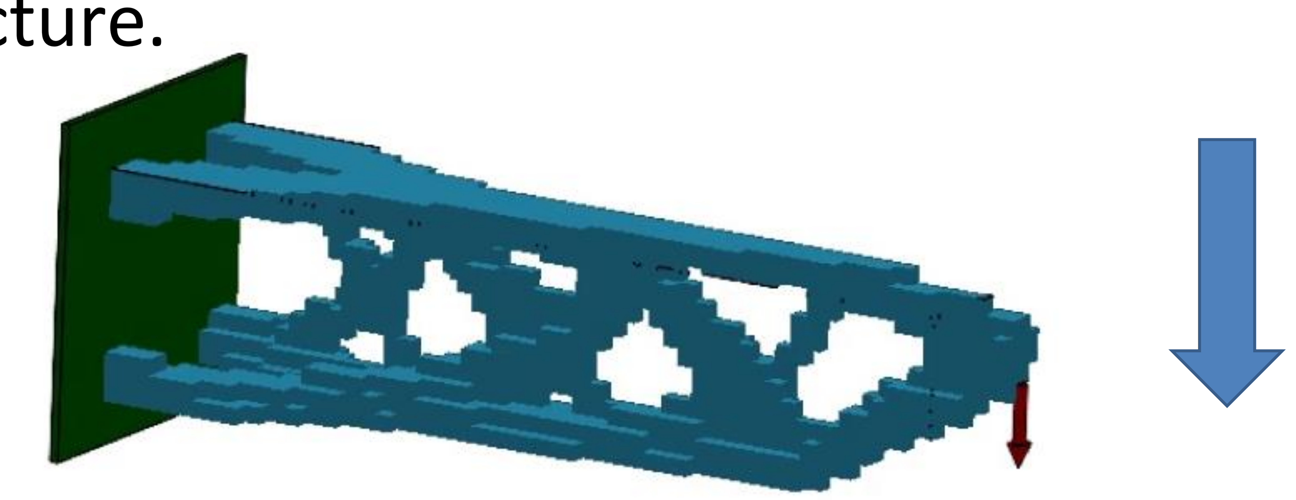
A motorcycle frame generated with TO

Topology Optimization Used With SolidWorks

The design space for the structure or machine component is defined, along the loading and supports.



TO removes the material that least contributes to the rigidity of the structure.

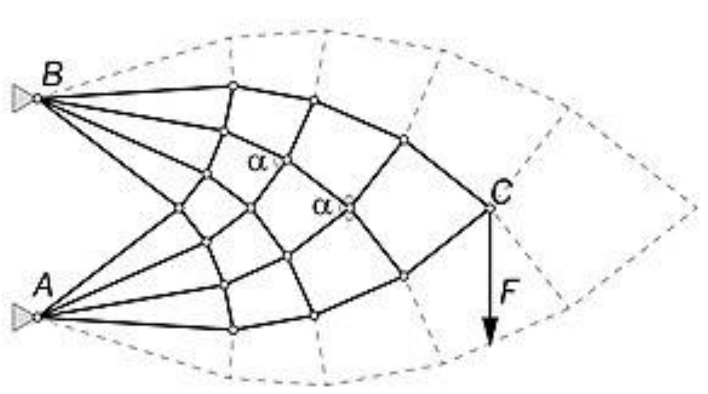


The results are transferred through the interpreter to SolidWorks. An automated routine generates structural tubing members and welds to create a fully manufacturable part.

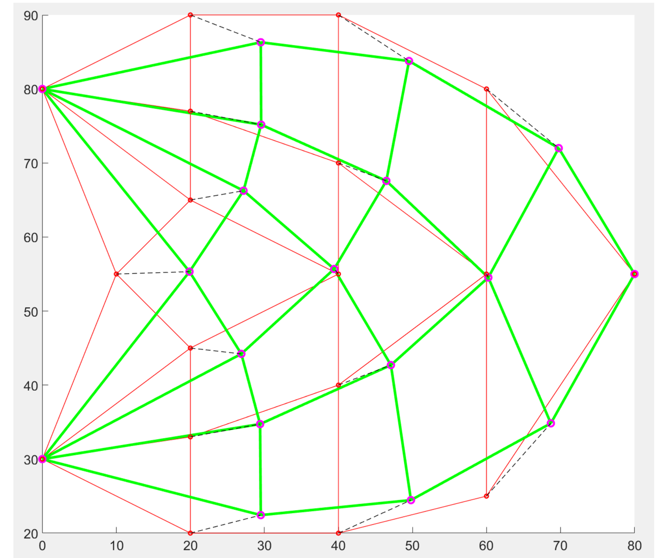
Size and Shape Optimization

As part of the interpreter, a shape and size optimization relocates the frame weld locations and the size of the tubing.

Initially, the frame optimization was written in Matlab to work in the plane and was tested by comparing the result with a known structure of optimal rigidity, the Michell Truss. The red lines represent the original structure and the green lines are the optimized structure.



Classic Michell Truss



Optimized Output

The process was extended to three dimensions in order to be utilized by the space frame interpreter.