Design Automation for Ultrasonic Transducer Cooling

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WHY DEVELOP TRANSDUCER-SPECIFIC COOLING SOLUTIONS?

The current limitation of power ultrasonics in vacuum environments is primarily thermal management of the transducer, which proves complicated due to the contact limitations imposed by the nature of the transducer as a freely oscillating mass. This restricts the operational window of power ultrasonic devices, putting a barrier on promising ISAM technologies. This project aims to create design automation to design flexure cooling structures which replace the existing electrodes in a piezoelectric transducer. The design automation will leverage implicit modeling to efficiently simulate mechanical and thermal conditions, lattice structures accordingly, check for proper resonance, and export a manufacturable design. This method would allow for extended testing of ultrasonics in vacuum environments, as well as fast adoption of new or modified transducer designs.

HEATING CHARECTERIZATION →

- Performed thermal camera imaging to identify main sources of heat generation and dissipation
- Further work will mostly be focused in this area, creating accurate models to predict heat generation from a given transducer configuration

IMPLICIT MODELING →

- Created an implicit 3D model of the transducer geometry, along with automation to change various parameters and automatically mesh for simulation using Ntopology

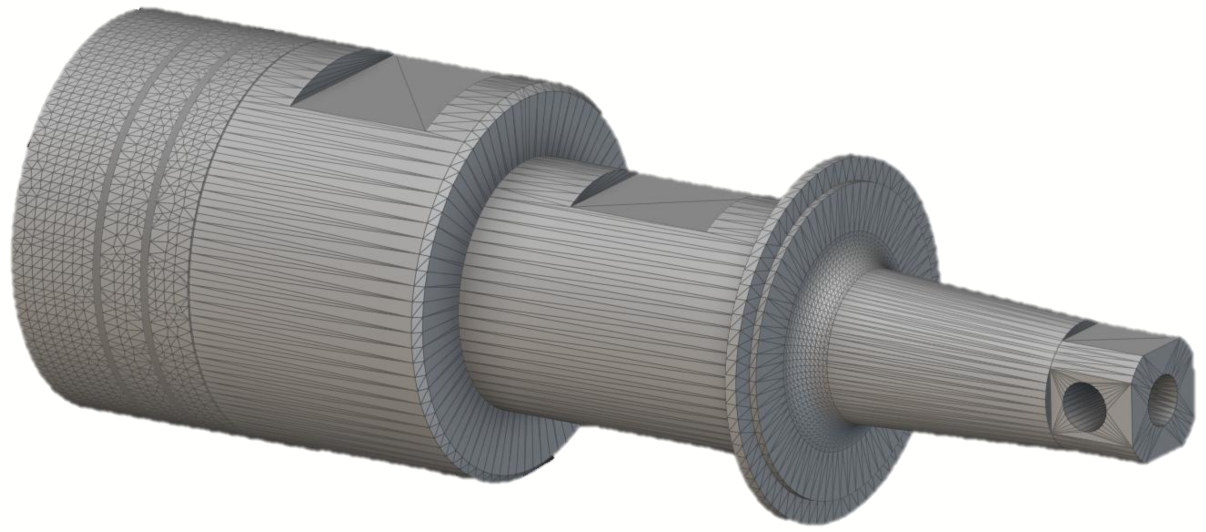
TOPOLOGY OPTIMIZATION →

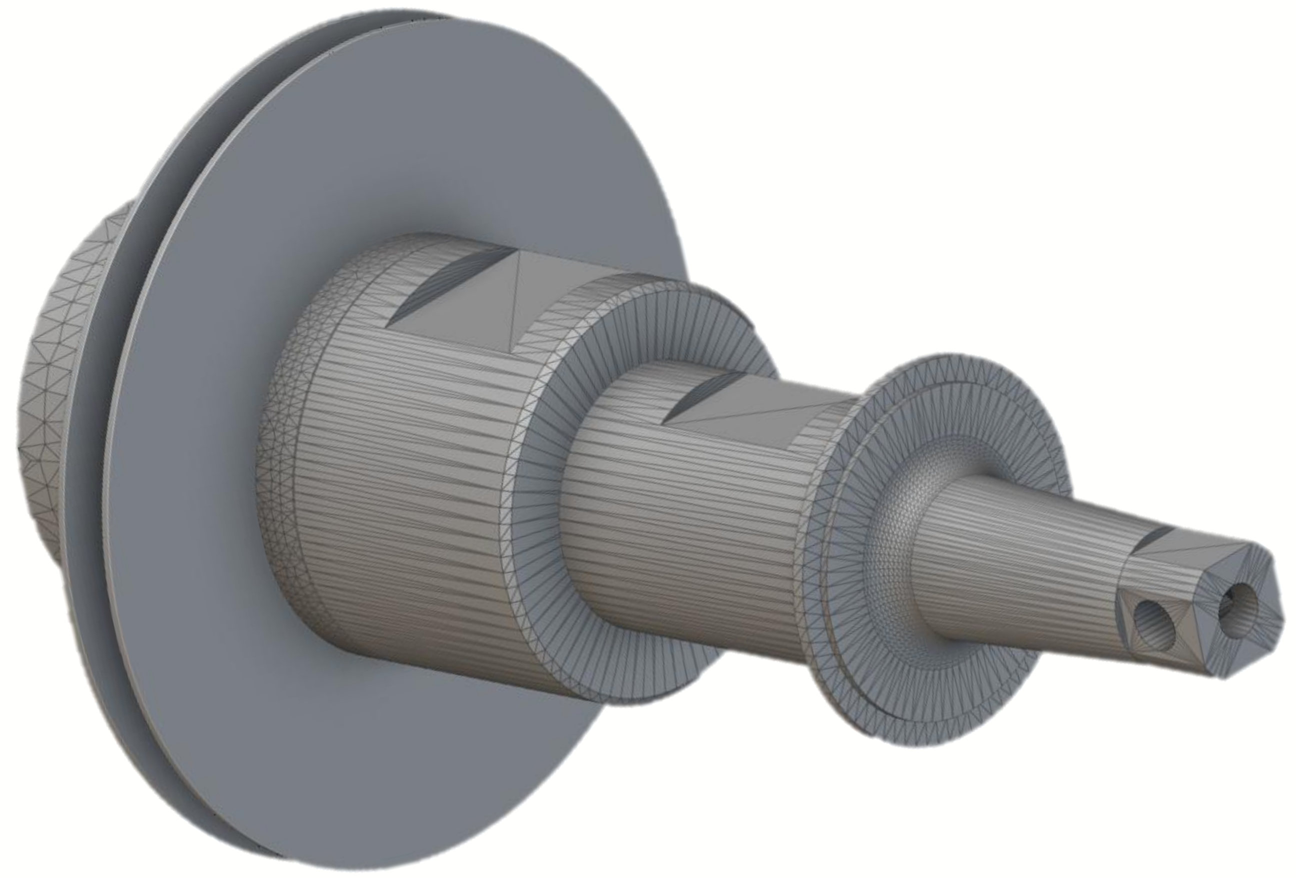
- Topology optimization program takes a required lateral stiffness (derived from previously calculated simulations), volume constraints (derived from heat transfer requirements), modal frequency constraints and fixed geometry features

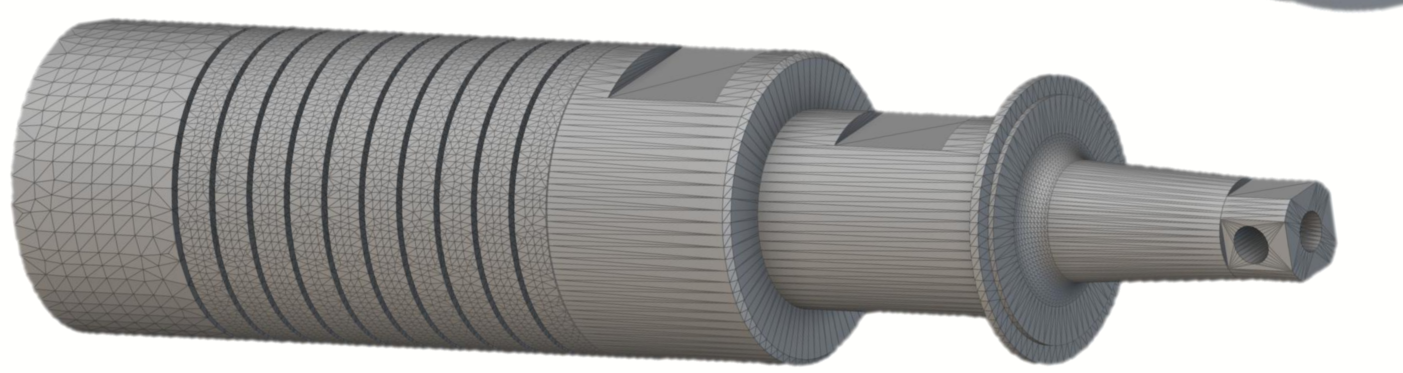
CURRENT STAGE

CAD/CAMM OUTPUT

- Convert generated implicit body into a standard CAD format (such as STEP) and export for further work
- Create a 2D milling toolpath for rapid manufacturing







CHALLENGES

- Complexity in generating meshes from frequently changeable geometries
- Software issues with generating topology optimizations