Popular science summary of the PhD thesis

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Title of the PhD thesis	Third Medium Contact for Topology Optimization
PhD school/Department	Department of Civil and Mechanical Engineering

Science summary

* Please give a short popular summary in English (approximately half a page) suited for the publication of the title, main content, results and innovations of the PhD thesis also including prospective utilizations hereof. The summary should be written for the general public interested in science and technology.

This PhD thesis presents groundbreaking research in the field of Third Medium Contact (TMC) - an innovative approach to modeling how structural components interact when they touch or press against each other. The work significantly advances both contact mechanics and topology optimization, which is a computational method for designing structures with optimized performance.
The research introduces a comprehensive framework that solves one of engineering's persistent challenges: accurately modeling contact between parts while optimizing their design. Traditional contact modeling methods cannot readily be combined with topology optimization. The TMC approach cleverly addresses this by treating contact areas as if they contain an imaginary third medium that naturally stiffens under compression.

Key innovations presented in the thesis include:
- Development of a complete Third Medium Contact framework that integrates seamlessly with established topology optimization methods
- Introduction of "HuHu-LuLu" regularization, a mathematical technique that maintains stability when modeling complex contact interactions
- Creation of the first friction model for TMC, based on crystal plasticity concepts, enabling realistic simulation of sliding contact

The practical demonstrations include the design of optimized hooks and the world's first three-dimensional topology-optimized structures with internal contact. These achievements represent significant steps toward designing more efficient mechanical components that can leverage contact mechanics as a feature rather than treating it as a limitation.

This research opens promising pathways for engineering applications in various fields, including mechanical component design, medical devices, robotics, and advanced manufacturing. By enabling designers to harness contact interactions as a fundamental design element, the framework could lead to structures with unprecedented performance characteristics - lighter, stronger, and more efficient than conventional designs.

Please submit the summary to the department PhD coordinator together with your thesis