Design and Inverse Problems in Structural Acoustics: Fusing Experimental Data, Simulation, and Optimization with High-Performance Computing

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Realistic acoustics and vibration applications present challenges in analysis, typically due to infinite and semi-infinite domains and many wavelengths in the domains of interest. As a result, the corresponding finite element models can become prohibitively large for rapid analysis and design. This problem is exacerbated when the physics is wrapped in optimization loops for design, optimal control, machine learning, and inverse problems, where the numerical models that approximate the solution of the wave equations need to be solved many times in the optimization sequence.

This talk will present 1) a brief overview of Sandia tools for solving these problems, starting with Sierra Mechanics that enables HPC solutions of the physics of interest, 2) the extension of Sierra Mechanics to scenarios where an optimization loop is required, such as design, optimal control, and machine learning, 3) the fusing of simulation and experimental data using Optimal Experimental Design (OED) and inverse methods, and 4) a set of example problems involving optimization in acoustics and vibration applications. By leveraging HPC for optimization problems in acoustics and vibration, we can enable engineers to rapidly solve optimization-driven structural acoustics problems where the multiplicative expense of the numerical solution of the wave equations is prohibitively expensive with traditional approaches.

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