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Announces the Ph.D. Dissertation Defense of

Trey Michael Brauch

for the degree of Doctor of Philosophy (Ph.D.)

Acoustic Response of the CNT-Reinforced Multilayered Acoustic Foam Composites (MAFC)

April 2nd 2026, 12PM - 1:30PM
Building EG36, Room 187
777 Glades Road
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DEPARTMENT: Department of Ocean and Mechanical Engineering

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ABSTRACT OF DISSERTATION:
Acoustic metamaterials are engineered materials designed to control and manipulate sound propagation. Many such systems incorporate acoustic foams due to their porous structure, low density, and high specific surface area, which promotes efficient sound absorption. However, a major limitation of conventional acoustic foams—particularly open-cell varieties—is their lack of waterproofing, rendering them unsuitable for underwater or moisture-prone environments. To address this limitation, a multilayered acoustic foam composite (MAFC) was developed as a lightweight, waterproof structure with enhanced sound absorption performance. The MAFC consists of five layers: the first and fifth layers are aluminum foam, providing structural integrity; the second and fourth layers are silicone rubber, ensuring waterproofing; and the central layer is polyurethane (PU) foam, serving as the primary sound-absorbing medium. To further improve acoustic performance, the PU foam was reinforced with carbon nanotubes (CNT) to enhance the sound absorption coefficient (SAC). Two aluminum foam densities and three CNT concentrations were investigated. The low-density MAFC without CNTs exhibited a peak sound absorption coefficient (α_{peak}) of 0.75 at 3300 Hz, while the medium-density configuration reached 0.78. With CNT reinforcement, α_{peak} increased to 0.93 for the low-density MAFC at 0.1 wt% CNT and to 0.89 for the medium-density case. A similar enhancement was observed at 2900 Hz. In contrast, at lower frequencies, sound absorption remained largely insensitive to both foam density and CNT inclusion. The dissertation presents detailed fabrication procedures, experimental methods, data processing, and analysis of the acoustic performance of the proposed MAFC.

BIOGRAPHICAL SKETCH:
Born in Wheat Ridge, Colorado
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CONCERNING PERIOD OF PREPARATION
& QUALIFYING EXAMINATION

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Publications:

- Brauch, T., Mahfuz, H., and Beaujean, P., "Enhancing Acoustic Response of Metamaterials with the introduction of Polyurethane Foam Layer," *ASME International Mechanical Engineering Congress (IMECE),* November 17-21, 2024, Portland, Oregon, presented and abstract published.
- Brauch, T., Mahfuz, H., and Beaujean, P., "Acoustic response of a multilayered acoustic foam composite (MAFC) via reinforcement of CNT into polyurethane foam for undersea applications." *Volume 1: Acoustics, Vibration, and Phononics; Advanced Design and Information Technologies*, 16 Nov. 2025, https://doi.org/10.1115/imece2025-168247.
- Brauch, T., Mahfuz, H., and Beaujean, P., "Acoustic Response of the CNT-Reinforced Multilayered Acoustic Foam Composites (MAFC)", submitted to Applied Acoustics (Elsevier), March 23, 2026.