Impact of the NASA Acoustics Damping Capstone

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Introduction

- Since 2016, thousands of high school students nationwide have been discovering NASA's aviation noise reduction research via a hands-on Acoustic Damping Capstone.
- The Acoustic Damping Capstone is managed out of NASA Glenn Research Center's (GRC) Office of STEM Engagement (OSTEM)
- NASA GRC Program Specialists created the capstone, adapting the activity so educators could teach it in a classroom setting.
- NASA GRC researchers serve as Subject Matter Experts.



High school students in Florida have used the NASA Acoustics Damping Capstone to learn more about careers in Science, Technology, Engineering, and Math (STEM). Image credit: M. Arockiasamy/Florida Atlantic University

Description of the Acoustic Damping Capstone for High School Students

- The capstone uses evidence-based strategies that rely on verifiable data, literature review, subject matter expert input, and information that has been gathered using the standards of professional research and evaluation organizations.
- **Objective 1:** Design and 3D-print a prototype of a porous structure to absorb sound.
- **Objective 2:** Assemble a simple normal incidence impedance tube from a kit of components.
- **Objective 3:** Test the 3D-printed prototype in the simple impedance tube to quantify sound absorption.



A simplified normal incidence impedance tube can be assembled by students using a kit-of-parts described by the NASA Acoustic Damping Capstone.

Image credit: NASA

Impact of the NASA-GRC-Facilitated Acoustic Damping Capstone

Schools and students can apply for a facilitated version of the Acoustic Damping Capstone led by Jerry Voltz, NASA GRC Program Specialist.

Typical Annual Schedule	
April-Sept	Applications accepted
October	Educator Workshop Virtual Kickoff with Students and NASA Subject Matter Experts
February	Virtual midpoint check
April	Hybrid culminating event with tours of NASA facilities

More information is available online at:

NASA GRC Acoustics Damping Capstone



The NASA Acoustics Damping Capstone Project Culminating Event at the NASA Glenn Research Center, April 2024
Image credit: NASA

Impact of the NASA-Facilitated Acoustic Damping Capstone

Ten schools have participated from 2017-present:

1) Toledo Technology Academy, (Toledo, OH)
2) Scott High School, (Toledo, OH)
3) Auburn Career Center, (Concord, OH)
4) Garrett Morgan High School, (Cleveland, OH)
5) St. Ignatius High School, (Cleveland, OH)
6) Sandy Valley high School, (Magnolia, OH)
7) Lake Ridge Academy, (North Ridgeville, OH)
8) John F. Kennedy High School, (Cleveland, OH)
9) Cleveland School of Science and Medicine, (Cleveland Hts, OH)
10) Magnificat High School, (Rocky River, OH)



Students tour the NASA GRC Aeroacoustic Propulsion Laboratory during the NASA Acoustics Damping Capstone Culminating Event
April 2024
Image credit: NASA

Impact of the MUREP Aerospace Academy (MAA)

- NASA provided a funding opportunity for the creation of MUREP Aerospace Academies.
- The capstone was integrated into NASA's MUREP Aerospace Academy (MAA) initiative, managed by Clarence Jones, NASA GRC Program Specialist with Education Specialists Daniel Ward and Susan Kohler.
- The solicitation for proposals was posted on NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES).
- The Notice of Funding Opportunity (NOFO) was entitled, "Engagement Opportunities in NASA STEM 2022 (EONS-2022)" Number NNH22AO001N
- Eight universities were selected for three-year grants totaling $3.8M, with a period of performance from 2022-2025.



High school students led by the UCF MAA team worked in groups of five to assemble the components of the impedance tube.
Image credit: Justin Urso/University of Central Florida

Impact of the MUREP Aerospace Academy (MAA)

At least six of the eight universities with MUREP Aerospace Academies grants have used the NASA Acoustic Damping Capstone in their outreach to high school students:

1) University of Central Florida (Orlando, FL)
   Dr. Justin Urso, Principal Investigator
2) Florida Atlantic University, (Boca Raton, FL)
   Dr. M. Arockiasamy, Principal Investigator
3) University of Texas (El Paso, TX)
   Dr. Racheal Haggerty, Principal Investigator
4) California State University San Marcos, (CA)
   Dr. Edward Price, Principal Investigator
5) Hartnell College, (Salinas, CA)
   Brian Palmer, Principal Investigator
6) Texas State University San Marcos (TX)
   Dr. Kristina Collins, Principal Investigator
7) Tennessee State University, Nashville
   Dr. Trinetia Respress, Principal Investigator
8) University of Hawaii, (Honolulu, HI)
   Dr. Dilmurat Azimov, Principal Investigator



High school students visited FAU and learned from guest speaker Dr. Joseph Cuschieri, P. E. Lockheed Martin Fellow, Rotary and Mission Systems on the topic of “Acoustic Damping and Noise Reduction in Jet Engines.”
Image credit: M. Arockiasamy/Florida Atlantic University

Impact of the MUREP Aerospace Academy (MAA)

NASA defined several key components for the MUREP Aerospace Academies. Grantees were required to include:

1) STEM Experiential Learning Opportunities aligned with NASA Capstones
2) Engagement Opportunities with STEM Professionals and Settings
3) College and Career Readiness Opportunities
4) Family Involvement



Students in the MUREP Aerospace Academy at California State University at San Marcos presented their acoustic damping capstone results at a culminating event at the McClellan-Palomar Airport.
Image credit: Ed Price/CSUSM

Impact of the NASA GRC Engineering Institute

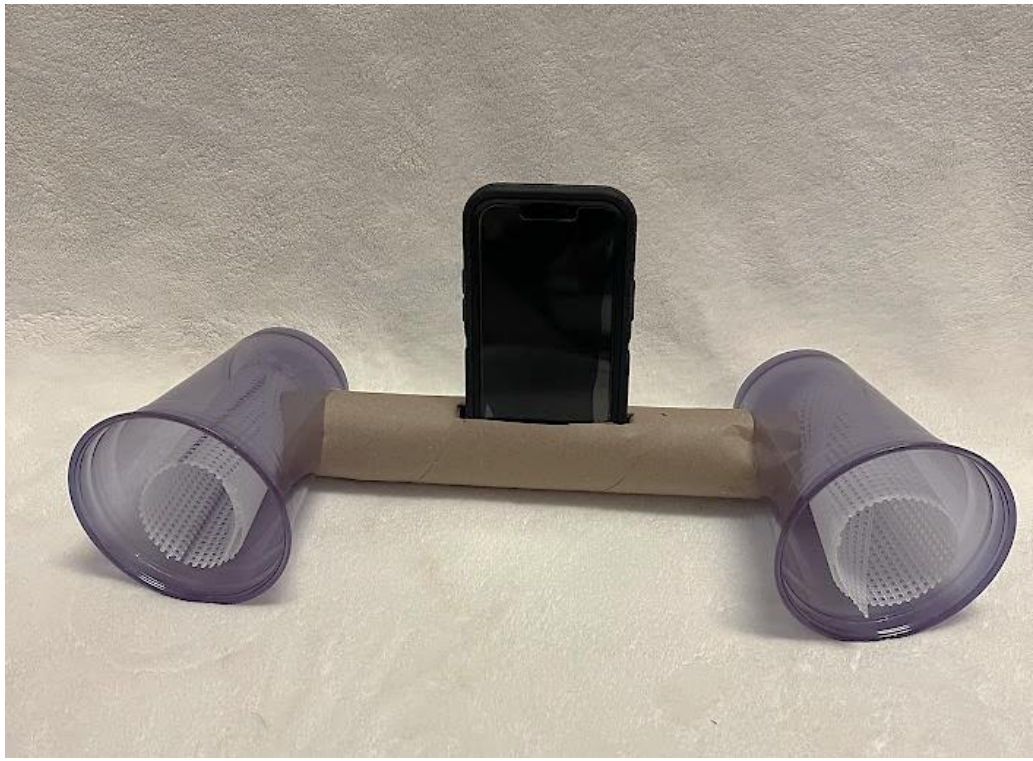
- Sixty students were chosen for the first NASA GRC Engineering Institute from four hundred applicants for one of three week-long sessions that were held on-site at NASA GRC July 7-25, 2025.
- Culminating events held on Friday afternoons for each session, attended by parents.
- The sessions were facilitated by NASA GRC Program Specialist Jerry Voltz.
- During the sessions, the students completed three capstone projects.
- During the Acoustic Damping Capstone, the students designed and 3D-printed structures to absorb sound and measured acoustic absorption with simplified normal incidence impedance tubes.



Students discovers aviation noise reduction research during the NASA GRC Engineering Institute, July 2025.
Image credit: NASA

Description of the Sound Off Engineering Design Challenge for Middle School Students

- NASA GRC Education Specialists created an experiment that middle school students can use to explore sound and created an Educator Guide and a Student Journal.
- Content is related to NASA's aviation noise reduction research for subsonic and supersonic aircraft engines.
- **Objective 1:** Construct a speaker to generate and amplify sound. (A mesh cylinder is added inside the cups to resemble the annular shape of an aircraft engine inlet duct acoustic liners.)
- **Objective 2:** Measure the sound with a sound level meter without sound absorbing materials.



Example of NASA's "Sound Off" experiment for middle school students.

Image credits: NASA

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- **Objective 2:** Measure the sound with a sound level meter without sound absorbing materials.
- **Objective 3:** Add sound absorbing materials to the cups and measure noise reduction.



Middle school students can experiment with sound and sound absorption using a hands-on activity created by NASA Education Specialists.

Image credit: Advanced Methods in Innovation School

Impact of the Sound Off Engineering Design Challenge for Middle School Students

- Call for proposals were announced via the NASA STEM Gateway website and the NASA GRC OSTEM website.
- Implementation occurred during Summer and Fall 2023 by selected schools and youth serving organizations
- 7 grants awarded for summer cohort, 210 student participants
- 6 grants awarded for fall cohort, 305 student participants
- Grantees received:
  - $20/per student for materials
  - 2-day virtual NASA-led educator workshop
  - Sample kit-of-parts with instructions
  - Live virtual connections with NASA professionals



Middle school students from the Advanced Methods in Innovation School (Youngstown) during the Sound Off Engineering Design Challenge.

Image credit: Advanced Methods in Innovation School

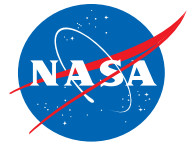
Conclusion

- NASA GRC Program Specialists created two activities for students to experiment with sound and engage with NASA aviation noise reduction research:
  - Acoustic Damping Capstone (grades 9-12)
  - Sound Off Engineering Design Challenge (grades 5-9)
- Grants have been provided by NASA to implement these activities with groups of students nationwide:
  - MUREP Aerospace Academy
  - Sound Off Engineering Design Challenge
- As a result, thousands of students, educators, parents, and STEM professionals have engaged with NASA research and discovered STEM education and career paths since 2016.



A St. Ignatius High School student discovers aviation noise reduction research with NASA Acoustics Branch Engineer Jeff Severino during the NASA-GRC-Facilitated Acoustic Damping Capstone 2025. Image credit: NASA

References



Presented at AIAA SciTech 2025, Orlando, Florida:

- Ayala, P., Vandeursen, C., Hilderbrand, I., Graham, J., Urso, J., Vasu, S., "Effective Materials to Use for Sound Damping to Mitigate Sound Pollution," AIAA 2025-2559, 2025, https://arc.aiaa.org/doi/abs/10.2514/6.2025-2559
- Majeska, M., Stafford, L., Brock, C., Vest, L. A., Marquez Valenzuela, O., Marty, A., Rickman, K., Kim, G., Vasu, S., "Investigation of Aircraft Noise Reduction Using an Impedance Tube," AIAA 2025-2557, 2025, https://arc.aiaa.org/doi/abs/10.2514/6.2025-2557
- Urso, J., Kim, G., Barrios Cadenas, G., Maia, A., Rickman, K., Klopp, S. Q., Vasu, S., "Hands-on Acoustic Impedance Activity for High School Aerospace Education and Training," AIAA 2025-2556, 2025, https://arc.aiaa.org/doi/abs/10.2514/6.2025-2556

A panel discussion was held at AIAA Aviation 2025, Las Vegas, Nevada

Session AA-37, Overview of NASA's Acoustic Damping Capstone Project (Invited)

…. A few more extended abstracts about this topic have been submitted to AIAA SciTech 2026

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- Dr. Cliff Brown, Chief (Acting)

NASA GRC Office of STEM Engagement
- Dr. Catherine Graves, Chief



Middle school students from the Advanced Methods in Innovation School (Youngstown) during the Sound Off Engineering Design Challenge.

Image credit: Advanced Methods in Innovation School

Questions

Thank you!

Questions?



Students at Ysleta Independent School District explore the science of sound in preparation for the Acoustic Damping Capstone led by the University of Texas El Paso, one of NASA's MUREP Aerospace Academy grantees.
Image credit: Racheal Haggerty/University of Texas El Paso