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Design and Development of a Tactile Wind Tunnel for Educational Purposes

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Overview

- An academic partnership between the University of Alabama in Huntsville (UAH) and the Cape Peninsula University of Technology (CPUT) in South Africa, known as the ALLiance for International Excellence among the future Space workforce (ALLIES), was formed in 2012.
- This partnership has now extended to the Universidad Autonoma de Centro America (UACA) and Universidad Latina de Costa Rica (ULCR).
- ALLIES is intended to develop the future of the Science, Technology, Engineering, and Mathematics (STEM) and space workforce by focusing on the following goals:
  - Establish collaborative efforts between universities in various nations.
  - Provide undergraduate engineering students the opportunity to work on international engineering design projects.
  - Encourage Kindergarten through 12th grade (K-12) students to pursue careers in STEM fields.

Objective

- To design a wind tunnel for classroom demonstration for K-12 students by the UAH American Society of Mechanical Engineers (ASME) student section and the North Alabama ASME professional section.

Impact

- Ongoing senior design project effort - the 6th wind tunnel within this project series.
- Knowledge and research utilized in the production of the wind tunnel will be used in K-12 STEM outreach in the North Alabama region as well as in Costa Rica.
- Currently impacting primary, secondary, and post-secondary students South Africa.
- Will be used by the UAH ASME student section for STEM outreach purposes as well as the North Alabama Section of ASME.
- The wind tunnel provides a tactile problem based learning experience that will enable young students to intuitively understand numerous theoretical concepts including lift, force, airflow, velocity, and airfoils, to name a few.
- The UAH student design team has garnered extensive knowledge and experience utilizing the National Aeronautics and Space Administration (NASA) Systems Engineering Handbook in the design and development of a product.

https://www.nasa.gov/sites/default/files/images/471670main_iotw-tdt-wing_full.jpg

Final Product Specifications

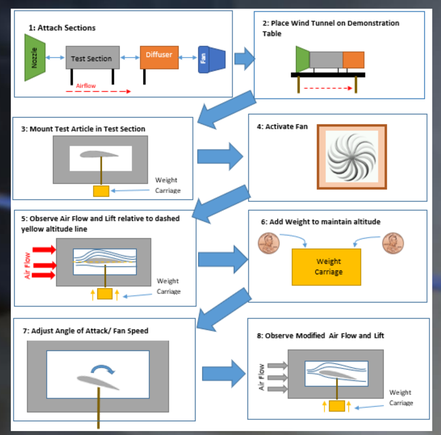
- Final Size: 32.53 inches long and 28 inches wide
- Final Weight: 40 lb
- Maximum Air Speed in test Section : 17.4mph
- Lift Capacity: 0.04lb- 0.11lb depending on the Angle of Attack
- Construction Materials:
  - Acrylic
  - Plywood
- Functionality:
  - Demonstrate lift
  - Demonstrate change in Angle of Attack

FEA of Test Article and Test Section

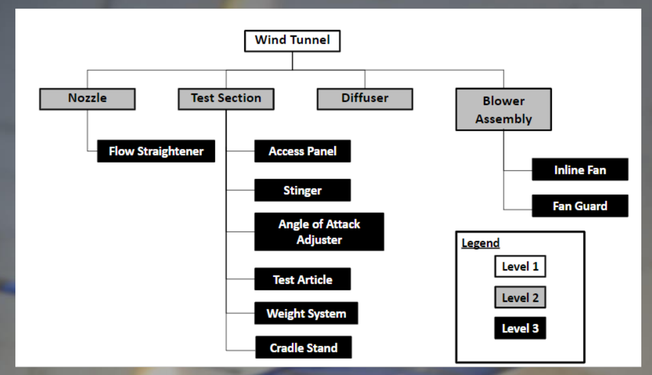
For NACA 4412 airfoil at mph 20 mph speed and 10 degrees angles of attack
- Calculated lift force = 0.152 lbf
- Maximum stress = 5.87E-5 psi
- Maximum Deflection = 7.322E-6 in.

Test section stress analysis
- Maximum stress = 6.48E-6 psi
- Maximum Deflection = 2.84252E-4 in.

Methodology

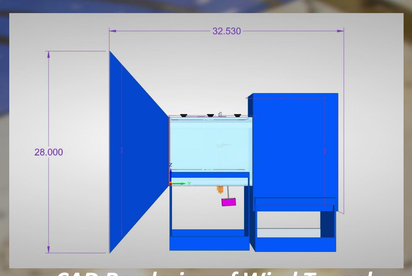


Concept of Operations

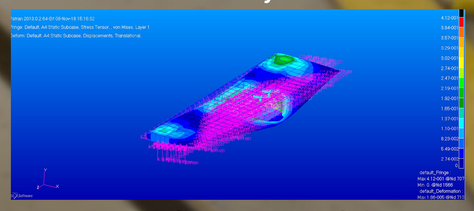


Product Breakdown Structure

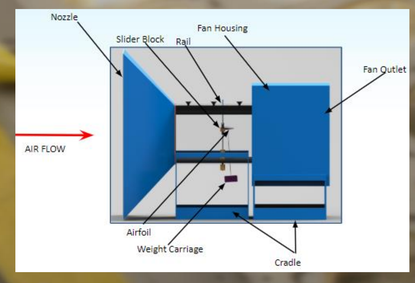
Final Construction of Wind Tunnel



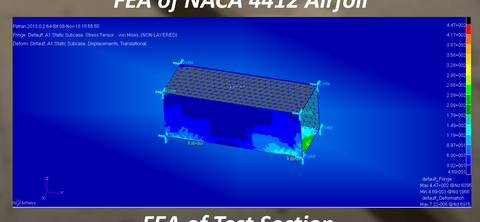
CAD Rendering of Wind Tunnel



FEA of NACA 4412 Airfoil



Details of Wind Tunnel



FEA of Test Section

Previous Senior Design Wind Tunnels

Acknowledgements

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