Wright Brother's Wind Tunnel Balance Display

Mechanical and Aerospace Engineering

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Abstract

This project involved designing, analyzing, and constructing a historically accurate 1901 Wright Brother's lift balance. It also included refurbishing a wind tunnel for Science Central museum in Fort Wayne .The goal was to teach kids basic aerodynamics and how wind speed affects lift and drag. Through prototypes, the team explored airflow effects on airfoils and gained hands-on experience with aerodynamic principles using the lab equipment they built. The team also created three subprojects: Lift Balance, Digital Force Balance, Manometer.

Customer Needs and Requirements

- Manufacture an interactive wind tunnel balance display that outputs clear and understandable data to a digital display for Science Central.
- The wind tunnel must not exceed specified dimensions allocated for the display (10'x6'x6')
- The balance must show some resemblance to the force balance made by the Wright Brothers
- Meet all safety requirements defined by Science Central
- Must not exceed the budget of $15000, provided by INSGC

Science Central

Indiana Space Grant Consortium

Concept Selection

Lift Balance Selection:

- The Lift Balance was broken into 5 subsystems: airfoil, drag plates, linkages, friction sleeves, and frame.

Digital Force Balance:

- The Digital Force Balance was broken into 4 subsystems: lift gauge, drag gauge, frame, and upper ball joint.

Final Wind Tunnel Display:

- The Wind Tunnel Display was broken into 3 subsystems: test section, display screen, and informational display.

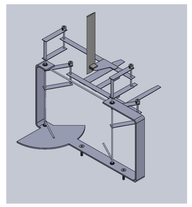
Manometer:

- The manometer was broken into 5 subsystems: tubing type and size, reservoirs, fittings, top mount, and scale.

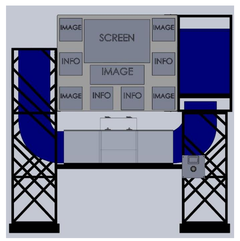
After selecting all subsystems and evaluating them with a selection matrix, the projects were ready for manufacturing.

Design Solution

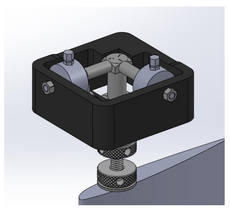
Lift Balance Selection:



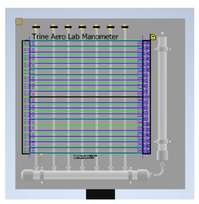
Wind Tunnel Display:



Digital Force Balance:



Manometer:



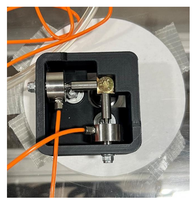
Manufacturing

Lift Balance

Picture of finished lift balance will go here

- Parts were developed in CAD then cut out using the water jet.
- The frame was bent into desired geometry using sheet metal bender and all components were painted to match the Science Central colors.

Digital Force Balance



- Parts were developed in CAD, then 3D printed and ordered.
- The components were adhered to the test section
- External force gauges are then connected to the read outs of force.

Manometer

- Parts were developed in CAD, then 3D printed and ordered.
- The components were fixed to the back board, with the scale glued behind the components.
- Tubes were then connected to multiple ports on the wind tunnel to read pressure differences.

Wind Tunnel Display

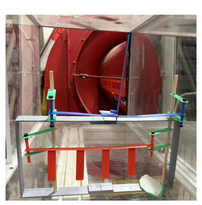
- Polycarbonate wind tunnel visible from front/back/and top views
- Based on the dimensions found by the team Dirig Sheet Metal fabricated the duct work.
- The ductwork was then powder coated alongside the framing by Vestil Manufacturing
- HMI display programmed through raspberry pi to display the effects of wind on the balance.

Testing and Validation

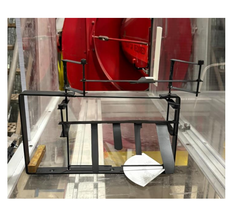
Preliminary

Lift Balance Development

- Airfoil
- Drag Plates
- Linkages
- Friction Sleeve
- Frame



3D Printed Lift Balance

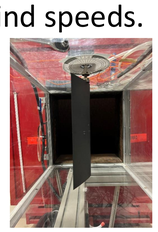


Painted Metal Lift Balance

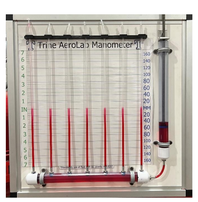
Intermediate

Test 1: Subproject Testing

- Digital Force Balance was tested at 3 wind speeds at 5 different angles of attack.
- Manometer tubes 1-6 were tested at 3 different wind speeds, 4 trials for each wind speed.
- Lift Balance was refabricated and tested at 3 different wind speeds.



Digital Force Balance Testing



Manometer Testing

Lift Balance Testing

Final

Test 2: Display Assembly

- Wind Tunnel
- HMI Display
- TV Display

Picture of final project will go here

Acknowledgments

We would like to thank our generous donors who helped fund our project: INSGC, Dirig Sheet Metal, Polymer Shapes, Vestil Manufacturing . We would also like to thank Dr. Gurudutt, Dr. Kamm, Mr. Joe Thompson II, our interns, and the entire ME Department for their continued support.