

Senior Capstone Design

Project: Aerodynamic Test Facility

Date Updated: 12/4/19

Team: Hotwings

Design Validation Plan & Results (DVP&R)

Requirement	Test	Test Subject	Target Date	Result	Recommendation
Mechanical Requirements Stand					
The stand will fit within an 21in X 21in x 39in volume	Analyze volume within Solidworks	Solidworks model	8/1/19	Passed (10/15/19)	
The stand will fit below the test section of the wind tunnel			12/3/19	Passed (12/3/2019)	
Stepper Motor fits into the stand connector plate.	Place stepper motor onto the plate.	Machined plate and stepper motor.	10/22/19	Passed (10/22/19)	
Stepper motors keyed shaft fits into lower machined connector plate.	Slide female end of lower connector plate onto stepper motors shaft.	Stepper Motor and Lower Connector Plate	11/1/19	Passed (11/6/19)	
Load Cell will fit onto lower machined connector plate.	Connect load cell to lower plate using M3-0.5 screws.	LC and Lower Connector Plate	11/1/19	Passed (11/1/19)	
Load Cell will fit onto upper machined connector plate.	Connect load cell to upper plate using M6-1 screws.	LC and Upper Connector Plate	11/1/19	Passed (11/1/2019)	
The stand shall be able to withstand a vertical static load of 100lbf	Place 100lbs on the top portion of the stand.	Full Stand	10/10/19	Passed (10/22/19)	
The stand will remain level during testing.	Small bubble levels will be placed on the stand to ensure it is evenly placed in the test section area. The stand will be able to be adjusted using adjustable legs attached to the bottom of the stand.	Adjustable Legs / Bubble Levels	11/4/19		

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The stand will remain still while the wind tunnel is operating.	The stand will be bolted to the floor using floor mount brackets.	Full Stand	11/22/19		
The stand will not weigh more than 50 lbs without the the test equipment attached	The full stand design will be weighed together on the scale in G.J. 126 after manufacturing has been completed. Before the scale can be used to verify the weight, the stand will be assembled in SolidWorks and the weight will be evaluated in the software	SolidWorks Model/Manufactured Stand	9/24/2019 (Model) 10/8/19 (Manufactured)	Passed (10/15/19)	
Stand will have shelf built in to hold all electronics needed to power the load cell. (i.e. Power supply, encoder, cables, DAQ)	Measure area of each component to be placed on shelf. Adjust shelf area accordingly.	Electronics being placed on shelf. Large piece of wood that will become the shelf.	11/12/19	Passed (11/12/2019)	
Shelf capable of holding all the electrical components without large displacement.	Place electronics equipment on the shelf and visually inspect displacement.	Electronics being placed on shelf. Large piece of acrylic that will become the shelf.	11/12/19	Passed (11/12/2019)	
Airfoil					
Airfoil needs to have a chord length such that no more than 10% of the test section area will be taken up at maximum the angle of attack	Do mathematical calculations and figure out what that chord length needs to be	Airfoil Model	7/18/19	Passed (7/2/19)	

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Airfoil needs to follow the profile of the NACA 0009 model	Research where NACA airfoil coordinates can be found and how to create a SolidWorks model	SolidWorks Model	9/21/19	Passed (7/10/19)	
Airfoil needs to fit together with smooth edges from 3D printer	Place the pieces together and ensure proper connection.	Airfoil Prototype parts	11/22/19	Passed (11/22/2019)	The airfoil fits together as expected but needs to be glued together with an epoxy to give smoother edges.
Airfoil needs to have a surface finish with a K value of 4 or less.	Use a test guage, if available and measure the surface finish of 3-D printed airfoil.	airfoil	12/4/19		
Airfoil needs to fit into the wind tunnel test section but be as close to the top and bottom as possible to maintain infinite airfoil application. (Within 1/8 in)	Measure wind-tunnel and design airfoil to be proper height to accomplish the infinite airfoil need.	Airfoil, wind tunnel test section	12/3/19	Failed (12/3/2019)	The connector on the bottom of the airfoil needs to be longer. We did not take into account the size of the screw heads that connect the load cell to the connector plate so there was not enough clearance for the airfoil to fit.
Airfoil needs to fit into the wind tunnel test section but be as close to the top and bottom as possible to maintain infinite airfoil application. (Within 1/8 in)	Measure wind-tunnel and design airfoil to be proper height to accomplish the infinite airfoil need.	Airfoil, wind tunnel test section	12/5/19		
Hardware Requirements					

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Motor/Encoder Circuit will work with basic arduino code validating circuit design	Build prototype circuit and code to perform basic movement	Motor/Encoder	9/10/19	Passed (9/10/19)	Motor works well with arduino. Is not the best for the purposes of this design but was a familiar controller to do a basic validation that our circuit is correct and will move forward with LabView
Motor/Encoder Circuit will work using LabView interface for motor movement	Build circuit with DAQ and use software to acheive basic motor movement	Motor/Encoder	10/4/19	Passed(10/22/19)	We acheived basic motor movement using the labview interface using a motion study in a single direction
Software will be able to interface with load cell/s chosen for use	Set up a simple test with load cell/s and software that allows testers to visually see load cell is acquiring data	Software, load cell/s	11/22/19	Passed (11/20/19)	Load Cell was reading within 0.2 N of what the "true" force reading was. However was not zeroed out
Software Requirements					
LabView software will be able to turn stepper motor	Hook up motor to software and run simple code to turn motor stem	Software, Stepper Motor	10/4/19	Passed (10/30/2019)	
Software should be able to operate stepper motor at 0.1° steps sizes	Connect stepper motor to software with code to verify 0.1° movement	Software, Stepper Motor	10/25/19	Passed (10/30/2019)	
Motor angle will be read by software				Passed (12/2/19)	Outputs angle movement but is not doing it accuratly. Needs more testing and tweaking to fine tune
Software will be able to interface with NI DAQ that is available for use	Run software and DAQ together to verfiy that they are speaking to each other to	Software, DAQ	10/13/19	Passed (10/22/2019)	

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Software UI will be easy to understand and contain the appropriate labels that help describe what each function accomplishes.	Do small focus groups with client, instructor, and other team members to gauge UI intuitivness	Software UI	11/21/19		
Labview will move motor in relation to its starting angle position	write labview code that shows the motors current position and can be manually changed by the UI that can be validated using a protractor	software, motor	11/21/19	Passed (12/2/2019)	Moves in relation to its starting angle but angle readout is not accurate
Load cells should be calibrated to read correct lift and drag output (Secondary Objective)	Apply 5 different loads for LC calibration, then apply load and verify accuracy of force measurment	Load Cells	11/8/19	Passed (11/20/19)	Reads force but not nessecarily the lift/drag force, need more testing to fully validate