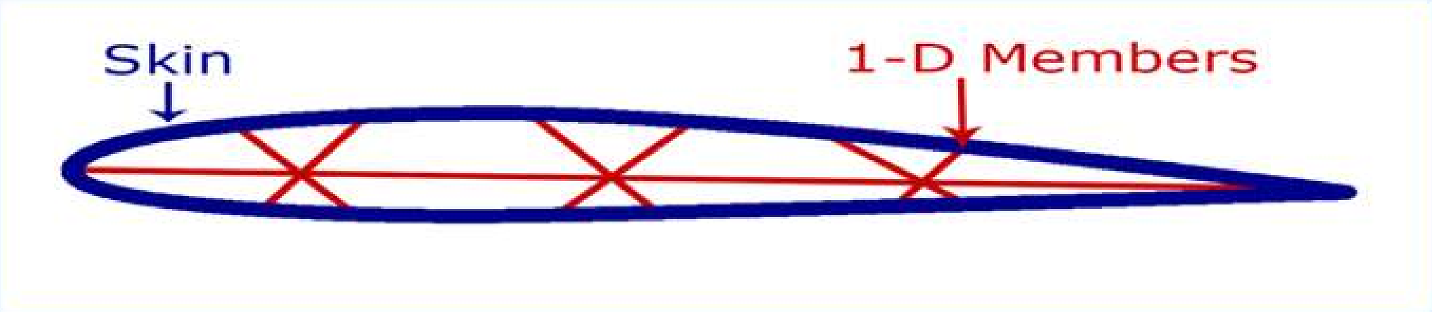
Fall 2018 Design Review

TENSEGRITY WING

UCI Samueli School of Engineering

Background

-The aerodynamics, control, and stability of an aircraft are heavily dependent on its wing shape, which is altered using several **control surfaces**. The **control surfaces** cannot achieve the optimal shapes for a given flight, so extra energy is needed for control and stability. Rigid **control surfaces** also increase drag, necessitating more engine thrust. This results in energy inefficiency.
-The purpose of a **tensegrity** wing would be to solve the aforementioned problems. **"Tensegrity"** refers to a set of bodies stabliized by 1-D tensile elements. A **tensegrity** wing would be made from a flexible **skin** and several **1-D members**. By adding and releasing tension in the **1-D members**, the wing would be able to change shape.



Goal

-Design a morphing wing that can change its shape on demand via an internal tensegrity structure.

Objectives

Fall
-Pressure distribution and aerodynamic properties
-Computational Fluid Dynamics/integration with mechanical analysis
-Mechanical analysis of wing/Finite Element Analysis
-Selection of materials and actuators

Winter
-Create fabrication plan and begin fabrication process
-Finish structure design
-Preparation for wind tunnel testing

Spring
-Test wing in wind tunnel
-compare wind tunnel and simulation data
-Revise and optimise design
-Finish fabrication
-Implement actuators and electronic components

Team

Advisor:
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Team Leads:
Elias Funez, Robert Rowe

Finance Managers:
Angie Gomez, Xiaoxi Zhang

SUBTEAMS:
Structures:
Angie Gomez, Justin Arakaki, Erling Eriksen, Richard Huynh, Oscar Mejia, Sean Redmond, Efrain Valtierra
Aerodynamics:
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Fabrication and Electronics:
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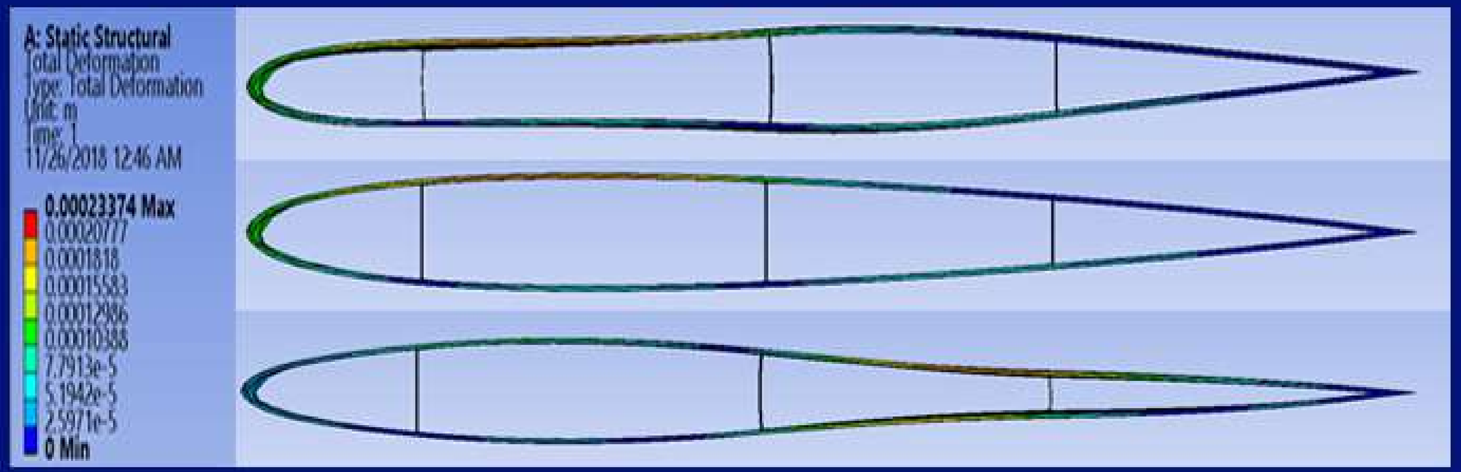
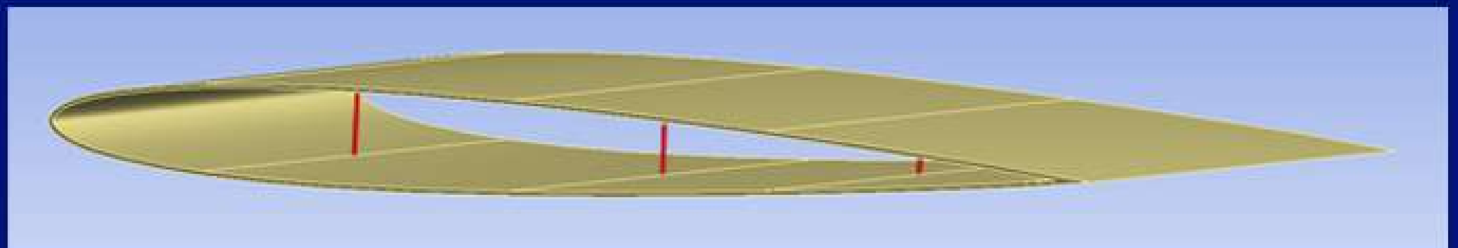
Current Status



5% reduction in length of leading 1-D member, Deformation Factor: 10

Undeformed

5% reduction in length of trailing 1-D member, Deformation Factor: 10



Wing segment showing skin and 1D members

-Materials and electronics selection
-Modeled 18 airfoils and their deformation via 1-D members
-Analyze how pressure distribution and aerodynamic properties change with airfoil shape using Profili software

What's Next: Torsional Deformation

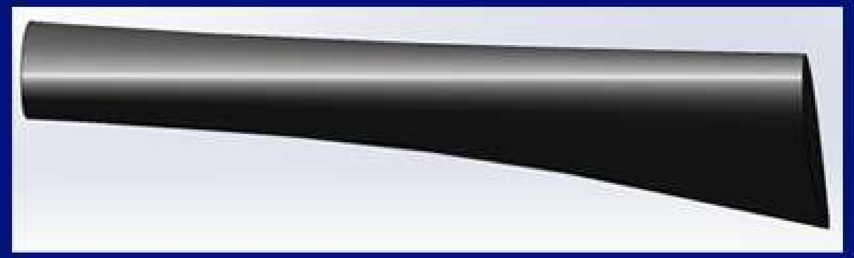
Undeformed

Leading Edge

Profile

Trailing Edge

Deformed



Leading Edge

Profile

Trailing Edge

The Bigger Picture

-Will accelerate progress within the aeronautical industry, by providing more jobs and new innovative ideas on how to improve airfoil design
-Could potentially reduce cost of flying because more efficient aircraft will use less fuel
-Since aircraft would be more efficient and use less fuel during flight, they will be environmnetally more friendly

Requirements

Wing Dimensions
-Chord Length: 100 mm
-Width: 250 mm
-Max Thickness: 10 mm

Segment Dimensions
-Chord Length: 100 mm
-Width: 80 mm
-Max Thickness: 10 mm

Structural Integrity
-Must retain structural integrity in wind speeds of up to 35 m/s in wind tunnel

Optimization Variables
-Minimization of mass
-Maximization of range of aerodynamic parameter values that the wing can achieve through morphing (example: lift coefficient)

Smart Actuators

-1D tensile members, which also act as actuators, are made from nickel-titanium shape memory alloy wires
-Contracts when heated to 70 degrees Celsius by running 410 mA of current through the wire, resulting in a 5% reduction in length
-Reduction in length results from nickel-titanium changing its structure from martensite to austenite

Materials

-Actuators and 1D members: Shape memory alloys
-Skin: Aluminum 6061-T6
-Microcontroller: Arduino Uno
-8 channel motor driver provides current to S.M.A. wires

Shape Memory Alloys

Arduino Uno

8 Channel Motor Driver

Image Sources:
http://www.dynalloy.com/flexinol.php
https://www.amazon.fr/SunFounder-Channel-Shield-Module-Arduino/dp/B00DR9SE4A
https://en.wikipedia.org/wiki/Arduino_Uno

Budget

Costs
70 degree C Flexinol Actuator Wire..........$82.50
Alclad Aluminum 6061-T6, T651 Sheets..........$75.00
Arduino Nano Microcontroller..........$66.00
Balsa Sheets 36"..........$80.00
License for Profili..........$587.84
Total Cost..........$891.34

Funds
Fall Quarter Lab Fees..........$1300.00