Airbus/WSU Wingbox Challenge (Open Category)

Showcase your aviation heritage
Design, build, and predict the performance of the lightest, strongest, and stiffest Wingbox possible!

Prize money

1st Prize : $2000

2nd Prize : $1000

3rd prize : $500

Deadline : August 10th, 2017

The Challenge

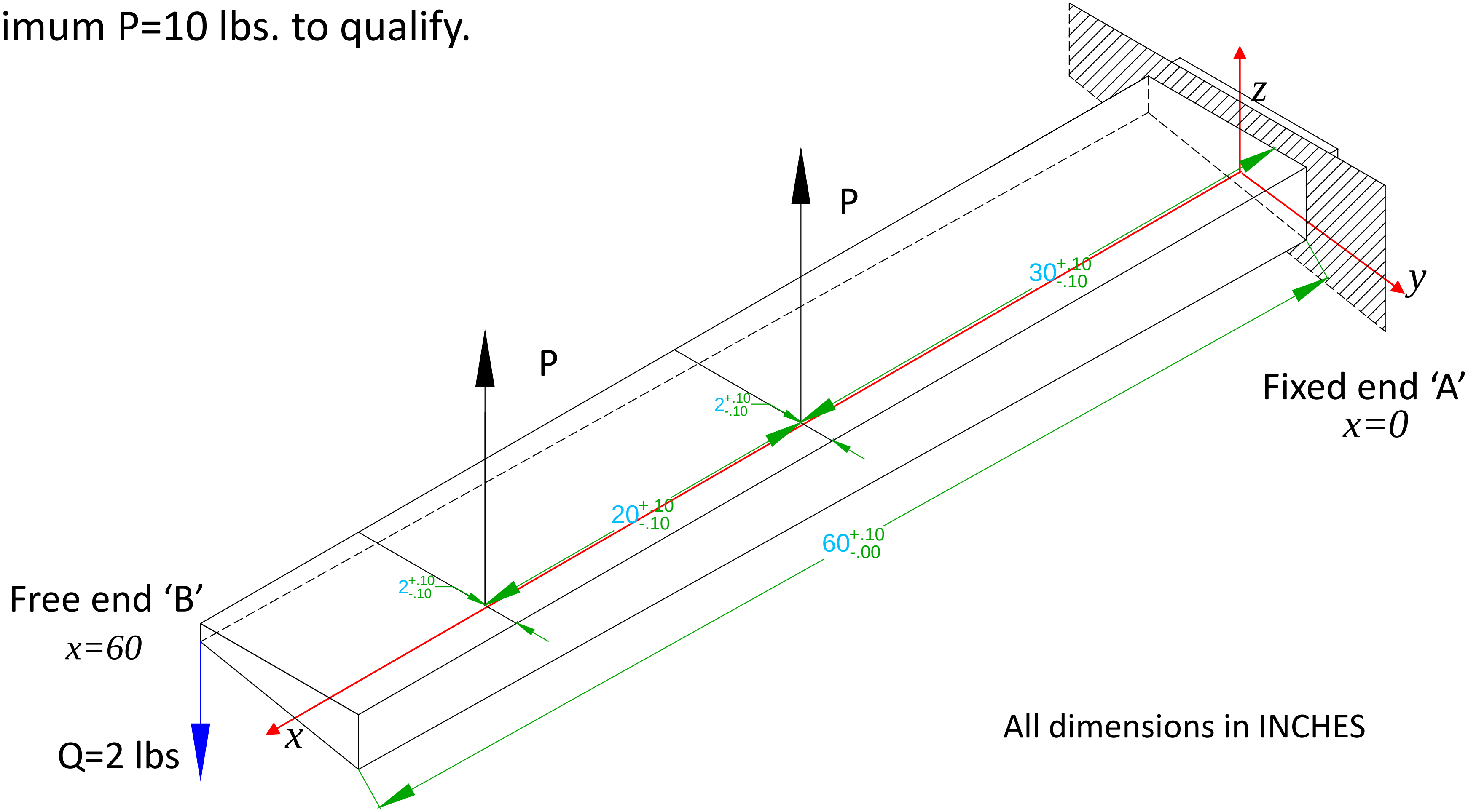
- Wings are a critical part of airplanes
  - They carry the weight of the plane
  - They are necessarily long and skinny
  - The wingbox is the core structure of the wing
- Engineers work very hard to make the wingbox light, strong, and stiff
- Here is a chance for you to do the same, & more!
  - Work with Airbus & WSU engineers
  - Start your future with WSU & with Airbus
  - Win prize money!

Teams

- The competition is open to the public and the team members can include hobbyists, practicing engineers, faculty, and students (high school, university, etc.).
- As part of the competition, you will be required to conduct structural analysis and predict the deflections and failure loads. You may use classical methods or numerical tools. It would be in the best interest of the teams to have at least one member who is proficient in structural analysis.

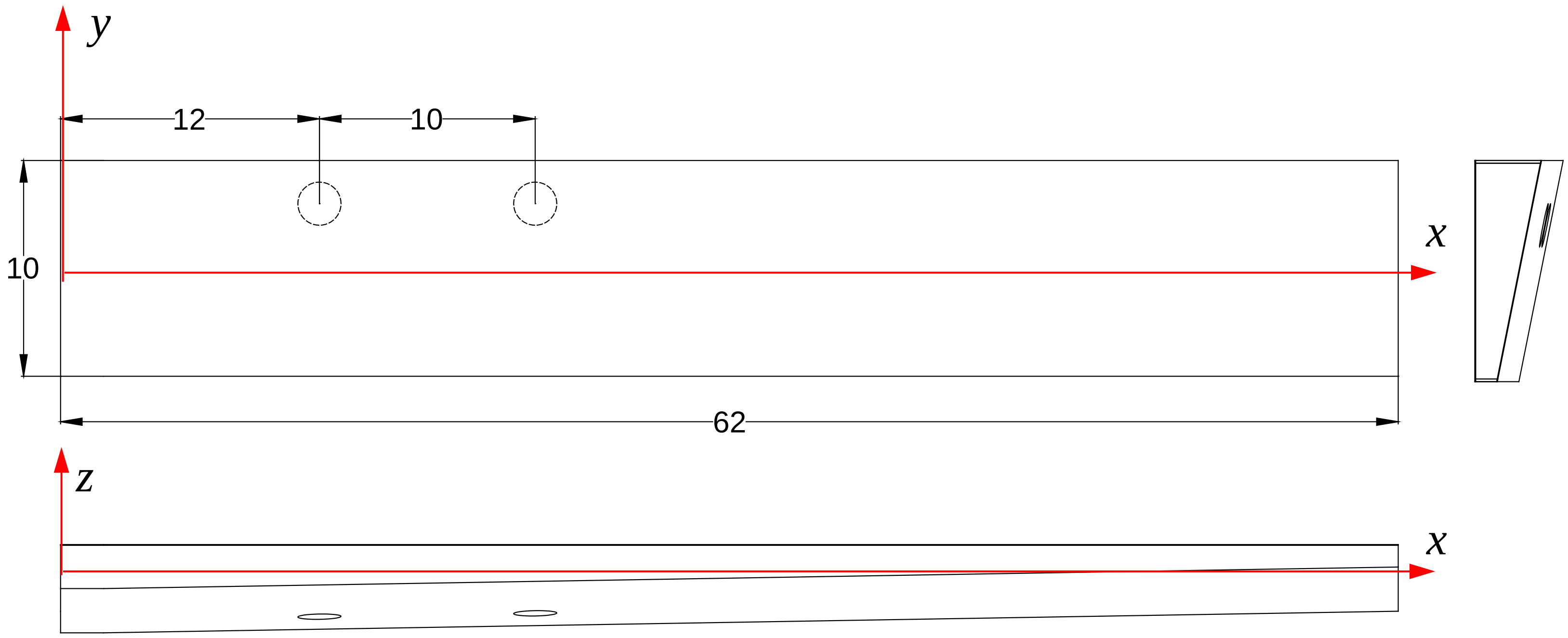
The Challenge

Using balsa sheets and sticks, **design**, **build,** and **predict** the performance of the lightest[A], strongest[B], and stiffest[C] wingbox. The wingbox should withstand a minimum P=10 lbs. to qualify.



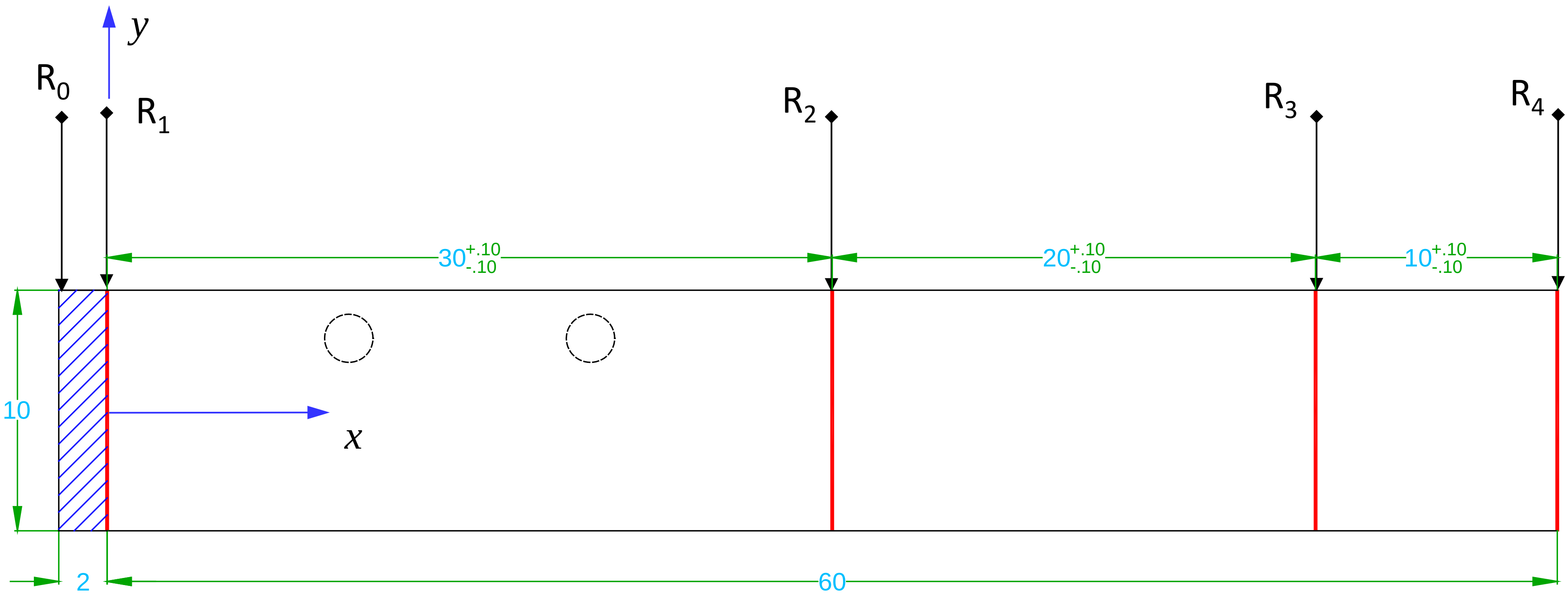
A. Minimize the weight
B. How much force it can withstand
C. Higher stiffness implies smaller deflections and twist

Geometry



All dimensions in INCHES

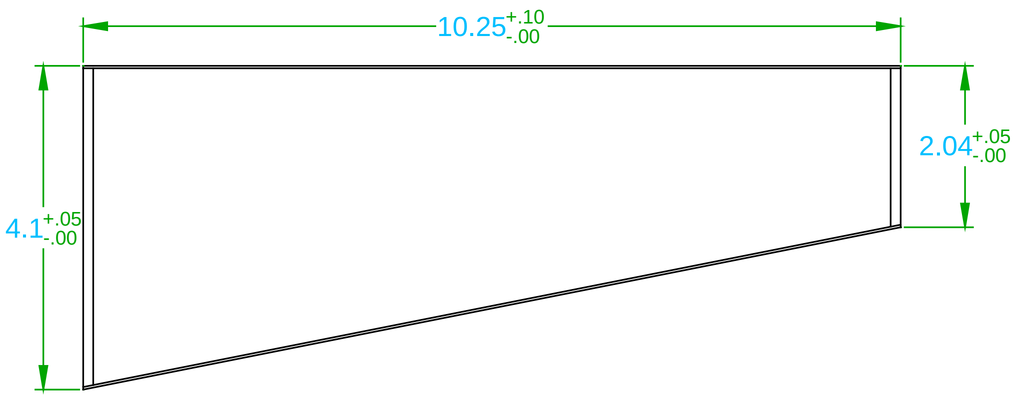
Geometry: Rib Locations



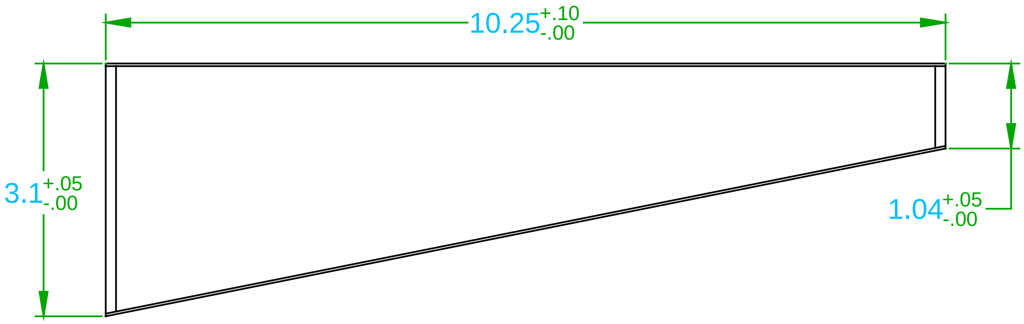
All dimensions in INCHES

- 1/8 balsa ribs are mandatory at locations R_1, R_2, R_3, R_4. These ribs are required for end-fixity and load introduction.
- There should be **no rib placed** at location R_0 and between R_0 and R_1. The hatched (blue) region will be used to pot the end of the wing-box to provide end-fixity.
- Additional ribs may be placed at other locations as dictated by your design

Cross-section geometry



Exterior dimensions not to be exceeded at stations R_0 and R_1

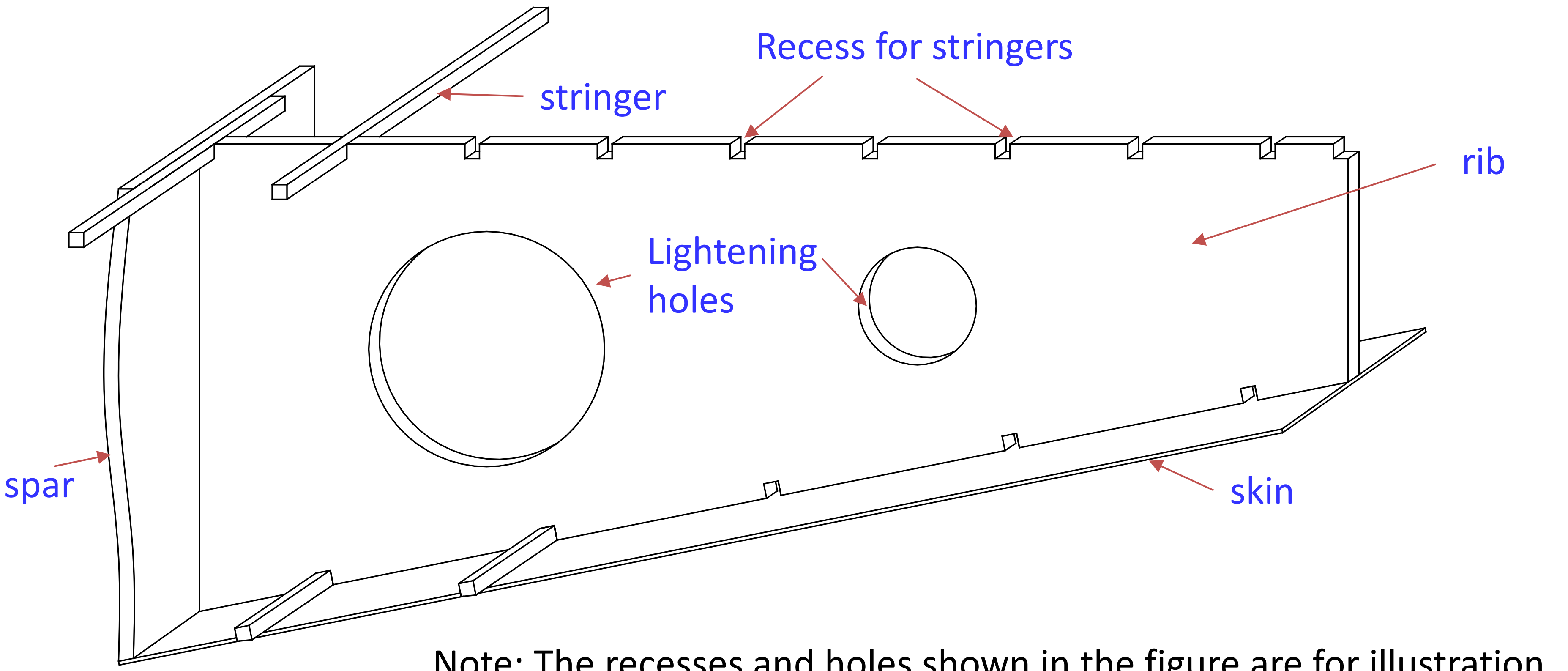


Exterior dimensions not to be exceeded at station R_4

All dimensions in INCHES

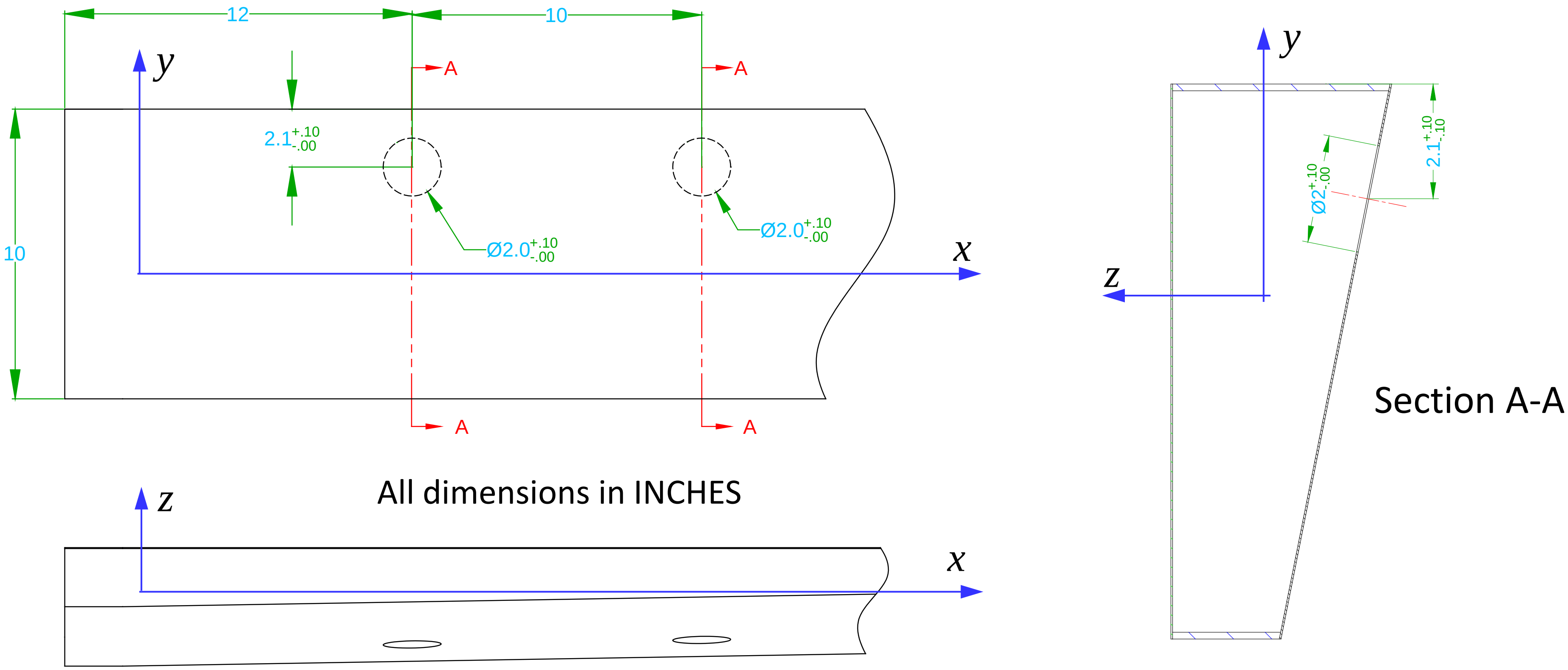
NOTES

1) The balsa sticks (extending the length of the wingbox) must pass through recesses cut in the ribs as illustrated in the figure below.
2) You may cut lightening (weight saving) holes in the ribs.
3) Once you have decided on the locations and dimensions of the recesses in the ribs, you may utilize the **laser cutter** at WSU to have your ribs cut precisely.



Note: The recesses and holes shown in the figure are for illustration purposes only. Their size, shape, and locations may be different for your design.

Geometry: Access ports

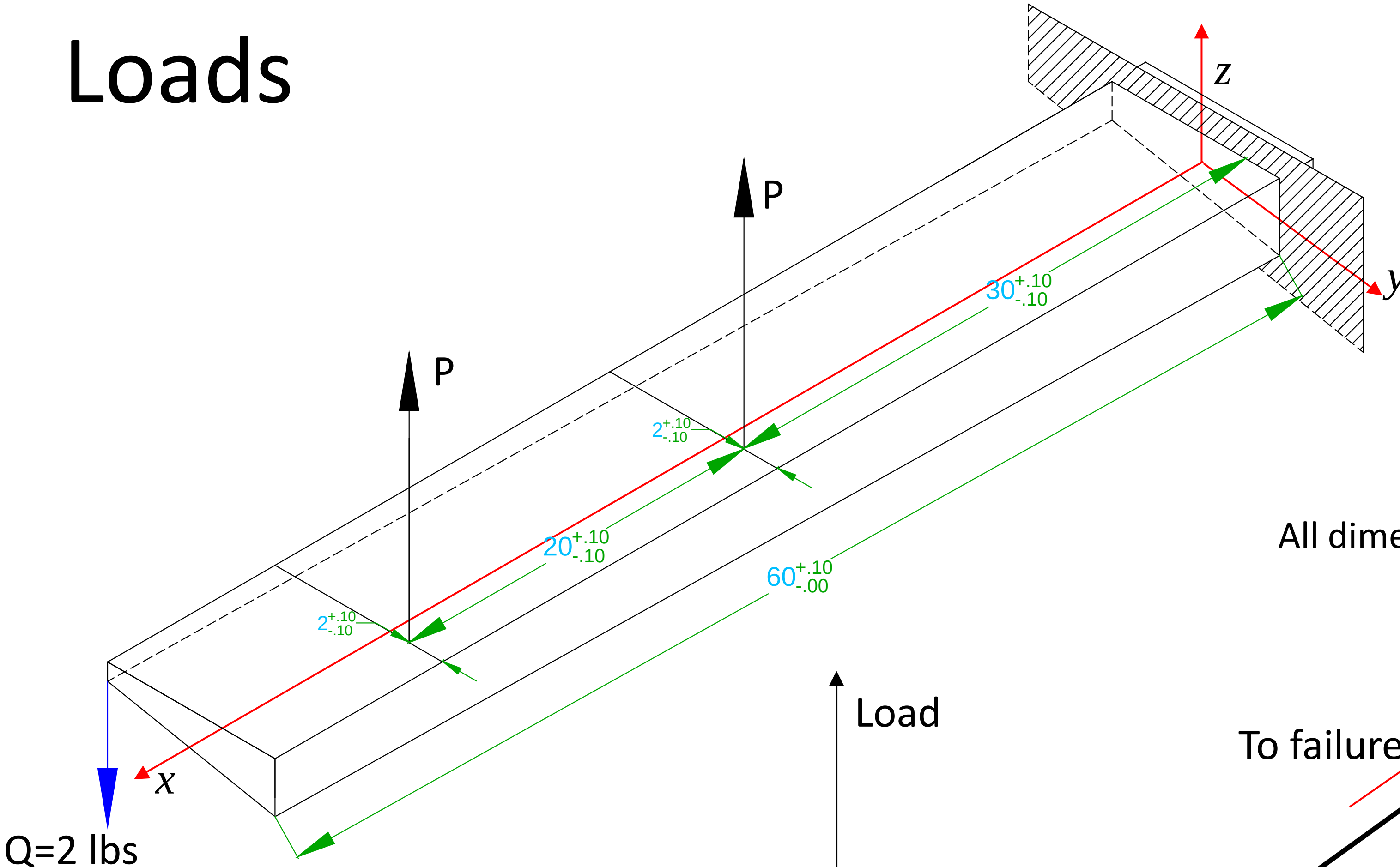


4) Circular access ports measuring 2 inches in diameter must be cut in the bottom skin of the wingbox at locations identified in the above drawing. The holes may be cut using the laser cutter at the WSU Experiential Engineering building.
5) You may reinforce the edges of the holes using balsa sheets and/or sticks. The reinforcements must be on the interior of the skin.

Materials

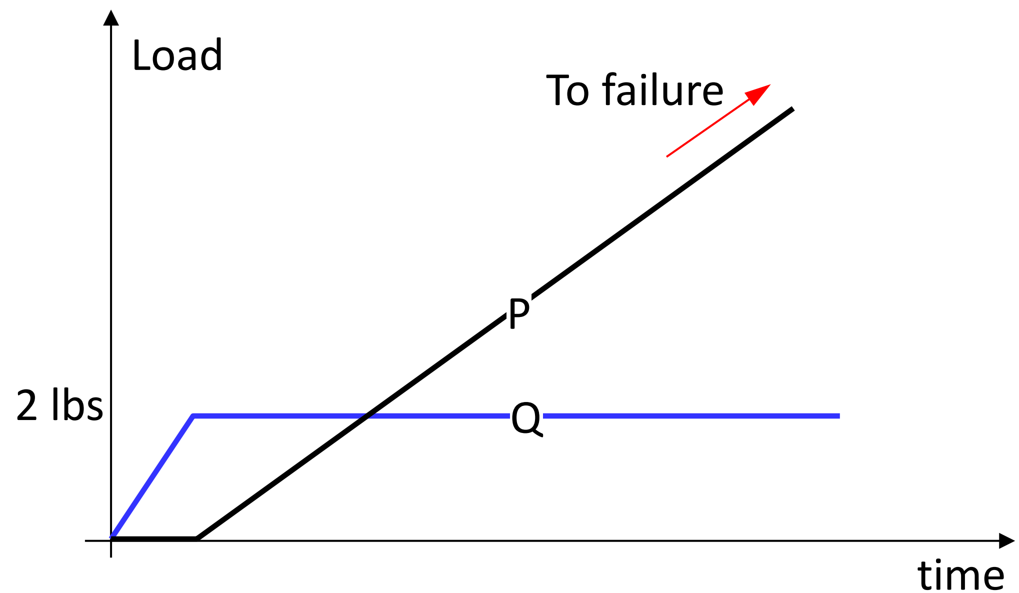
- The balsa skins should be no more than 1/32 inches thick.
- The balsa spars should be no more than 1/8 inches thick.
- Balsa sticks with only 1/8-inch or 1/16-inch <u>square</u> cross-section dimensions are allowed. (May not be laminated)
  - The balsa sticks(stringers) must be placed on the interior of the structure.
  - Any combination of balsa sticks may be used
- The balsa sticks running along the length must be 62-inches long. They must extend by 2-inches beyond the first rib (on the root end) as illustrated in the figure.
- The balsa ribs must be no greater than 1/8-inch thick.
- Use hobby store adhesives for bonding (Superglue, epoxy, etc.)

Loads



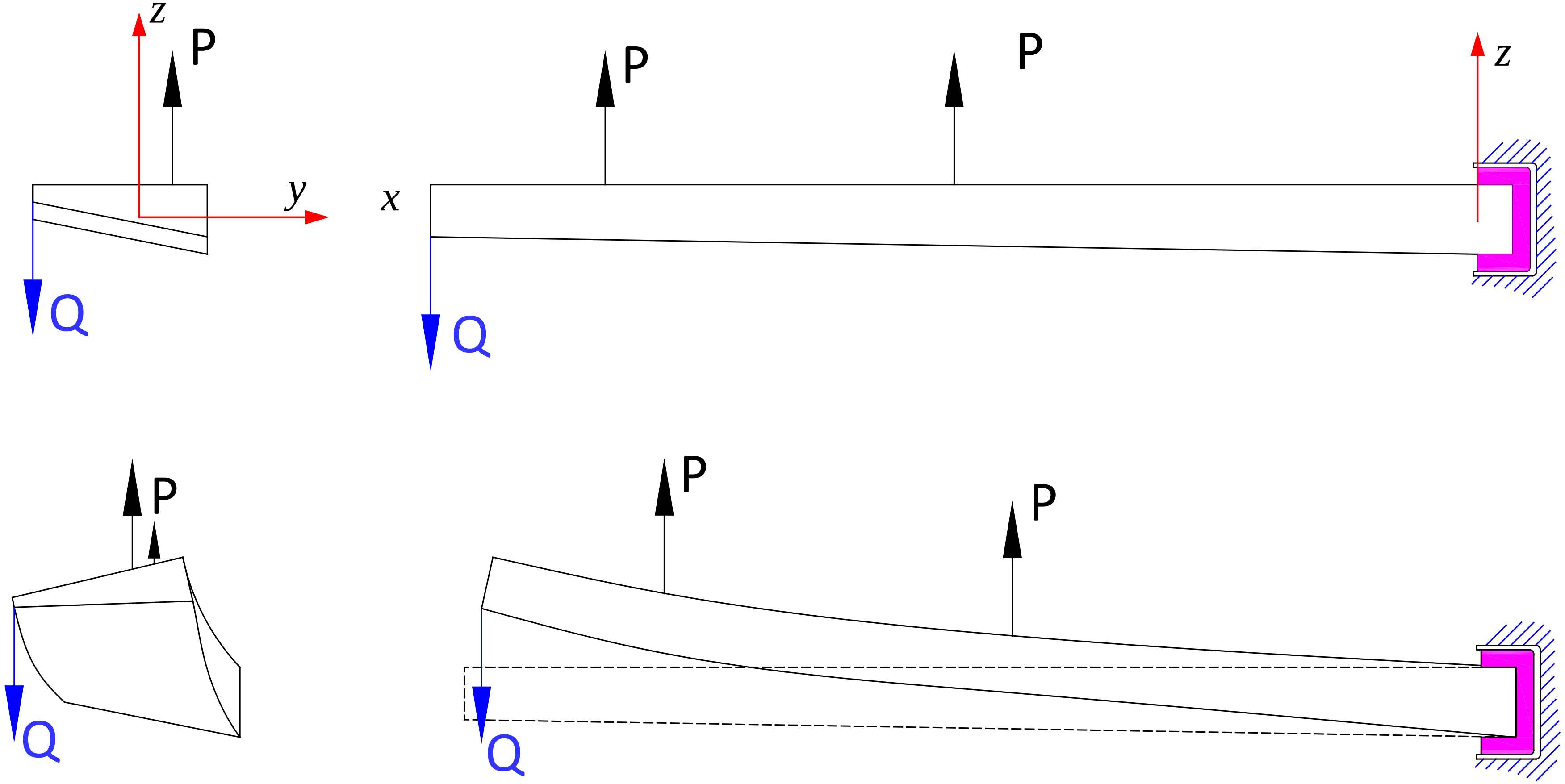
All dimensions in INCHES

An initial load of Q=2lbs will be applied. While holding this load, the forces P will be increased until failure occurs



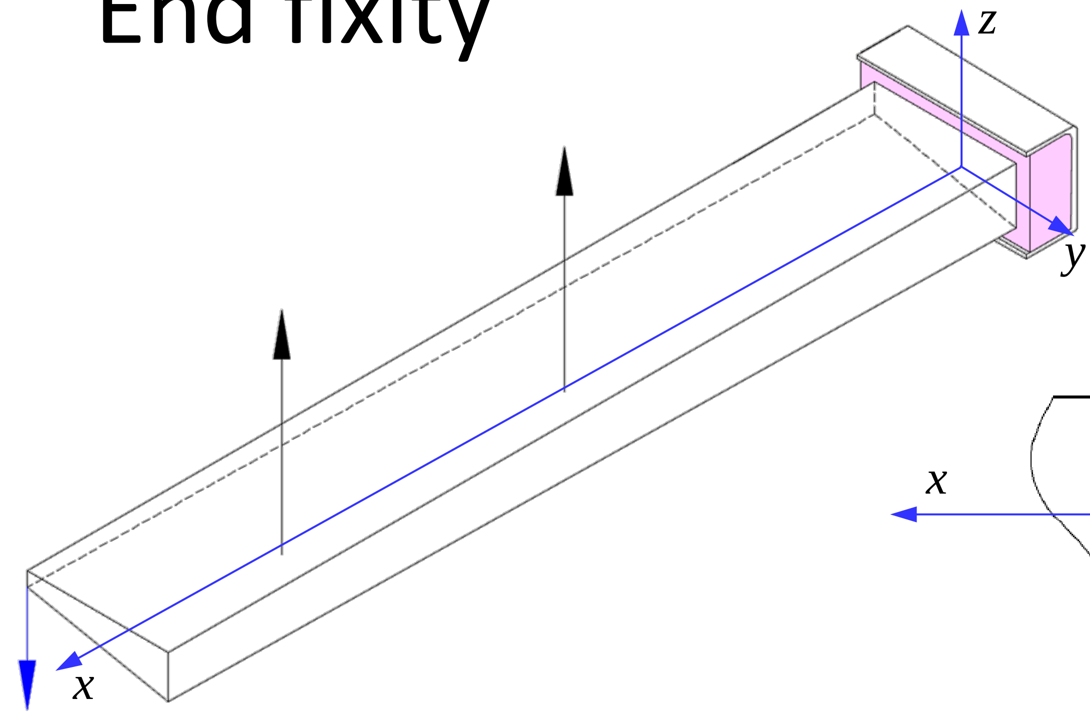
Orientation of loads

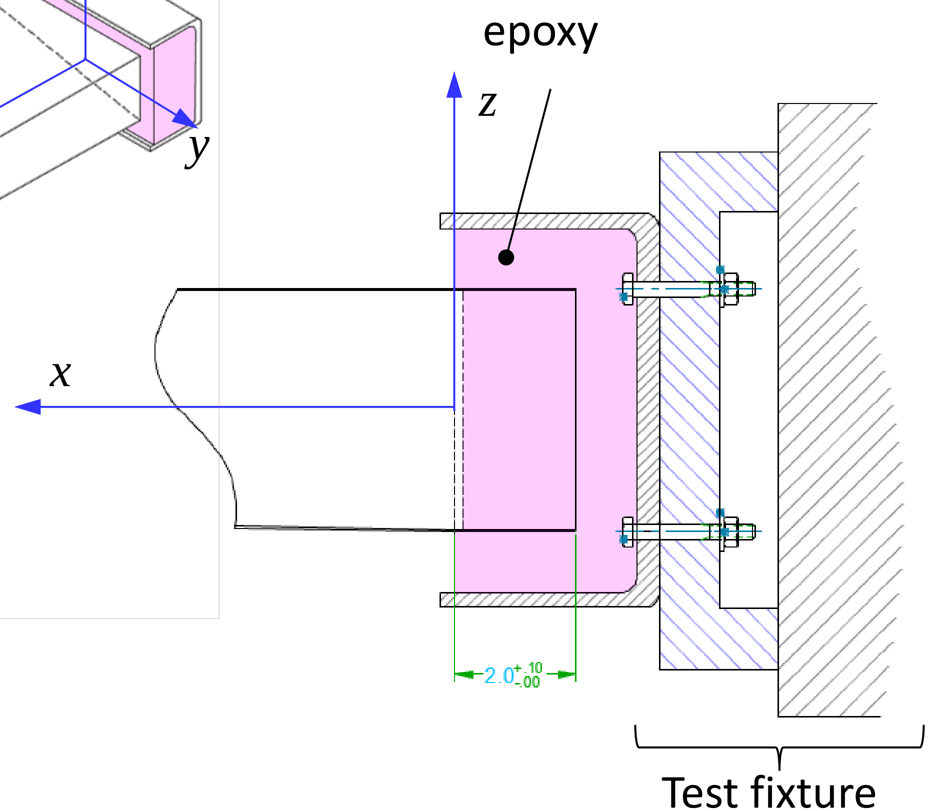
The loads P, wll be introduced using a whiffle tree assembly. Loader frames will be mounted on the wingboxes to introduce the loads.



Note: Deformed configuration is shown for illustration only. Your wing-box may deform differently depending on your design.

End fixity





- The extension behind station R_1 will be cast (or potted) in epoxy resin to provide the necessary end support condition. You should NOT do the end casting. This will be done by WSU
- The skins, spars and stringers must extend behind station R_1 till R_0. Failure to do so will result in rejection of wing box from the competition.

Wingbox Challenge Rubric

- Wingbox designs are scored based using the following:

  Score $S = S_1 + S_2 + S_3 - S_4 + S_5$

  – S_1 (Maximum of 20 points). A deduction of 1 point for exceeding 0.1” in the overall dimensions

  – $S_2 = (P_f/W) \times 10$
    - P_f is the load at failure and W is the weight of the wingbox (as submitted)

  – $S_3 = (1/\Delta_f) \times 100$
    - Δ_f is the tip or free end deflection at failure

  – $S_4 = W_{glue}/W_{total} \times 100$
    - W_{glue} is the weight of the glue(adhesive) used. You may weigh each of the balsa parts used before assembling them and their sum gives you the total weight of balsa wood. This should be documented in your report. Weigh the completed WingBox and use it to estimate W_{glue}. Failure to report weight of glue will result in $S_4=25$

  – S_5 (Maximum of 25 points for the report)
    - Drawing with dimensions and list of parts (10 points)
    - Weight of Balsa and glue (5 points)
    - Summary of activities (5 points)
    - Design philosophy (5 points)

Deliverables

- Deadline : 5 p.m., August 10th, 2017
- A summary report (not exceeding 10 pages in Word format, 12pt font, single spacing, 1” margins) outlining the following:
  - Team name, affiliation, list of Team members, & mentors (1 page)
  - Summary of your design (why you decided to build the wingbox a certain way) and dimensioned drawings identifying the various parts (3 pages)
  - Summary of activities (materials used, time spent in design, constructing, testing, etc.). Photographs of activities are also welcome. (2 pages)
  - Details of Wing-box analysis, and a summary of your predictions (free end deflections and rotations, failure locations) at the following loads (5 pages)
    - With 2 lbs end load
    - With 2 lbs end load and P= 10 lbs
    - With 2 lbs and your predicted failure load
- Deliver your fully constructed Wingbox to WSU
  - The teams are responsible for delivery of the Wingboxes to the below address

    200 Wallace Hall, Department of Aerospace Engineering, Wichita State University
    1845 Fairmount, Wichita, KS 67260-0044

- The Wingboxes will be tested during the week of October 17th , 2017
- The results will be announced during the first week of December, 2017.