Glider Activity

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Introduction

- What is being shared today is an adaptation of a project we do in the freshman level introduction to aerospace course
- This project has been adapted with a 3rd to 5th grade audience in mind, however, can be easily modified to challenge students at any grade level!
- In this project, students will learn about the engineering design process and practice applying problem solving and critical thinking skills through the design, build, and test of a small glider aircraft.
- This is a very open-ended design problem with no right answer.
- The result of the project will be a flight test where each student tests their design and creates a short final report on the activity.

Mapping the Glider Project to School Subjects





- **Math**
  - Measurement
  - Ratios
  - Finding Area
- **Science**
  - Forces and Center of Gravity
  - Newton's Laws and Bernoulli's Principle
  - Basic Aerodynamics
- **Writing/Communication**
  - Oral or Written Report
  - Discussion of Design Choices
- **History**
  - History of flight
- **Design/Critical Thinking**
  - Engineering Process
  - Problem Solving
  - Learn, Design, Build, Test, Improve

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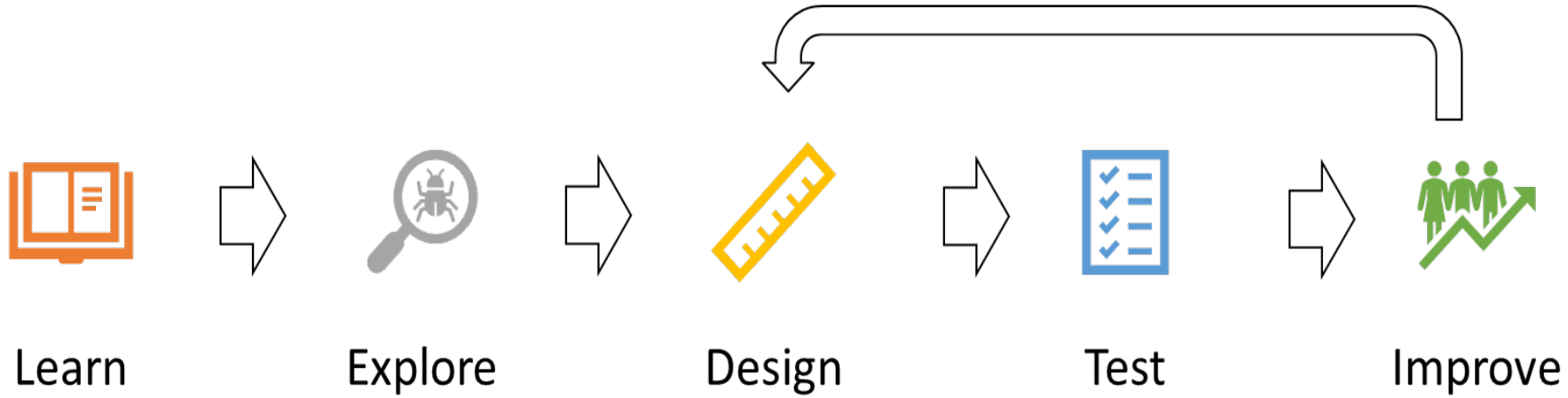
Design Process Used for the Project



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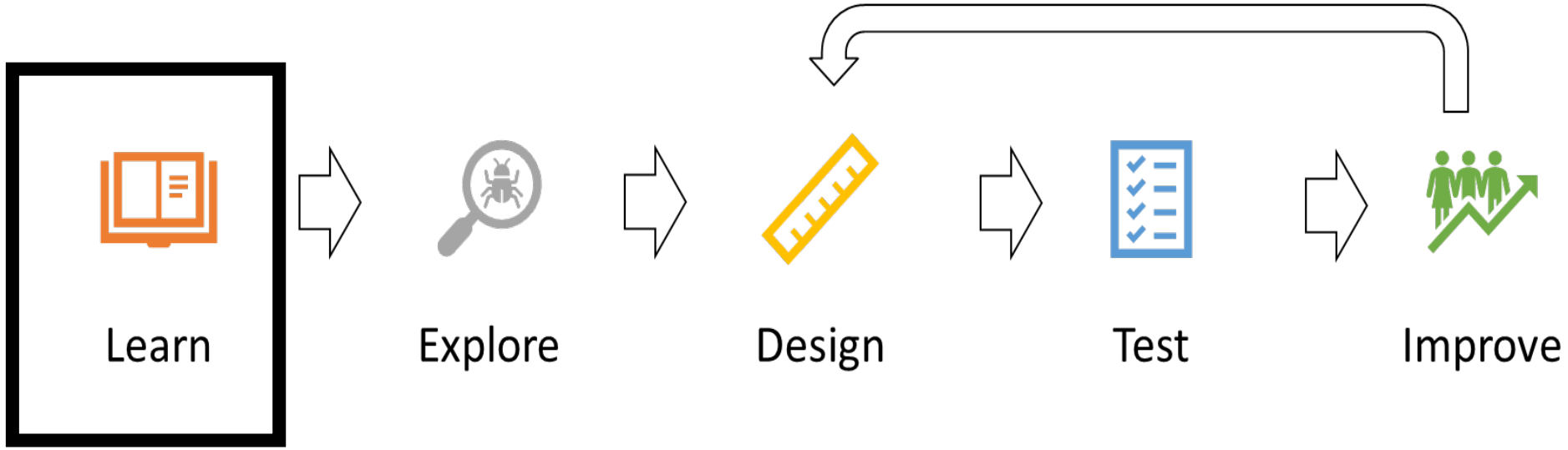

I'm going to give you a crash course, but we are working on developing a set of videos made by GT students to help with this step in the classroom.

We can also send a guest speaker to help!

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Parts of an airplane

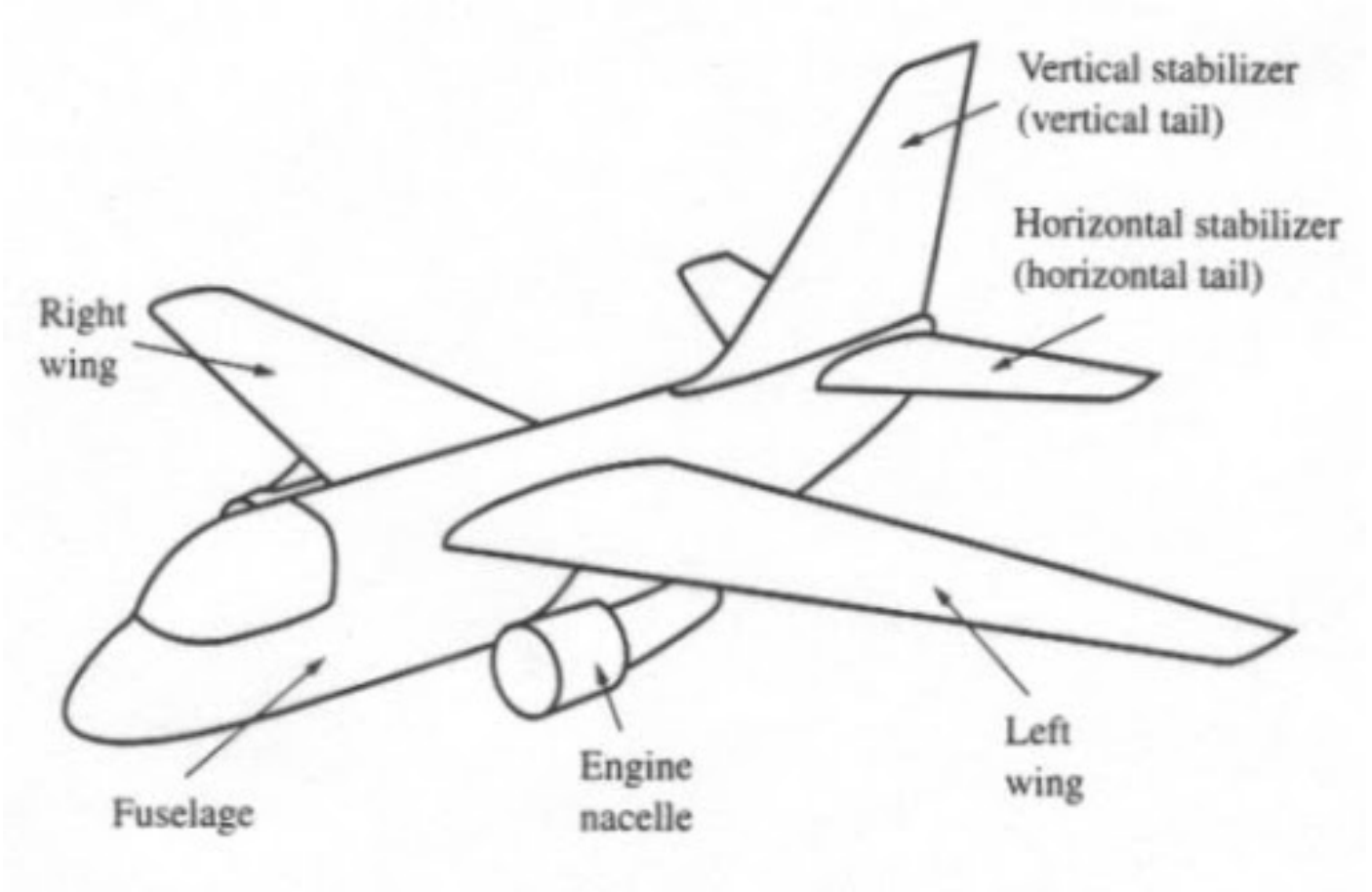
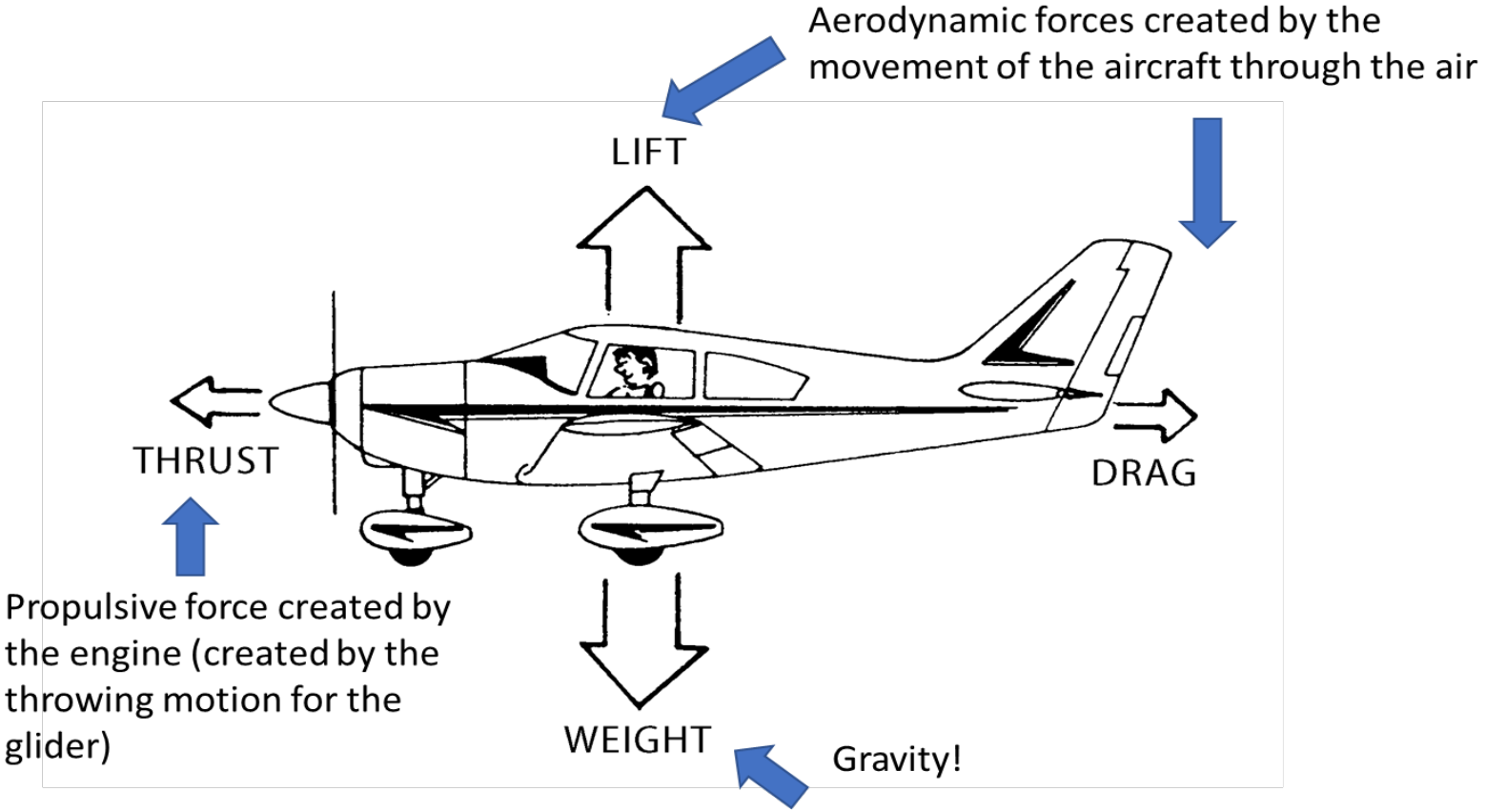


Image Credit: aerospaceweb.org

Forces of Flight



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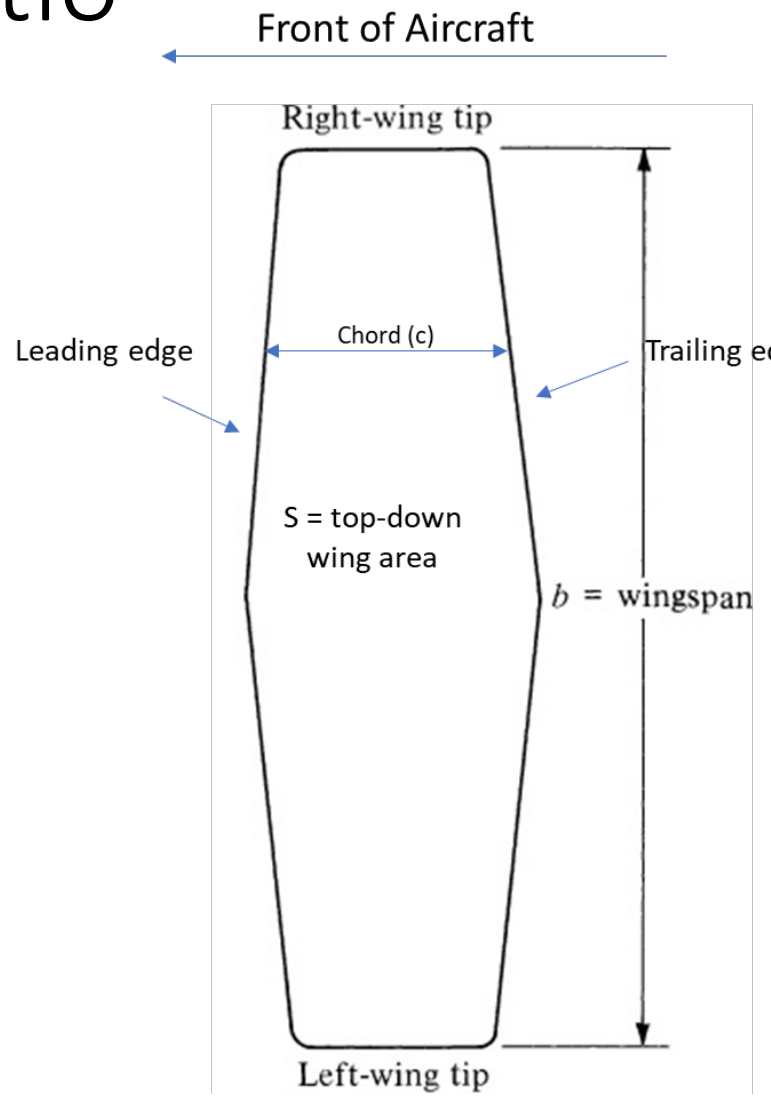
Wing Area and Aspect Ratio

- The **Wing Area** is the area of the wing if you look straight down from the top
  - Lift increases as wing area increases
- The **Aspect Ratio** tells the ratio of the span (length) to chord (width) of the wing
  - High aspect ratios mean long, skinny wings, while low aspect ratios correspond to short, wide wings
  - Higher aspect ratios generally lead to lower drag in flight



Aspect Ratio

$$AR = \frac{b^2}{S}$$

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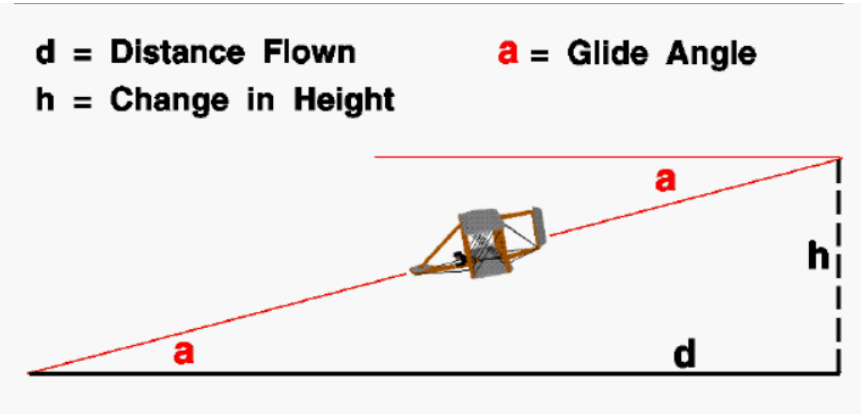
A bit about glider performance

- Glider range is maximized when the **Lift to Drag Ratio** is maximized
  - Remember, a large wing area increases lift, but a large aspect ratio minimized drag
  - Therefore, glider wing design is a tradeoff between these two
  - In the classroom, students can explore different wing designs by calculating their wing area and aspect ratio, and testing their performance

- We can talk about glider performance in terms of the **glide angle**
  - By drawing a triangle with the height of the glider throw and the distance traveled, students can measure their glide angle

- Generally, minimizing weight is important to aircraft design. Students can weigh their glider and observe how weight influences performance across the class.



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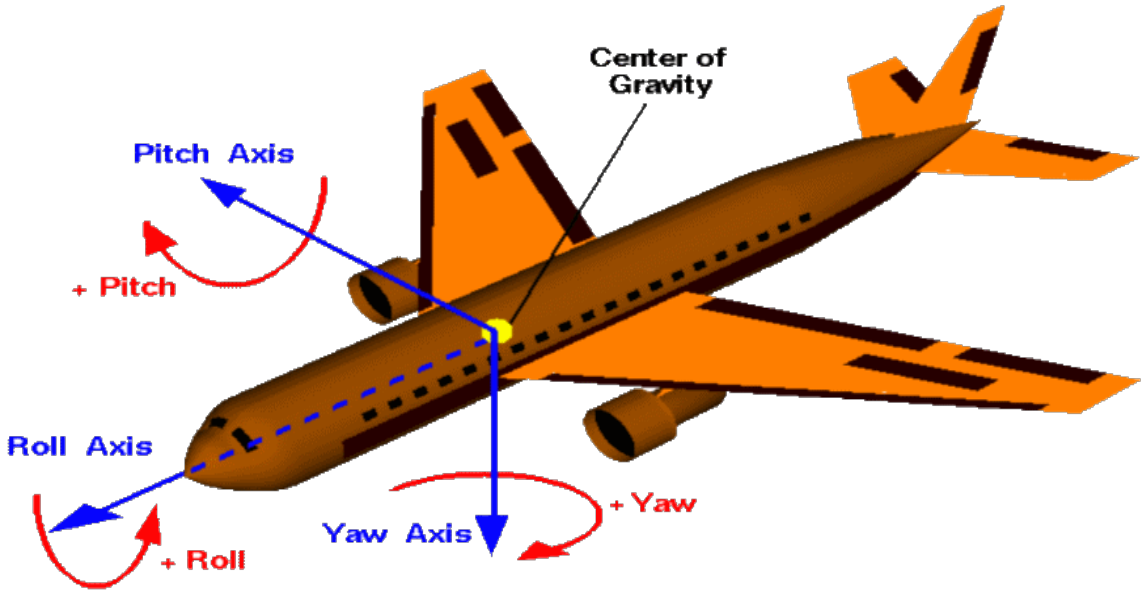
Flight Stability

- In order for a glider to fly straight, it must be stable.
- This means that we need to prevent the glider from rotating in flight
- This is why planes have tails!
  - Vertical tail affects stabilize Yaw
  - Horizontal tail helps to stabilize Pitch
- Wings can be given a slight **dihedral** (v shape) to stabilize Roll
- Additionally, the weight has to be balanced!



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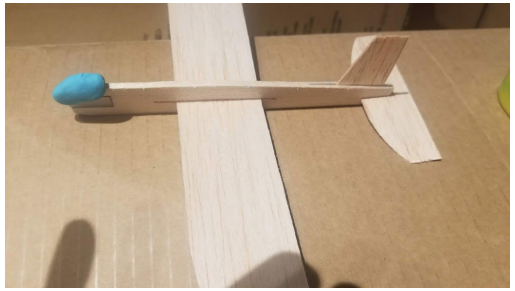
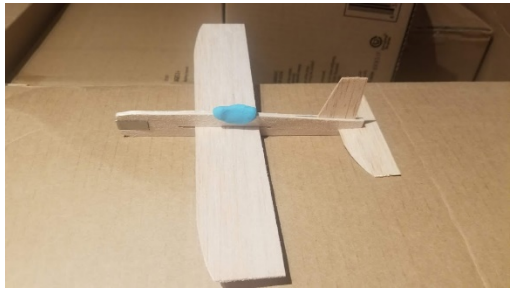
How does weight affect stability?



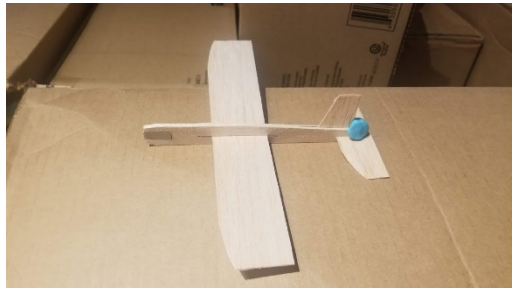
Add playdoh to the nose.
Throw the glider.

Move to the front of the wing.
Throw the glider.



Move it to the back of the wing.
Throw the glider.

Move it to the behind the wing.
Throw the glider.



Move it to the tail.
Throw the glider.

How did the position of the playdoh affect the flight of the glider?

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Center of Gravity

- The location of the **center of gravity** has a strong impact on stability
- If the glider has more weight on one side than the other, the glider may roll or yaw during flight
- If the glider has too much weight toward either the nose or tail, the glider may pitch up or down

- A **balanced** glider will achieve the best flight
- Most small gliders need weight added to the nose to achieve this balance.
  - We will use playdoh
  - Students can experiment with using more and less playdoh placed on the nose to achieve a steady flight

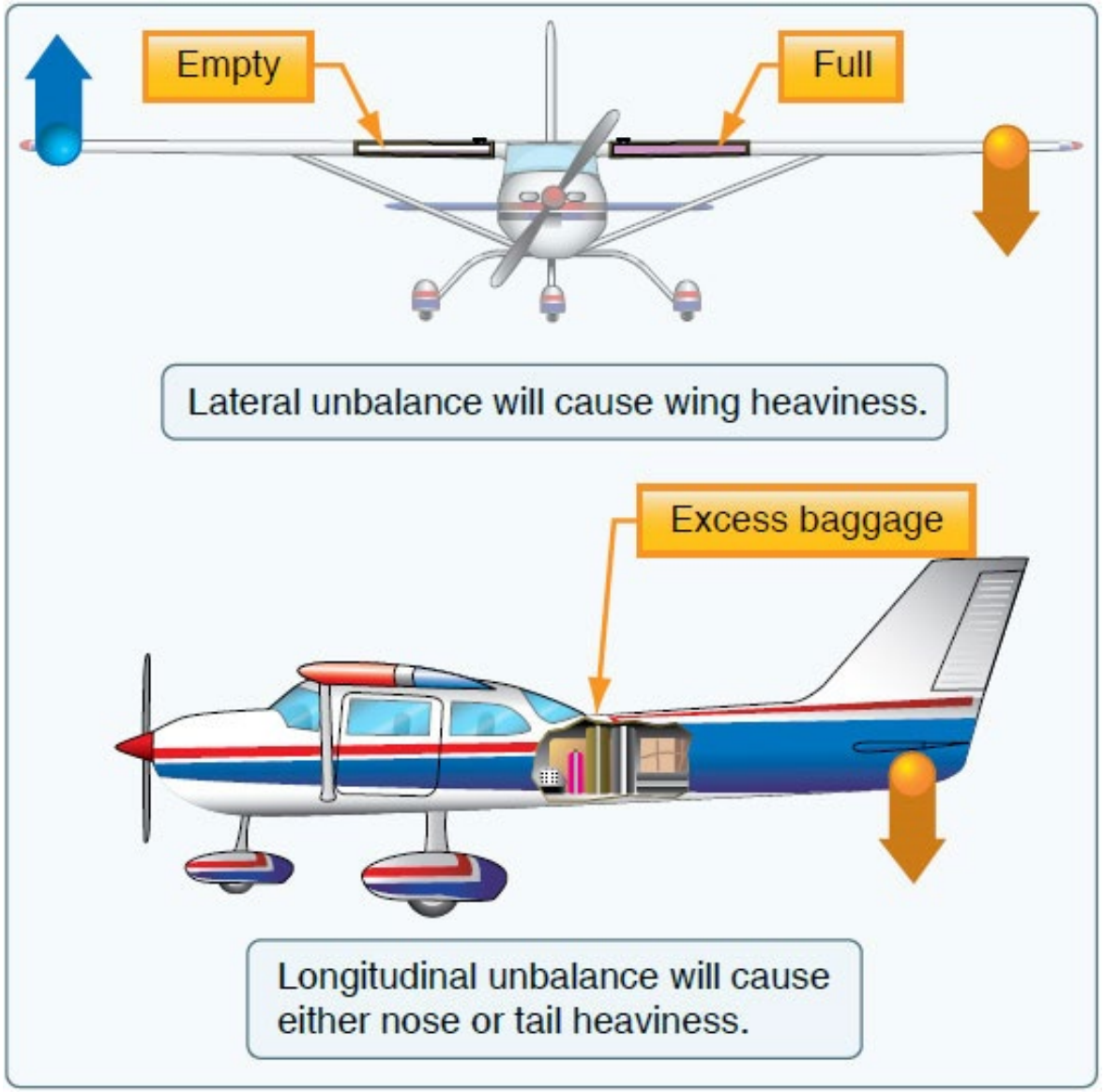

Image Credit: https://www.flightliteracy.com/balance-stability-and-center-of-gravity-effects-of-adverse-balance/

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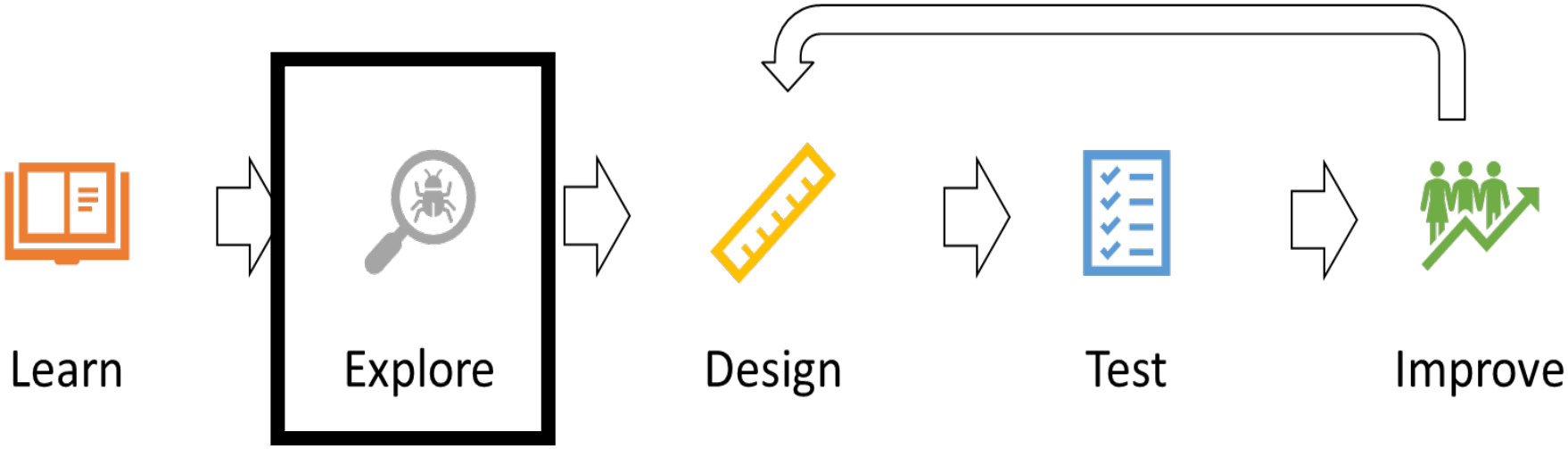
Design Process for the Project



During this stage, we might ask students to look at examples of real gliders and make observations. We will skip this today.

Look at examples of gliders. What is similar between the designs? What is different?

What do their wings look like? How are their tails designed? Why do you think that is?

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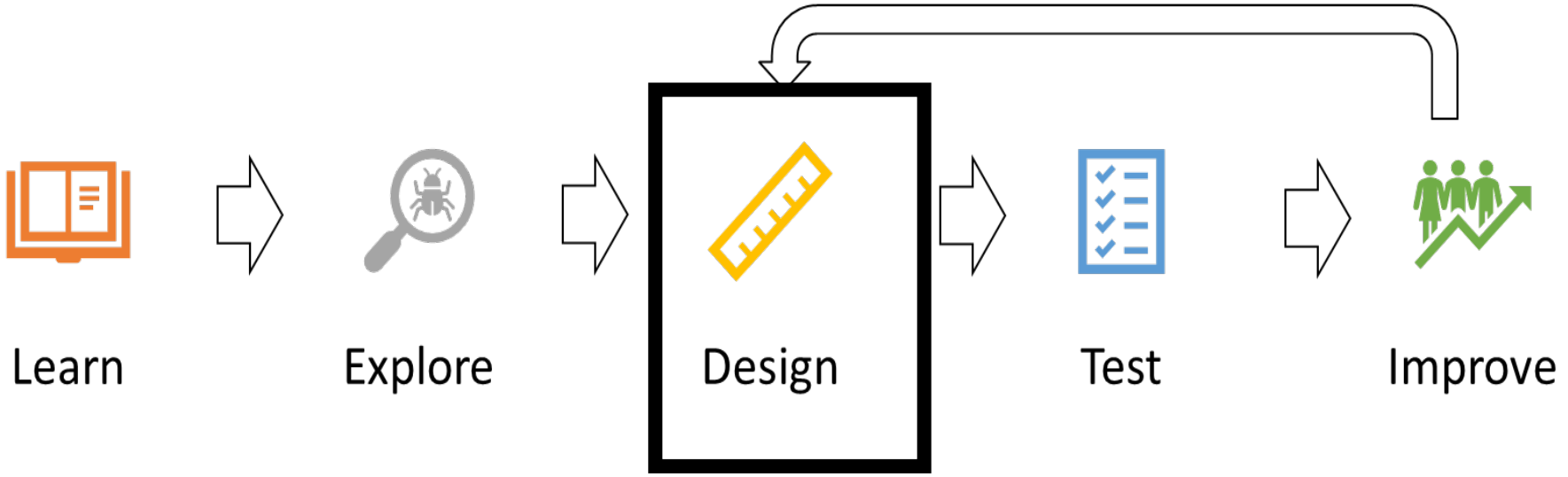
Design Process for the Project



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Let’s try it!

- We are going to do our design worksheets in this order:
  - Wing Design
  - Tail Design
  - Overall Design

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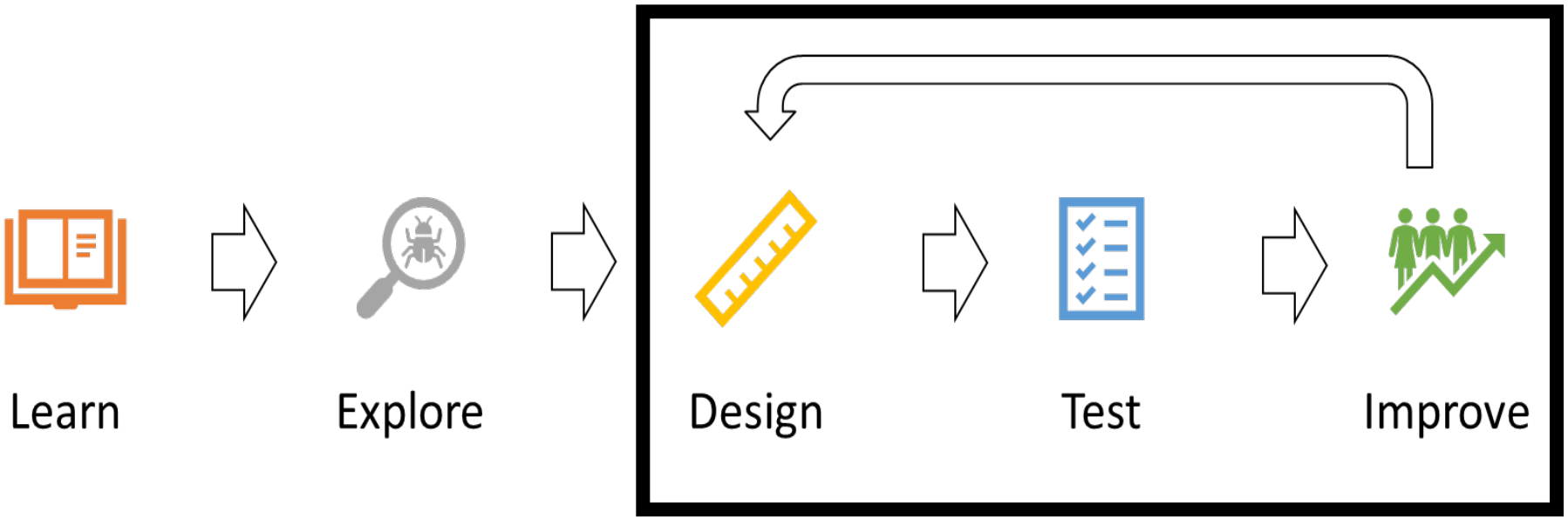
Design Process for the Project



Now that we have our starting point, let's build our design, test it, and improve on it until we have a successful glider.

Balancing the glider will be a huge part of the test and improve stage

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Balancing your Glider

1. Add a small amount of playdoh to the nose of the glider. Balance it on your finger to find the center of gravity.
   - Add or remove playdoh until the CG is about ¼ of the distance along the wing chord. This is a good starting point for most gliders.
2. Throw your glider and observe its behavior. Did it fly smoothly and straight? Or did it pitch, yaw or roll?
   - Based on what you observed, here are some things you can try to improve your flight performance
   - Repeat this step until you have a balanced flight!

Pitch Up (stall)

- Try adding more playdoh (weight) to the nose to move the CG forward
- Try angling the horizontal tail slightly downward to create a pitch down force

Pitch Down (nose dive)

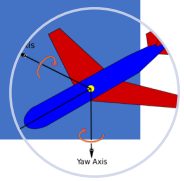
- Remove some of the weight from the nose
- Reduce any downward angle on the horizontal tail

Roll right or left

- See if there is a weight imbalance between the right and left side. If so, add a small bit of playdoh to the lighter side to have a better weight balance
- Add a small bit of dihedral (v-shape) to the wing

Yaw right or left

- See if there is a weight imbalance between the right and left side. If so, add a small bit of playdoh to the lighter side to have a better weight balance
- Adjust the angle of the vertical tail to make sure it is straight



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Ideas to Explore Class Results

- Have a discussion where students give a short presentation about their design journey and how they improved their glider
- Make a plot and see if you can spot any trends!
  - Aspect Ratio vs. Distance
  - Wing Area vs. Distance
- Have students repeat their flights, and make a chart of the distances they achieve
- Have students describe an iteration they made and how it improved their flights. Can they figure out why the change had that effect?
- Compare qualities of very successful gliders (top 5). What do they have in common? What was different between them?

Ideas for Related Activities

- Discussion of the impact of flight on society/globalization
- Exploration of impact of aviation on the environment, and learn about what is being done to make cleaner skies
- Art project or poetry project imagining your glider's flight if it were a real aircraft
- Art project imagining the aircraft of the future – draw what you think air travel might look like in 30 years!
- Discussion around aviation-related careers
- Listen to/watch/read a biography of a famous aviation pioneer and discuss

Questions? Discussion?

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