7TH GRADE · DESIGN CHALLENGE

Flight of Fancy

Teacher Facilitation Guide

Duration: ~ 10 50-minute class sessions

CHALLENGE OVERVIEW

The Design Challenge is the capstone of the Flight of Fancy unit. Students apply everything they have learned across all four challenges to design, model, fabricate, test, and pitch an improved wing for the glider. They work as aerospace engineering firms competing for a contract: design a new wing that flies farther than the baseline glider (average 12.108 ft across 10 trials), then pitch their design — including data, 3D model, interior design from the Systems Challenge, and profit projections — to a panel of judges.

This challenge is intentionally the most open-ended and the most student-driven. The teacher's role shifts here: less direct instruction, more facilitation and coaching. Students have the skills they need — the Design Challenge is where they use them.

BY THE END OF THIS CHALLENGE, STUDENTS WILL BE ABLE TO:

- Apply the Engineering Design Process (EDP) to a real design problem from start to finish
- Use data from previous challenges to inform and justify design decisions
- Design and fabricate a physical wing prototype using cardstock
- Test the wing prototype and collect flight data (10 trials) to compare with the baseline
- Create and present a final Sales Pitch that integrates work from all four challenges

MODULE STRUCTURE
Activity 1 — Introducing the Wing Challenge (Day 1, ~50 min)
Activity 2 — Ideation and Design Selection (Day 2, ~50 min)
Activity 3 — 3D Modeling the New Wing (Days 3–4, ~100 min)
Activity 4 — Fabrication and Testing (Days 5–7, ~150 min)
Activity 5 — The Final Sales Pitch (Days 8–10, ~150 min)

MATERIALS

Cardstock — 1 sheet per team for wing fabrication

Scissors

Tape (clear and masking)

Glider fuselages — 1 per team (foam, from Data Challenge)

Computers or Chromebooks with TinkerCAD access

Tape measure or measuring tape

Printed student activity sheets and Final Pitch Rubric

Engineering Notebook

Handout 1 – Wing Design RFP
Handout 2 – EDP: Identify & Understand the Problem
Handout 3 – Wing Ideation Sheet
Handout 4 – Evaluation Matrix Sheet
Handout 5 – Wing Configuration Reference
Handout 6 – Flight Data Recording Sheet
Handout 7 – Pitch Planning Sheet
Handout 8 – Final Pitch Rubric

STANDARDS ALIGNMENT

NGSS Engineering Design

MS-ETS1-1: Define the criteria and constraints of a design problem
MS-ETS1-2: Evaluate competing design solutions using a systematic process
MS-ETS1-3: Analyze data to determine if a design solution works as intended
MS-ETS1-4: Develop a model to generate data to test ideas

Science and Engineering Practices

Practice 1: Asking questions and defining problems
Practice 6: Constructing explanations and designing solutions

Common Core Standards for Mathematical Practice

SMP 1: Make sense of problems and persevere in solving them
SMP 3: Construct viable arguments and critique the reasoning of others
SMP 4: Model with mathematics
SMP 6: Attend to precision

See the Flight of Fancy Design Challenge Planning Guide for complete alignment details.

KEY VOCABULARY	
Engineering Design Process (EDP)	A step-by-step approach engineers use to solve problems: Identify, Understand, Ideate, Plan, Create, Test, Improve. (Activity 1)
Request for Proposal (RFP)	A document from a client that describes what they need, the criteria a solution must meet, and the constraints designers must work within. (Activity 1)
Criteria	The requirements a solution must meet to be considered successful. (Activity 1)
Constraints	The limits designers must work within — time, budget, materials, size, etc. (Activity 1)
Ideation	The process of generating many possible design ideas before choosing one to develop further. (Activity 2)
Evaluation Matrix	A scoring tool that rates each design concept against specific criteria so teams can make a data-based decision on which concept to develop. (Activity 2)
Prototype	An early physical version of a design used to test whether the design idea works. (Activity 4)
Iteration	Improving a design based on test results. Engineering design is almost always an iterative process. (Activity 4)
Sales Pitch	A short presentation in which a design team presents their solution and tries to persuade a client to choose their design. (Activity 5)

ACTIVITY 1

Introducing the Wing Challenge

TIME
~50 min

Essential Question: What does the client need, and what are the rules of the design problem?

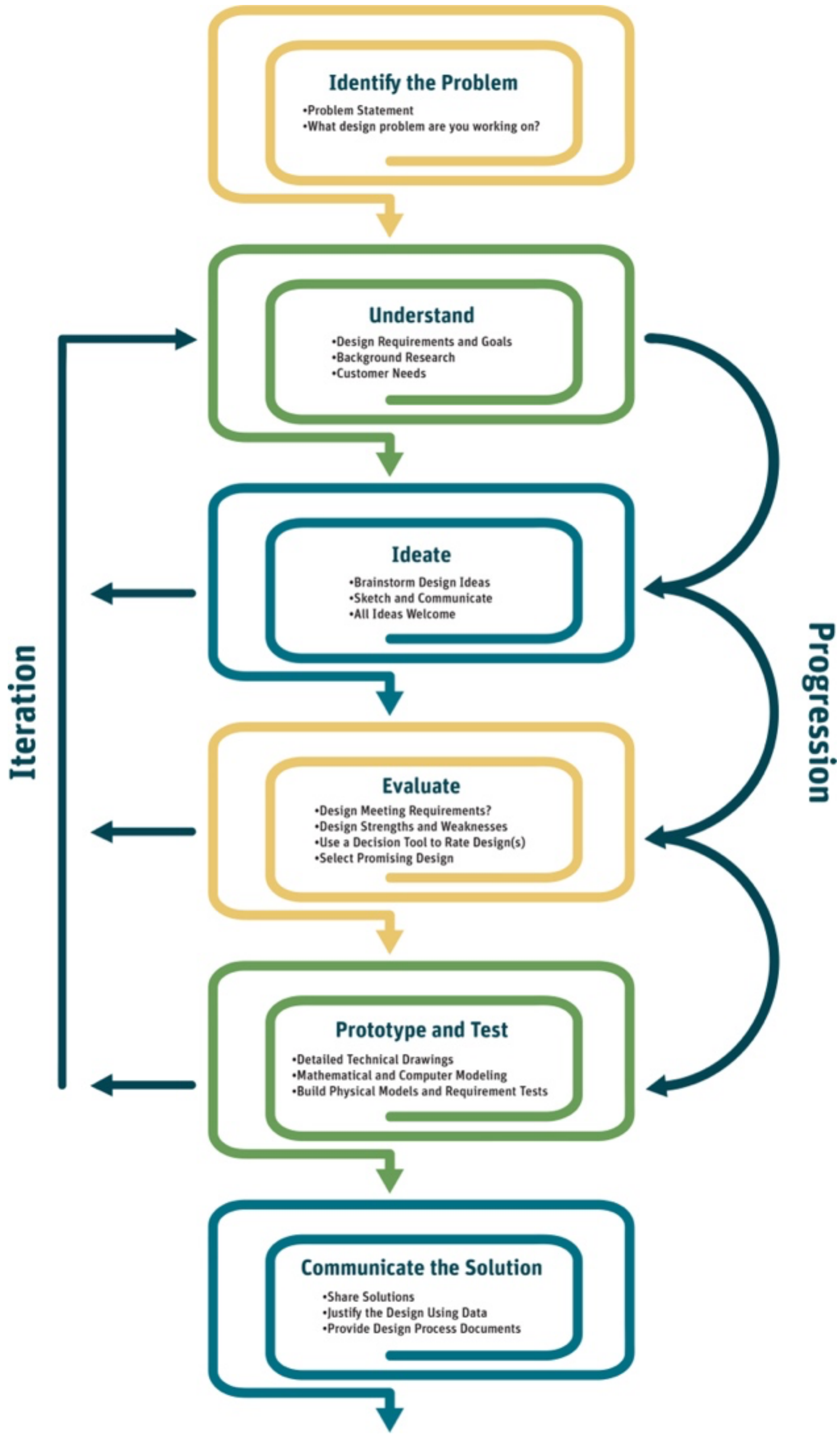
Students receive the Wing Challenge RFP, review the provided baseline flight data, and begin the first two phases of the Engineering Design Process: Identify the problem and Understand the criteria and constraints. By the end of class, every student should be able to state what they are designing, what it must do, and what limits they must respect.

SETUP & MATERIALS

- Wing Design RFP
- EDP: Identify & Understand the Problem Sheet
- Foam glider wing data from the Data Challenge — posted or projected for reference

Part 1 — Review the Engineering Design Process (10 min)

Review the Engineering Design Process. Tell students that in the Design Challenge they will go through all seven phases. In this activity, they are doing phases 1 and 2.


Identify the Problem
•Problem Statement
•What design problem are you working on?
Understand
•Design Requirements and Goals
•Background Research
•Customer Needs
Ideate
•Brainstorm Design Ideas
•Sketch and Communicate
•All Ideas Welcome
Evaluate
•Design Meeting Requirements?
•Design Strengths and Weaknesses
•Use a Decision Tool to Rate Design(s)
•Select Promising Design
Prototype and Test
•Detailed Technical Drawings
•Mathematical and Computer Modeling
•Build Physical Models and Requirement Tests
Communicate the Solution
•Share Solutions
•Justify the Design Using Data
•Provide Design Process Documents
Iteration
Progression

Part 2 — Read and Discuss the RFP (20 min)

Distribute the Wing Design RFP. Give students five minutes to read it independently, then discuss as a class.

Students are given the glider baseline flight data below with the RFP. They did not collect this data themselves — it is provided so the challenge can focus on design, modeling, and fabrication rather than data collection. The goal is to design a new wing that beats the baseline average of 12.108 ft.

Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8	Trial 9	Trial 10
12.5 ft	11.8 ft	12.0 ft	12.3 ft	11.9 ft	12.2 ft	11.5 ft	12.4 ft	12.1 ft	12.4 ft

Baseline Average	**12.108 ft**

DISCUSSION QUESTIONS

- What is the client asking for? Put it in your own words.
- What are the criteria — what must the wing do to be a successful solution?
- What are the constraints — what limits what you can design?
- Looking at the baseline data, what do you notice? Is the baseline average a hard number to beat, or does it seem achievable?

Part 3 — Connect to the Data Challenge (15 min)

Post or project the foam glider wing configuration averages from the Data Challenge. Remind students that they already have data on which wing shapes tended to fly farther when they tested foam gliders earlier in the semester.

Wing Configuration	Average Flight Distance (ft)
Straight Wing	12.07
Elliptical Wing	12.70
Swept-back Wing	14.75
Delta Wing	14.18
Swept-forward Wing with Canard	13.37
Swept-back Wing with Canard	12.18

DISCUSSION QUESTIONS

- Which wing shapes performed best on the foam gliders? Do you think those results will carry over to the glider? Why or why not?
- Are there any wing shapes that didn't appear in the Data Challenge that you'd want to try?
- What other factors besides wing shape might affect how far the glider flies?

Part 4 — EDP Phases 1 and 2: Record What You Know (5 min)

Before class ends, have students complete the Identify and Understand EDP worksheet and add it to their Engineering Notebook. They should be able to write, in their own words: what problem they are solving, what the wing must do, and what limits they must stay within.

TEACHER TIP

- Some students will want to jump straight to designing. Encourage them to slow down — the Ideation phase in Activity 2 is specifically designed for that energy. Today is about understanding the problem.
- Students sometimes find drafting a problem statement difficult. Here is an example statement:

  Example: "A+ Airways needs a new wing design that will make their aircraft glide farther because their current wings are fuel-inefficient."

  If students need support for this task, consider providing a sentence stem for them to complete:

  "A+ Airways needs ________________________ because _______________.

ACTIVITY 2

Ideation and Design Selection

TIME
~50 min

Essential Question: How do we choose the best design idea from many possibilities?

Students generate multiple wing design concepts, evaluate them against the RFP criteria using an Evaluation Matrix, and select one concept to develop into a 3D model and physical prototype. The goal of ideation is quantity first, quality second — students should sketch as many different ideas as they can before they start judging them.

SETUP & MATERIALS

- Wing Ideation Sheet
- Evaluation Matrix Sheet
- Wing Configuration reference
- Goam glider data — posted or projected
- Rulers and pencils for sketching
- Wing Challenge RFP

Part 1 — Ideation: Four Wing Concepts (20 min)

Students work individually to sketch four different wing concepts. Each sketch should show the wing from above (top view / planform), label the wing shape name, and include rough dimensions (length and width). They do not need to be perfect drawings — they need to capture the idea.

TEACHER TIP — RUNNING A GOOD IDEATION SESSION

- Set a timer for 20 minutes and tell students the only rule is that all four boxes must be different designs. No repeats.
- Remind students to use the foam glider data as inspiration — not as a rulebook. They can adapt a swept-back shape, combine features from two configurations, or try something completely new.
- Encourage students to label what they are thinking about for each design — for example: "wider than the original," "more swept," "pointed tip." Labels help them remember their reasoning when they evaluate the designs.

DISCUSSION QUESTIONS (mid-ideation check-in)

- What wing shapes have you come up with so far? Are any of them similar to the foam glider configurations you tested?
- What is one thing about your designs that you think might make the glider fly farther? What is one thing you're not sure about?

Part 2 — Evaluation Matrix (20 min)

Students evaluate their four designs using the Evaluation Matrix. The matrix rates each design against the key criteria from the RFP. Each criterion is scored 1–5 for each design concept.

Evaluation Matrix criteria (from the RFP):

- Fits the fuselage wing slot (yes/no — designs that don't fit are eliminated)
- Likely to improve on baseline distance (based on what they know from the Data Challenge and physics reasoning)
- Feasible to fabricate — can we actually build this from cardstock? (1–5)
- Both wings are symmetric (equal)
- Design confidence — how confident am I that this shape will outperform the baseline? (1–5)

After scoring all four design concepts, students circle the design with the highest total score. If there is a tie, they should write one sentence explaining which they would choose and why.

TEACHER TIPS: Evaluating Wing Designs

- The Evaluation Matrix is a tool for thinking, not a binding verdict. If a student's highest-scoring design is one they have very low confidence in, it is fine to override the matrix and choose the design they believe in — as long as they write a rationale.
- Because students will be focusing on designing a single part, it is recommended that all students ideate and evaluate wing designs. You can decide whether students work individually to select one of their individual designs to model, prototype, and test (in Activities 3-5) or whether students work in collaborative groups on one wing design select from the groups best design concepts.
- If a student has a design that "breaks" the matrix (scores high on everything), check whether they are being honest with themselves about the fabrication difficulty. Very complex wing shapes are hard to cut accurately from cardstock.

Part 3 — Design Selection and Planning Notes (10 min)

Once a design is selected, students record their choice and complete two planning questions:

1. What dimensions will my wing have? (estimated length and width based on the fuselage slot constraints)
2. What 3D shapes will I need to create in TinkerCAD to build this wing? (e.g., box + wedge, box + cylinder, etc.)

These planning notes are the bridge between Activity 2 and Activity 3. Students who arrive at Activity 3 with clear dimensions and a clear modeling plan will move much more quickly.

DISCUSSION QUESTIONS

- What design did you choose and why?
- What data or reasoning from earlier challenges influenced your decision?
- What is one thing you're still uncertain about — that you'll only know once you test it?

ACTIVITY 3

3D Modeling the New Wing

Essential Question: How do we turn a design sketch into a precise 3D digital model?

TIME
~100 min (2 class periods)

Students use the 3D modeling skills they built in the Visualization Challenge to model their selected wing design in TinkerCAD (or chosen software). Unlike the Visualization Challenge — where they were modeling an existing object from measurements — here they are modeling a design they created. The dimensions come from their own plans, not from a physical object they can measure. This shift is worth naming for students.

SETUP & MATERIALS

- Laptops with TinkerCAD (or chosen software) open and accounts logged in
- Completed Wing Ideation Sheet with design sketches, dimensions, and planning notes.
- Fuselage wing slot dimensions — posted or projected (from the RFP) so students can verify their wing will fit

TEACHER TIP — CONNECT TO THE VISUALIZATION CHALLENGE

- Remind students at the start of this activity: you have done this before. In the Visualization Challenge, you modeled the vertical stabilizer, horizontal stabilizer, wings, and fuselage of the glider. This time, you are modeling one new wing. It should be the most straightforward modeling task yet — one part, your own dimensions.
- Students who struggled with TinkerCAD in the Visualization Challenge may need a quick refresher on the basics (adding shapes, setting dimensions, using holes to cut shapes).

Part 1 — Build the Wing Model (~80 min)

Students build their wing in the software using their design sketch and planning notes as their guide. The wing should be modeled as it will be fabricated — at the actual dimensions of the physical prototype, not scaled up or down.

Key modeling steps:

1. Start with the basic planform shape (the wing's outline from above).
2. Set the wing's length, maximum width, and thickness from the planning notes.
3. Add any tapering, sweep angle, or curved edges using the subtraction or wedge techniques from the Visualization Challenge.
4. Model only one wing panel — the second is a mirror image.
5. Use the "mirror" or "duplicate and flip" function to create the second wing.
6. Check that the combined wingspan and root width are compatible with the fuselage slot dimensions from the RFP.

TEACHER TIP – WING MODELING

- Students occasionally design a wing in Activity 2 that turns out to be very hard to model in 3D. If a student is spending more than 30 minutes stuck on a complex shape, help them simplify. A slightly simpler wing that gets built is better than a perfect design that never gets modeled.

DISCUSSION QUESTIONS

- How does your 3D model compare to your original sketch? Did you have to change anything to make it work in the software?
- Looking at your model now, is there anything about the wing shape that makes you more or less confident about how it will fly?

Part 2 — Review and Export (last ~20 min)

Before moving to fabrication, students do a quick review of their model:

1. Does the wing look like the design sketch?
2. Do the dimensions match the planning notes?
3. Will the wing root fit the fuselage slot? (Check against the RFP slot dimensions.)
4. Is the model saved and named clearly (e.g., "[Name] Wing V1")?

Have students export or screenshot their model. These images become part of the Sales Pitch in Activity 6.

ACTIVITY 4

Fabrication and Testing

Essential Question: Does our design actually work when we build it and fly it?

TIME
~150 min (3 class periods)

Students fabricate a physical wing prototype from cardstock, attach it to the glider fuselage, and conduct 10 flight trials to collect performance data. This is the "Prototype" and "Test" phase of the EDP. It is often the most exciting part of the challenge — and the most humbling, because designs that looked great on screen sometimes don't fly as expected.

SETUP & MATERIALS

- Cardstock
- Scissors
- Rulers and pencils — for tracing the wing shape onto the material
- Sandpaper (fine grit) — for smoothing cardstock edges (optional but recommended)
- Cardstock glider fuselages
- Measuring tape
- Flight Data Recording Sheet
- Tape or a marked line on the floor to indicate the throw line

Part 1 — Wing Fabrication (~50 min)

Students translate their wing design from the 3D model into a physical prototype. The process:

1. Draw the wing shape onto the cardstock using the actual dimensions from the planning notes and 3D model.
2. Carefully cut along the traced lines using scissors.
3. Sand any rough edges on cardstock wings to reduce drag (optional).
4. Fit the wing into the fuselage wing slot to confirm it fits before any final trimming.

TEACHER TIP – MEASURE TWICE CUT ONCE

- Cutting accuracy matters. Students who rush the cutting phase end up with a wing that is asymmetrical or slightly off the planned dimensions. Encourage them to measure twice before cutting.
- If a wing doesn't fit the fuselage slot, students should trim rather than start over. A small trim is faster and teaches them something real about the relationship between design precision and fabrication.
- Some students will have designed a wing that is technically too wide or too narrow for the slot. Have them reference the RFP slot dimensions and adjust the wing dimensions before cutting if needed.

Part 2 — Test Protocol and Practice Throws (~20 min)

Before collecting official data, establish the throw protocol with the class. Consistency in how the glider is thrown matters as much as the wing design — inconsistent throws produce noisy data that is hard to interpret.

Example Throw protocol:

1. The thrower stands behind the tape/throw line.
2. The glider is held at the fuselage — not by the wings.
3. The throw is a smooth, level release at chest height (not an overhand throw or an upward arc).
4. Distance is measured from the throw line to where the nose of the glider lands.
5. If the glider lands on its side, the trial still counts — measure where the nose lands.

Allow 3–5 practice throws so students can get comfortable with the protocol before official trials begin. Practice throws are not recorded.

TEACHER TIP

- If students are testing in groups, designate one student as the consistent thrower for all 10 trials. If multiple students throw, natural variation in throw strength introduces a variable that has nothing to do with wing design. One thrower per group keeps the test fair.
- If the hallway or gym is available, use it — a longer space lets gliders with good designs fly freely rather than hitting a wall. If class is in a standard classroom, push desks to the sides.

Part 3 — 10 Official Trials (~30 min)

Students conduct 10 official flight trials, recording the distance of each throw in feet (to one decimal place) on the Flight Data Recording Sheet. One student throws; another measures; a third records. Students rotate roles between trials.

TEACHER TIP

- Walk around during testing and watch for protocol violations — throws that are clearly angled up, released from the wrong height, or released from in front of the line. These produce outlier data. If you see one, have students redo that trial.
- If a prototype breaks during testing (a wing cracks or falls off), students should repair it with tape and continue testing. Students should note on the recording sheet which trials, if any, were with the repaired wing.
- Students who finish all 10 trials early can run a second set and average all 20 — this produces more reliable data and gives them more to discuss in Activity 5.

DISCUSSION QUESTIONS

- Looking at your 10 trial distances, what do you notice? Is there a lot of variation, or are the distances consistent?
- Did any throws produce results that seemed like outliers — much farther or much shorter than the others? What might have caused those?

Part 3 — Calculate Average Flight Distance (10 min)

Students add their 10 trial distances and divide by 10 to calculate their average. They record this on the Flight Data Recording Sheet. Then they calculate how their average compares to the baseline:

1. Average flight distance = sum of 10 trials ÷ 10
2. Difference from baseline = student average − 12.1 ft (positive means beat the baseline; negative means below it)
3. Percent change = (difference from baseline ÷ 12.1) × 100%

TEACHER TIPS

- Many students will be nervous about whether they beat the baseline. Prepare them before they calculate: the goal was to design a wing that flies farther, but not beating the baseline is also a valid result — as long as they can explain why and what they would change. Engineering is iterative.
- Some teams will have one or two outlier trials that significantly pull their average up or down. If a student asks about this, it is a great moment to discuss outliers and how scientists sometimes report data with and without outliers — but for this challenge, they should use all 10 trials in their average.

DISCUSSION QUESTIONS

- Who beat the baseline? By how much? What do you think made the difference?
- Who didn't beat the baseline? What do you think happened, and what would you change?
- Did anyone's results surprise them — in either direction?

ACTIVITY 5

The Final Sales Pitch

Essential Question: How do we present our work in a way that persuades a client to choose us?

TIME
~150 min (3 class periods)

The Final Sales Pitch is the capstone of the entire Flight of Fancy unit. Students present their work as aerospace engineering firms pitching to a client. Pitches bring together work from the Systems Challenge (the interior seat model) and the Design Challenge (new wing design). Students have two class periods to prepare and one class period to present.

SETUP & MATERIALS

- Pitch Planning Sheet
- 3D model screenshots from Activity 3
- Interior design / seat model work from the Systems Challenge
- Profit and cost analysis from the Systems Challenge
- Wing Evaluation Matrix from Activity 2
- Physical wing prototype from Activity 4
- Projector and laptop for presentations
- Final Pitch Rubric

TEACHER TIP — SETTING UP JUDGES

- The Sales Pitch works best when there is a panel of "judges" that students present to. Options: invite another teacher, an administrator, or a parent or community member. If no external judges are available, the teacher can serve as the panel, or students can use a structured peer evaluation form.
- Give judges the RFP criteria before the presentations so they know what to look for. Judges should evaluate: (1) Did the team beat the baseline and explain why? (2) Did the pitch connect work from all four challenges? (3) Was the presentation clear and persuasive?

Part 1 — Preparing the Pitch (Days 8–9, ~100 min)

Students use the Sales Pitch Planning Sheet to organize their presentation. Use Day 8 to draft content for each pitch component, and Day 9 to rehearse, refine, and finalize visuals or materials. The pitch must include all of the following components:

Pitch Component	What to Include
Company Introduction	Name(s), company name, and a one-sentence description of what your company does.
The Problem	What the client needs and what the baseline data shows.
Your Wing Design	Show the design sketch, the 3D model screenshot, and the physical prototype. Explain what wing shape you chose and why — cite the foam glider data from the Data Challenge.
Your Flight Data	Show the 10 trial results, the average, and whether you beat the baseline. Use a table or simple chart. Explain what you think caused the results.
The Airplane Interior	Reference the seat configuration and interior design from the Systems Challenge. Remind the judges how many passengers the airplane can carry and what the interior layout looks like.
Profit Projection	Reference the cost and revenue analysis from the Systems Challenge. What does a ticket cost? How much profit does the airline make per flight?
Why Choose Us	A one-minute closing argument: why should the client choose your team's design? Connect the performance data, the business case, and the design quality.

TEACHER TIP — PITCH PREPARATION

- Students do not need to make a formal slide deck if the logistics are difficult. A printed poster with sections, or even a well-organized table display of their materials, works fine as a pitch format.
- If students do make slides, limit them to one or two slides per pitch component. Students often spend too much time making slides look nice and not enough time practicing what they are going to say.
- Circulate during prep time and listen to students rehearse. The two most common problems: (1) students just show the data without explaining it, and (2) students spend too much time on one component and run out of time before reaching the closing argument.

Part 2 — Presentations (Day 10, ~50 min)

- Students present their pitches. Depending on class size, allow 5-7 minutes for group presentations plus 2–3 minutes for judge questions. Use the remaining time for a class debrief.
- If class size or time doesn't allow for all students to present to the class or if students completed the challenge individually, presentations can be done in a poster session or round table format where pitches are delivered to a subset of classmates.

TEACHER TIP — MANAGING PRESENTATIONS

- Keep time strictly. Warn teams when they have 1 minute remaining so they can wrap up. This is a real-world skill — engineers presenting to clients almost always have a time limit.

Part 3 — Class Debrief and Reflection (last 10–15 min of Day 10)

Close the Flight of Fancy unit with a whole-class debrief. Acknowledge that the students have just completed a real engineering challenge — data collection, systems analysis, 3D modeling, design, fabrication, testing, and presenting.

DISCUSSION QUESTIONS

- Looking back over the whole module, what was the most surprising thing you learned — about flight, about engineering, or about yourself?
- How might the skills you built in this unit — data analysis, systems thinking, 3D modeling, design — show up in work you do after school?

TEACHER TIP — CELEBRATING THE WORK

- Students have done a lot. Take a moment at the end of the unit to name that — acknowledge what they built, what they tested, and what they presented. A brief public recognition of the work (even just naming it clearly) matters.
- Consider displaying student 3D models and pitch materials in the hallway or classroom.

Companion Handouts

Handout 1. Wing Design RFP

A+ Airways Wing Design RFP

A+ Airways is requesting proposals for the wing design of our next-generation passenger aircraft. Our current fleet not fuel-inefficient, does not meet federal air quality regulations, and requires costly maintenance. We have already selected a manufacturer for the aircraft body, but we need engineering teams to design the best possible wing.

The wing design must maximize fuel efficiency and glide performance. In an emergency where engines are shut off, the aircraft must be able to glide as far as possible to ensure passenger safety.

Design Requirements:

Your wing design MUST meet the following requirements:

1. **Glide Distance:** The balsa glider prototype with your new wing must glide farther than the standard baseline glider (class average: 12.1 feet).
2. **Wing Shape:** The wing must use one of the six approved planform shapes: straight, elliptical, swept-back, delta, swept-forward, or tapered.
3. **Symmetry:** Both wings must be identical in shape and size (symmetric lift on both sides).
4. **Attachment:** The wings must fit in the slot in the fuselage. The slot is 52mm wide and 1mm tall (52mm x 1mm).
5. **Evidence:** Your proposal must include glide-distance test data proving your design outperforms the baseline.

Design Constraints:

Your wing design must work within the following constraints:

A. **Materials:** Wings must be cut from the provided cardstock only.

B. **Fuselage:** You may NOT modify the fuselage body provided.

C. **Weight:** Additional weight (ballast) may only be added to the nose of the fuselage, not to the wings.

D. **Wingspan:** Maximum total wingspan (tip to tip) is 30 cm.

E. **Time:** You have four class periods to build and test your prototype before the Sales Pitch.

Baseline Data: Current Wing Performance

To beat the current design, you need to know how far it flies. The table below shows the baseline performance of the standard straight-wing glider.

Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8	Trial 9	Trial 10
12.5 ft	11.8 ft	12.0 ft	12.3 ft	11.9 ft	12.2 ft	11.5 ft	12.4 ft	12.1 ft	12.4 ft

Baseline Average	**12.1 ft**

What A+ Airways Expects in Your Proposal

Your final proposal (Sales Pitch) must include:

1. Your chosen wing design and why you selected it
3. A 3D model of your wing (created in TinkerCAD)
4. Test results from your prototype (average glide distance)
5. A comparison showing how your design performs compared to the 12.1-foot baseline

1. What is A+ Airways asking you to design?

2. What is the most important requirement? Why?

3. What does your design need to beat? Write the target distance:

4. What are two constraints (limits) that will affect your design?

Handout 2. EDP: Identify and Understand the Problem

Name: Date: Period:

Engineers follow a process to solve problems. The first step is to clearly understand who you are designing for, what problem you are solving, and what already exists. This sheet guides you through identifying the problem before you start designing your new wing.

Step 1: Know Your Customer

Who is your client (customer)?

What does your client need? Use evidence from the Wing Design RFP.

Step 2: Define the Problem

Write a clear problem statement. A good problem statement answers: WHO needs WHAT and WHY?

Step 3: Prior Research — Wing Configurations

Use your class data and the Wing Configurations Reference sheet to answer the questions below.

1. **Which wing configuration had the best average glide distance in the Data Challenge?**

2. **Which wing configuration had the worst average glide distance? Why do you think that is?**

3. **Based on the class data AND what you know about aerodynamics, which wing shape are you considering for your design? Explain your thinking.**

Handout 3: Wing Ideation Sheet

Name: Date: Period:

Brainstorming Your Wing Design

Before you pick your final design, brainstorm at least FOUR different wing ideas. Sketch each one, name it, describe how it is shaped, and explain why you think it would glide well.

Remember: there are no bad ideas in brainstorming! Try different shapes, sizes, and combinations.

Design Idea 1:

Wing Sketch *(top-down view)*	**Design Name:** **Wing Shape:** **Why might this wing shape glide well?**

Design Idea 2:

Wing Sketch *(top-down view)*	**Design Name:** **Wing Shape:** **Why might this wing shape glide well?**

Design Idea 3:

Wing Sketch *(top-down view)*	**Design Name:** **Wing Shape:** **Why might this wing shape glide well?**

Design Idea 4:

Wing Sketch *(top-down view)*	**Design Name:** **Wing Shape:** **Why might this wing shape glide well?**

Handout 4: Wing Evaluation Matrix

Name: Date: Period:

How to Use This Matrix

An evaluation matrix helps engineers compare their design ideas fairly using the same criteria for each design. Write your design names in the columns below, then rate each design idea from 1–5 on each requirement (1 = does not meet requirement, 5 = fully meets requirement). Add up the scores to see which design rates highest overall. Note: A high score does NOT guarantee a good design — use this as one tool, not the final answer.

Wing Design Evaluation Matrix				
Requirement	**Design 1** *(name: ________)*	**Design 2** *(name: ________)*	**Design 3** *(name: ________)*	**Design 4** *(name: ________)*
Fits the fuselage wing slot (yes/no — designs that don't fit are eliminated)				
Likely to improve on baseline distance (based on what they know from the Data Challenge and physics reasoning)				
Feasible to fabricate — can we actually build this from cardstock? (1–5)				
Both wings are symmetric (equal)				
Design confidence — how confident am I that this shape will outperform the baseline? (1–5)				
TOTAL SCORE				

1. **Which design scored highest? Does your team agree this is the best choice? Why or why not?**

2. **Are there any requirements that were hard to rate? Why?**

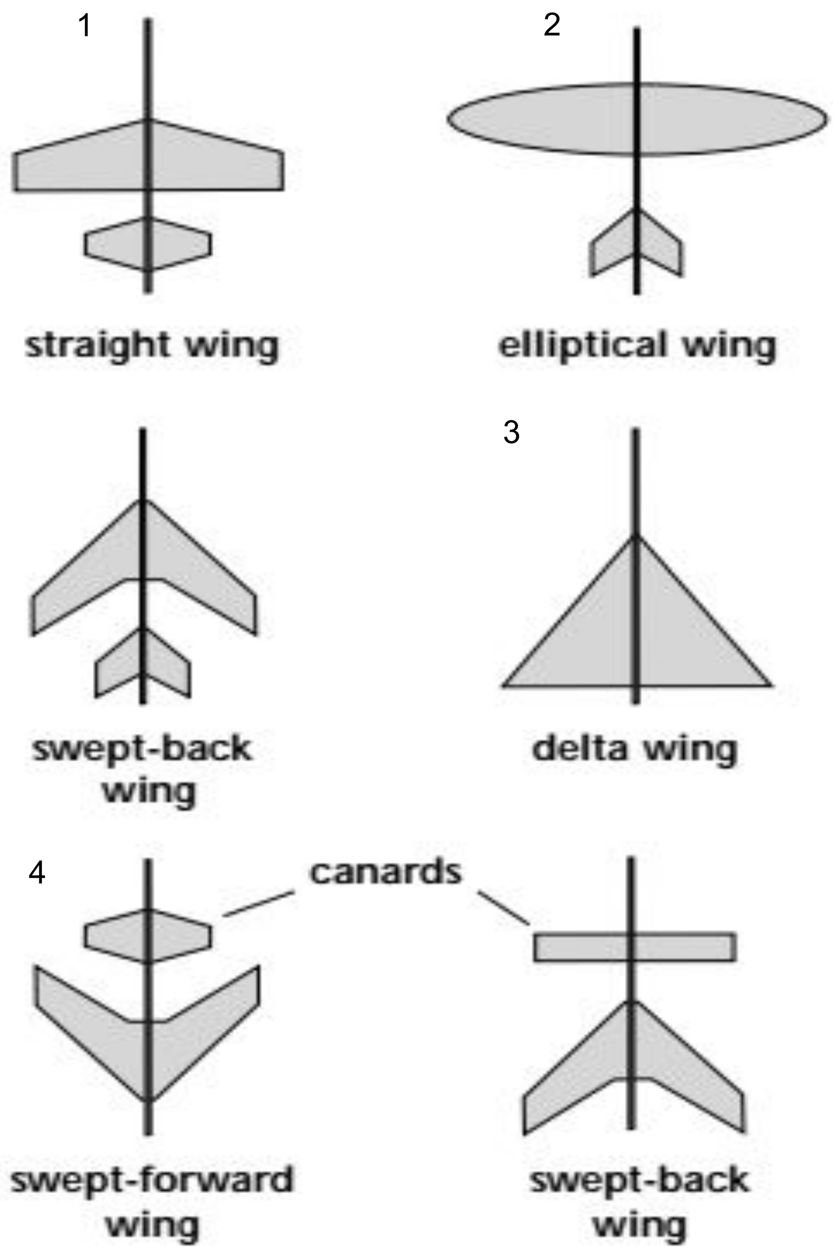
3. **Which design will your team build? (It does not have to be the highest score — explain your reasoning.)**

Handout 5. Wing Configuration Reference

Wing Configuration Reference

About Wing Planforms

A 'planform' is the shape of the wing when seen from above (bird's-eye view). Different planform shapes affect how much lift the wing creates and how much drag it produces. Engineers choose wing shapes based on the aircraft's purpose — speed, fuel efficiency, stability, or maneuverability.



Six Wing Configurations — Reference Guide

1. **Straight**: Extends straight out from the fuselage at a right angle. Simple to build. Good lift at slow speeds. Used on small propeller planes and gliders.	2. **Elliptical:** Curved, oval shape. Excellent aerodynamic efficiency — produces the most lift with the least drag. Difficult to manufacture. Used on WWII Spitfire fighter.

3. **Swept-Back:** Wings angle backward toward the tail. Reduces drag at high speeds. Most common on commercial jets. Less effective at slow speeds.	4. **Delta:** Large triangular shape. Very stable at high speeds and in thin air. Used on supersonic aircraft. Less efficient for slow, fuel-saving flight.

5. **Swept-Forward:** Wings angle forward toward the nose. Increases lift at low speeds; unstable at high speeds. Rare — mainly experimental aircraft	6. **Tapered:** Wider at the root (fuselage) and narrower at the tip. Good balance of lift and efficiency. Common on modern gliders and regional aircraft.

Handout 6. Flight Data Recording Sheet

Flight Data Recording Sheet

Name: Date: Period:

Testing Your Wing Design

Now it's time to test your new wing design! You will fly the glider with your protoype wing 10 times and record the distance of each flight. Use the same launch technique every time. After 10 trials, calculate the average to see if your design beats the baseline of 12.1 feet.

Wing Configuration:

Wingspan (cm):

Flight Test Data

Trial	Distance (feet)	Observations / Notes
Trial 1		
Trial 2		
Trial 3		
Trial 4		
Trial 5		
Trial 6		
Trial 7		
Trial 8		
Trial 9		
Trial 10		
AVERAGE	*Add all distances ÷ 10 = _________ ft*	

Results: Did your prototype outperform the baseline?

	Distance (feet)
Baseline (straight wing class average)	12.1 ft

Your prototype average	
Difference (+/−)	

1. **Did your design beat the baseline? By how much?**

2. **Was your result what you expected based on the Data Challenge? Explain.**

3. **If you could change one thing about your design to improve it, what would you change?**

Handout 7. Pitch Planning sheet

Pitch Planning Sheet

Name: Date: Period:

Your Pitch to A+ Airways

You will present a pitch to A+ Airways. You need to convince them that your wing design is the best choice. A strong pitch is organized, evidence-based, and persuasive. Use this sheet to plan what you will say for each section.

Pitch Component	What to Include	What Will you Say?
Company Introduction	Team name, company name, and a one-sentence description of what your company does.	
The Problem	What the client needs and what the baseline data shows: *Explain the problem A+ Airways is facing in your own words. Why does this matter?*	
Your Wing Design	Show the design sketch, the 3D model screenshot, and the physical prototype. Explain what wing shape you chose and why. *What makes your design unique?*	
Your Flight Data	Show the 10 trial results, the average, and whether you beat the baseline. Explain what you think caused the results. *What was your average glide distance? How does it compare to the 12.1-foot baseline?*	
The Airplane Interior	Reference the seat configuration and interior design from the Systems Challenge. Remind the judges how many passengers the airplane can carry and what the interior layout looks like.	
Profit Projection	Reference the cost and revenue analysis from the Systems Challenge. What does a ticket cost? How much profit does the airline make per flight?	
Why Choose Us	A one-minute closing argument: *Why should A+ Airways choose YOUR design over the others?* Connect the performance data, the business case, and the design quality.	

Presentation Checklist

Before your pitch, make sure you can check off each item:

- ☐ Clear explanation of the client's problem
- ☐ Description of wing design and show the TinkerCAD 3D model
- ☐ Prototype test results (average glide distance) ready
- ☐ Clear recommendation and reasons A+ Airways should choose us

If you are presenting as a group, who will present each section? Write team member names next to their role:

Handout 8. Final Pitch Rubric

Final Pitch Rubric

Name / Group: Class Period: Date:

Category	1 — Beginning	2 — Developing	3 — Proficient	4 — Exemplary	Score
Problem Statement	Does not explain A+ Airways' problem or it is very unclear.	Mentions the client's problem but lacks detail or accuracy.	Clearly explains the client's problem with reference to the RFP.	Explains the problem with precise RFP evidence, audience engagement, and clear context.	
Design Description	Wing design is not described or is unrecognizable.	Wing design is named but description is vague or missing key details.	Clearly describes the wing configuration, shape, and key features with 3D model shown.	Description is detailed and precise; 3D model is integrated smoothly into the explanation.	
3D Model (TinkerCAD)	No 3D model presented.	3D model is shown but does not resemble the wing design or is incomplete.	3D model is complete and clearly represents the wing design.	3D model is accurate, well-proportioned, and team can explain each part of the model.	
Test Data	No prototype test data is presented.	Some test data is presented but average is missing or incorrect.	Presents average glide distance and compares it to the 12.1-foot baseline.	Presents organized trial data, calculated average, clear baseline comparison, and explains what the numbers mean.	
Baseline Comparison	No comparison to baseline is made.	Mentions the baseline but comparison is unclear or inaccurate.	Clearly states how their design compares to the 12.1 ft baseline (better/worse by how much).	Explains the comparison with specific numbers, percentage improvement, and links it back to the RFP requirement.	
Recommendation & Persuasion	No clear recommendation is made.	Makes a recommendation but without evidence or reasoning.	Makes a clear recommendation backed by data and logical reasoning.	Makes a compelling, confident recommendation using multiple forms of evidence and directly addresses why their design is the best choice.	
Organization & Clarity	Presentation is difficult to follow; no clear structure.	Some organization is present but transitions are unclear or sections are missing.	Presentation is organized with a clear beginning, middle, and end; easy to follow.	Presentation flows seamlessly; all components are clearly connected; transitions are smooth and professional.	
TOTAL SCORE (out of 28 points):					

Feedback

Strengths:

Areas for Growth:

Additional Comments:

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