Family edition

Flight Lab: Design, Test, Improve

Ages 11-14 · about 45 minutes, in one sitting

Your child writes the test, change, test again loop as a rule a paper plane simulator runs, improves it, then folds the plane from a printed plan and throws it for real.

What you need

- A computer or Chromebook with a current browser, and a mouse or trackpad.
- The lesson link: mytekdev.com/try/flightlab?lesson=design-test-improve&ref=fam-flightlab-4. No account, no email and nothing to install.

Before you start: try it once yourself

Open mytekdev.com/try/flightlab?lesson=design-test-improve&ref=fam-flightlab-4. A short guide opens over the app. It is the classic dart with its back edges flat, How hard 3, in the gym, standing.

1. **The rule.** Press `Fly` and scroll to Your trim rule. It reads: when it dives, bend the back edges up 2; when it climbs then dives, bend the back edges down 2; when it glides, stop.
2. **Try it.** Press `Try my rule`: a numbered list. It dove 14 ft, the rule bent the back edges up 2, it glided 16 ft, and the rule said stop. `Keep this trim` keeps the bend it found.
3. **Change it.** Change up 2 to up 8 and try again: it stops at a glide of 24 ft. Up 4 stops at 19 ft, up 6 at 22 ft, up 12 at 24 ft, up 16 at 21 ft.
4. **The plan.** Press `Export`. Under A plan to fold, press `Lines only, to save ink`. The first page is the sheet at full size with every crease numbered in the order to fold it; the last box says how far to bend the back edges and what flight Flight Lab expects from a gentle throw.

> The moment that lands is the first run: the rule stops at 16 ft, and a bend of 8 glides 24. They have to work out what the rule cannot see.

The ideas, in plain words

Engineers improve a design by changing one thing at a time, testing it, and keeping what worked. A trim rule is that loop written down: after each throw, the first line that fits what the plane did makes its change, and the app throws again, up to ten times. It is a simple feedback controller, like a thermostat.

The rule sees only the kind of flight, never the distance, so it stops at the first glide. Small steps stop early, at a short glide; big steps can jump past the best bend. A rule with no stop never settles: ten throws and it is still changing. Folding the plan builds a prototype, and comparing the real throw with the model is how engineers check a model.

Common mistakes: the rule knows the best answer; the model must be wrong when the real plane lands somewhere else; changing several things before the next throw. Flight Lab works out each flight from the folded shape and the throw. A few of its numbers are our own, set where no published measurement exists, so a real paper dart lands near the distances on screen, not exactly at them. Real throws also vary more than the app's, real paper softens with use, and the app never shows a stall: its short paper wings tip over before they would stall.

Do it together

1. Before you start, open mytekdev.com/try/flightlab?lesson=design-test-improve&ref=fam-flightlab-4, press `Export`, and under A plan to fold press `Lines only, to save ink`. Print the first page at 100%, not fit to page.

   > **If you get stuck:** If the printed sheet is smaller than the paper, the printer was set to fit the page.
   >
   > **You'll know it worked when:** A full-size sheet with every fold numbered.

2. Press `Fly`, scroll to Your trim rule, and press `Try my rule`.

   > **You'll know it worked when:** It dove 14 ft, the rule bent the back edges up 2, it glided 16 ft, and the rule said stop.

3. In the rule's first line, change up 2 to up 8 and press `Try my rule` again.

   > **You'll know it worked when:** This time it stops at a glide of 24 ft.

4. Fold the printed plan, bend the back edges as it says, and throw it along a clear line three times. Ask: did it fly the way the plan said?

   > **If you get stuck:** Fold slowly and press each crease flat before the next.
   >
   > **You'll know it worked when:** The throws land near the plan's distance, and differ from each other.

Talk about it

Ask these while you work together. A child who has understood it can answer them without help:

- What did the rule do after the first throw, and why?
- Why did the rule stop at 16 ft when 24 is possible?
- What would the rule need to know to find the best bend?
- Did your real plane fly the way the plan said?
- Name two things that are different about real paper and a real throw.

> The third question is the real test: a child who says the rule needs to know how far each throw went has seen what a model can and cannot decide.

For younger and older kids

Younger: For a younger child, run the rule together and spend the time on folding and throwing.

Older: For a teenager, write a rule that keeps going after a glide, and explain why it never settles.

Keep going

- Set How hard to 5 with the dart as it came, and press Try my rule. How does the rule handle a plane that climbs, then dives?
- Change the rule so it keeps going after a glide. What happens after ten throws, and why does a rule need to know when to stop?
- Pick a contest on the Fly bench and improve a plane for it, one change at a time, with a written record of every throw.

Bring it into other subjects

- Computer science: rewrite the trim rule as a flowchart, with a loop and a stop.
- Math: find the average of your three real throws, and how far it is from the plan's distance.
- Building: fold the plan again with the back edges bent a little more, then a little less. Does the real plane glide farther or shorter, as the app says it should?
- English: write a short report: what you tested, what you changed, and what you would try next.

For your records

Ready to copy into an hour log, a portfolio or a transcript.

LESSON	Flight Lab: Design, Test, Improve
SUBJECTS	Physical science, Engineering
TIME	45 minutes
WHAT WE DID	Wrote and improved a rule that trims a paper plane in a simulator, folded the plane from a plan, and compared the model with a real flight.
SKILLS PRACTICED	Engineering design; Models and prototypes; Writing rules

Activity sheet (optional)

Name: _____ Date: _____

Open the app: scan the QR code, or go to mytekdev.com/try/flightlab?lesson=design-test-improve

Essential question: How do engineers improve a design, and can a rule do some of the testing?

Warm-up: Your paper plane dives. Write the steps you would follow, over and over, until it flies well.

_____

1. **Vocabulary.** Iterate, rule, model, trim, prototype: write each in your own words.

2. **The rule log.** For each run: the rule bends up _____ each time; it stopped at back edges _____; its last glide _____ ft.

3. **The real flight.** The plan's last box says _____. My throws: _____ ft, _____ ft, _____ ft.

1. Why did the rule stop at a short glide? What would it need to know to find the best one?

2. How was your real plane different from the model, and why?

Quick check

Name: _____

1. The trim rule says "when it glides, stop". Why might it stop before the best trim? (A) It only knows what kind of flight it was, not how far (B) It ran out of paper (C) It always finds the best

2. Engineers improve a design by (A) changing everything at once (B) changing one thing, testing, and keeping what worked (C) testing once

3. Your real plane flew a different distance from the one the model said. Give two reasons why.

Answers

QUESTION	ANSWER	WHY
1	A	The rule sees only glide, dive or climb then dive, so the first glide stops it, short or long.
2	B	One change at a time shows what each change did.
3	Two real differences	Any two: real throws are never exactly the same speed or angle; real folds are not perfectly straight or even; real paper bends and softens; the air in a room moves; the model sets some numbers by our own tests. "The app is wrong" alone is half.

If your state or umbrella school asks, this lesson covers NGSS MS-ETS1-4, NGSS MS-ETS1-3.

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The app this lesson uses is free and runs in the browser, with nothing to install and no account needed. It is at mytekdev.com.

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