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Air Traffic Control Lab: A Second Runway, Testing a Design

Grades 9-12 · 45 minutes

Engineering · Computer science



Slides, rubric and answer key | Print and go | No student accounts | Chromebook friendly

What's included

- A one-page overview: objectives, essential question, vocabulary, standards and assessment
- A 45-minute lesson sequence: warm-up, direct instruction, guided practice, independent practice, closure
- Slides for the board: a PowerPoint file that also opens in Google Slides
- A student worksheet with a QR code and a table for six runs
- A 3-question exit ticket, two to a page, with an answer key
- A rubric: 3 criteria, 4 levels, scored out of 12
- Differentiation for English learners, students with IEPs or 504 plans, and students who need more support or more challenge
- Cross-curricular extensions, and notes for teaching it in middle school and in an engineering course
- Standards: NGSS and CSTA 2017

Air Traffic Control Lab: A Second Runway, Testing a Design

Grades 9-12 · 45 minutes · Engineering, Computer science

Air Traffic Control Lab's Build your traffic runs a busy schedule: 14 arrivals 2.5 minutes apart and 12 departures. A program lands and launches it all, and it sends each departure only when the next arrival is more than 4.5 miles out. On one runway the departures wait 10.1 minutes on average. Students add a second runway, for departures only, and run the same schedule again: the departures still wait 10.1 minutes. The new runway changed nothing, because the program still waits for the arrivals. Students find the condition in the Python, take it out for the second runway, and the wait drops to 0.3 minutes. Then they test both designs on lighter schedules and decide when a second runway is worth building.

At a glance

ESSENTIAL QUESTION

Does a better design help if the rules stay the same?

OBJECTIVES

Students will be able to:

- run a design and its alternative on the same test case
- measure a result and compare it fairly
- explain why a change to the design did not change the result
- find and change the condition in an event-driven program
- decide when a change is worth its cost, from data

VOCABULARY

Departure, Parallel runway, Throughput, Delay, Test case, Event handler

STANDARDS

HS-ETS1-4, 3A-AP-16

TIME AND MATERIALS

45 minutes, grades 9-12.

- One computer or Chromebook per student
- A projector
- The worksheet and exit ticket, one copy each per student
- The rubric, one copy per student if you grade the work

PREP

Make copies of the worksheet and exit ticket. Before class, open mytekdev.com/try/airtrafficlab?lesson=a-second-runway-testing-a-design&ref=tpt-airtrafficlab-4 once on a student computer, which checks that your school's filter allows the app, and follow the short guide yourself: about ten minutes. Each run takes about 3 to 4 minutes at 16 times faster.

ASSESSMENT

- Formative: the questions under What to look for, asked while students work, and the exit ticket (answer key included).
- Summative: the worksheet, scored with the rubric.

TECHNOLOGY AND PRIVACY

Runs in any browser, Chromebooks included, with nothing to install. Students need no account and no email: the link works signed out, and nothing they do is stored on our server unless they choose to save.

Lesson sequence

MINUTES	STAGE	WHAT YOU DO	WHAT STUDENTS DO
0 to 5	**Warm-up** Hook	Show the title, essential question and Today I can slides (about 1 minute). Then the warm-up: the second cafeteria door.	Answer the warm-up on the worksheet.
5 to 12	**Direct instruction (I do)** Model it	Project the starter. The tower view is on the left: the airport from the control tower, the airliners with their landing lights on and a tag with each call sign. The radar is on the right: the runway at the top, the dashed final approach line, and a green dot for each airplane with its data block (call sign, altitude in hundreds of feet, speed in tens of knots). Under the radar the radio log keeps every word said, marked "you" or "program". Click an airplane on the radar to give it an instruction. Open the Python tab and read the program aloud: slow each arrival at check-in, keep its place, clear it at 5 miles, and send a departure when the next arrival is over 4.5 miles out. Show the test case slide. Press play and Speed up to 16 times; while it runs, point at the departures waiting at the runway's end. **It's working when:** Ask why the program checks the next arrival before sending a departure. A departure needs the runway for about a minute; an arrival close in would find it busy.	Watch, and fill in the vocabulary on the worksheet.
12 to 22	**Guided practice (We do)** Add a runway	Students open the link or scan the QR code. A short guide runs the schedule on one runway, then has them add the second runway in Build your traffic and run it again. Students write both waits. They are the same, 10.1 minutes. Ask why before anyone touches the program. **Watch for:** Students who think the app is broken. The departures do roll on the new runway; they still wait for the arrivals, because the rule says so.	Follow the guide. Write both waits, and an explanation.
22 to 38	**Independent practice (You do)** Change the rule, test the designs	Students take the if out of ready for the two-runway design, so a departure goes as soon as it is ready, and run it: 0.3 minutes. Then they test one runway without the if (a conflict: unsafe), and both designs at 3 and at 4 minutes apart, in Build your traffic. Time runs at 4 times by default. Speed up and Slower, under the tower view, change it; the round play button starts the shift again from the beginning, with the program as it is now. Walk the room with the What to look for questions. **If they ask:** "What stayed the same between your runs, and why does that matter?" The fair test **Watch for:** Students who change the schedule and the runway at once. One change a run.	Fill in the table with six runs, and answer the questions.

MINUTES	STAGE	WHAT YOU DO	WHAT STUDENTS DO
38 to 45	**Closure** Is it worth building? And exit ticket	Show the closure slide. Take positions with reasons from the table. Hand out the exit ticket.	Discuss, then answer the exit ticket.

Before you teach: a ten-minute walkthrough

Open mytekdev.com/try/airtrafficlab?lesson=a-second-runway-testing-a-design&ref=tpt-airtrafficlab-4. A short guide opens over Build your traffic's busy schedule, with the program in Python. The tower view is on the left: the airport from the control tower, the airliners with their landing lights on and a tag with each call sign. The radar is on the right: the runway at the top, the dashed final approach line, and a green dot for each airplane with its data block (call sign, altitude in hundreds of feet, speed in tens of knots). Under the radar the radio log keeps every word said, marked "you" or "program". Click an airplane on the radar to give it an instruction.

1. **The schedule.** 14 arrivals straight in on the final, about 2.5 minutes apart, none bunched; 12 departures; wind from 360 at 8; schedule number 7. The same settings and number always make the same traffic. Missions, Build your traffic shows and changes them.
2. **The program.** Four rules: slow each arrival to 160 knots when it calls in; every 10 seconds, keep each arrival's place behind the one ahead (follow_speed); clear it at 5 miles; and ready, which sends a departure when the next arrival is more than 4.5 miles out.
3. **The second runway.** Parallel, 3,000 ft west of the first, for departures only. Arrivals land on 36R and departures leave from 36L, and the radio says so. The radar draws both runways.
4. **Speed.** Time runs at 4 times by default. Speed up and Slower, under the tower view, change it; the round play button starts the shift again from the beginning, with the program as it is now. At 16 times a run takes about 3 to 4 minutes; a busy computer may run a little slower.
5. **Numbers to expect.** One runway: departures wait 10.1 minutes on average, 29 movements an hour. Two runways, the same program: 10.1. Two runways, ready without the if: 0.3, 33 an hour, and the shift ends about 6 minutes sooner. One runway without the if: a conflict. Arrivals 3 minutes apart: 1.7, 1.3 and 0.3. 4 minutes apart: 1.2, 1.2 and 0.3.

> With the if taken out on one runway, a departure rolls in front of an arrival close in, and the conflict alert ends the shift. It is a good thing for students to see: the rule that slowed the two-runway airport is the rule that keeps the one-runway airport safe.

Background for the teacher

Busy airports often have parallel runways, one for arrivals and one for departures, so a departure need not wait for a gap between arrivals. Whether that helps depends on how busy the airport is, and on the procedures: the rules the tower and the airplanes follow. A new runway with the old procedures can carry no more traffic than before.

The program here is event-driven: ready runs each time a departure is waiting and a runway clears. Its condition, the next arrival over 4.5 miles out, was right for one runway and wrong for two. Comparing designs on the same test case, and finding why one did not help, is the work of engineering with a simulation.

The app simplifies: real parallel runways need a set distance apart to be used independently, departures also wait behind a heavy jet's wake, and real schedules vary through the day. Air traffic controllers in the United States are hired by the FAA, which says it hired a record 2,235 trainees in its 2026 fiscal year. Applicants must apply before turning 31, and the median pay was $148,080 a year in 2025 (Bureau of Labor Statistics).

What to look for

Ask these while students work. A student who has understood the lesson can answer them without help:

- What stayed the same between your runs, and why does that matter?
- Why did the second runway not help at first?
- What does ready do, and when does it run?
- Why is the if needed on one runway and not on two?
- When is a second runway worth building?

> The second question is the one that matters. A student who says "the program still waited for the arrivals" has found that a design is the hardware and its rules together. A student who says "it was a glitch" has not looked at the program.

Cross-curricular extensions

- Math: graph the departures' wait against the arrival spacing for one runway and for two.
- Economics: if each minute of delay costs an airline a set amount per departure, what does the second runway save in a year of such hours?
- Careers: look up what an airport planner does, and how airports decide to build a runway.
- Civics: find a runway project near you, and what the people living nearby said about it.

Vocabulary

Departure	An airplane taking off. It waits short of the runway until it is cleared for takeoff.
Parallel runway	A second runway beside the first, pointing the same way. Here it is 3,000 ft west, for departures only.
Throughput	How many airplanes land and take off in an hour.
Delay	How long an airplane waits beyond its best time: here, how long departures wait at the runway.
Test case	One set of inputs to test with. Here, one schedule: the same airplanes at the same times, every run.
Event handler	The code that runs when something happens: here, ready, which runs when a departure is waiting.

Differentiation

ENGLISH LEARNERS

- Keep the vocabulary slide up, and point at the radar, the airplane or the radio log as you say each word: the picture carries the meaning.
- Give a sentence frame on a card: With ____ runway(s) and the ____ rule, departures waited ____ minutes.
- Draw the two runways and the waiting departures on the board, and move a magnet for each one as it goes.

STUDENTS WITH IEPS OR 504 PLANS

- Pair students, one at the keyboard and one recording.
- Give the table with the schedules filled in, so the work is the runs and the waits.
- Where the IEP allows a modified assignment, score the first two rubric rows only.

STUDENTS WHO NEED MORE SUPPORT

- Make the change to ready together on the board: delete the if line, and move the next line left.
- Run the first two rows of the table together.
- The card after each run gives the departures' wait.

STUDENTS READY FOR MORE

- On one runway, change the 4.5 in ready to other numbers, one run each, and find the smallest that stays safe. What does each change do to the wait?
- Find the arrival spacing where a second runway starts to save more than 5 minutes a departure.
- Add arrivals from the east and west in Build your traffic: does the program still land them all? What would it need?

Adapting for other grades

Younger students: In middle school, run the guide together on the board, then let pairs do only the change to ready on two runways. Score the first two rubric rows, total 8, and 6 meets the objectives.

Older students: In an engineering course, add a cost: say a runway costs a sum a year, and each minute of departure delay costs a sum per airplane. Find the arrival spacing where the runway pays for itself, from the table.

Student worksheet

Name: _____ Date: _____

Open the app: scan the QR code, or go to mytekdev.com/try/airtrafficlab?lesson=a-second-runway-testing-a-design

Essential question: Does a better design help if the rules stay the same?

Warm-up: A school adds a second cafeteria door, but the line is just as slow. How could that happen? _____

1. **Vocabulary.** Departure, parallel runway, throughput, delay, test case, event handler: write each in your own words.

2. **The guide.** One runway: departures waited ____ minutes. Two runways, same program: ____ minutes. Why the same? _____

3. **My table.** Spacing / runways / ready with or without the if / wait or what happened. 2.5, 2, without: ____. 2.5, 1, without: ____. 3, 1, with: ____. 3, 2, without: ____. 4, 1, with: ____. 4, 2, without: ____.

4. **My change.** The lines of ready after my change: _____

1. Why is the if needed on one runway and not on two?

2. Would you build the second runway? Use your table.

Exit ticket

Name: _____

1. Comparing two designs fairly means: (A) changing as much as possible each run (B) using the same test case and changing one thing (C) running each design once on a different schedule

2. ready runs: (A) once, at the start (B) when a departure is waiting and a runway clears (C) every second

3. A friend adds a third runway and nothing improves. Use what you learned today to say what they should look at, and why.

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Exit ticket

Name: _____

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Answer key: exit ticket

QUESTION	ANSWER	WHY
1	B	With the same schedule, a difference in the result comes from the one change.
2	B	It is an event handler: the system calls it when the event happens.
3	Open answer	The rules: a condition written for the old design may still make airplanes wait, like ready's check on the arrivals.

Worksheet: what students should find

BLANK	WHAT THE APP SHOWS
The guide	10.1 and 10.1. ready still sends a departure only when the next arrival is over 4.5 miles out, runway or no runway.
My table	2.5, 2, without: 0.3. 2.5, 1, without: a conflict. 3, 1, with: 1.7. 3, 2, without: 0.3. 4, 1, with: 1.2. 4, 2, without: 0.3.
My change	def ready(plane): then tower.cleared_for_takeoff(plane), four spaces in.
Question 1	On one runway a departure and an arrival share the runway, so the departure must wait for a gap; on two, the departure has its own.
Question 2	Open: at 2.5 minutes apart it saves about 10 minutes a departure; at 4 minutes, under one. A good answer uses the table and names a cost.

> Build your traffic with the same settings and schedule number gives the same traffic on any computer, so the waits match. A student whose numbers differ changed a setting or the program.

Rubric

Score each row from 1 to 4.

Name: _____

CRITERIA	4 EXCEEDS	3 MEETS	2 APPROACHING	1 BEGINNING
Testing fairly	Runs six tests, one change each, on the same schedules, and says why that makes the comparison fair.	Runs four or more tests with one change each.	Runs tests but changes more than one thing at once.	Does not test.
Explaining the result	Explains with the program why the second runway alone did not help, and what changed it.	Explains that the rule kept the departures waiting.	Notices the waits were the same, without a reason.	No explanation.
Deciding	Makes a decision about the second runway from the data at three spacings, and names other criteria it needs.	Makes a decision from the data.	Makes a decision without data.	No decision.

Total: ____ / 12. A score of 9 or more meets the objectives.

Standards

The lesson is built for HS-ETS1-4: students use a computer simulation to compare two designs for a busy airport against delay and safety, and find that the design includes its rules. Changing the departure handler, the code an event runs, is CSTA 3A-AP-16.

FRAMEWORK	CODE	GRADES	STANDARD	HOW THE LESSON MEETS IT
NGSS	**HS-ETS1-4**	9-12	Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.	Students run one and two runways on the same schedules in the simulation, measure the departures' delay, and decide when the second runway is worth it.
CSTA 2017	**3A-AP-16**	9-10	Design and iteratively develop computational artifacts for practical intent, personal expression, or to address a societal issue by using events to initiate instructions.	Students change the handler that runs when a departure is ready, from a version written for one runway to one for two, and test both.

Checked November 2026 against: NGSS: HS-ETS1 Engineering Design, CSTA K-12 Computer Science Standards, Revised 2017.

Optional: save student work in a free class

The whole lesson runs at the link on the worksheet, with no accounts and no sign-up.

To keep students' work, and see it all in one place, make a free class. It takes about ten minutes, once, and covers every lesson in this series: mytekdev.com/tools/class-setup

Students in a class open mytekdev.com/tools/air-traffic-control-lab/lessons/a-second-runway-testing-a-design/start instead of the worksheet link. Each one gets their own copy of the starter, and the same link reopens it next time.

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