NASA: With You When You Fly

NASA plays a major role in NextGen research.

NASA and the NextGen ATS

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Agenda

Introduction to Air Traffic Control

LineUp With Math Training
  - Sector 33 air traffic control simulator
  - Math strategies
  - Practice with worksheets

How to access the classroom materials

Challenges of Air Traffic Control

During the busiest travel times, about how many commercial planes are flying in the US?

About 5,000 planes!

World's Largest D-R-T Problem

Smart Skies™

24 Hours Of Flight
A 60-Second Animation
Ground Control (tower) - from gate to runway
Local Control (tower) - takeoff & landing
Terminal Radar Approach Control (TRACON) - ascending & descending
En-Route Traffic Control (center) - high cruising altitude

Air Traffic Control 101

How do ATCs maintain safety & efficiency?

Analyze the situation.
Detect potential conflicts.
Resolve the problem.
Communicate the solution.

...and they use a little math along the way.

Two Classroom Activity Sets

LineUp With Math: Gr. 6-7
- Scenarios involving 2 planes
- Hands-on physical experiment
- Multiple representations (six math methods)
- Graphing simulator

FlyBy Math: Gr. 5-8
- Scenarios involving 2 to 5 planes
- Realistic air traffic control simulator
- Proportional reasoning

Smart Skies™

www.smartskies.nasa.gov/lineup

Standards Based & Classroom Tested

- Aligned with both Common Core and State Standards:
  - Distance = rate \cdot time
  - Proportional reasoning
  - Problem solving
  - Decision making

- Tested with 4,500 students nationwide
LineUp with Math
Math-Based Decisions in Air Traffic Control (ATC)

- Act as an Air Traffic Controller
- Use a simulator and math
  - to change plane routes and speeds
  - to keep planes safely separated and on time

6 Workbook Problem Sets

Introduction to ATC

Speed Changes

Route Changes

4-plane and 5-plane challenge problems are available (without workbooks).

Welcome to Sector 33

Introductory video for students available on student website:
www.atcsim.nasa.gov

Intro to the Simulator

ATC Simulator Problem 3-8
Line up 3 planes over MOD, 3 Nmi apart.

- Change route
- Change speed
- Match the target time.
- Requires math!

The Goal Over MOD

The planes must be spaced 3 Nmi apart over MOD. The last plane must arrive in 3 min and 48 sec.
A Closer Look at the Goal

The Sector 33 ATC Simulator

Select Problem 3-8

Run Problem 3-8 Without Changes

Analyze and Detect Conflicts
All 3 planes: Are the same distance, 35 Nmi, from MOD. Are flying at the same speed, 600 kts. Arrive over MOD at the same time!!

Ways to Resolve Conflicts

✓ Route Change(s)
✓ Speed Change(s)
● Altitude Change(s)

Try Using a Route Change

Can you change the route for: UAL74? DAL88? AAL12? No No Yes

Verify the Route Change

Let’s change the route for AAL12. What’s its new flight distance to MOD? 32 Nmi

Try Using a Speed Change

Let’s reduce the speed of UAL74. Try 540 knots (smallest reduction).

Communicate the Strategy

• “AAL12 cleared direct MINAH to MOD.”
• “UAL74 reduce speed to 540 knots.”
Apply the Route & Speed Changes

Send AAL12 direct
MINAH to MOD.
Slow UAL74 to 540 kts.

Result of Route & Speed Changes
Note the spacing at the target time:
3 Nmi between AAL12 & DAL88
4 Nmi between DAL88 & UAL74

How can you keep UAL74 from falling so far behind?

Review & Fine Tune the Solution

• Investigate the problem in Review mode.
• Pause at 1, 2, and 3 minutes.
• Note the plane spacing each minute.

Review the Problem 3-8 Solution

Using Review Mode
At One Minute

At Two Minutes

At Three Minutes

Fine Tune the Solution

Goal Achieved!

Understanding Speed Change

- We changed a plane’s speed to achieve Ideal Spacing and meet the Target Time.
  - How did we know which speed to select?
  - Why is the speed menu in 60-knot increments? 600 kts, 540 kts, 480 kts …
  - To explain, we begin with 2 walkers.
How do walker speeds (steps per minute) relate to plane speeds (nautical miles per hour)?

Controllers make decisions in minutes, not hours. So controllers use speed in miles per minute.

A plane's speed is 600 knots:
In 1 hour, it flies 600 Nmiles.
In 60 minutes, it flies 600 Nmiles.
In 1 minute, it flies 10 Nmiles.

A plane's speed is 540 knots:
In 1 hour, it flies 540 Nmiles.
In 60 minutes, it flies 540 Nmiles.
In 1 minute, it flies 9 Nmiles.

Determine:
1. The order of plane arrival and spacing at MOD
2. How much each plane must fall back
3. If you can use a route change
4. The degree of speed change and duration
Analyze Problem 2-6

All planes at the same speed, 600 kts.

Solve Problem 2-6

All planes at the same speed, 600 kts.

Analyze Problem 3-4

All planes at the same speed, 600 kts.

Solve Problem 3-4

540 kts

Create Your Own ATC Problems

Classroom Implementation

Explore with the Simulator.

Do the math in a Workbook.

Meet the time challenge.
Interagency Partnership

- Partnership in education with the FAA
  - Classroom visits from air traffic controllers
  - Student visits to air traffic control facilities
  
  www.faa.gov/education

Sector 33 Mobile Game

www.nasa.gov/sector33

A real-world extension to LineUp With Math:
- No pause button
- No review mode
- Student performance is scored
- Designed to further challenge students in a more realistic setting

for Apple & Android mobile devices

Recent Recognition

The National Coalition for Aviation and Space Education (NCASE) awarded Smart Skies the:

2013 Dr. Mervin K. Strickler Award for Aerospace Education Leadership

Contact Us

- By email: smartskies@mail.nasa.gov
- On the web: www.smartskies.nasa.gov

Send an email to smartskies@mail.nasa.gov if you would like:
- To be added to the Smart Skies email list
- To receive professional development for your dept/district via distance learning

Thank you from Smart Skies

What’s on your radar screen?