

National Aeronautics and Space Administration

**Smart Skies™**

**NASA Distance-Rate-Time Math  
In Air Traffic Control**

Grades 5-9

Standards-Based

Free!



**Rebecca Green & Gregory Condon**  
NCTM Annual Meeting – Denver, CO

19-Apr-2013

**Overview**

Welcome
Introduction to FlyBy Math™
Physical Experiment
Six Math Methods
Online Graphing Visualization Tool
How to Access the Classroom Materials

Smart Skies™

**Challenges of Air Traffic Control**

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



About 5,000 planes!

Smart Skies™

**World's Largest D-R-T Problem**


**Smart Skies™**



**24 Hours Of Flight**  
A 60-Second Animation


**Two Classroom Activity Sets**

**FlyBy Math**



Pre-algebra or Algebra

**LineUp With Math**



Pre-algebra

Free!

- Real-world applications
- Multiple representations
- Aligned to state math standards

Free!




Smart Skies™

**Smart Skies FlyBy Math**



[www.smartskies.nasa.gov/flyby](http://www.smartskies.nasa.gov/flyby)

### Standards-based & Classroom-tested


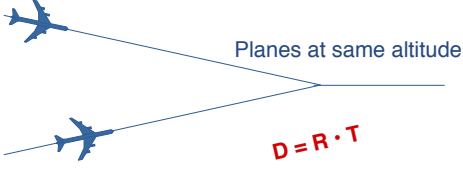
All 50 states

- Rates
- Modeling
- Graphing
- Data collection
- Measurement
- Problem solving

*Alignment to Common Core Standards in process.*

FlyBy Math™

### Analyze Two-Plane Problems


Planes at same altitude

$D = R \cdot T$


- Which plane arrives first at the intersection?
- How far apart are the planes at that time?

FlyBy Math™

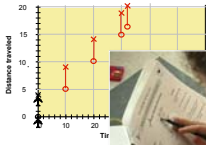

### Multiple Representations



Physical experiment




Print-based worksheets with 6 math methods


Pre-algebra & Algebra

Graphing Simulator




FlyBy Math™

### Introduction to FlyBy Math™



FlyBy Math Video

### Five Air Traffic Control Problems



1 Same Speed	2 Same Speed	3 Different Speeds	4 Different Speeds	5 Different Speeds
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Grade 5

Grade 6


Grade 7

Grade 8

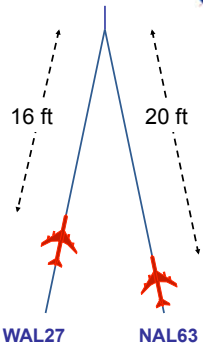
Grade 9

FlyBy Math™

### Understand Problem 2



- Speed of each plane = 1/2 foot per second
- Will the planes meet at the intersection?
- If not, how far apart will they be when the first plane arrives?



16 ft

20 ft

WAL27

NAL63

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### Physical Experiment



- Students act as Pilots, Controllers, and NASA Scientists.
- Students measure & lay out two jet routes.
- Pilots step down the routes.
- Students measure and record time and separation distance.

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### Six Math Methods

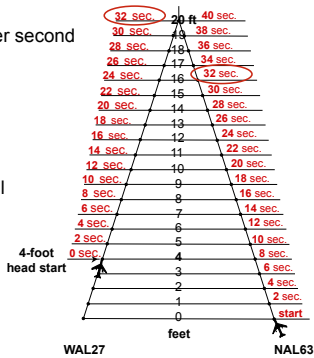


- Non-traditional**
  - Count feet and seconds
  - Draw and stack blocks
  - Plot points on two vertical lines
- Traditional**
  - Plot points on a grid
  - Derive & use the distance-rate-time formula
  - Graph two linear equations

FlyBy Math™

### Count Feet and Seconds

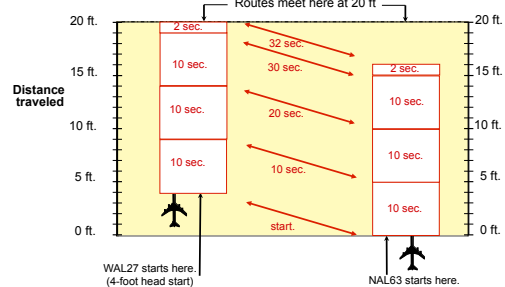
- Speed =  $\frac{1}{2}$  foot per second
- So in 1 second, the plane travels:  $\frac{1}{2}$  foot
- Thus the plane will travel 1 foot in 2 seconds.



FlyBy Math™

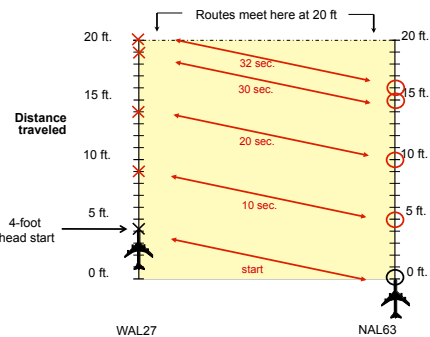
### Draw and Stack Blocks

$\frac{1}{2}$  ft/sec = 5 feet in 10 seconds  
= 1 foot in 2 seconds



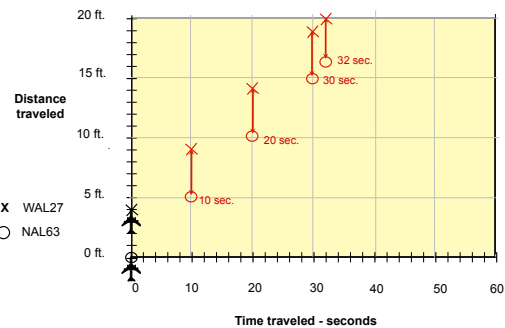
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### Plot Points on Two Vertical Lines



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### Plot Points on a Grid



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### Derive and Use Distance-Rate-Time Formula

$d = r \cdot t$

$t = \frac{d}{r}$

$t_{WAL27} = \frac{16 \text{ feet}}{0.5 \text{ feet/sec}} = 32 \text{ seconds}$

$t_{NAL63} = \frac{20 \text{ feet}}{0.5 \text{ feet/sec}} = 40 \text{ seconds}$

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### Graph Two Linear Equations

NAL63  $\circ$ ----- $\circ$   $d = 0.5t$

WAL27  $\times$ ----- $\times$   $d = 0.5t + 4$

t seconds	d feet
0	0
10	5
20	10
30	15
40	20

t seconds	d feet
0	4
10	9
20	14
30	19
40	24

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### Let's Slow One Plane

What happens to the planes where the lines intersect?

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### Graphing Simulator

- In each panel, we can change speed & starting position.
- A change in one panel changes the other two panels.
- Helps students link the math to the real world.

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### Crash or No Crash?

- When the lines cross on the graph, do the planes collide?
- We can use the simulator to answer the question.

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### No Crash!

- On the graph, the lines intersect at (30, 15).
- At 30 sec, each plane is 15 ft from its jet route start.
- Note: the planes are on 2 routes that intersect at 20 ft.

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### Crash!

On the graph, the lines again intersect at (30, 15).  
 At 30 sec, each plane is again 15 ft from the jet route start.  
 Note: the planes are flying on the **same** route.

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### Challenge!

For 2 planes on **2** routes, configure the graph to represent a collision.  
 Where is the **only** place on the routes a collision can occur?

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### Problem 4

Speed of WAL27 =  $\frac{1}{3}$  foot per second  
 Speed of NAL63 =  $\frac{1}{2}$  foot per second

Will the planes meet at the intersection?  
 If not, how far apart will they be when the first plane arrives?

WAL27:  $\frac{1}{3}$  ft/sec  
 NAL63:  $\frac{1}{2}$  ft/sec

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### Problem 4

Will the planes meet at the intersection?  
 If not, how far apart will they be when the first plane arrives?

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[www.smartskies.nasa.gov](http://www.smartskies.nasa.gov)

Smart Skies Homepage  
 For Teachers

Free!

LineUp With Math™

FlyBy Math™

[www.smartskies.nasa.gov/flyby](http://www.smartskies.nasa.gov/flyby)

FlyBy Math Homepage  
 For Teachers

Click here to access the graphing simulator & materials

FlyBy Math™

## FlyBy Math Educator Materials



### FlyBy Math:

- Quick Start Guide
- Educator Guide
- Answer Guide for each workbook and assessment
- Video and Poster

**Free Online!**

### FlyBy Math Simulator:

- Quick Start Guide
- Teacher Guide
- Answer Guide for each worksheet and assessment
- Animated Introduction to the Simulator

## FlyBy Math Student Materials



### FlyBy Math:

- Movies
- Role playing signs
- Workbook for each problem set
- Assessment for each problem set

**Free Online!**

### FlyBy Math Simulator:

- Simulator
- Animated Introduction to the Simulator
- Worksheet for each problem set
- Assessment for each problem set (except problem set A)

## Materials for Teacher Workshops



[www.smartskies.nasa.gov/trainer](http://www.smartskies.nasa.gov/trainer)

## www.atcviztool.nasa.gov



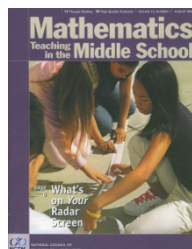
**Free!**  
**For Students & Teachers**

FlyBy Math™

## Smart Skies Dissemination



- Professional development workshops: NCTM, NSTA, CMC,...
- MTMS cover article, August 2006
- Chosen for NCTM's online project, *Making Connections: Mathematics across Disciplines*



Smart Skies™

## Contact Us



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