Math In Aviation

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The Boeing Company

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The *Wright Flyer*, Kitty Hawk, North Carolina, December 17, 1903

About Me

- Live in Norman, Oklahoma
- Graduated from Oklahoma State University in 2010 with a Bachelor of Science in Aerospace Engineering, Mathematics Minor
- Graduated from University of Colorado Boulder in 2014 with a Master of Science in Aerospace Engineering, Bioastronautics Focus
- In past jobs and academia, I've worked on the Orbcomm Generation 2 (OBG2) communication satellite constellation, Dream Chaser space plane, and industrial combustion systems
- Been with Boeing for ~4.5 years as a Systems Engineer and a Mechanical Systems Engineer

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What I Do at Boeing

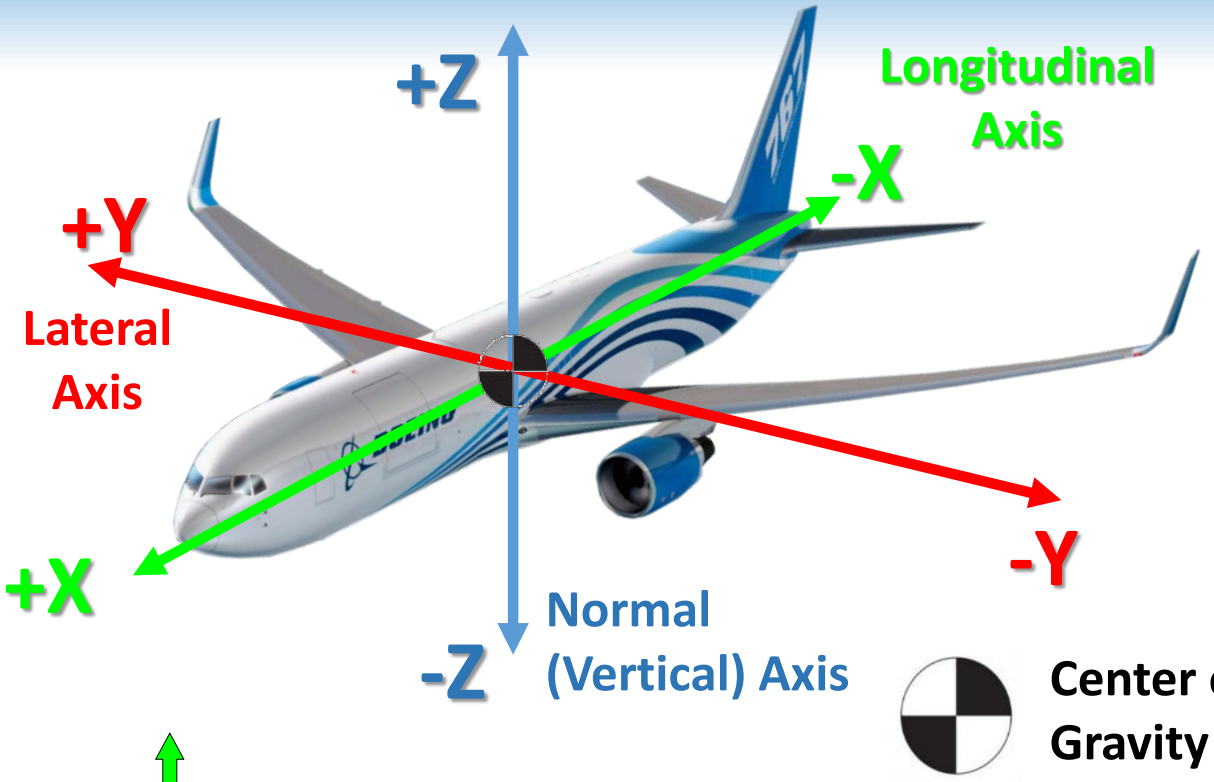
- I am a Mechanical Systems Engineer, responsible for:
  - Environmental Control Systems (ECS) – Air temperature, pressure, humidity, ozone, & equipment cooling
  - Flight Control Systems – Aircraft controls, like the rudder, elevator, ailerons, and flaps
  - Fuel Systems – Storing and moving fuel throughout the aircraft
  - Oxygen Systems – Ensuring the crew and passengers always have adequate oxygen during an emergency
  - Hydraulics & Pneumatics – Using fluids (oil & air) to power and move parts of the aircraft
  - Vacuum Waste System – Bathrooms…believe me, you don't want to know!
  - And many other parts of the aircraft!
- I work mainly on the KC-135 aerial refueling tanker, a "flying gas station" that refuels fighters, bombers, and other aircraft in the air
- I've worked on 19 different types of aircraft for the USA, France, Australia, Japan, South Korea, the UK, Turkey, Saudi Arabia, Israel, Chile, Brazil, and Argentina (plus NATO)

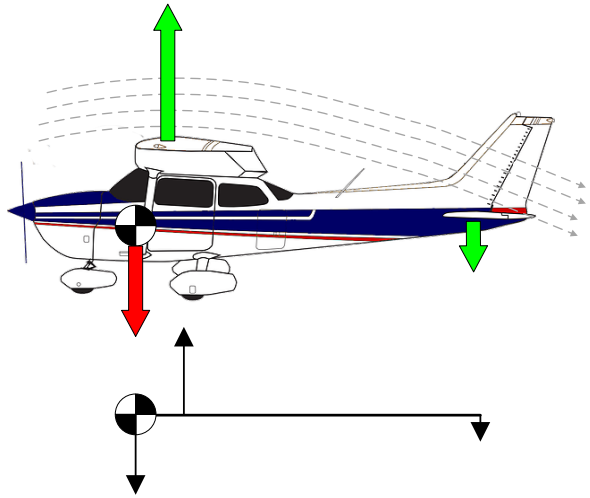
How Are Integers Used to Fly an Airplane?

- Integers are key to most communications relating to flight; they are clear and simple to speak, reducing confusion over the radio
- They are extremely useful for sharing general information: number of passengers, weight of fuel remaining (usually in pounds), direction, and other critical values
- Some examples:
  - **Navigation:** bearings (the direction from you to a target of interest, like a city or another aircraft) and headings (your direction relative to the compass) are almost always given in integer values (ex: “We’re on heading 180” means we are heading directly south at 180° from true north)
  - **Runways:** runways are numbered in integer values from 1 to 36, with the number being the number of degrees from north (01 = 10° from north, 90 = 90° from north, or due east, etc.)
  - **Altitude:** Pilots report altitude in “Flight Levels” (FL), integer values where each number is hundreds of feet above sea level (ex: FL380 = 38,000 feet above sea level, the altitude at which most airliners fly)
  - **Speed:** Speeds, including the aircraft’s ground speed (speed relative to the ground), air speed (speed relative to the outside air), and wind speed are almost always given in integers.
- These are approximations (the wind might actually be 35.76554 mph, but we say 36 mph because it is close enough for most jobs in the air

How Is Math Used In Aviation?

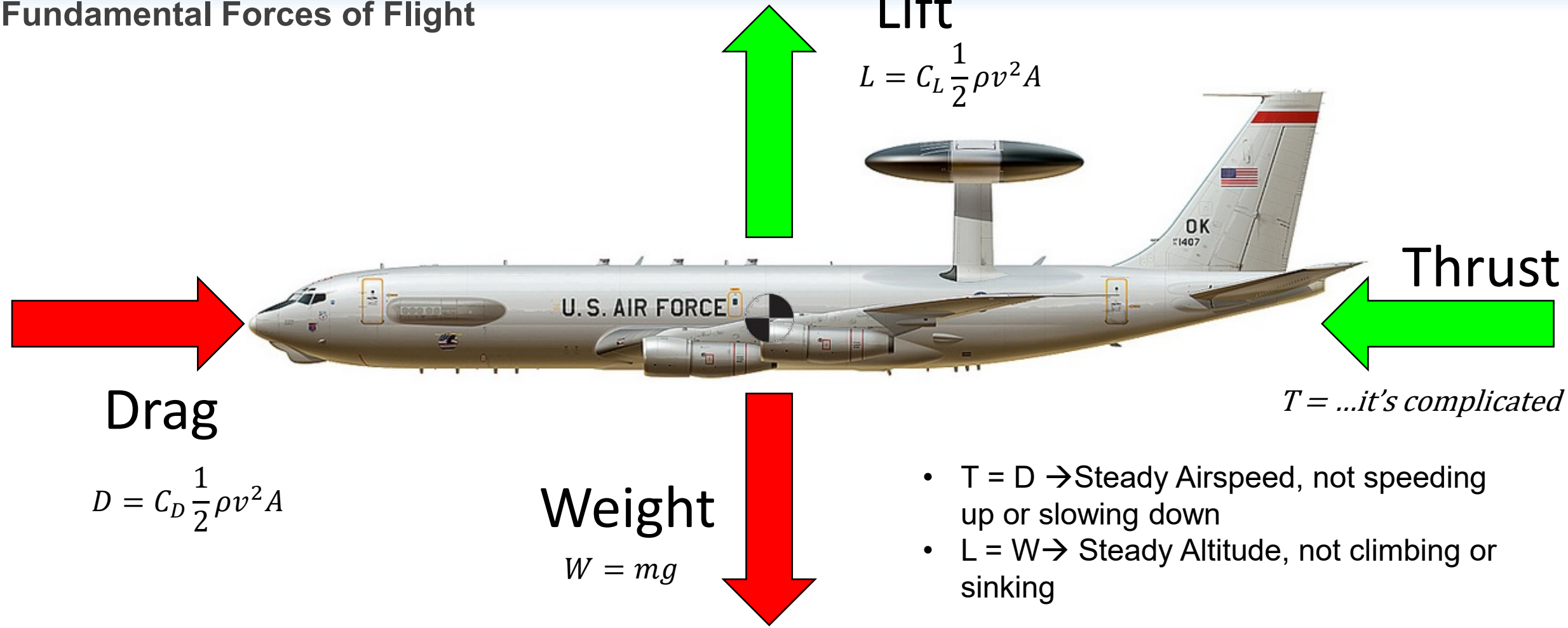
- Math is fundamental to every single part of aviation, from engineering to construction to airports to airlines setting ticket prices
- Geometry is vital to knowing the shapes and sizes of the different parts of an aircraft
- Algebra and trigonometry is used to calculate how an airplane moves, what the air flowing over the wings is doing, how the engines are performing, how the plane gets balanced when passengers and cargo are being loaded, etc.
- Calculus, differential equations, linear algebra, and most other types of advanced math are used in the design and testing of an aircraft, and of the systems and pieces that make up a working airplane
- Statistics and probability are used to ensure aircraft are safe and reliable
- Economic math is central to the business of aviation, paying for the aircraft, making money off of flights, etc.





How Is Math Used In Aviation?

Fundamental Forces of Flight

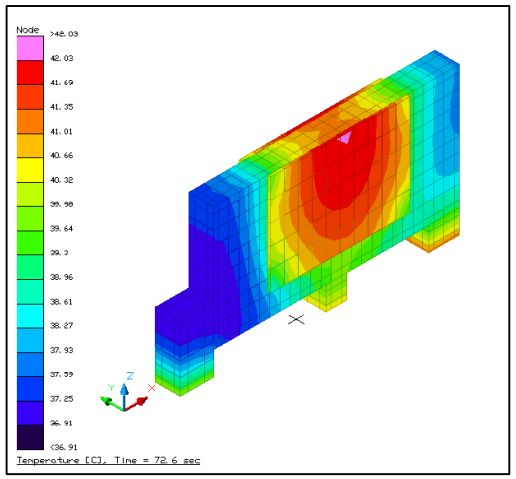


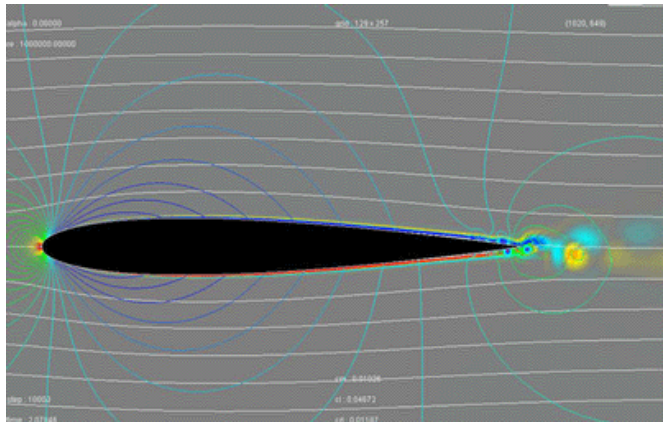
- T = D →Steady Airspeed, not speeding up or slowing down
- L = W→ Steady Altitude, not climbing or sinking

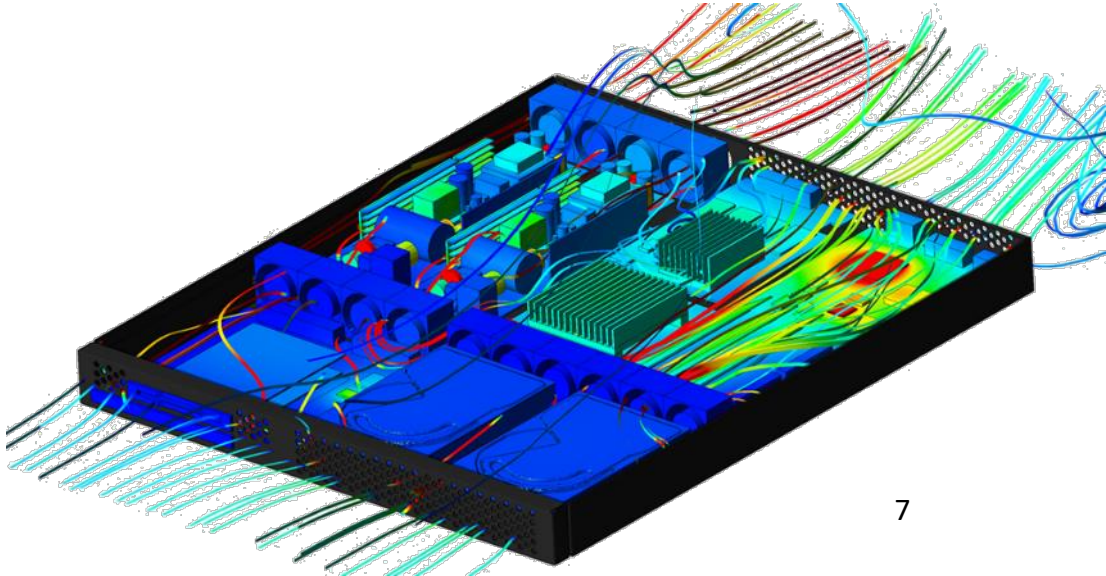
Everything on this slide changes during flight (except gravity...*usually*...)

Why Are Basic Math Skills Important to a STEM Career?

- Basic math is vital to not just mathematics (calculus, statistics, etc.), but is used for all engineering, science, and technology jobs
- It allows you to understand the world in a straightforward way, and to share that with others: regardless of language, country, or anything else, everyone can speak basic math
- Critical thinking skills are at the core of all STEM jobs: How does that work? Why does this behave the way it does? How many of this thing do we need to get the job done? All of those questions involve math
- **Math is a tool.** I love math because of what it lets me do: with math, I can solve problems, I can learn about the world and how it works, I can build aircraft, repair broken machinery. Ultimately, **with math, I can make the world a better place**. And so can you!!







Questions?