EXPLORE AERODYNAMICS

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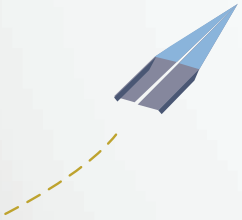
YOUR MISSION:

Help students understand why aerodynamics is important. Encourage them to imagine themselves with a job in this field, designing cars, buildings, airplanes and more.

ADVICE ON VOLUNTEERING

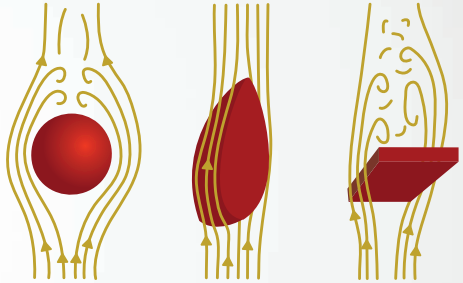
SAFETY CHECK: Look for this symbol in the scripts. Our exhibits are hands-on, but **some require close supervision.** Make sure students explore safely (no running, no poking each other in the eye, etc.) and follow instructions from the facilitator.



ENCOURAGE EXPLORATION: Ask questions about what they see, hear, and feel and make sure everyone gets a chance to participate. A little positive feedback goes a long way.

GET EXCITED! You don't have to be an expert. Your curiosity and enthusiasm inspire kids to learn.

AREA OVERVIEW



AIR IS REALLY PUSHY! Aerodynamics is the science of how objects interact with air. "Aero" means fluid, like air or water. "Dynamic" refers to the relationship between air or water and an object.

DESIGNERS USE AERODYNAMICS TO MAKE SURE THAT AIRPLANES STAY UP, that race cars go fast, and that bridges aren't blown down by the wind. Why are airplanes and canoes pointed at the front? Why do bicyclists shave their legs? Why are skyscrapers skinny? It's all about aerodynamics.

EXPLORE AERODYNAMICS

- Right now, there are about 5,000 planes in the sky over America. Across the world, more than 8 million people fly every day.
- Most airplanes fly at about 550 miles per hour. The retired Concorde plane used to fly at 1,350 mph. Now engineers are working on a plane that can fly from Florida to Alaska in an hour.
- The only living creatures capable of powered flight are insects, birds and bats. The rest of us need airplanes (or big helium balloons, hang-gliders, parachutes, giant kites, or… what else can you imagine?)

GRAND CHALLENGES

If you could do one thing to make life on Earth better, what would that thing be? Here's a **GRAND CHALLENGE:** according to some of the world's smartest people, this is a challenge that humans will face in the next 100 years. **What would you do to help solve it?**

ENHANCE VIRTUAL REALITY

Virtual reality can be used to train pilots and other professionals who need to practice flying (or performing open-heart surgery, or deactivating bombs, or just about anything else). Virtual reality also lets all of us explore experiences that we'd otherwise only be able to imagine, like swimming at the bottom of the ocean or flying through the solar system. You could make it possible for anyone to see what it's like to fly!

JOKES

What do you call a fly without wings?

A walk.

What do you get when you cross a bridge with a bicycle?

To the other side.

Why don't ducks tell jokes while they fly?

Because they would quack up.

BERNOULLI'S PRINCIPLE

AREA: AERODYNAMICS

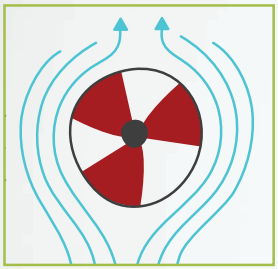
EXHIBIT: BERNOULLI'S PRINCIPLE

STUDENTS CAN TOUCH

SAFETY FIRST: HOW TO USE

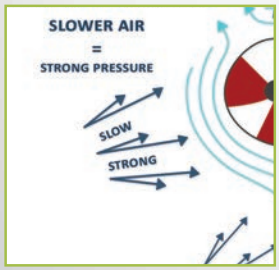
- Okay for students to handle.
- Hold the handles and tilt the air flow gently back and forth.
- What happens to the beach ball when you tilt the air flow?

CONCEPT BREAKDOWN



- This exhibit shows how air pressure, air movement, and gravity work together to keep the ball in the air.
- Ask the students: what is air pressure? Air pressure is caused by the weight of air molecules. Bernoulli's Principle says that air pressure gets weaker inside a stream of flowing air. The faster the air stream, the weaker the air pressure.

- When air hits a curved object (like the beach ball or an airplane wing), that air speeds up to get around the object. That means the air pressure gets weaker (but it's still strong enough to lift the object!).



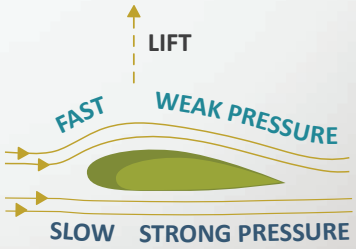
- The air pressure in the rest of the room moves slowly, so it's stronger. The room's stronger air pressure pushes all around the object so that it can't fall out of the weak stream, even when you tilt the air flow.
- Eventually, gravity wins. If you tilt the nozzle far enough, the ball will fall.

RELATE TO REAL LIFE!

Imagine you have a full balloon, and you let go of the opening. What happens? It deflates. That's because air pressure from outside of the balloon squeezes against the sides of the balloon, forcing the air out. Human lungs also use air pressure to help you breathe!

We know that airplane wings use Bernoulli's Principle for lift. What other flying objects use their shape for lift?

A boomerang.
A kite.
A bird.



AREA: AERODYNAMICS

EXHIBIT: BERNOULLI'S PRINCIPLE

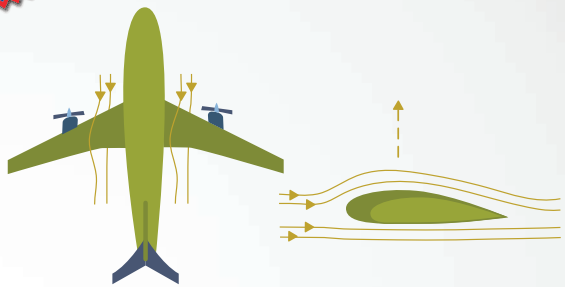
BERNOULLI'S PRINCIPLE

QUESTIONS

Do you think the ball is being pushed by the air or pulled by the air?

- It looks like it's being pushed, right? But what happens when you tilt the nozzle ? if the ball were being pushed, wouldn't it go in that direction?
- The movement of air around the ball actually creates a *pull*, or *lift*.

CAREER



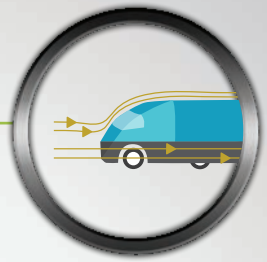
COMMERCIAL PILOTS fly passenger airplanes. Military pilots fly fighter jets. Other pilots drop water onto wildfires, rescue stranded sailors, or take people on sightseeing tours.

AVERAGE SALARY: $140,000

ADDITIONAL INFORMATION

Why can't humans fly like birds? We don't have wings, but it's not just that. Our chest muscles just aren't strong enough to lift our bodies by flapping wings. Fortunately, inventors like the Wright Brothers looked at the structure of birds to design machines that let us fly.

TURBULENCE



AREA: AERODYNAMICS

EXHIBIT: TURBULENCE

SAFETY FIRST: HOW TO USE

- At the start of your volunteer shift, open the Wind Tunnel app on each tablet.
- *Note: If you have a problem with a tablet, check the power cord to make sure it is plugged in!*
- Click on "Interact," then click on "Draw Wall" to set it up for the first student.
- Explain the concept of turbulence (see Concept Breakdown, below).
- Ask each student to draw different shapes (car, airplane wing, etc.) to test an aerodynamic shape. Have them look for signs of turbulence (a swirling motion), then erase and redraw the shape to see if they can reduce the amount of turbulence. **GOAL:** Air flowing smoothly as possible on all sides.
- To reset the application for the next student:
    1. Click on "File" within the Wind Tunnel app
    2. Click on "Reset"
    3. Click on "Interact"
    4. Click on "Draw Wall"

CONCEPT BREAKDOWN

- **Turbulence is unsteady air, water, or gas.** It can be caused by a collision of weather fronts, or by the collision of water or air into a building, mountain, or car. Engineers use their understanding of aerodynamics to limit turbulence.
- Aerodynamics is the study of how objects interact with air and water.
- Engineers use their understanding of aerodynamics to design faster or more efficient cars, airplanes, boats, bicycles and skateboards – to list just a few!
- Engineers also use aerodynamics to help design bridges and buildings that can withstand high winds, like in tornadoes and hurricanes.

RELATE TO REAL LIFE!

Have you ever been on a bumpy plane ride? That's another example of turbulence. Air tends to flow like water in a river, in a horizontal line. This line of air is called a **jet stream**. When the fast air of the jet stream hits slower moving air along the sides – fasten your seatbelt! Just like the fast-flowing water in a river pushing against the riverbank and creating rapids, fast air pushes against slow air to create swirls and other unsteady air conditions.

Turbulence can be scary, but it's not dangerous. Engineers design planes to withstand lots of bumps!

AREA: AERODYNAMICS

EXHIBIT: TURBULENCE

TURBULENCE

QUESTIONS

What shape for a boat would move faster: a triangle or a square? Why?

- A square boat would push against the water and take more energy to move forward. It would also create more turbulence.
- A triangle boat goes faster. That's why most boats have some version of a triangular shape: a pointed prow (the front of the boat) that faces the direction of travel, built to encourage air and water to flow around the boat.

CAREERS

AUTOMOTIVE ENGINEERS design, develop, test and build everyday cars, pick-up trucks, school buses, racing cars and motorbikes. They also work on improving parts like engines, electronics, and aerodynamics to make the vehicles move more efficiently.

AVERAGE SALARY: $115,000

ADDITIONAL INFORMATION

If you were making a car, how would you test to see if the car shape is AERODYNAMIC?

Engineers attach ribbons to the cars and then put them in a wind tunnel. They can tell which areas the wind slides over easily by how smooth the ribbons are. In areas that catch the wind, ribbons will ripple or tear off.

BRIDGE VS. WIND

AREA: AERODYNAMICS

EXHIBIT: BRIDGE VS. WIND

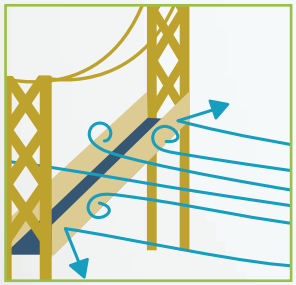
SAFETY FIRST: HOW TO USE

- Watch the video.

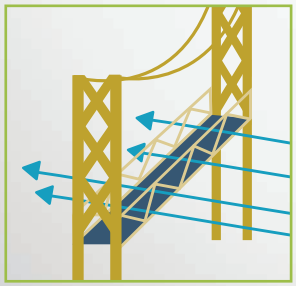
CONCEPT BREAKDOWN

- What's stronger, steel or wind?
- Even though this bridge was built from strong materials, wind pushed it down.

HOW DID THAT HAPPEN?



- First, the wind pushed against the non-aerodynamic surfaces of the bridge.
- This made the bridge sway back and forth.
- Each time the bridge moved, the steel got weaker.



- Now, bridges and skyscrapers are designed to allow air to flow smoothly around and sometimes through them.

RELATE TO REAL LIFE!

Have you ever bent a paperclip until it broke? How many times did you have to bend it before it broke? Each time you moved it, you weakened the metal, just like the metal of the bridge weakened when the wind moved it.

AREA: AERODYNAMICS

EXHIBIT: BRIDGE VS. WIND

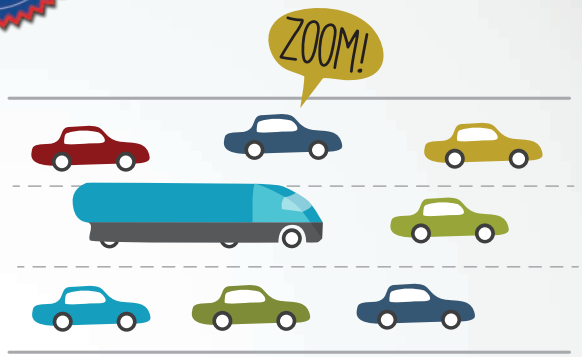
BRIDGE VS. WIND

QUESTIONS

Did you ever wonder how a bridge gets built?

- Some bridge pieces can be constructed on land and then placed into the water.
- For some projects, construction crews have to build water-tight chambers, called cofferdams, to keep the water out while they build. Early bridge-builders, like the ancient Romans, probably used cofferdams.

CAREER



Who designs bridges? **CIVIL ENGINEERS** design the structures that help us live better: roads, bridges, sewer systems, flood protection, and much more.

AVERAGE SALARY: $98,000

ADDITIONAL INFORMATION

The **TACOMA NARROWS BRIDGE,** shown in this video, only stood for 4 months and 6 days. In 1940, forty mile per hour winds brought it down.

WIND TUNNEL

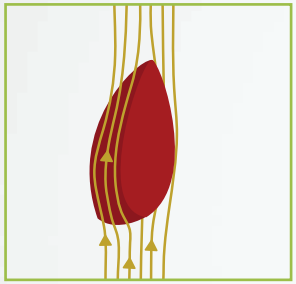
AREA: AERODYNAMICS

EXHIBIT: WIND TUNNEL

SAFETY FIRST: HOW TO USE

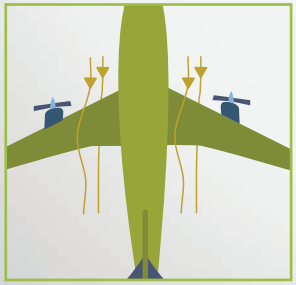
- Okay for students to handle.
- Try putting different shapes into the wind tunnel.
- Watch how they catch the air. Which shapes move fastest? Which move slowest?

CONCEPT BREAKDOWN



- Aerodynamic describes a shape that reduces the drag or pull from air moving past it.
- An aerodynamic shape, like an airplane wing or a canoe, cuts through the air.

- Non-aerodynamic shapes, like parachutes and sails, are used to catch the air.



- Air pressure is a very strong force. Engineers study the interaction between air and objects to design faster airplanes, taller skyscrapers, and safer bridges.

RELATE TO REAL LIFE!

Have you ever put your hand out a car window when the car is moving?

What happens when you hold your palm facing the wind?

What happens when you tilt your hand so that the skinny side faces the wind? You've been experimenting with aerodynamics!

AREA: AERODYNAMICS

EXHIBIT: WIND TUNNEL

WIND TUNNEL

QUESTIONS

What shapes go up the fastest? Does this mean they are aerodynamic or non-aerodynamic?

- Shapes that catch the air (non-aerodynamic shapes) go up faster.

What do you think the best shape is for a skyscraper?

- This is a trick question: there's no right answer. Architects and engineers have been experimenting with this question for years! Some shapes include tall skinny rectangles, tall skinny cylinders, tall skinny triangles, tall ovals with cut-outs, twisted cylinders, and even collections of cylinders.

CAREER

If you design cars for a living, you'll use aerodynamics to make your designs faster, safer and more fuel efficient. For example:

AUTOMOTIVE ENGINEERS design motorcycles, cars, buses, and trucks. They figure out how we'll get around on the surface of Mars, how to teach a car to drive itself, and how to power a car without gasoline.

AVERAGE SALARY: $105,000

ADDITIONAL INFORMATION

WIND TUNNELS like the one in this exhibit are used in aerodynamic research to test how different shapes interact with wind.

THEY RE ALSO USED FOR FUN! Recreational wind tunnels let you see how aerodynamic YOU are. What do you think would happen if you were in a giant wind tunnel and held your arms and legs out?

THANK YOU!

Thank you for inspiring students and encouraging them to explore careers in STEM. We could not do this work without you, and we truly appreciate your support.

If you took photos today or plan to post to social media about your experience, please consider tagging the TAME State Office. We would like to recognize your hard work and may share images and stories on TAME.org or with our corporate partners who help bring this experience to different communities around Texas.

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