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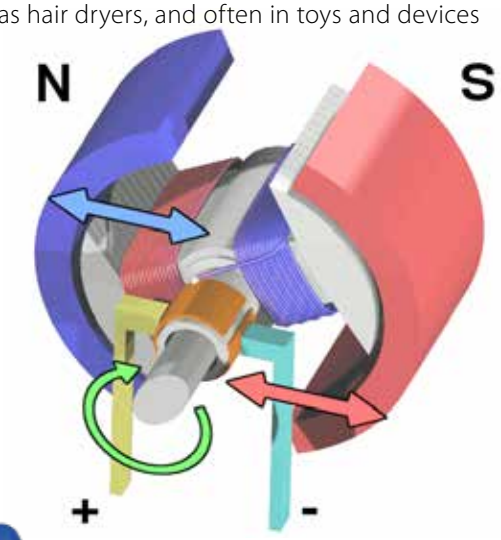
SYSTEM ALERT!

Tomorrow is almost here.

Coils and currents and torque: Oh my!

How a DC motor works

DC motors are used in battery-operated devices and some other applications. They convert direct current (DC) into mechanical energy. They are found in tools such as drills, small appliances such as hair dryers, and often in toys and devices that run without a connection to an external power source.



In the most basic DC motor, coils made of conductive wire are situated between the opposing magnet poles. The magnets surrounding the coils naturally generate a magnetic field. Electricity from a battery flows into, through, and back out of the coils.

When this current flows through the magnetic field, it causes mechanical energy, motion, in the conductive material. The coils are arranged so that they express this mechanical energy by rotating. This rotation ultimately drives a shaft that extends out from the motor. The rotation of this shaft drives the moving parts in the machine that the motor is powering.

Torque is a rotational force. In a DC motor, torque refers to the power needed to rotate the shaft when resistance (weight) is added to the shaft. The more weight that the motor can rotate on the shaft, the higher the torque rating.

Add enough weight, however, and any motor will stall. Stall means the motor stops spinning. In this case, the rotating coils cannot generate enough power to turn the weight.

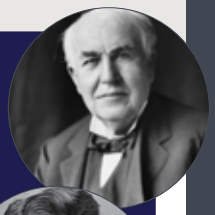
When a motor stalls, there is always a risk of burning out the motor. Why? The coils of conductive wire have an insulator on them. The heat buildup from the stall can cause the insulator to melt. This causes electrical shorts, and the motor fails.

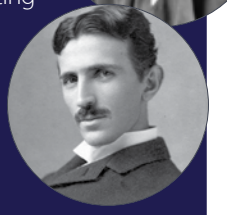
CHECK OUT:
Pitsco.com/TETRIX-MAX-TorqueNADO-Motor-with-Encoder

The TorqueNADO™ is a DC motor designed for use with the TETRIX® robotics system. If you are looking for durability and power to ensure good performance at competition, look no further.

TorqueNADO has a factory-rated stall torque of 700 ounce-inches. That means the motor can rotate, at one inch on the shaft, up to 700 ounces (about 43 pounds) before stalling. When it stalls, the TorqueNADO has another advantage. Its relatively low stall current of 8.7 amps (the amount of power it draws when it's stalled) means it can hold position several minutes before burning out.

Direct current versus alternating current





In the late 1800s, an epic battle was waged between two geniuses who each wished to be the prophet of the world's technological future. The business-minded researcher Thomas Edison and the eccentric inventor Nikola Tesla had competing visions for the uses of electricity. Edison favored direct current (DC) electricity, which always flows in one continuous direction. Tesla favored alternating current (AC) electricity, which continually reverses the direction of its flow.

Edison touted DC as safer than AC. Tesla touted the efficiency of AC. In the end, they both won. AC is the power that comes through the electrical outlets in your home. DC is the power stored in batteries that operate your handheld devices.

Online quiz and electronic version now available. Visit Pitsco.com/SySTEMalert.

Precision in the heart of the storm

Aerodyn wind tunnel

Welcome to Mooresville, North Carolina, also known as Race City, USA. Home to more than 60 NASCAR teams and one IndyCar team, Mooresville is full of automotive know-how and white-knuckle competitive spirit. And if you need aerodynamics expertise, this is your town.

Barreling down the track with a nearly 900-horsepower motor, a NASCAR vehicle encounters serious friction from the air it collides with and pushes out of its way. Friction from the air is called drag, and it slows cars down. A design that guides air away in smooth layers is essential to minimizing drag. At the same time, a certain amount of downforce from the air is necessary for good tire grip and cornering speeds. Getting that balance right means testing, testing, testing.

Wind tunnels are the classic tool for aerodynamics testing.

Gary Eaker owns and operates not one but two wind tunnels in Mooresville. Even in a town of experts, Eaker is recognized as an airflow sage. His tunnels – the Aerodyn and the A2 – are in use extensively by teams hunting a competitive edge. We'll focus on the Aerodyn, but the general picture applies to most professional-level wind tunnels.

CATCHING THE DATA

Air, drawn at high speeds through the tunnel by 22 fans running at 100 horsepower each, rushes across the body of the car. Wind speeds in the Aerodyn run up to 130 miles per hour – comparable to an EF2 tornado.

As the force of the air impacts the car, the forces are detected by an extremely precise balance in the floor.

"The balance measures all three axes," explains Eaker, "X, Y, and Z. It has drag, which is parallel to the airflow. It has lift, which is perpendicular, up and down. And it has side force, which is perpendicular, left and right." But then for each of these axes, there is also a twisting force (called roll about the drag axis, yaw about the lift axis, and pitch about the side force axis).

Anemometers and pressure gauges can provide additional quantitative (numerical) data. And smoke testing, which makes the airflow visible, provides qualitative data. Though veteran

aerodynamicists with well-honed instincts might have less use for smoke, it is still useful in unfamiliar situations and for learning the basics of airflow.

CHAOS AND CONTROL

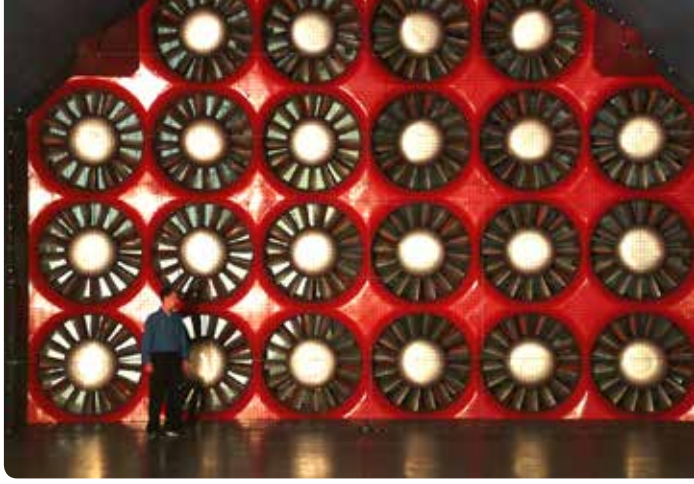
Wind tunnels were devised in the 1800s, when computer simulation was a distant dream. Are wind tunnels still relevant today? The long line of NASCAR teams waiting to have their turn in Aerodyn sure indicates so.

Computer simulations are valuable, predicting airflow to many decimal places with mathematical models. But computer simulations can't always portray the complexities of physical testing. Testing outside on an actual racetrack, on the other hand, can be a little too real world, with numerous chaotic variables.

Eaker emphasizes that a wind tunnel is a laboratory. "Laboratories are not identical to the real world. They are simplifications. Which means that you don't have as many variables to deal with. Which means that it is a manageable kind of experiment."

That is the power of the wind tunnel – airflow more "real" than a mathematical simulation but more controlled than a track run. Without control, individual variables can't be isolated and understood. And without that, there can be little confidence in the results.

"You can have the greatest simulation in the world," says Eaker, "but if you don't have a high level of confidence, it's not really worth much."



The way of the engineer

"You don't go to college to become an engineer. You go to college to become a better engineer. You're born, you're wired to be an engineer."

That is according to Gary Eaker, creator and owner of the Aerodyn and A2 wind tunnels. Raised in Flint, Michigan, Eaker originally dreamed of being a fighter pilot. When he was told he needed glasses in fifth grade, that dream ended. Fortunately, his interest in cars was equally strong. He has pursued that passion with fire his whole life.

While Eaker was working as an engineer at General Motors, a supervisor learned of his personal hobby doing aerodynamics testing on motorcycles. That landed him a job in aerodynamics, and that led in time to Aerodyn.

"If you really have a passion for what you do, you're not limiting it to a classroom. That is who you are. You never quit learning," says Eaker.

Wind tunnels in the classroom

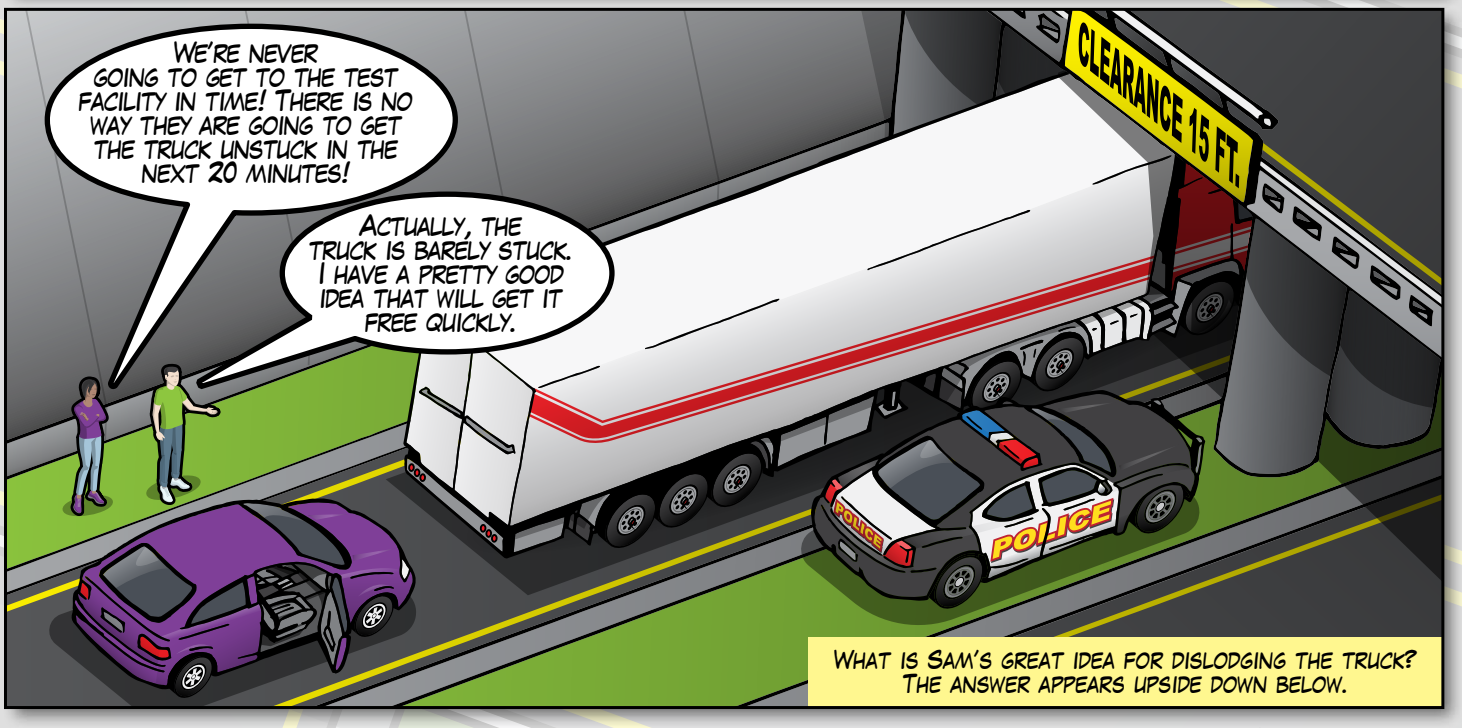
In CO_2 racing, just as in professional racing, prototyping, testing, and analysis are key to performance. Pitsco offers several wind tunnels for classroom use:

- X-Stream
- Airtech Scout 2.0
- FLO Visualization Tunnel

A streamlined design minimizing drag will give more bang for the buck, but unlike in NASCAR, downforce might not be desired. A CO_2 dragster is essentially a rocket blasting along a guideline down a track. Power doesn't come through the wheels, so grip might not be a big factor. According to Pitsco R&D Manager Paul Uttley, "A characteristic we found common to a lot of top finishers is that lift and downforce on the car were pretty neutral."

CHECK OUT:
Pitsco.com/X-Stream-Wind-Tunnel-with-Vehicle-Platform-Sensor

STEM FORCE



Storyline: Cody White | Artwork: Jason Redd | ©2018 Pitsco Education

ANSWER: BY LETTING ENOUGH AIR OUT OF THE TIRES NEAR THE FRONT, THE CAB AND FRONT OF THE TRAILER WILL LOWER. THE TRUCK WILL BECOME DISLODGED AND WILL THEN BE FREE TO BACK OUT. TIRE PRESSURE IS MEASURED IN PSI (POUND-FORCE PER SQUARE INCH). LESS PSI EQUALS LESS TIRE INFLATION EQUALS A LOWER VEHICLE HEIGHT.

LEARN MORE ABOUT THE ELITE TEAM OF HEROES IN STEM FORCE BY VISITING PITSCO.COM/SYSTEMALERT/STEMFORCE.

Light pollution – the end of night

Emissions from factories and automobiles lead to air pollution. Chemicals and waste contribute to ground and water pollution. If you have ever been kept awake by a noisy road or inconsiderate neighbors, you are familiar with noise pollution. But have you heard of light pollution?

Particularly around urban environments, human civilization produces great amounts of light. This has led to nighttime conditions that have never before been seen on Earth before modern times. Of course, our artificial light brings us many advantages, but scientists are finding that it has many drawbacks as well.

Exposure to excessive light is linked to fatigue among humans, possibly through the disruption of natural cycles and the production of chemicals such as melatonin. Migration patterns of birds and other animals have been shown to be influenced by city lights. It appears that the animals become confused.

Humans need light. But could we be using it in a healthier way? Some scientists, designers, and city planners believe so. Can you think of any innovations we might introduce to lessen the impact of light pollution?

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Student name: _____ **Class/Hour**: _____

SySTEM Alert! Quiz (Volume 6, Number 4)

1. What is the maximum wind speed in the Aerodyn wind tunnel?
    A. 80 miles per hour
    B. 110 miles per hour
    C. 130 miles per hour
    D. 170 miles per hour

2. Which is not a recognized type of pollution?
    A. air pollution
    B. sound pollution
    C. light pollution
    D. food pollution

3. DC motors convert _____ into _____.
    A. direct current, mechanical energy
    B. direct current, potential energy
    C. alternating current, mechanical energy
    D. alternating current, potential energy

4. What word or phrase best describes torque?
    A. chemical energy
    B. rotational force
    C. horsepower
    D. potential energy

5. Friction between the surface of a car and the air is called what?
    A. drag
    B. torque
    C. pitch
    D. alternating current

6. How can downforce help a race car?
    A. It keeps the car from flying away.
    B. It helps fuel efficiency.
    C. It improves the grip of the tires.
    D. It doesn't. Downforce is always a disadvantage for a race car.

7. Match the inventor to the electrical current he promoted.
    A. Michael Faraday, electromagnetic current; Steve Jobs, design current
    B. Steve Jobs, design current; Michael Faraday, direct current
    C. Thomas Edison, direct current; Nikola Tesla, alternating current
    D. Nikola Tesla, torque current; Thomas Edison, alternating current

8. What is the advantage of testing cars in a wind tunnel over testing cars on a track?
    A. Air speeds are greater in a wind tunnel.
    B. Wind tunnels help narrow a test to look at specific variables.
    C. It is harder to schedule time at a track.
    D. No equipment has been invented to test cars on a track.

9. Excessive light can disrupt the production of which chemical in the body?
    A. melatonin
    B. cortisol
    C. insulin
    D. lactic acid

10. What is the most common application for DC motors?
    A. fans
    B. cell phones
    C. fidget spinners
    D. battery-operated devices

Bonus:
Artificial lighting has advantages. But it also has disadvantages. The excess light in urban areas creates unnatural conditions that can confuse nearby wildlife and disrupt biological cycles in humans. Do you think it is worth the effort and cost to redesign the technology we use for artificial lighting? Why or why not?