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SYSTEM ALERT!
Tomorrow is almost here.

Microcontrollers out of sight

For thousands of years, people have looked to technology to bring convenience and wonder to life. In modern times, it has become harder and harder to observe the inner workings of many of these technologies. Take the face off of a windup clock and you can see its gears moving. Compare this to a digital clock or a smartphone; when the case is opened, these appear as unmoving pieces of silicon, metal, and plastic.

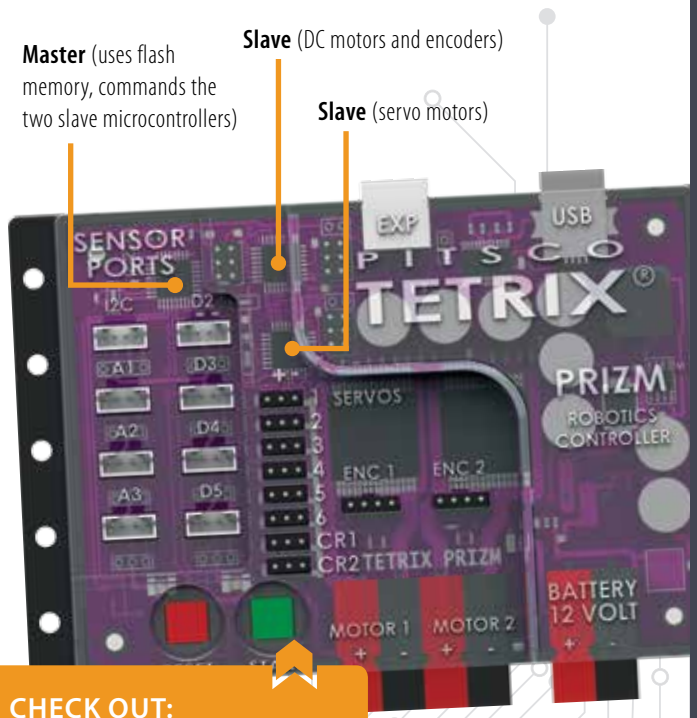
A microcontroller is one such technology that profoundly affects our lives but works in ways that can't be directly observed. You might have never seen a microcontroller, but you have certainly used one. Essentially they are tiny computers. Found within countless devices and machines, they bring functionality by following programmed instructions. For example, when you put a flash drive in the USB port of a laptop computer, it is a microcontroller inside of the flash drive that communicates with the laptop to transfer the information between the two systems.

Pitsco recently released a product called PRIZM™ that enables students to program TETRIX® robots to do tasks. PRIZM connects to a robot and tells the different components of the robot how to behave. But what is going on inside of the PRIZM itself? The device has numerous components, but at the heart of its operation are three microcontrollers. These microcontrollers cooperate to perform the instructions that students have written in the form of code.

When students decide what they wish their robot to do, they write out a set of instructions in code. (PRIZM comes with software that simplifies this considerably.) The code is not quite like standard written English, but it is made for humans to understand. A computer, however, can't understand it until it is compiled. This means that it is translated into ones and zeroes.

The code is sent to the first microcontroller within PRIZM, where it is saved using flash memory. Until it receives code it is just a blank chip with transistors, inputs, and outputs that can manipulate the flow of electricity to do mathematical calculations. This first microcontroller is called the master.

There are two other microcontrollers. These are not called masters, however. These are slaves. That is because the master tells them what to do. The slave microcontrollers have specialized functions. In PRIZM, one of them controls the robot's DC motors. The second controls all of the robot's servo motor functions. These perform the tasks that the master instructs them to do. These three microcontrollers working together to execute code cause a robot to behave in complex ways.



CHECK OUT:
TETRIXrobotics.com/PRIZM

Paul Uttley, manager of Research and Development at Pitsco, led the development of PRIZM™, which uses three microcontrollers. He reflects on his personal connection to programming and technology. "The first time I started using microcontrollers, it was like creating art to me. That sounds funny, but you can take this blank piece of silicon that does nothing, and you can write tasks on your computer in the form of code and then flash those down onto the microcontroller – and the microcontroller does what you tell it to do. It almost comes to life!"

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

Everything blurs

There is more than one famous family in auto racing. Veteran drag racer Randy Meyer already had made a name for himself, and now his daughters are following him into the sport. His eldest daughter, Megan, recently gained some glory for the family – becoming the fastest female in the history of top alcohol drag racing. Megan, who is also a professional graphic designer, started racing at 10 years old.

Recently *SySTEM Alert!* sat down with her to find out what it is like to be in the driver's seat of a vehicle that travels close to 300 miles per hour.

How fast can you go down the quarter-mile track in your top alcohol dragster?

My record that I broke for the quickest female was 5.17 seconds. That is not typical. The average is about 5.3 seconds or maybe a little quicker than that. When I ran the 5.17, we had cool weather conditions and a good track.

The differences you mention are measured in hundredths of a second.

It's the hundredths and thousandths of a second that make all the difference in racing. Usually you are neck and neck.

How does it feel to go that fast?

It is **3 g** from when you leave the starting line. Your mind can't go that fast. The first couple times I did it, it was so blurry I couldn't see anything. It was a huge adrenaline rush. The more full-track passes that I made, the more I got used to it and the more I could start seeing where stuff is on the track.

Whenever you pull the parachutes, it is negative 3 g. When they strap you in the car your seat belt is on so tight you literally can't move. But when you pull the parachutes, you end up leaning forward. Because of this, the seat belts can actually stretch out, so every two years we put new seat belts on it.

What roles do the members of your team play?

Here's how we do our program. Other teams can be completely different.

The driver's duties are filling up the car with fuel between rounds. You've got to make sure the 95 to 5 percent **ratio** is correct and within the rules. We cool our fuel, so it can't be below 40 degrees. You don't want it to be warm because it loses power. I'm also the one who takes the **Racepak data** from the car to our laptop and goes through it with my dad. We analyze what happened in the run.

Our crew chief, which is my dad, is the guy who looks over everybody else. Usually the crew chief takes care of all the tuning. So he is

Nitro-methanol fuel

Meyer's top alcohol dragster runs on a mix of 95 percent nitro and five percent methanol. The nitro provides way more power than gasoline, but it also causes the motor to get extremely hot even after just a few seconds. It gets so hot it can be hard to shut the engine down. The methanol dilutes the nitro. ⚠

G-forces

3 g? What does that mean? Getting technical, your weight is a measure of how much force is created by the acceleration due to gravity (g). When you are standing still, you have the normal force of Earth's gravity acting on you, which results in your current weight. That is a result of an acceleration of 1 g. Speeding up and slowing down are both changes in acceleration and so affect the amount of g you experience, and this in turn affects your perception of weight. At 2 g, you "weigh" twice what you do at 1 g. At 3 g, three times. Every part of you feels heavier. Very high g-forces can be dangerous. ⚠

One small trip for Uber, a giant drive forward for self-driving cars

The transportation service company Uber recently got in on the self-driving car trend. The company launched a small fleet of the autonomous vehicles in the city of Pittsburgh, PA. Though the cars are capable of navigating by themselves in traffic, a human driver accompanies the vehicles for safety backup. ⚠

Racepak data logger

The Racepak Meyer speaks of is a type of data logger. During the race it records information from sensors located throughout the car. Looking at this data after the race, the team can get a detailed picture of how the car performed and how it might be improved. "There are tons of sensors on the car," says Meyer. "We have a brake pressure sensor, a wheelie bar sensor, a front wheel sensor, exhaust, oil pressure, air fuel, fuel temperature – to name just a few."

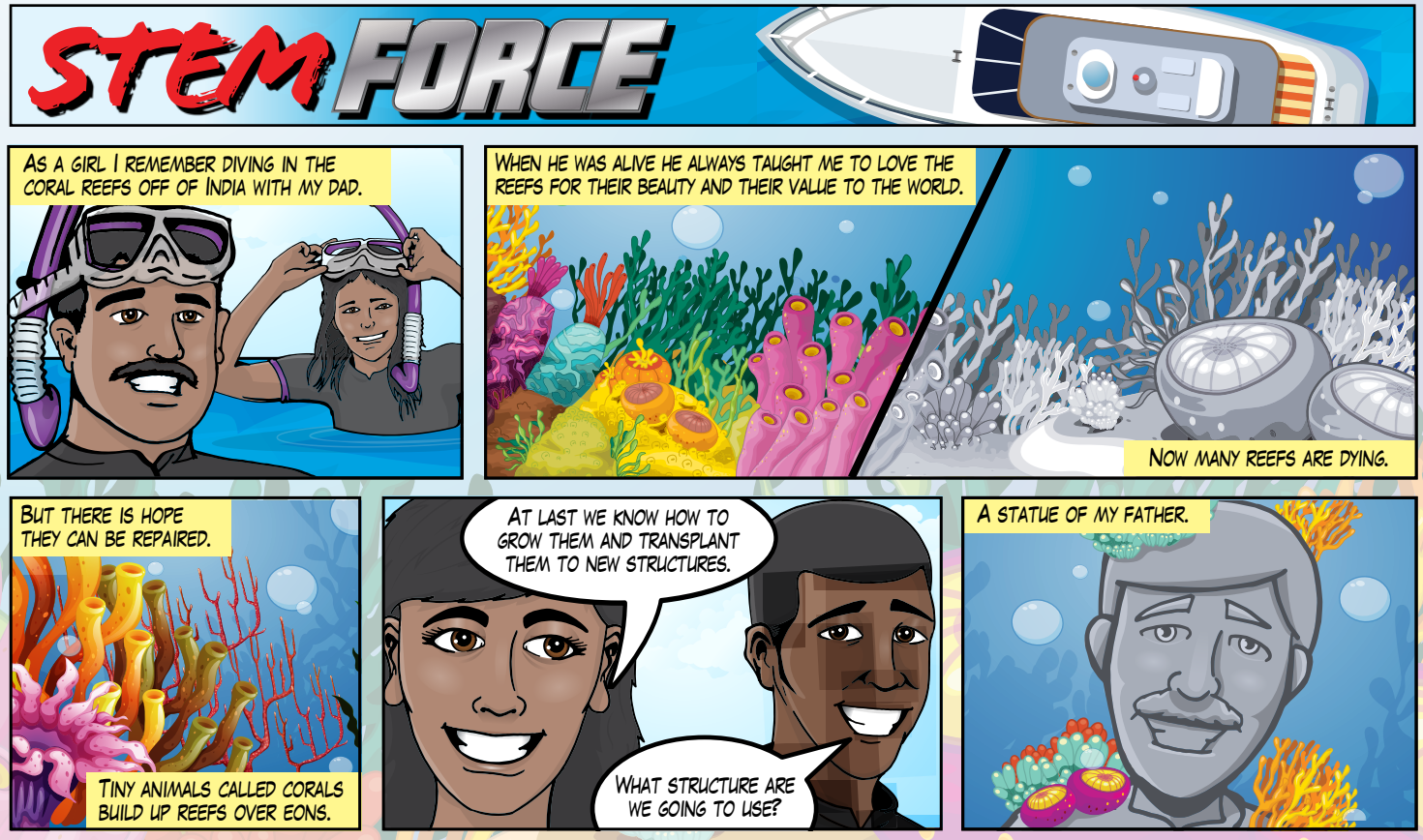
going to be on the computer in the trailer going over all of the past data, trying to figure out what kind of tune-up we need to put into the car to put into the Racepak. He's the one who makes all the calls.

We have a top-end guy on the right side of the car and a top-end guy on the left side. They do the exact same things, just on their own sides. After every run they put in new spark plugs and three gallons of oil. And then they'll check the valves. If anything is hurt they'll put a new part in it. But typically we don't hurt many parts.

For underneath the car, we have a bottom-end guy. That was the job I had before I was a driver. They drain the oil from the car, put new bearings in, check the rods and pistons, and check the cam. Putting the bearings in takes the longest of all the mechanical jobs because you have to take everything apart and put it back together.

We also have our clutch guy. He manages the tires, the rear end, and the clutch. Every run we take out our clutch pack and put a new clutch pack in. He is in charge of the back half of the car.

CHECK OUT:
Pitsco.com/Foldnroll



Learn more about the elite team of heroes in STEM Force by visiting www.pitsco.com/systemalert/stemforce. Discover character bios, previous issues, and more.

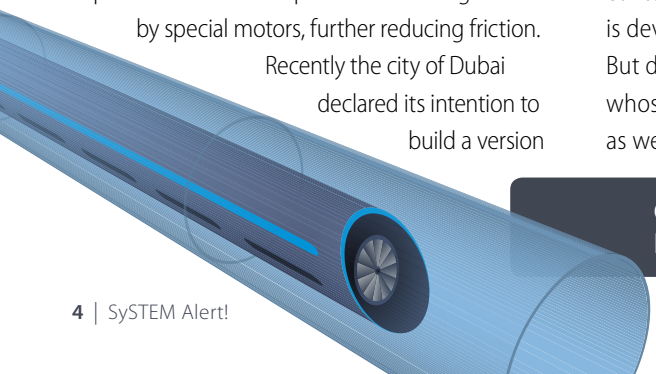
Innovators worldwide cooperating to make the **Hyperloop** a reality

When Japan's maglev bullet train achieved a speed of 374 miles per hour it became the world's fastest train. But that might come to seem like a lazy stroll if billionaire entrepreneur Elon Musk's vision of the Hyperloop becomes a reality. At projected velocities of 760 miles per hour, the Hyperloop could transport commuters at unprecedented speeds.

The key to the Hyperloop concept is this: air, or the lack of it. The passenger-carrying capsules would travel in tubes in which most of the air has been pumped out. The lack of air pressure would dramatically reduce friction. Within these tubes, the capsules would ride atop a cushion of air generated by special motors, further reducing friction.

Recently the city of Dubai declared its intention to build a version of the Hyperloop that would travel to the city of Abu Dhabi, 100 miles away, in 12 minutes. Some caution that engineering hurdles still remain and that the mode of transportation isn't ready to be deployed yet, but others around the world are working to overcome the hurdles.

Interested onlookers are keeping their eyes on a competition among teams to devise the most innovative capsule design. In the contest's first round, more than 120 teams competed, making small-scale models of their designs. Twenty-nine college and university teams were selected to move on to the next round of the contest. Much of the world's greatest innovation is developed by research teams at universities. But don't count the other teams out: one team whose members met online is also competing, as well as a team of high school students.



CHECK OUT:
Pitsco.com/Maglev

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

SySTEM Alert! Quiz (Volume 5, Number 3)

This quiz covers the information in *SySTEM Alert!* Volume 5, Number 3. Circle the letter of the correct answer or write the letter by the question number.

1. When a computer compiles a programming language, what does it do?
   A. sends a command to a master microcontroller
   B. translates it into ones and zeroes
   C. saves data
   D. activates a servo motor

2. What type of memory is used in the master microcontroller in the PRIZM™ programmable controller?
   A. ice memory
   B. bolt memory
   C. flash memory
   D. bubble memory

3. What is the nitro-to-methanol ratio used in Megan Meyer's top alcohol dragster?
   A. 95 to 5
   B. 93 to 7
   C. 3 to 4
   D. 1 to 1

4. Getting technical, _____ is a measure of how much force is created by the acceleration due to gravity.
   A. mass
   B. temperature
   C. volume
   D. weight

5. If you weigh 150 pounds at 1 g, how much do you weigh at 3 g?
   A. 50 pounds
   B. 150 pounds
   C. 450 pounds
   D. 1,500 pounds

6. Which organization recently launched a small fleet of self-driving cars in the city of Pittsburgh, PA?
   A. Uber
   B. Toyota
   C. Amazon
   D. NASA

7. Which of the following is not a sensor in a top alcohol dragster?
   A. gravity
   B. brake pressure
   C. exhaust
   D. fuel temperature

8. What tiny animals build reefs in the oceans over long periods of time?
   A. ocean sunfish
   B. echinoderms
   C. algae
   D. corals

9. What is the projected top speed of the Hyperloop?
   A. 335 miles per hour
   B. 500 miles per hour
   C. 760 miles per hour
   D. 1,220 miles per hour

10. Which city is working to build a 100-mile stretch of Hyperloop track?
    A. Dubai
    B. San Diego
    C. Moscow
    D. Atlanta

Bonus question:
Imagine you are designing a test of a self-driving car. The vehicle will be tested on city streets in normal traffic. Describe your test. What precautions will you take? How many cars will you use? How long will your test take? Justify your answers.