COMMONLIT

Name: _____ Class: _____

A Slick Little Robot

#3 due Friday

By Harry T. Roman
2015

Harry T. Roman is an educational adviser, author, and inventor. In this article, Roman discusses one of the many robots he helped design and the impact it has made in the world. As you read, take notes on how OTIS changes work for humans.

[1] OTIS is a mobile[1] robot, and I helped design it.

Actually, OTIS is just one of about twenty robots I helped create. CECIL crawls inside the dangerous reactor areas of nuclear power plants[2] and submarines. RoBall can walk inside steel pipes and inspect them with a tiny camera. And SURBOT climbs stairs, guards high-security areas, and lifts heavy objects.

But OTIS is my favorite. It was the first robot I helped design, and now it is used all over the world.

"OTIS crawls along, inspecting the floor of an oil tank." by Eugene Silverman, ARD Environmental, Inc., Laurel, MD is used with permission.

OTIS is short for Oil Tank Inspection System. It is used to inspect oil tanks at refineries,[3] power plants, and seaports.[4] Those large, tuna-can-shaped tanks hold fuel oil for trucks, homes, and factories. The tanks are often forty to one hundred feet across and fifty feet high. Five to eight medium-sized houses could fit into one of these tanks.

[5] To make sure oil doesn't leak into the environment, the tanks must be cleaned and checked regularly. The usual way of cleaning and inspecting the tanks creates problems. Draining the oil from the tanks is messy. Also, the people who climb inside the tanks to inspect them are in danger, even though they use special suits and breathing equipment. These inspectors sometimes must spend weeks doing the hot, boring work.

OTIS does the job in a couple of days, saving time and money. The oil tanks need to be drained only when OTIS finds a spot that has to be fixed.

OTIS's Job

When we designed OTIS, our challenge was to create a robot that could clean the oil and inspect the steel floor of the tank while all of the oil was still in the tank! No one had ever done that before. Here is how we did it.

1. **Mobile** *(adjective):* able to move freely or easily
2. a facility that generates power using nuclear energy
3. a facility that purifies substances
4. a harbor or town that is accessible by ships

Our first problem was to choose the right material for OTIS's body. Otherwise, the oil in the tank would harm the robot and possibly leak inside and destroy delicate electronic equipment. We used a strong plastic. Rubber seals between body parts prevented the oil from leaking into OTIS, even at high pressures. The pressure at the bottom of an oil tank is similar to being under tons of water.

Next, we made an important decision about how OTIS would move around inside the tank. There were two choices: Let the robot swim through the oil or roll along the bottom of the tank.

[10] Since OTIS would need to bring vacuum hoses and electrical cables to do the job, we decided to lower the robot in through the opening at the top of the tank. We used magnetic wheels to attach OTIS to the metal tank floor. Having the robot crawling on the floor gave us a way to track where OTIS was at any time.

Seeing Through Oil

Next we gave our robot special camera eyes so we could see the tank floor. We designed lights that would allow OTIS to "see" through the yellow-orange color of the oil. These eyes show us the floor plus any obstacles that OTIS may have to avoid, such as devices that warm the oil in cold weather.

In OTIS's belly, between his wheels, we placed a small but high-powered vacuum system. This device sucks up dirty oil that has sunk to the bottom of the tank. The dirty oil goes up one vacuum hose to the top of the oil tank, where a special filter removes the dirt. The clean oil then flows back into the tank through another hose.

The Robot's Brain

Maybe the hardest part to design was OTIS's "brain." We had to solve the problem of how OTIS could check the metal floor of a tank for cracks, holes, or other problems.

We used high-pitched sound waves called ultrasonics. We cannot hear these sound waves. They are beyond the range of human ears.

[15] Like a bat hunting for insects, OTIS uses ultrasonics to read the surface of the metal. Common bats of North America hunt by sending out squeaks, which bounce off objects and return to the bat. A bat can tell where an insect is by how long it takes sound waves to bounce off that insect and enter the bat's ears.

In a similar way, OTIS gets information about the floor of the oil tank by sending down sounds that bounce off the floor back to the robot.

OTIS is constantly sending information by sound so that the person operating the robot can tell where it is and what it's doing. OTIS's location is shown on a screen. As OTIS gathers information about the floor of the tank, that information also shows on the screen. The good areas of the floor appear as green, and the bad areas are shown in red.

Whenever I see those large tanks I think of OTIS. I wonder where he is, helping to keep the environment clean and humans safe from dangerous work. Now there are more robots like OTIS, doing the same kind of work. I wonder what their names are!

Text-Dependent Questions

Directions: For the following questions, choose the best answer or respond in complete sentences.

1. PART A: Which statement best expresses the central idea of the article?
   A. The purpose of all robots is to protect humans from taking part in life-threatening tasks.
   B. All of Harry T. Roman's robots have helped protect humans and the environment.
   C. Robots are often designed based on the special skills or behaviors of certain animals.
   D. OTIS accomplishes complicated tasks that could be dangerous or unpleasant for humans.

2. PART B: Which detail from the text best supports the answer to Part A?
   A. "RoBall can walk inside steel pipes and inspect them with a tiny camera. And SURBOT climbs stairs, guards high-security areas, and lifts heavy objects." (Paragraph 2)
   B. "To make sure oil doesn't leak into the environment, the tanks must be cleaned and checked regularly." (Paragraph 5)
   C. "OTIS does the job in a couple of days, saving time and money. The oil tanks need to be drained only when OTIS finds a spot that has to be fixed." (Paragraph 6)
   D. "Common bats of North America hunt by sending out squeaks, which bounce off objects and return to the bat." (Paragraph 15)

3. Which sentence best describes the relationship between OTIS and ultrasonics?
   A. OTIS bounces soundwaves off of objects to get around and collect information.
   B. OTIS uses sound to find his way around, because it's impossible to see through the oil.
   C. OTIS uses ultrasonics to communicate his finding directly to humans.
   D. OTIS is able to take instructions from humans by listening to ultrasonics.

4. How does paragraph 5 contribute to the development of ideas in the text?
   A. It emphasizes the risks and challenges associated with cleaning oil tanks.
   B. It stresses the skills required of humans to clean the inside of oil tanks.
   C. It reveals how oil can affect the environment if it leaks from a tank.
   D. It suggests that cleaning oil tanks is an expensive task.

Discussion Questions

Directions: Brainstorm your answers to the following questions in the space provided. Be prepared to share your original ideas in a class discussion.

1. In the article, the author outlines the benefits of OTIS. What are potential disadvantages of mobile robots? What are the costs and benefits of technology? Do you think the benefits outweigh the costs? Why or why not?

2. The author lists several robots that he helped to create with the intention of helping people. What are other examples of robots in the world that help humans complete boring or dangerous tasks? Do you use any types of robots in your daily life? If so, describe them.

* USE RACES and Underline

5. Explain the author's point of view of OTIS in the text. Cite evidence from the text in your response.

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Dividing Fractions

1. Another term for the multiplicative inverse is the _____.
2. To find the reciprocal of a number, write the number as a _____.
3. Then, _____ the numerator and denominator.
4. Any number times its reciprocal is _____.
5. Find the reciprocal of each number below.

$\frac{1}{4} \times \_ = 1$ $\frac{2}{5} \times \_ = 1$ $\frac{8}{9} \times \_ = 1$ $7 \times \_ = 1$

6. To divide fractions, change the operation to _____.
7. Then, multiply the dividend by the _____ of the divisor.
8. An easy way to remember it is:

KEEP the first fraction the same
CHANGE division to multiplication
CHANGE the second fraction to its reciprocal

$\frac{1}{2} \div \frac{2}{3} =$	$\frac{3}{7} \div \frac{3}{8} =$

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Practice: Dividing Fractions

Find each quotient. Simplify your answers.

#1 $\frac{2}{9} \div \frac{10}{14} =$	#2 $\frac{6}{10} \div \frac{2}{7} =$
#3 $\frac{4}{9} \div \frac{8}{12} =$	#4 $\frac{6}{14} \div \frac{1}{8} =$
#5 $\frac{1}{3} \div \frac{15}{21} =$	#6 $\frac{3}{24} \div \frac{2}{6} =$

#7 Shea is making costumes for the school play. She has 14 feet of ribbon. She needs to cut pieces that are $^3/_5$ feet long. How many full pieces can Shea cut? How much will she have leftover.