NXT Project – Automated Mining

By Coni I. Peralta

## Robotics Coordinator

Felta Multi-Media, Inc.

Connect Phase
Automated Mining

Underground mining is a very hazardous operation. With threats from fire, tunnel collapse, and the underground environment itself, the mining industry is always looking for ways to increase the safety of its employees, while still extracting the needed materials. An automated mining machine may be the answer.

Continuous Miner

The National Robotic Engineering Center's Underground Mining Operator Assist project improves safety and increases productivity in the underground mining industry. Sensors mounted on the mining equipment can accurately measure the machine's position, orientation and motion. These sensors allow operators standing at a safe distance to precisely control the machine.

Replay
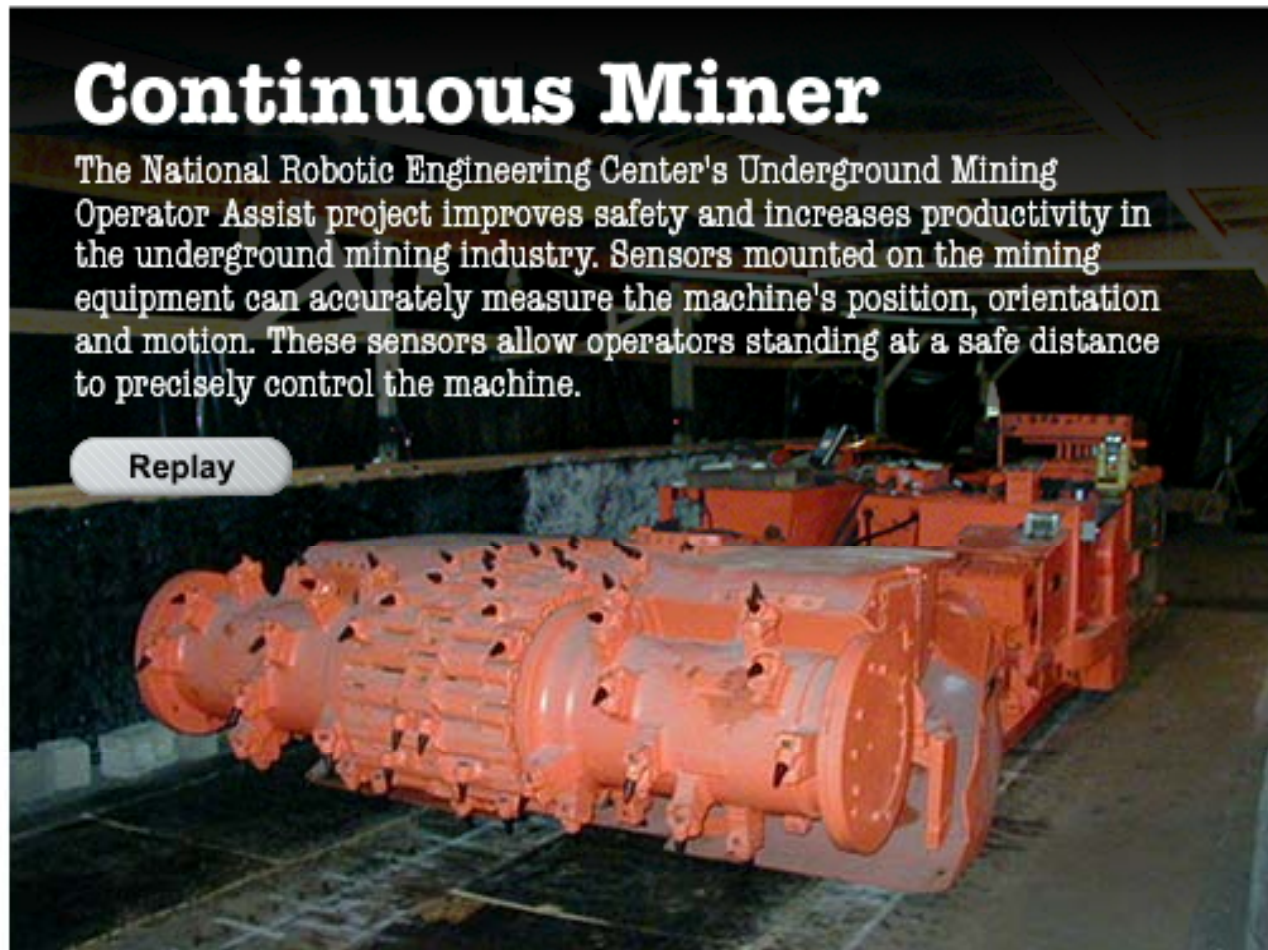
Footage courtesy the National Robotics Engineering Center

Materials

Mining Robot

Mining Robot
Ultrasonic Sensor
Attachment

Maze-Making Materials

Moveable Wall

NXT Bins

Wood or cardboard

Construct Phase
Goals and Materials

You will:

- Construct a robot with an independently-articulated Ultrasonic Sensor mount

- Program the robot to:

  - Drive along the 'stem' of a T-shaped mineshaft until it reaches the intersection

  - Get close enough that the Ultrasonic Sensor can see around the corner

  - Turn the Ultrasonic Sensor (without turning the rest of the robot) to measure the distance down both tunnels

  - Decided which tunnel is shorter

  - Drive down the shorter (unmined) tunnel until robot is at wall face
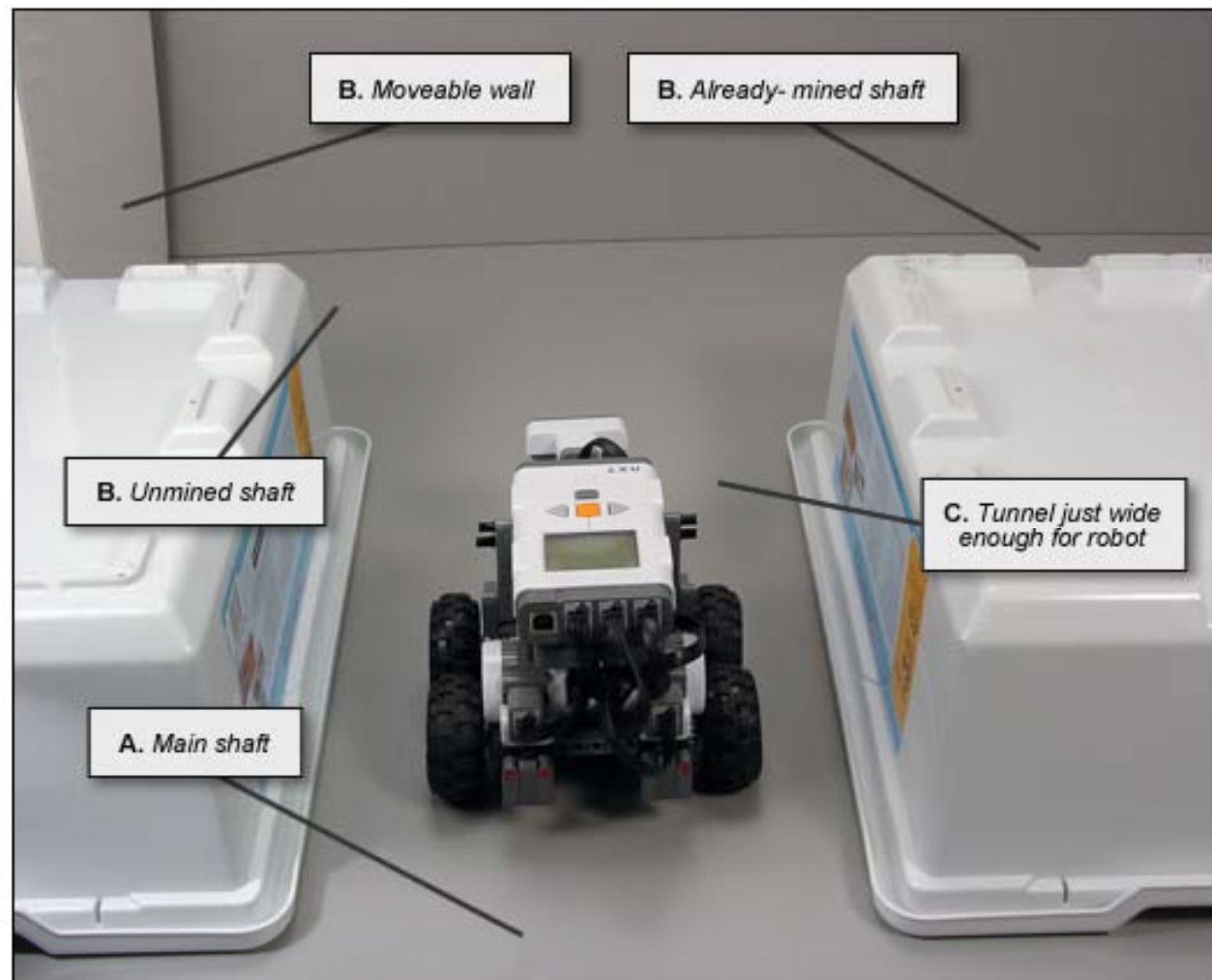

Worksheet

Open Worksheet

Construct Phase
Build Simulated Environment

Using cardboard, wood, NXT bins or other materials, construct a simulated mining environment. Your setup should resemble the photo at right.

A. The environment should have two long shafts meeting at a T-intersection.

B. The "horizontal" part of the 'T' should have one short shaft and one long shaft to represent the unmined area and the already-mined area.

C. The tunnel should be wide enough for your robot to travel, but not much more. It's expensive to build wide tunnels!

B. Moveable wall

B. Already- mined shaft

B. Unmined shaft

C. Tunnel just wide enough for robot

A. Main shaft

Construct Phase

Create a New Program

Follow along with the video on the right to start up the LEGO MINDSTORMS Edu NXT programming software and create a new program.

Review
How to use the NXT programming software

My Computer

Now that the robot is built, we need to program it.

start

Construct Phase
Rotating Ultrasonic Sensor

In this first segment of the program, you will program your robot to turn its Ultrasonic Sensor to the left and the right and take readings. It will display these readings on the screen.

Tip: If you ever need to adjust the direction of the sensor, pull off the 20-tooth grey gear, rotate the sensor, then replace the gear.

Construct Phase

Navigate to Intersection

In this second segment of the program (which actually comes before the first segment, program-wise), the robot will move and position itself in the intersection based on distance to the back wall of the "T".

Construct Phase
Choose Unmined Tunnel

In the third and final programming segment, the robot will take the two sensor readings and decide which tunnel is the unmined (shorter) one. It will then turn and move up to the wall face in that tunnel to begin its mining operation.

Contemplate Phase
Conclusions & Exercises

1. How does the robot know which way to turn to continue mining?

2. Why is it important for the robot not to run into any walls?
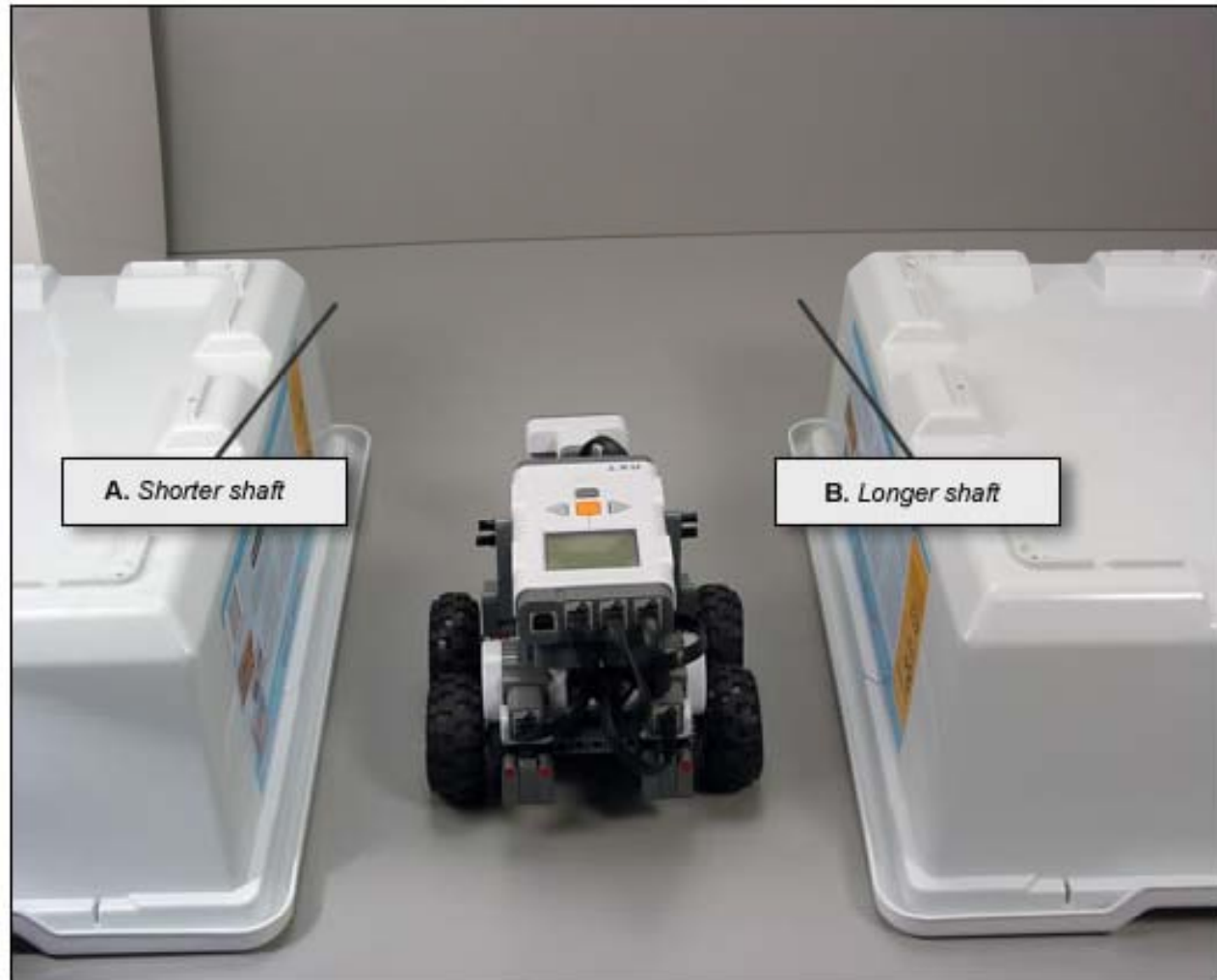
Continue Phase
Longer Shaft

Change one single Block in your program so the robot moves down the longer shaft instead of the shorter one.

A. *Shorter shaft*

B. *Longer shaft*

Continue Phase
Emergency Stop

Mine shafts can be full of dangerous conditions. Add a sensor to your robot that prevents it from striking an object or falling into a deep hole... perhaps a Touch Sensor? Building instructions for the **bumper** shown here can be found below.

For a greater challenge, try adding a bumper that *releases* when the robot finds a "negative obstacle" like a hole in the ground. The Touch Sensor Block can react to being released as well as pressed...

You can add emergency stop functionality to your existing program without changing any of the other blocks! Consult the **Abort program** example.

Review
NXT Sensors

Build
Mining Robot
Bumper Attachment

Sample Program
Abort Program example

Continue Phase
Light & Dark Finder

Monitoring conditions in the mine are important for the robot. Add a Light Sensor to the robot so that it can check for three or more conditions:

• Darkness: to be sure it is in the main shaft
• Light: to know when it has found an opening
• Conditions between dark and light in case other conditions should be added and/or checked.

To check for multiple conditions, you can add a Switch inside a Loop and set the Switch for multiple cases. See Advanced: Multiple Cases.

Review
NXT Sensors

Review
Parts Identification

Advanced
Multiple Cases