UNIT 5

Building & Programming

UNIT OVERVIEW

UNIT NUMBER: 5

DURATION: Iterative until end of semester or the end of competition (whichever comes later)

SUMMARY

In this unit, students will begin building and programming the robot designed in the previous units. They will implement the rest of the design process (prototype, test, redesign), and through this process will learn about working with hardware, electronics, and programming. They will build and program the robot and then test it to see where it fails. Then they will go back to the drawing board to design and implement improvements. The programming and engineering teams will work closely to make sure the physical design and software design are always in sync.

INSTRUCTIONS

1. Have students create a project timeline.
2. Students will then use the design process to build the robot. They will:
    1. Build and program the prototype.
    2. Test the prototype.
    3. Redesign the robot.
3. Students should use the Knows and Need-to-Knows listed in the previous modules to guide their learning.
4. Students should access engineering and programming tutorials included in this unit and

LEARNING RESOURCES

Below are general learning resources. Specific tutorials related to this unit are in production and will be added when ready.

Engineering Resources

Modern Robotics Hardware Tutorials
Rev Hardware Tutorials
Robot Building Resources
How to Solder
Modern Robotics Sensors

previous units, as well as online resources to gain the skills they need.

5. Remind students that they must:
    1. Document everything in the Engineering Notebook.
    2. Demonstrate safe use of a tool to you before using it in the build process.

Programming Resources

FIRST Tech Challenge Specific Resources

Java Tutorials

Blocks Tutorials

FIRST Tech Challenge GitHub Code

Java Resources

Codecademy Java Course

Learn Java Online

ASSESSMENTS:

1. Weekly Engineering Notebook
2. Weekly Self & Peer Evaluation

TOOLS & MATERIALS

1. Tetrix Kit of Parts or Rev Kit of Parts
2. Electronics parts
3. Anderson Power Pole
4. Soldering iron
5. Saws
6. Wrenches
7. Drill
8. Allen wrenches
9. Any and all power tools available

STANDARDS ADDRESSED:

Full course standards alignments can be found here.

CREATING A PROJECT TIMELINE

Robot Order of Operations
Have the team create progressive deadlines between now and your first competition. Even if your team(s) are not competing, deadlines are still a vital project management skill for students to learn. Major milestones are listed below, but your teams should be much more specific.

1. Design the Robot
2. Build the Robot frame
3. Attach the Android phones
4. Lay out the wiring and draw a wiring diagram
5. Wire the Robot
6. Program the Robot
7. Test the Robot
8. Make adjustments
9. Repeat

Specific Tasks
Teams should take the major milestones and break them up into small tasks. This list should include everything that needs to be done throughout the season. Helpful questions may be:

1. What is involved in completing this milestone?
2. How many parts are included?
3. How does this design fit into this milestone?
4. What materials are needed for this task?

This process is often difficult for new teams because they don't always know what is involved until they get farther into the work, but that's okay. The plan may change along the way, but this will help the students learn to plan and think through the process beforehand. If they don't plan beforehand, they will get distracted, make design changes too late in the process, fall behind their deadlines, and ultimately fail to finish on time.

Due Dates
The team should then assign due dates to each of the tasks listed. Helpful questions may be:

1. How long will this task take?
2. What needs to be done before this task can be started?
3. Which team members will be responsible for this task?

The team should refer to these dates on a daily basis to make sure they are on track. If they are, congratulate them! If not, help them figure out how they can catch up or adjust their deadlines.

ADVANCED ENGINEERING SKILLS

The following challenges are not required, but may be useful if it applies to the team's robot design.

Using gears

Gears are a great way of adding power to a robot.

Use gears to increase force to the robot's drivetrain or servo-based manipulator.
https://youtu.be/0W1q1_hU57g

Creating a motor-powered pickup system

Design a motor-powered system to pick up objects.

Creating a motor-powered pickup system - In the video below, Robot in 3 Days shows their end effector design to pick up objects for the 2015-2016 season.
https://youtu.be/JMwx87KibR4

Creating a lift system

The *FIRST*® Tech Challenge robot must begin the competition by fitting in an 45.72mm (18 in.) cube, but it may then expand to any size it needs to accomplish the tasks of the game. Expansion is necessary to reach field objects and do things such as climb hills and hang from bars.

Use a 4-bar linkage, rack & pinion system, scissor lift, or another unique design to build a manipulator that expands beyond the 45.72mm^3 (18 in$^{3)}$ starting size.

Creating a lift system - There are many ways to design lift systems. In the video below, Robot in 3 Days shows their design for the 2015-2016 season. https://youtu.be/JMwx87KibR4

Mitigating electrostatic discharge

Robots can sometimes create an electrostatic charge while moving around on the playing field. This can cause problems in the way your robot functions, so certain design principles can be used to mitigate such discharge.

Mounting encoders

Encoder kits contain instructions on how to mount them onto the motors. Use these instructions to mount your encoders. The general steps are:

1. Use M3 screws to screw the encoder base to the Tetrix motors.

2. Then place the optical disk with the pattern side down (so that the LED on the encoder base will shine onto that surface) and use the spacer tool to slide the disk into place. (Hint: Users should be careful not to touch the optical disk and leave fingerprints.)
3. Then, snap the cover in place and plug in the connector cable.

Rev Inertial Measurement Unit

https://youtu.be/eN7fQnQ8zeg

Advanced Hardware Setups

https://youtu.be/gBHW4kVQsiM

https://youtu.be/U3E5AM56xzg

https://youtu.be/7rbLDden-Rs

DEMONSTRATING TOOL SAFETY

The following challenges are not required, but may be useful if it applies to the team's robot design.

Stopping on a line

Place a line of tape on the ground. Program your robot to move forward until it reaches the line, and then stop.

Java - Using an Optical Distance Sensor https://youtu.be/44UlKiU_8us

Blocks - Using a Color Sensor Part 1 https://youtu.be/iQufRF1HFRc
Blocks - Using a Color Sensor Part 2 https://youtu.be/uSEEO3_JVTI

Stopping on different color lines

Place another line three feet behind the first line using a different color of tape. Program your robot to distinguish the difference between the colors. The robot should NOT stop when it reaches the original line, but should stop upon reaching the new line.

Stop a certain distance from an object

Program the robot to stop at a specific distance from an object.

Stop when touching an object

Program the robot to stop when it has touched an object.

Using touch sensor

https://youtu.be/r2ZanwiETj0
