

Project Assessment 2

This document is an excerpt from the full Orchard Project Overview. The material included here focuses on high-level themes and assessment, and is intended as a reference. For details on logistics and sequence, please see the full overview or the lessons excerpt.

Orchard Project Assessment Guide

The Orchard project is composed of two major parts.

In Lesson 1, students will research the role of automation technology in one sector of agriculture (pesticide spraying), and put together a presentation to a prospective client to secure funding to begin development.

Lesson 2 is an introduction to radio control, programming and sensors through a series of increasingly sophisticated prototypes of a mobile robot platform that can navigate the tight spaces between rows of trees in an apple orchard.

Lesson 2: The Solution

Students will develop a robot in four iterations that will be able to navigate the orchard successfully using progressively more advanced and reliable techniques. This lesson may overlap with Lesson 1, so that students use early iterations of their robot as “proof of concept” in their presentation.

	Standards Addressed	9-12 Benchmarks
8	Attributes of design	<p>H. The design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype, testing and evaluating the design using specifications, refining the design, creating or making it, and communicating processes and results.</p> <p>I. Design problems are seldom presented in a clearly defined form.</p> <p>J. The design needs to be continually checked and critiqued, and the ideas of the design must be redefined and improved.</p> <p>K. Requirements of a design, such as criteria, constraints, and efficiency, sometimes compete with each other.</p>
9	Engineering design	<p>I. Established design principles are used to evaluate existing designs, to collect data, and to guide the design process.</p> <p>J. Engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.</p> <p>K. A prototype is a working model used to test a design concept by making actual observations and necessary adjustments.</p> <p>L. The process of engineering design takes into account a number of factors.</p>

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10	Other problem-solving approaches	<p>I. Research and Development is a specific problem-solving approach that is used intensively in business and industry to prepare devices and systems for the marketplace.</p> <p>L. Many technological problems require a multidisciplinary approach.</p>
11	Apply design processes	<p>M. Identify the design problem to solve and decide whether or not to address it.</p> <p>N. Identify criteria and constraints and determine how these will affect the design process.</p> <p>O. Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product.</p> <p>P. Evaluate the design solution using conceptual, physical, and mathematical models at various intervals of the design process in order to check for proper design and to note areas where improvements are needed.</p> <p>Q. Develop and produce a product or system using a design process.</p> <p>R. Evaluate final solutions and communicate observation, processes, and results of the entire design process, using verbal, graphic, quantitative, virtual, and written means, in addition to three-dimensional models.</p>
12	Use and maintain products and systems	<p>G. Most technological development has been evolutionary, the result of a series of refinements to a basic invention.</p> <p>I. Throughout history, technology has been a powerful force in reshaping the social, cultural, political, and economic landscape.</p>
17	Information and Communication Technologies	<p>L. Document processes and procedures and communicate them to different audiences using appropriate oral and written techniques.</p> <p>M. Diagnose a system that is malfunctioning and use tools, materials, machines, and knowledge to repair it.</p> <p>N. Troubleshoot, analyze, and maintain systems to ensure safe and proper functioning and precision.</p> <p>O. Operate systems so that they function in the way they were designed.</p> <p>P. Use computers and calculators to access, retrieve, organize, process, maintain, interpret, and evaluate data and information in order to communicate.</p>
17	Information and Communication Technologies	<p>L. Information and communication technologies include the inputs, processes, and outputs associated with sending and receiving information.</p>
19	Manufacturing Technologies	<p>R. Marketing involves establishing a product's identity, conducting research on its potential, advertising it, distributing it, and selling it.</p> <p>M. Information and communication systems allow information to be transferred from human to human, human to machine, machine to human, or machine to machine.</p> <p>O. Communication systems are made up of source, encoder, transmitter, receiver, decoder, storage, retrieval, and destination.</p>

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Objectives:

At the end of this unit, students will be able to...

1. Design, build, and program a robot able to navigate autonomously or by remote control through a model orchard.
2. Evaluate a robot design and propose and implement improvements to it.
3. Strategize about the best way to accomplish a scored task within given resource and performance constraints.
4. Reflect upon, document, refine, and communicate with others about their design process.

Big Ideas:

1. The robot is a system with sensory input and actuator output which must communicate and be properly coordinated by the programmed control logic in order to accomplish a task.
2. A program is a set of instructions that govern the robot's behavior. The robot's overall behavior can be broken down into progressively smaller behaviors (connected by the appropriate control logic) until the behaviors can be expressed using commands in the programming language. Programming is a component of the robot's control system.
3. The robot must be designed, and usually redesigned several times, to best perform the desired function.
4. Time is a critical factor, and engineering projects such as the construction of the robot must be properly planned and managed in order to meet this and other constraints.

Unit Objective	Assessment Criteria		
	Below Target	At Target	Above Target
The robot is a system with sensory input and actuator output which must communicate and be properly coordinated by the programmed control logic in order to accomplish a task	Understands that the robot is composed of different parts that work together, although the ways in which they do so are unclear. Knows that the program "tells the robot what to do" but cannot elaborate.	Understands that the robot is composed of different parts, and can identify the function and role of each physical component in the robot's design. Knows that the program resides on the micro controller and uses information from memory and sensors to inform choices about commands to issue to the actuators.	Understands that the robot is composed of different parts, can identify the function and role of each physical component in the robot's design, and understands the electromechanical nature and form of the communication which takes place between subsystems on the robot. Understands that the program is a set of instructions that control the flow of electrical signals and power according to a logically constructed system of rules to produce a desired behavior. Knows how sensor input is typically used to gather information about the environment and inform choices about commands to issue to the actuators. Understands the similarities in purpose and nature between radio control and sensor input.

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<p>A program is a set of instructions that govern the robot's behavior. The robot's overall behavior can be broken down into progressively smaller behaviors (connected by the appropriate control logic) until the behaviors can be expressed using commands in the programming language. Programming is a component of the robot's control system.</p>	<p>Knows that the program is responsible for "telling the robot what to do". Understands that the robot executes commands in the order they are given, and that the flow can be directed based on external events detected by sensors.</p>	<p>Understands that things the robot does can be described as behaviors. Knows that behaviors generally fall into a hierarchy that allows them to be broken down into smaller and smaller pieces until the behaviors describe single commands, and that those commands (and the logic organizing them) are reflected in the program code. Understands that sensor feedback is often central to a behavior, and can cite and implement sensor-based behaviors. Can troubleshoot a misbehaving robot by examining its exhibited and intended behaviors.</p>	<p>Understands that things the robot does can be described as behaviors. Knows that behaviors generally fall into a hierarchy that allows them to be broken down into smaller and smaller pieces until the behaviors describe single commands, and that those commands (and the logic organizing them) are reflected in the program code. Uses appropriate constructs inside the programming environment (functions, subroutines, loops, comment blocks, etc.) to reflect the behavioral structure and nature of the program. Clearly understands the role of sensors in behaviors and can implement advanced behaviors demonstrating a high level understanding of both the role of sensors and programming logic (for example, using multiple sensors simultaneously). Can troubleshoot a misbehaving robot by examining its exhibited and intended behaviors.</p>
<p>The robot must be designed, and usually redesigned several times, to best perform the desired function</p>	<p>Builds the basic robot as described in the building instructions. Makes only cosmetic or detrimental modifications to the robot with no clear goals or system.</p>	<p>Builds the basic robot as described in the building instructions, and modifies it several times to improve performance in line with the goals of each challenge. Demonstrates an understanding of the relationship between form and function in planning and making changes to the robot.</p>	<p>Builds the basic robot as described in the building instructions, and either modifies or overhauls it to improve performance with specific goals aligned with the challenge tasks. Demonstrates an understanding of the relationship between form and function in planning and making such changes. Plans and documents the process of design revision on the robot, and uses this information to inform future decisions.</p>

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<p>Time is a critical factor, and engineering projects such as the construction of the robot must be properly planned and managed in order to meet this and other constraints</p>	<p>Procrastinates, scrambles to catch up, spends a lot of time on off-topic activities, and generally makes inefficient use of project time. Makes major last-minute changes to the robot without sufficient time to test and refine the design.</p>	<p>Works industriously with an eye on the clock. Able to make design and process decisions based on the amount of time remaining in the development period, but may not plan ahead much.</p>	<p>Works on both the robot and on planning. Makes efficient use of time, and schedules development using effective time management techniques. Coordinates both class and out-of-class time to make optimal use of both (for example, makes modifications to the robot overnight, and uses the class period to test and refine it because access to the board is limited during non-class hours).</p>
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Evidence for assessment:

1. Performance of robot on each phase of the model orchard challenge
2. Interim presentations on successful aspects and design process