

Teacher Notes: 3-5 Week Lesson Plan (Engineering Projects)

Course > 3-5 Week Engineering Project

Mine Mapping, Sentry System, Tree Surveying

Goal:

Introduce students to...

- Engineering Process
- Time Management
- Project Management
- Reinforce fundamental math and science
- Problem solving
- Advanced Programming using the NXT
- Bluetooth Technology
- Teamwork

Resources:

1 NXT kit for every two-three students
1 robot for each team of students
1 USB cable to upload programs to the robot
1 computer for every two students
1 copy of the LEGO® MINDSTORMS® Edu NXT programming software
1 copy of Robotics Engineering curriculum installed on each computer
Either the NXT battery pack or 6 AA batteries for each robot

Note to the Teacher

Robotics is an excellent tool to teach engineering. A teacher new to “teaching engineering” will be well advised to use the engineering projects as they have been designed. If you introduce the engineering problem without proper scaffolding many students will flounder. The guided research investigations develop a basic understanding of the foundational concepts that students will need to understand *BEFORE* they can solve the engineering design problem.

The Robotics Engineering Project Planner provides a convenient visual reference for both you and your students to keep track of the deadlines for the various activities and deliverables in the project.

Student Time Management and Teacher Assessment

The engineering journal is a key tool for both students and teachers that the teacher needs to introduce at the very beginning of the project. Students will use the engineering journal to organize and document their project. The teacher can use the journal as an evaluation tool that the teacher is either able to collect periodically and check, or can go around the class and check as the students are working on their engineering projects. Students will use the engineering journal to document the completion of all teacher assigned parts of their projects. The engineering journal will include: handouts, homework, worksheets, project schedules, notes from design reviews, copies of their programs, sketches, tests, and quizzes. The notebook is graded at the teacher’s discretion. It is a tool that allows students to keep their work organized.

Engineering journals should have the following characteristics:

- They should be in sequential order by the date the project was assigned.
- The notebook should be complete and contain all teacher assigned work
- The notebook should be neat; ripped, torn, and ragged papers will not be given full credit. The contents in the notebook will be graded on teacher specified criteria.



Purpose

The Engineering Projects section in the *Robotics Engineering: Guided Research* software is designed to teach students engineering process. Students should have completed the *Robotics Engineering: Introduction to Mobile Robotics* material (or equivalent) before they move to larger-scale engineering projects. Students should already have learned about fundamental programming, how sensors work, and have some experience using math and science to solve robotic problems. The guided research and engineering projects are designed to extend these learning activities allowing students to develop a deeper understanding of sensors, programming, and applied math and science as well as teach fundamental engineering processes.

Engineering Projects

Teacher resources can be found at the “Lessons” link in the Teacher Guide, tagged with “project overview”. The teacher resources include:

- A lesson starter Power Point which explains the Engineering Project as a whole
- Teacher notes and concepts
- A copy of the engineering journal evaluation guide
- Handouts and Assessment Rubrics for the following:
 - Internal Design Review
 - Research Publication
 - Request for proposal
 - Presentation
 - External Design Review
 - Presentation
 - Follow Up Proposal

Project Part 1: Guided Research Investigations

An engineering project consists of two parts: the guided research investigations and the student-directed engineering project. The guided research investigations come at the beginning of the project, in the “Research” phase. These guided lessons are designed to provide the scaffolding needed to complete the project. Once the students complete the guided research investigations, they should have the requisite knowledge that they need to complete the actual engineering design portion of the project.

The amount of time your class takes to complete each guided research investigation will be dependent on your students’ ability to stay on task to complete the assignment, and how much work is assigned as homework verses how much time is assigned as class work. It is suggested that homework is assigned to complete the research investigation worksheets, and to work on some of the more writing-intensive deliverables, such as the Project Proposals. It will be up to the teacher to assign due dates for work. Students will take as much time as you give them.

How students work through a guided research project is explained in detail in the lessons section of the orange Teacher Guide software. In this section, teachers will find the following teacher resources for each project that are designed to support classroom instruction:

- An introductory PowerPoint presentation that can be used to introduce the lesson
- A teacher’s note that covers the concepts covered in the lesson as well as problems that students may encounter and a time estimate of the lesson
 - A description of the Activity
 - What the students will do
 - A note to the teacher describing the rationale for the lesson
 - What the student will be able to do by the end of the lesson
- The student worksheet (also provided directly to students in the Student version)
- An answer key for the worksheet

Project Part 2: Student-Directed Development

Having finished the guided investigations, students will now begin developing their solutions. The engineering projects are built around very specific deliverables for student teams. Projects have four project milestones where teachers are able to check student progress to date.

The project milestones are:

- The internal design review,
- The project proposal,
- The external design review,
- And the demonstrated project solution.

The “Project Proposal” milestone in particular is designed as a “gatekeeper” deliverable that will allow you to evaluate whether students are adequately prepared to begin working independently on their solutions, or if they need additional assistance first.

If you are truly interested in helping students learn to manage time, then it will be very important to assign fixed due dates for the project milestones. This is what happens in industry; work has to be completed by specific dates. The suggested amount of time between milestone deliverables is two to three days.

Suggested timelines

Depending on homework load, time on task, and student experience, these times can vary significantly (sometimes by a factor of 2-3). This list is just a starting point. What is most important is that you set deliverable dates firmly so that students have concrete deadlines. Students should record these deadlines in their Project Planner sheets so they are always clear and available.

The following represents a potential timetable for a focused, fast-paced course that will challenge students to complete work quickly and efficiently:

<i>Present the engineering design problem / divide into teams</i>	<i>Day 1</i>
<i>Begin guided research investigation 1</i>	<i>Day 2-3 + homework</i>
<i>Begin guided research investigation 2</i>	<i>Day 3-4 + homework</i>
<i>Begin guided research investigation 3</i>	<i>Day 4-5 + homework</i>
<i>Brainstorm and mock-up solution designs</i>	<i>Ongoing</i>
<i>Internal design review</i>	<i>Day 6</i>
<i>Project planning and scheduling</i>	<i>Day 7</i>
<i>Complete project proposal</i>	<i>Day 8</i>
<i>Create working prototype</i>	<i>Day 9-10</i>
<i>External design review</i>	<i>Day 11</i>
<i>Test and revise solution</i>	<i>Day 11-14</i>
<i>Develop presentation materials</i>	<i>Day 12-14</i>
<i>Present solution</i>	<i>Day 15</i>

This timetable would be more suitable for a class with shorter 45-minute periods:

<i>Present the engineering design problem / divide into teams</i>	<i>Day 1</i>
<i>Guided research investigation 1</i>	<i>Day 2-4 + homework</i>
<i>Guided research investigation 2</i>	<i>Day 5-7 + homework</i>
<i>Guided research investigation 3</i>	<i>Day 8-10 + homework</i>
<i>Brainstorm and Internal design review</i>	<i>Day 9-11</i>
<i>Project planning and scheduling</i>	<i>Day 11-12</i>
<i>Complete project proposal</i>	<i>Day 13-14</i>
<i>Complete first working prototype</i>	<i>Day 14-17</i>
<i>External design review</i>	<i>Day 17-18</i>
<i>Test solution/develop presentation materials</i>	<i>Day 18-20</i>
<i>Present solution</i>	<i>Day 21</i>