

Instructions for Using the Oregon High School Engineering Design Notebook Template Draft, 11/29/2011

These instructions are for the Oregon High School Engineering Design Notebook template that can be found on the web at <http://www.ode.state.or.us/search/page/?id=32>. The template includes a graphic of the Engineering Design Process that aligns with the High School Oregon Science Content Standards.

Pages of the Template

First let's consider what's on each page and what the students will add to these pages.

Cover: The student should fill in the blanks. You can give specific guidance about things like semester/trimester and class section.

Inside front cover: A graphic summarizes the engineering designs assumed by the high school engineering design section of the Oregon Science Content standards. You can use the glossary of terms at the end of this document to explain the steps to your students.

Table of Contents: This page lists the chapters of the engineering design notebook. In most cases you will want to allow your students to decide how many pages each section should have. You may want to tell them the minimum and maximum number of pages for each section. The students should number each page and put the page number of each section on this page.

The Problem: You may want to assign a specific problem or you might want to assign a category of problems to be solved. An example of the former would be design a pouch that is no larger than 6 inches by 6 inches by 3 inches that can be hung from the handlebars of a bicycle to transport school supplies. An example of the latter would be design something that would be useful for students going to and from school that could be made from less than five dollars in materials. In most cases the problem should be described in terms of a human need or some other need. Once your students have had some experience with specific problems you may want to give them more latitude about the types of problems than can tackle.

Criteria, Constraints and Priorities: Students should list and describe the criteria, constraints and priorities associated with the problem on this page. The best criteria and constraints are usually quantitative. For instance, "supports at least 200 grams" is a clearly criterion than "supports a weight." In some cases you may provide some or all of the criteria, constraints and priorities and the students' job should paraphrase what you have provided in this section. In others cases you may ask them to come up with criteria, constraints and priorities based on

their experience with the category of problem you have assigned. If there is time they may also want to survey possible users of the solution to better understand their needs or do library or web research on the need.

Possible Solutions: Students should understand that engineering problems typically have many possible solutions. Students can start by coming up with several ideas even if some of them don't seem to address all the criteria and constraints. The possible solutions can be compared to the criteria and constraints as well as each other. Students should discuss the trade-offs between the possible solutions. Some students will think of additional solutions after they analyzed and compared the initial solutions.

Proposed Solution(s): Students should choose at least one solution and describe them here in more detail and with more refinements than when there were many possible several solutions being considered. If time and materials permit, students should then build the proposed solution(s) or something like them.

Testing the Solution(s): Students should test the solution they have built including making and recording measurements. The tests should determine whether the solution accomplishes the purposes described in the problem in terms of the criteria and constraints. The most important measurements are those that that relate to these criteria and constraints. If it is not possible to build the proposed solution or something similar to it, students should find another way of analyzing their solution. Students should consider how the testing has given them insights on improving the solution(s) and propose improvement to them.

Analysis: Using the test and measurements in the previous section, students should describe what they have learned about their solution. In particular they should discuss how well the solution met the criteria and stayed within the constraints. Because testing is never complete, students should identify and discuss what uncertainties remain about their proposed solution(s). They should also discuss the trade-offs they made between the various criteria in the final solution(s).

Recommended solution: Students should recommend a particular solution as being best. Their recommendation should be based on the original criteria, constraints and priorities as well as their analysis. They should describe strengths and weaknesses of the recommended solution as well as how and why it is better overall than the other solutions that were considered. They should also describe how further engineering might be done to refine the recommendation.

Ways of Using the Template

The template can be used in several ways.

- (1) **“Loose-leaf” individually bound notebooks:** Provide each student with copies all the pages of the template. They can use the graph paper and lined paper at the end of the template to make additional sheets to insert in the various sections or you can provide supplies of these two sheets for students who need extra pages. Notebooks may be “bound” according to your or the students’ preferences using staples, report covers, three-ring binders, or some other method.
- (2) **“Glue-stick” customization for pre-bound composition notebooks:** Provide each student with copies of all the pages of the template except the blank lined page at the end of the template. Students should glue pages onto pages in their composition books as they are completed. When students need additional pages in a section they can use the notebook pages without gluing on pages or they can glue copies of the graph paper onto composition pages. The Table of Contents Page should be updated as new sections in the notebook are started.

Alternatively, the students can use the template as guidelines for what they handwrite on the pages of the composition books.

- (3) **“Pre-bound” individual notebooks:** Provide each student with either a full-size or half-size copy of the template, choosing the number of pages you think is appropriate for each step. Here is one possible solution that assumes half-size pages:
 - 1 each – Cover
 - 1 each – Inside front cover – Engineering Design Process graphic
 - 1 each – Table of Contents
 - 1 each – Introduction
 - 2 each – The Problem
 - 2 each – Criteria, Constraints and Priorities
 - 2 each – Relevant Principles and Scientific Knowledge
 - 6 each – Possible Solutions
 - 2 each – Proposed Solution(s)
 - 4 each – Testing the Solution(s)
 - 2 each – Analysis
 - 2 each – Recommended Solution
 - 1 each – Inside back cover
 - 1 each – Back cover

If you use this format you can pre-number all the pages and fill in the Table of Contents with the page numbers of the first page of each section.

Glossary

Constraints: Limits on possible solutions. When we solve a practical problem we usually have limits on how big the solution can be, how much it can cost, how much it can weigh, etc.

Criteria: The things your solution should do. Engineering problems are usually described in terms of a set of goals that become the criteria against which we judge possible solutions.

Knowledge: When a practical problem is being solved we need to consider what scientific facts about the problem and possible solutions to the problem might be needed to solve the problem. In many cases we need to gather more scientific information to come up with a good solution.

Need: The reason why we want to solve a problem. Most engineering problems relate to a need that relates to people, society or the world around us.

Priority: The relative importance of the criteria and constraints. Usually some criteria are more important than others. Likewise for constraints.

Principles: Most engineering design solutions use scientific principles to accomplish meet the goals of project. One example would be various types of energy can be transformed into to thermal energy or heat.

Problem: The goal of an engineering design project. Most engineering projects relate to a practical problem that provides a benefit to people or improve upon an existing solution.

Solution: A possible way of solving a practical problem.

Trade-off: Practical problems almost always have many solutions. When we compare one solution another, doing a better job of achieving one criterion often means doing a worse job on another criterion. In other words, we are forced to trade off one criterion for another.

Uncertainties: Because testing is never complete and conclusions must be reached with incomplete information, it is important to identify and explain the uncertain nature of the conclusions.