DESIGN IT! MIDDLE SCHOOL

Instructions for Using the Oregon Middle School Engineering Design Notebook Template

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These instructions are for the Oregon Middle 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 8th grade Oregon Science Content Standards. If you are using it for 6th or 7th grade science, please see the list of suggested changes at the end of this document.

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 8th grade 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 starting 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 being solved on this page. In some cases you may provide some or all of these things and their job is to paraphrase what you have provided. 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. Some students will think of additional solutions after they analyzed and compared the initial solutions.

Proposed Solution: Students should choose a particular solution and describe it here usually in more detail and with additional refinements than when it was only one of several solutions. If time and materials permit, the student should then build the proposed solution or something like it.

Testing the Solution: Students should use the solution they have built to make and record measurements. The most important measurements are those that that relate to the criteria and constraints associated with the problem. If it is not possible to build the proposed solution or something similar to it, students should find another way of analyzing their solution.

Evaluation: Using the tests 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. They should discuss the trade-offs they made between the various criteria.

Design Improvements: Students should describe how their solution could be improved.

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 the composition book 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 this 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
- 4 each – Testing the Solution
- 2 each – Evaluation
- 2 each – Design Improvements
- 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.

Suggestions for Design Notebooks for 6th Grade.

The Oregon Science Content Standards do not require coverage of criteria, constraints and priorities for 6th grade students. You may therefore want to leave that section out of your template for those students. Developing ideas for multiple solutions is also not required at the 6th-grade level so you can leave out the Possible Solutions section. If you decide to leave out criteria, constraints and priorities, you should avoid referring to these items as well as trade-offs when you instruct students on what they should cover in their Testing and Evaluation sections. You can also leave out the Design Improvements page.

Suggestions for Design Notebooks for 7th Grade.

The Oregon Science Content Standards do not require coverage of criteria and priorities for 7th grade students. You may therefore want to simplify the Criteria, Constraints and Priorities section for 7th-grade students. Developing ideas for multiple solutions is also not required at the 7th-grade level so you

can leave out the Possible Solutions section. If you decide to leave out criteria and priorities, you should avoid referring to these items as well as trade-offs when you instruct students on what they should cover in their Testing and Evaluation sections. You can also leave out the Design Improvements page.

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.*