

Material Selection for Sustainable Products
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Abstract:

This module with its accompanying PowerPoint presentation explores materials selection from an eco-efficiency perspective. Typical accounting practices and subsequent management practices have typically placed heavy emphasis on cost reduction via labor reduction. However, as automation increases, labor costs are constantly shrinking. This situation is particularly true for high volume commodity products. Increasingly the cost of raw materials is becoming the principle cost factor for most durable goods. Therefore, designers need to consider many aspects as they prepare to develop their ideas, particularly the materials they choose. Selection of an appropriate material is traditionally made by service performance demands like: environmental stability, strength to weight ratio, density, and manufacturability. The material chosen must also take into account customer satisfaction by providing value at a competitive cost. As raw material costs and concern for the environment increase the selection of appropriate materials is becoming more involved. Sustainability concepts like product take back needs to become a central consideration for designers and managers in the early stages of design. Raw material selection based on, life cycle assessment, ease of reuse, and recyclability will be explored and developed for specific classes of materials. A Motorola case study has been provided within the PowerPoint presentation.

This paper and PowerPoint presentation have been created in an effort to provide instructors a basic framework for material selection in an effort to mitigate and or eliminate environmental impact of precious raw materials and at the same time conserves energy.

Student Learning Objectives:

After reviewing the content of this module the student will be able to:

- list and explain the underlying causes of unsustainable practices
- research how much energy is used to extract, transport, convert, product, and finish various types of consumer products
- explain the basic characteristics of the major categories of materials
- discuss the environmental impact of each materials
- outline how to select materials for a given application
- discuss other issues that relate to material selection beyond functional characteristics
- list the general classes of materials that can be re-melted for reuse
- list the general classes of materials that are the most difficult to recycle

MatEd Core Competencies Covered:

- 4.D Demonstrate cultural awareness in the workplace
- 7.A Identify the general nature of metals
- 7.B Describe the general nature of plastics
- 7.C Describe the general nature of composites
- 7.E Describe the general nature of ceramics and glasses
- 7.F Describe the general nature of other materials (elastomers)
- 7.J Demonstrate how materials properties are used in engineering design
- 7.L Explain how plastics and polymers differ from other materials
- 19.B Apply statistical, cost, life cycle and related management principles to manufacturing processes and management

Key Words: material selection, sustainable products, design for environment, product take back

Type of Module/Mode of Presentation: Classroom activity with powerpoint presentation

Time Required: Approximately 60 minutes

Prerequisite Knowledge: some basic knowledge of manufacturing processes

Grade Level Intended:

Technical High School grades 10 through 12

Project Lead the Way

Engineering by Design

College – freshman – technology non-majors and majors

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Equipment and Supplies Needed: none

Curriculum Overview and Notes for Instructor:

The major objective of this classroom exercise is to review material selection criteria that support sustainable product design. A brief review of current environmental issues will be explored. Each class of materials will be briefly reviewed outlining their strength and weaknesses in regard to selection criteria and their environmental impact based on ease of recycling.

The PowerPoint presentation is intended to help educators give their students a fundamental idea of the basic categories of materials and how the selection of a specific raw material class impacts the environment. The materials selection process requires that students think through product requirements not only from a functional perspective but also an ecological perspective. As student's progress through their technology or engineering curriculum they must begin to integrate both perspectives to make appropriate materials selections. As students acquire new knowledge about design they will be able to make more sophisticated judgments about design features that will enable the reuse and/or recycling of raw materials. It must be emphasized that the eco-friendly materials are increasingly proven to be highly cost effective for companies and are increasingly in demand by the consumers they serve.

These slides can be altered to provide either more or less detail when covering material selection in various classes. Exploring local recycling policies and reclamation sites (dumps) can also be helpful for out of class activities. The emerging use of substitute materials such as press board for plastics food containers is becoming more popular vs. plastic containers. The idea behind these press board products is that they are biodegradable and therefore disposable. This begs the question: does providing for disposable product help or hurt recycling efforts? Do these products encourage a mentality that encourages littering, since the rationale is that they will decompose. This is an interesting paradox to explore with students.

Newly designed water bottles of lighter weight have been developed and a comparative analysis can be done by weight. An analytical scale can be used to measure the difference and raw material costs can be found on the web. Cost saving can be realized by reducing the weight of the container. However, is this only cost savings? It would be instructive to explore with students the other costs associated with weight such as shipping costs.

Notes regarding potential classroom use are given below.

Pre- class review:

The faculty should ask their students to consider: what are some of the problems when trying to dispose of common consumer products? Another possible assignment is to ask students to bring in one "simple" consumer product and have them try to determine what class of materials it is made from and how to recycle each component. Another problem could be to have the students select a new material for an existing product or suggest ways that the material selected can reduce the energy footprint.

Homework Assignments:

Have the students review the various related web sites. It would be helpful if each class students could add to this list along with their own annotations. Have student select a product application and argue for or against using different materials based on ecological concerns.

Module Procedure:

Review the PowerPoint slides & Motorola Cell Phone Case Study with the students. Follow this with a discussion regarding sustainable design. Use the abovenoted pre-class review and follow-up homework assignments, as appropriate for the class.

Supporting Materials:

New analysis tools are gaining popularity such as Okala for sustainable material selection. The Okala book is highly recommended because of its modular format as well as the straight forward analysis technique used for materials selection. It can be obtained for a nominal fee at: www.idsa.org/whatsnew/sections/ecosection/okala.html

In addition, please visit the MatEd website at: www.materialseducation.org

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Evaluation:**Student evaluation questions (discussion or quiz):**

1. Select one consumer product. Discuss potential ways that it or parts of this product can be
 - a. Recycled
 - b. reused
2. If you viewed the powerpoint on the web, please indicate:
 - a. Did the powerpoint load properly (including any video portions)?
 - b. Were you able to follow the module over the web?

Instructor evaluation questions:

1. At what grade level was this module used?
2. Was the level and rigor of the module what you expected? If not, how can it be improved?
3. Did the powerpoint work as presented? Did they add to student learning? Please note any problems or suggestions.
4. Was the background material sustainable use sufficient for your background? Sufficient for your discussion with the students? Comments?
5. Did the module generate interest among the students? Explain.
6. Please provide your input on how this module can be improved, including comments or suggestions concerning the approach, focus and effectiveness of this activity in your context.

Course evaluation questions (for the students)

1. Was the module clear and understandable?
2. Was the instructor's explanation comprehensive and thorough?
3. Was the instructor interested in your questions?
4. Was the instructor able to answer your questions?
5. Was the importance of materials testing made clear?
6. What was the most interesting thing that you learned?