NJIT New Jersey's Science & Technology University

LESSON PLAN

MODULE TOPIC:
Analysis of product material properties and characteristics and their role in manufacturing of product components (multi-components products).
Modeling of components using 3D modeling software.

STANDARD(S) & INDICATOR(S):
NGSS
MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

OBJECTIVE(S): Students will be able to,

- Determine the properties of materials used to manufacture various common place items and products with respect to the design process using a variety of tests.
- Analyze the application of these specific materials in the manufacture of the items and products from a scientific and engineering point of view.
- Create part files (.idw and assembly files) of the components of the products analyzed using the3D design software.
- Determine the properties of the components using the 3D software design tools.

Lesson Part 1

MATERIALS:

- Computer with internet access.
- Engineering notebook.
- Digital scale.
- Graduated cylinder, assorted beakers, water, etc.
- Measuring device – digital caliper, engineering ruler, micrometer, etc.
- Auto-Ranging Digital Multimeter.
- Nail(s).
- 3D modeling software.
- Assorted plastic and metallic products made of at least three parts.

LIST OF HANDOUTS (attach original copies of each handout - teacher & student edition)
BACKGROUND INFORMATION:
When purchasing items and products for our everyday use there are many factors that make us want to buy a particular product. Material selection for products requires scientists and engineers to consider material properties against anticipated use. Engineers must sometimes find alternative materials for a part in their design for many reasons.

CLASSROOM ACTIVITY DESCRIPTION (LABORATORY/EXERCISES/PROBLEMS) including detailed procedures:

Lesson Day 1.

- Working in teams of two, students will brainstorm a list of ten common products found at home that consist of at the least three parts. These may be products such as cell phones, sneakers, stapler, backpack, etc. (make a list of your products).
- As a team identify three items or products from your brainstorming list to bring to the next class meeting. Record the product and team member responsible for bringing the product to class.

Lesson Day 2.

- Examine and discuss as a team the functions and properties of each of the three products.
- Illustrate and describe product #1. Include detailed information relating to function, operating procedure, operating environment, cost, manufacturing origin, and product life cycle.
- Repeat as above for the other two products.
- Disassemble your product if necessary or possible in order to continue with the next set of activities. (See teacher before proceeding with this activity).
- Sketch and describe all product components. Include detailed information relating to component interaction and function within the product.

Lesson Day 3/4.

- Select two components from each product to investigate further.
- Further component investigation.
  List the product and the component (number them). Then using the various testing equipment/items or apparatus, conduct the following tests/measurements.
  Continuity test – use a multi-meter with a built-in continuity tester or a simple circuit consisting of a power source and a light to check for the components ability to conduct electricity.
  Ferrous metal test – pass a magnet over the component.
  Hardness test – use a nail to attempt to scratch the surface of the component.
  Weight – use a digital scale to weigh the component.
  Density – density = mass/volume.
  Surface area – use a measuring device and calculator to sum up all the areas that cover the surface of the component.
  Volume – submerge the component in a container with a predetermined measurable amount of water (graduated cylinder, beaker, etc.) if the component is buoyant, use a paper clip to keep the object submerged during the testing. Measure the increased volume of the water due to the component being submerged in the container.
  Hand flexure test – use only your hands and attempt to bend the component. Does the component deform permanently?
  Repeat this set of tests for the second component.

Part 2 - Computer Modeling.

Day 5/6.

- Product components are assigned to individual team members.
- Use a measuring device to create in your engineering notebook, a detailed sketches of your assigned product component, including appropriate dimensions and annotations.

- Students will use their knowledge of technical drawing and design to create, using the 3D modeling software (Autodesk Inventor 215), a detailed drawing of their assigned component.
- Use 3D modeling software to determine the components mass, volume and surface area.
- Use 3D modeling software to create and print part files illustrating your assigned component and highlighting its distinguishing characteristics.

SAMPLE QUESTIONS TO ELICIT CLASS DISCUSSION:

Using various products as examples, students will discuss the following questions.

- Will extreme environmental conditions affect the material?
- Will these conditions cause the material and hence the product to fail?
- How safely will the materials used to make the product handle the load?
- How will the material(s) behave if its temperature is drastically reduced?
- Will the material remain as strong as it was prior to being formed?
- When engineers cannot find a material that provides the desired traits of a product what do they do?
- What properties of materials are important to understand before selecting materials for production?
- What liability issues, if any, are related to each product?

HOMEWORK ACTIVITY/EXERCISES/PROBLEMS:

- Students will select an item or product of their own choice from a variety of everyday office or home products composed of at least three parts and create a design decision matrix for two different materials that could be used to make the product.
- Student will describe the life cycle of the item or product of their choice with proper graphics depicting the stages and activities at each stage of the product life cycle.

PARAMETERS TO EVALUATE STUDENT WORK PRODUCTS:

Engineering notebook and lab reports.

- Sketches/diagrams or illustrations showing components investigated/analyzed. Procedure/method detailing how each parameter/property of the component was determined (theory). Sketches/drawings where required to be shown in tabular form.
- Engineering notebook detailing brainstorming results prior to selection of assigned team member components.
- Precautions to ensure accuracy of their results.
- Sample mathematics calculations showing how the equations were used to arrive at the results of the properties.
- Preliminary design sketches in their engineering notebooks of the components assigned the team member.
- Drawings (.idw) part files/printouts of the individual components created using the 3D design software. Drawings to show all dimensions and annotations (where necessary).
- A rubric will be used to assess the engineering journal entries and their conforming to the rules of making any entries. Another rubric will also be used to measure the accuracy of their designs using the modeling software and part files.
  A rubric will be used to assess the homework detailing the product life cycle and activities at each stage of the product.

REFERENCES:

Foundations of Physics. – Tom Hsu, PhD.

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David A. Madsen, Terence M. Shumaker, J. Lee Turpin and Catherine Stark.
Delmar Publishers.

Engineering Drawing and Design, 3rd edition
Kevin Standford and Catherine Stark.
Delmar Publishers.

Project-Lead-the-Way (PLTW) Introduction to Engineering Design (2012) **Teacher Resources**.
Project Lead The Way, Inc.
3939 Priority Way South Drive
Suite 200, Indianapolis, IN 46240

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