

# Session 2 – Material Selection

The assignment for the second session was as follows:

Review the material data provided, as well as the list of property definitions and descriptions of materials. **Determine which material would be most appropriate for the product you were assigned. If you desire you can look up other materials for your product as long as you can determine the values for the different properties listed.** ( For some products this may be required.) You should be able to turn in a short written answer to these questions and discuss them in class.

- Determine the design elements and constraints you would like to place on the product.
- What method did you use for selecting the best material?
- How did you handle the relative importance of each property?

# Opening Discussion

- Determine the design elements and constraints you would like to place on the product.
- What method did you use for selecting the best material?
- How did you handle the relative importance of each property?

# Decision Matrix

- Decision matrices are tools that have been developed for selecting the best option among several candidates.
- Terminology:
  - **Alternatives**: candidate material or process
  - **Criteria**: properties deemed essential to satisfying the functional requirements
  - **Weighting Factors**: numerical representations of the relative importance of different criteria

# Weighted Property Index Method

## Step 1

- Each material property (“criteria”) is assigned a **weighting factor** ( $w_i$ ) between 0 and 1 relative to its importance to the overall design.
  - Pair-wise comparison
  - Saaty’s comparison

# Weighted Property Index Method

## Step 2

- Property values for each alternative are normalized by a **scaling factor**, usually the largest value among all alternatives.
  - If a high property value is desirable (e.g. strength):

$$\beta = \frac{\textit{value \_ for \_ material}}{\textit{max value}} \times 100$$

- If a low property value is desirable (e.g. density):

$$\beta = \frac{\textit{min value}}{\textit{value \_ for \_ material}} \times 100$$

# Weighted Property Index Method

## Step 3

- **Weighted property index** is calculated by multiplying the scaling factor by the weight factor. Then the summed for the criteria.

$$\gamma = \sum_{i=1}^n \beta_i w_i$$

# W.P.I. Method Example

The material selection for the **legs** of a table is being evaluated on the basis of the following properties: (1) density, (2) stiffness, (3) cost, (4) production energy, and (5) CO<sub>2</sub> production.

What information do we need?

# Information Needed for W.P.I. Method

- Alternatives
  - Bamboo, Cast iron, Low carbon steel, and Oak
- Property Values (see handout)
- Weighting Factors (How do we determine these?)
  - Your/design team's intuition (good)
  - Pair-wise comparison (better)
  - Saaty's Scale for Pair-wise comparison (best)

# Weighted Property Index Method

## Step 1

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  - **Pair-wise comparison**
  - **Saaty’s comparison**