Announcements

• No class Monday!

• Recitations all meet next week!
• Assignment 3 due the day before recitation.
Project Deliverables

Design Fair Poster
Model
Team Notebook
Assignment Grading

+1  Superior performance; exceeds expectations.
0   Acceptable quality; meets expectations
-1  Poor quality or incomplete
-2  Late or missing

Sum of assignment grades will be added to your final project score.
Today

Quantifying what we hope to accomplish:
- Functional specifications
- Constraints
- Design metrics
An Engineering Design Process

Client Need

Problem Definition

Conceptual Design

System-level Design

Detail Design

Design Communication

Final Design
Problem Definition

Gather information to develop a statement of client wants in engineering terms:

1. Clarify objectives
2. Establish user requirements
3. Identify Constraints
4. Define desired functions

statement of:
objectives
constraints
requirements
functions

client’s statements
Last Time

**Functions** = what system must do to achieve objectives
Black Box Approach

Inputs
- Energy
- Material
- Information

Main Function

Outputs
Divide Functions into Subfunctions

- Subfunction A
- Subfunction B
- Subfunction C
- Subfunction D

Main Function
Functional Specifications

How well must the design accomplish the functions?
- Measurable
- Solution neutral
- Things client/users care about
Utility Graph

Utility

Level of Variable

0

1
Threshold and Saturation Regions

Utility

Level of Variable

Below Threshold

Saturation
“Zone of Interest”

Utility

Level of Variable

Zone of Interest
“Zone of Interest”

Utility

0

1

Level of Variable

Zone of Interest
Example: Braille Printer Noise

Quieter is better, but how quiet?
Example: Braille Printer Noise

<table>
<thead>
<tr>
<th>dB</th>
<th>Typical Source</th>
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<tbody>
<tr>
<td>10</td>
<td>Physical hearing threshold</td>
</tr>
<tr>
<td>20</td>
<td>Whisper</td>
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<tr>
<td>30</td>
<td>Quite conversation</td>
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<td>50</td>
<td>Normal office background</td>
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### Example: Braille Printer Noise

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Marginal Value?
**Example: Braille Printer Noise**

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Marginal Value?
Graphically

Utility

Noise Level

whisper

lawnmower

1

0
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- **OSHA Req’t**
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Zone of Interest
Exercise

With your team members
• Identify a key function of your design.
• Make a list that shows the full range of performance levels possible
• Identify:
  – Threshold level
  – Saturation level
  – Zone of interest
• How can you quantify?
How to set specification levels?

- Client and user input
- Competitive analysis
- Field analysis
House of Quality

Customer Interests

Importance Rating

Required Functions

Relationship Matrix

Competitors Ratings

Targets/specifications
Example: House of Quality

• Handout
Constraints

- Often numerical
- Can be upper/lower bounds on functional performance
- Do not add frivolously! Only if truly exist.
Metrics vs. Specifications

**Functional Specifications** = how well system must perform
→ correspond to functions

**Design Metrics** = measure extent to which an objective has been realized
→ correspond to objectives
Design Metrics

• Define units (e.g., kg, $, N)
• Determine level of accuracy
• Define how you will measure
• Assess whether it is reasonable
  – does it measure what you want to measure?
  – is it accurate enough?
  – is measurement practically feasible?
  – is it repeatable?