Preliminary Design & Prototyping

Client Statement → Problem Definition

Conceptual Designs → Preliminary Design

Detailed Design → Design Communication

End Product → Construction-Manufacturing
Proof of Concept

Feasibility
- Will it hold its shape?
- Are the sensors sensitive enough?

Physical Mockup
- Minimize investment ($$$, effort)
- Software (Matlab)
- Mechanism (Lego, cannibalized parts)
- Circuit (breadboard)

Record everything in a bound notebook.
Proof of Concept

- Try to make design **FAIL**
- Low lying fruit
  1. Hand drawn sketch
  2. Mathematical verification
  3. CAD drawing / solid model
  4. Physical mockup

Detailed Comparison

- 2 or 3 Alternatives
- Optimize Alternatives
- Rank WRT Requirements & Constraints
- Numeric Analysis
  1. Weight
  2. Complexity
     - # of components
     - Development time
  3. Cost (estimated)
Preliminary Prototype

- Scale Model
- Look & Feel
- Functionality
- One-Off
  1. Rapid prototype
  2. Custom machined
  3. Breadboard / Veroboard

Evaluation

- Does it work?
- Does it satisfy requirements?
- What are the deficiencies?
- Are they easily corrected?
- Does the customer like it?
Modify & Repeat

- Alter design
- Try other alternative
- Start from scratch
- Re-assess requirements & constraints

Example: Proof of Concept

Hand drawn sketches in bound notebook
Physical Prototype

• Conventional (machined)
  – Choice of material

Solid Model (SolidWorks) → Engineering Drawings → Machine Shop → Part

IGES, DXF File → CNC / Waterjet

• Rapid Prototype
  – Fast
  – No communication error
  – May not be a working model

Solid Model (SolidWorks) → STL File → Rapid Prototype (3-D Printer) → Part or Assembly

Rapid Prototyping

• STL File
  – Standard file format for rapid prototyping
  – Surfaces defined by triangles
  – More triangles =
    • Higher resolution
    • Larger file size
    • Less stair-casing
Preliminary Design

Stair-casing

Rapid Prototyping

- **Stereolithography (SLA)**
  - Layers of photosensitive resin cured by laser

- **Selective Laser Sintering (SLS)**
  - Layers of powder spread over part and sintered together by laser

- **Fused Deposition Modeling (FDM)**
  - ABS melted and applied to part to extrude features layer by layer
Rapid Machining

- Waterjet Cutting
  - 2-D parts (flat material)
  - Bend & spot weld for 3-D
  - Not for wood

Homework

- Mount strain gauge and demonstrate using PCB circuit.
- Demonstrate at beginning of next week’s lab (or during your progress meeting).