The Design Process

or how to build something you need and not regret it later
Overview of the Design Process

• Identify the problem
• Lay the foundations for design (time constraints, $, etc)
• Find the best solution
• Implement the best solution
• Reflect to learn from what you’ve done (and redesign if necessary)
Step 1:

Identify the Problem
Identify the Problem

• What do you need to accomplish?
• Break it up into small pieces
  – Some small pieces might already have solutions!
• Ask others for input if you are unfamiliar with the topic
Step 2:

Identify Constraints
Constraints

• Advisor wants this done by…
• It must cost less than…
• I want to graduate by…
Have a plan of how to spend your time:

Gantt Chart
Gantt Chart

• A graphical representation of WHAT and WHEN
• Can also be used to show the “critical path”

Critical path: the sequence of activities with the longest overall duration, determining the shortest time possible to complete the project. Any delay of an activity on the critical path directly impacts the planned project completion date (i.e. there is no float on the critical path).  (from Wikipedia)
Gantt Chart: Building a House

23 Allen Creek
1. Dig hole for foundation
2. Build foundation
3. Back fill
4. Deliver rough lumber package
5. Rough frame house
   5.1 Deliver windows
   5.2 Install windows
   5.3 Deliver shingles
   5.4 Install shingles and flashing
6. Rough plumb house and install ductwork
   6.1 Rough wiring
   6.2 Pick up returnable lumber
   6.3 Rough structure inspection
7. Insulation
   7.1 Dry wall
   7.1.1 Paint dry wall. Refer to written decorating sheets
   7.1.2 Deliver trim work
   7.2 Install trim work
8. Paint trim work
9. Paint finish plumbing and install furnace
   9.1 Finish electrical trim
   9.2 Install light fixtures
   9.3 Prelim final clean up
   9.4 Finalize building inspection approval
   9.5 Install carpet
10. Punch list walk through and follow up
11. Final clean up
12. Closing meeting
13. Customer move in
14. Service check up
Finding the best solution:

FRDPARRC Chart

pergatory.mit.edu/2.007
FRDPARRC Chart

- Functional Requirements (events)
- Design Parameters (design ideas)
- Analysis
- References
- Risks
- Countermeasures
## FRDPARRC Chart

<table>
<thead>
<tr>
<th>Functional Requirements (Events)</th>
<th>Design Parameters (Idea)</th>
<th>Analysis</th>
<th>References</th>
<th>Risk</th>
<th>Countermeasures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Words</td>
<td>Words &amp; Drawings</td>
<td>Experiments, Words, FEA, Equations, Spreadsheets...</td>
<td>Historical documents, <a href="http://www">www</a>...</td>
<td>Words, Drawings, Analysis...</td>
<td>Words, Drawings, Analysis...</td>
</tr>
</tbody>
</table>
## FRDPARRC Chart

<table>
<thead>
<tr>
<th>Functional Requirements (Events)</th>
<th>Design Parameters (Idea)</th>
<th>Analysis</th>
<th>References</th>
<th>Risk</th>
<th>Countermeasures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Words</td>
<td>Words &amp; Drawings</td>
<td>Experiments, Words, FEA, Equations, Spreadsheets...</td>
<td>Historical documents, <a href="http://www">www</a>...</td>
<td>Words, Drawings, Analysis...</td>
<td>Words, Drawings, Analysis...</td>
</tr>
</tbody>
</table>

**Example**
Picking the best solution:

Pugh Chart
Pugh Chart

- Compares your possible solutions against a set of criteria
- Great for organizing complicated lists of pros and cons
# Pugh Chart

<table>
<thead>
<tr>
<th>Criteria 1</th>
<th>Criteria 2</th>
<th>Criteria 3</th>
<th>Criteria 4</th>
<th>Criteria 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idea 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Idea 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Idea 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Criteria 1</td>
<td>Criteria 2</td>
<td>Criteria 3</td>
<td>Criteria 4</td>
</tr>
<tr>
<td>-------</td>
<td>------------</td>
<td>------------</td>
<td>------------</td>
<td>------------</td>
</tr>
<tr>
<td>Idea 1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Idea 2</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Idea 3</td>
<td>-1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Pugh Chart: carrying textbooks

<table>
<thead>
<tr>
<th></th>
<th>Comfortable straps</th>
<th>Weather-proof</th>
<th>Stylish</th>
<th>Padded laptop pocket</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>backpack</strong></td>
<td>1</td>
<td>1</td>
<td>-1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>Messenger bag</strong></td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>Leather briefcase</strong></td>
<td>-1</td>
<td>-1</td>
<td>1</td>
<td>-1</td>
<td>-2</td>
</tr>
</tbody>
</table>
Implementing the best solution:

Just Do It

That’s what the rest of this class is about!
For more information

• pergatory.mit.edu/2.007 -> Fundamentals of Design (FRDPARRC chart)
• Wikipedia.com (Gantt chart)
• 4pm: Material selection

Tuesday
• 3-4pm: Design basics
• 4-5pm: Design tips and mistakes

Wednesday
• 3-4pm: Manufacturing: metal removal
• 4-5pm: Design for milling/turning/drilling

Thursday
• 3-4pm: Manufacturing: rapid prototyping, molding, forming, casting
• 4-5pm: Drawing, dimensioning, tolerancing, and working with outside shops

Friday
• 3-4pm: Effective use of drills, saws, taps, and dies
• 4-5pm: Motion control