the bad news is time flies
the good news is that you’re the pilot

Michael Altshuler
2.009 Product engineering processes today

time estimation resource budgeting
scheduling project management—you’re about to grow!
but first …

list the 4 components of a specification

specification

- need
- attribute
- metric
- value
- unit
- owner
- measurement
- observation
Mockup review
concept names and presentation order within section

let me know concept names and order by 9 PM Wednesday (that’s tonight!)
Mockup review

demonstration location (Pappalardo portion)

Red A: smoke detector, computer lock (welding area)
Red B: ember, pipe freeze (Pappa loading dock)
Green A: stump cutter, vibration isolation (Killian, near fish bowl)
Green B: wheelchair lift, rescue litter (team area)
Silver A: blade brake, longboard governor (wood shop)
Silver B: speed bump, training mat (Pappa parking)
Blue A: safe blade, cooling brace (team area)
Blue B: hand washing, glass breaking (Pappa south conference 1/2)
Yellow A: protection bracelet, door opener (Pappa south conference 1/2)
Yellow B: life line, baby cystic fibrosis (Killian court building 3 entrance)
Pink A: walk n roll, ice measurement (team area)
Pink B: safe brake, vibration isolator (Killian north end)
Orange A: phone disinfection, fire communication (team area)
Orange B: thermal flotation, smart sprinkler (???)
Purple A: hospital bed, smart mattress (team area)
Purple B: breast pump, lifting spotter (2.678 lab)
Time estimation

Origami experiment

put your name and time estimate on the handout
do not look at the back side of the page!
Time estimation
Origami ball experiment

put your name and time estimate on the handout
do not look at the back side of the page!

when I start timer, turn over the handout
make the ball, work independently
record your actual time (no fudging please)
go to course website
enter and submit data
hand in paper estimate
Time estimation

Experiment results
Time estimation

Take-home message

\[
\text{task time estimate} = \text{expected time} \times \text{multiplier}
\]

multiplier \( f \) (familiarity, complexity, process uncertainty)
Time estimation

Visual model: 9 hours
Time estimation
Preliminary solid model: 6 hours
Time estimation

Sketch model: 2.5 hours
Time estimation

String dynamometer: 20 hours
Time estimation

Robot rabbit mockup: 30 hours

1953

1962

space program mercury 1958-63
**Electric scooter**

Electric scooter prototype: 110 hours fabrication + lead time

all examples: fabrication time only!
Project scheduling

Step 1: task list and milestones

by project (course/program)
Project scheduling

Step 1: task list and milestones

by project (course/program)
by development phase/concept (system integrators)

<table>
<thead>
<tr>
<th>Mockup tasks</th>
<th>Estimated time</th>
</tr>
</thead>
<tbody>
<tr>
<td>refine needs</td>
<td>2 days</td>
</tr>
<tr>
<td>refine benchmarking</td>
<td>1 day</td>
</tr>
<tr>
<td>refine concept</td>
<td>6 days</td>
</tr>
<tr>
<td>refine attributes</td>
<td>1 day</td>
</tr>
<tr>
<td>preliminary contract</td>
<td>1 day</td>
</tr>
<tr>
<td>resolve risk 1</td>
<td>6 days</td>
</tr>
<tr>
<td>resolve risk 2</td>
<td>6 days</td>
</tr>
</tbody>
</table>

why 6 days?

total: **23 days**

imagine it is last Friday (12th)…

<table>
<thead>
<tr>
<th>Milestones</th>
<th></th>
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<tbody>
<tr>
<td>team review</td>
<td>Oct. 17</td>
</tr>
<tr>
<td>mockup review</td>
<td>Oct. 18</td>
</tr>
</tbody>
</table>

**time to review:** 6 days
Project scheduling
Step 2: task sequencing

sequential

refine concept ➔ resolve risk 1

parallel

refine concept ➔ resolve risk 1

together

refine concept ➔ resolve risk 1
## Project Scheduling

### Step 2: Sequence Based Upon Interdependencies

<table>
<thead>
<tr>
<th></th>
<th>Refine Needs</th>
<th>Refine Benchmarking</th>
<th>Refine Attributes</th>
<th>Refine Concept</th>
<th>Resolve Risk 1</th>
<th>Resolve Risk 2</th>
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<tr>
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<td>X X X X X</td>
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</tbody>
</table>

**Need Info (Row):**
- need info (row)

**Provide Info (Col.):**
- provide info (col.)
Project scheduling

Step 3: Visualization

Gantt charts (tasks, resources, milestones)
Project scheduling

Step 3: Visualization

Critical path
Pert charts (program evaluation and review technique)
Project scheduling
managing a deadline crunch

start early
manage/change deliverable scope
freeze decisions based on timeline
increase work load
outsource or engage additional resources

reallocate resources to critical path
(eliminate secondary items)
eliminate parts of critical path
Scheduling

Step 1: task list and milestones

by project

by milestone/concept

by sub-problem: risk 1 *(weekly task forces)*

<table>
<thead>
<tr>
<th>Risk 1 tasks</th>
<th>Estimated time</th>
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<tr>
<td>brainstorm options</td>
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<tr>
<td>develop options</td>
<td>1 days</td>
</tr>
<tr>
<td>analyze options</td>
<td>1/2 day</td>
</tr>
<tr>
<td>design mockup</td>
<td>1 day</td>
</tr>
<tr>
<td>build mockup/test bed</td>
<td>2 1/2 days</td>
</tr>
<tr>
<td>run experiment and document</td>
<td>1 days</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Milestones</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>task force progress review</td>
<td>Oct. 16</td>
</tr>
<tr>
<td>team review</td>
<td>Oct. 17</td>
</tr>
</tbody>
</table>
Section schedule preparation

Gantt charts starting after your team decision!

key milestones
list tasks and estimate completion times
sequence tasks based upon dependencies
allocate resources and draft a Gantt chart

draw Gantt chart on team white board!
Wrap up
miscellaneous items

Gantt chart software linked on home page

Send email with concept names and order 9 PM tonight!

Mockup logistics online is updated with venues