CSCE482: Senior Capstone Design
Today...

- “The Five Dysfunctions of a Team: A Leadership Fable”
- Reexamine the nine step design process
  - Some tools for your toolbox in thinking about design problems.
  - In particular we care about the first few steps right now.
Nine Step Model of Design Process

1. Recognizing the need
2. Defining the problem
3. Planning the project
4. Gathering information
5. Conceptualizing alternatives
6. Evaluating the alternatives
7. Selecting the preferred alternative
8. Communicating the design
9. Implementing the preferred design
Cost of Making Changes During Different Phases of the Design Life Cycle

- Preliminary design
- Detailed design
- Production
- Consumption

Cost of change, $
Summary of the methodology

Identify the Need

Goal Statement  →  Design Criteria

Objectives  ←  Constraints
Step 1: Identify the Need

Sandra: “Jane, we need you to design a stronger bumper for our new passenger car.”

Jane: “Why do we need a stronger bumper?”

Sandra: “Well, our current bumper gets easily damaged in low-speed collisions, such as those that occur in parking lots.”

Jane: “Well, a stronger bumper may be the way to go, but there may be better approaches. For example, what about a more flexible bumper that absorbs the impact but then returns to its original shape?”

Sandra: “I never thought of that. I guess I was jumping to conclusions. Let’s restate the need as “there is too much damage to bumpers in low-speed collisions.” That should give you more flexibility in exploring alternative design approaches.”
Step 1: Identify the Need

1. So we are Identifying the client
2. Working from the Client’s perception of the need
   Asking: Why is this a need?
   Trying to: Identify the reason for the need
Step 2: Defining the Problem

Goal Statement
Idealized and scope still poorly delineated

Objectives
Each is unambiguous and measurable

Constraints
Each is unambiguous and measureable, clearly satisfied or violated. Hard requirements; cut down the feasible set

Design Criteria
Compact descriptor: useful for first-pass analysis of alternative approaches
Step 2: Defining the Problem: Goal

• Now we try to produce a Goal Statement

• Sets out to answer the question “How are we going to address this Need?”

• Brief, general, and ideal response to the Need.

• At this stage: Is so ideal that it might never be achieved, or so general that we cannot determine when it is achieved.
  – Its selection establishes the general direction of the design effort.
  – Don’t yet have readily identifiable closure.
Step 2: Defining the Problem: Goal

- Goal Statement scope is often not clear initially.
- Statement needs to be understood by the client.

Example:

Need: Childproof pill bottles are too difficult for people with arthritis to open.

Possible goal statements: Design a –

Childproof pill bottle that is easier to open
Childproof pill container that is easier to open
Childproof system for dispensing pills
Childproof system for dispensing medication
Step 2: Defining the Problem: Goal
Step 2: Defining... Objectives

- Quantifiable expectations of performance.
- Establish operating environment.
- Indicators of progress toward achieving Goal.
- Define the performance characteristics of the design that are of most interest to the client.
- Facilitate determination of which alternative designs best meet expectations.
Step 2: Defining... Objectives

Examples from the bumper problem:

- inexpensive
- no significant damage to bumper
- no significant damage to other parts
- easily recyclable
- operative

Revised Need: *There is too much damage to cars in low-speed collisions*

Revised Goal: *Design an improved front bumper*
Step 2: Defining... Objectives

<table>
<thead>
<tr>
<th>Objective</th>
<th>Measurement Basis</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inexpensive</td>
<td>Unit manufacturing cost for a production run of 50,000</td>
<td>dollars</td>
</tr>
<tr>
<td>No significant damage to bumper</td>
<td>Distance bumper is pushed into body</td>
<td>inches</td>
</tr>
<tr>
<td>No significant damage to other parts</td>
<td>Repair cost</td>
<td>dollars</td>
</tr>
<tr>
<td>Easily recyclable</td>
<td>Amount of aluminum</td>
<td>lb</td>
</tr>
<tr>
<td>Retain maneuverability</td>
<td>Turning radius</td>
<td>ft</td>
</tr>
<tr>
<td>Retain braking capability</td>
<td>Braking distance</td>
<td>ft</td>
</tr>
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Step 2: Defining... Constraints

Constraints establish permissible range of the design and performance parameters.

Three types:

1. yes/no constraints (or go/no-go)
   e.g., must use 3/8”-24 UNF SAE grade 5 bolts

2. equality constraints
   e.g., must be 18” high

3. inequality constraints (single and double sided)
   e.g., cannot weigh more than 50 lb, must hold at least 50 lbs of steam,
   must be between 12” and 15” long
Aside: Objective-Constraint Duality

Restating the problem in a slightly different way can result in some objectives becoming constraints and vice-versa.

- The **objective** “not causing significant damage” can be reworded as a **constraint** “not costing more than $200 to repair”.

- It may be desirable to include both in the problem statement.
  - Or at least think about which is the better form.
  - Think: landscape gradient vs. bounds.
Step 2: Defining... Criteria

Objectives ➔ Quantifiable expectations of performance
Criteria ➔ Value-free descriptor of objective

Same units; same basis for measurement

Example:
Design objective: should be lightweight
Associated criterion: weight

Criteria are compact descriptors of performance associated with objectives.
Criteria can be developed from approaches. They allow you to think about common and unique features.
## Step 2: Defining... Criteria

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Design Criteria
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Gathering Information

• There are vast amounts of information available on any subject.
• It is always better to base your design on existing information rather than relying exclusively on your own ideas
• Sources
  – Technical (Library, Papers, Internet)
  – Creative (Brainstorming)
  – Acquisition (Catalogs)
  – Economic (Market forecasts, etc.)
Gathering Information: Stages

• Identify the kind of information required.
• Physically or electronically gather the information.
• Determine how reliable and credible the information is.
• Decide when to stop looking.
Team work

Personality Characteristics

- Myer-Briggs Type Indicator is designed to classify individuals according to four basic preferences
  1. extraversion versus introversion
  2. sensing versus intuitive
  3. thinking versus feeling
  4. judgment versus perception
- Given the time frame of the project, it is best to accept rather than try to change people’s personalities

Leaders and Followers

- “Born Leaders” myth -- no scientific evidence
- Different leaders may emerge depending on the situation at hand
Roles within the group

**Generators**
- People who have lots of ideas

**Integrators**
- Good at integrating other people’s ideas into credible proposals

**Developers**
- Advance the idea stage into a product or process

**Perfector**
- Improves the product or process
What does a leader do?

**Task oriented function**
- Organize the group, help define goals, monitor progress, make adjustments to meet the goal

**Relationship oriented function**
- Responsive and considerate to the needs of each group member
Group Tasks

Group project activities operate in a cycle:

– Group meets
– Tasks are assigned to individuals
– Individuals go off and accomplish tasks
– At next meeting, individuals report to group
– Group discusses and evaluates progress
– New tasks are assigned
– Cycle repeats
Group Tasks

Figure 3-1. Traditional lifecycles
Group Tasks

Figure 3-2. XP lifecycle
Elements of Project Planning

• Divide project into tasks, tasks into subtasks, subtasks into ...

• Estimate duration of each task, subtask, ...

• Estimate resource requirements for each task, subtask, ...(budget, personnel, facilities)

• Identify precedence relations among tasks
Benefits of Project Planning

• Communications tool
  – Clients and coworkers

• Resource allocation
  – funds, personnel, facilities, equipment

• Benchmarking
  – progress monitoring
  – required adjustments
Gantt Chart

Durations explicitly listed on the left

The critical path is in red

The slack is the black lines connected to non-critical activities

Diamonds used to mark milestones

Can mark progress along the bars by highlighting fraction complete
  e.g., cross-hatching
Oral Communication

• Never underestimate the importance of an oral presentation
• Many decisions are made based on the basis of a presentation

Presentation Design:
  1. Tell them what you are going to say.
  2. Say it.
  3. Tell them what you just said.
Oral Communication: Preparation

• Rehearse, rehearse, rehearse...
• Do not exceed available time!
• Become aware of your crutch words

On the average, a picture is worth a thousand words
  – A poorly executed picture can be detrimental

Text in visual aids
  – Each slide should only one idea
Oral Communication: Delivery

- Speak clearly and slowly
- Maintain eye contact
  - But do not fixate on a single person
- As a guideline allow one minute per slide
  - Figure out your “style”
- Presentation Zen, Guy Kawasaki
  - Good video: Authors@Google: Garr Reynolds
- Watch TED talks
THE SHRINKING FAMILY DOCTOR
In California
Percentage of Doctors Devoted Solely to Family Practice

<table>
<thead>
<tr>
<th>Year</th>
<th>1964</th>
<th>1975</th>
<th>1990</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>27%</td>
<td>16.0%</td>
<td>12.0%</td>
</tr>
</tbody>
</table>

1: 3,167
6,694

1: 2,247 RATIO TO POPULATION
8,023 Doctors

1: 4,232
6,212

Visual Displays

Darrell Huff’s
“How to lie with statistics.”
Edward Tufte has a series of books. The first is “The Visual Display of Quantitative Information”