ME 213 S2023: Introduction to Engineering Design

Lecture 04: Concept Selection Techniques
Outline

1. Review: Generation vs. Selection
2. Go/No-Go
3. Selection Matrix
4. Pugh Chart
5. General Tips
6. Why This Process Can Be Difficult
7. Get Started
1. Review: Generation vs. Selection

Concept Generation

Concept Selection

DIVERGE
CREATE CHOICES

CONVERGE
MAKE CHOICES
2. Go/No-Go Scoring

- For each objective/requirement, decide if concept can/might meet it (Go) or not (No-Go)
- Sum Go’s and No-Go’s for each concept
- Choose the concept with highest positive rating (most Go’s, fewest No-Go’s)

**Pro:**
- Simplest system, just needs requirements

**Cons:**
- Doesn’t consider priority of requirements
- Doesn’t consider the *degree* to which a requirement is met or not.

<table>
<thead>
<tr>
<th>Objective/Requirement 1</th>
<th>Concept 1</th>
<th>Concept 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Go</td>
<td>No-Go</td>
</tr>
<tr>
<td>Objective/Requirement 2</td>
<td>No-Go</td>
<td>Go</td>
</tr>
<tr>
<td>Objective/Requirement 3</td>
<td>Go</td>
<td>No-Go</td>
</tr>
<tr>
<td>Objective/Requirement 4</td>
<td>Go</td>
<td>Go</td>
</tr>
</tbody>
</table>

| Sum Go’s | 3 | 2 |
| Sum No-Go’s | 1 | 2 |
| Total     | 2 | 0 |
3. Selection Matrix

- Choose a **benchmark** to serve as a datum.
- For each objective/requirement, mark if the concept:
  - + performs better than the benchmark
  - 0 performs equal to the benchmark
  - - performs worse than the benchmark
- Sum +’s and subtract -’s for each concept
- Choose the concept with the highest net score

<table>
<thead>
<tr>
<th>Objective/Requirement 1</th>
<th>Concept 1</th>
<th>Concept 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Objective/Requirement 2</td>
<td>0</td>
<td>+</td>
</tr>
<tr>
<td>Objective/Requirement 3</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>Objective/Requirement 4</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

| Sum +  | 2 | 3 |
| Sum -  | 1 | 0 |
| Total Score | 1 | 3 |

**Pro:**
- Provides finer resolution than go/no-go

**Con:**
- Doesn’t consider priority of requirements.
- Relies on a functional benchmark.
4. Pugh Chart

- Choose a **benchmark** to serve as a datum.

- For each objective/requirement, decide how well concept meets the objective/requirement relative to datum:
  1. Much worse
  2. Slightly worse
  3. Equally well
  4. Slightly better
  5. Much Better

- Multiply each score by a **weight**, chosen based on requirement priority.

- Sum **weighted scores** for each concept.

- Choose the concept with the highest score.

<table>
<thead>
<tr>
<th>Objective/Requirement</th>
<th>Weight</th>
<th>Raw Score</th>
<th>Weighted Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective/Requirement 1</td>
<td>5</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>Objective/Requirement 2</td>
<td>3</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>Objective/Requirement 3</td>
<td>4</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Objective/Requirement 4</td>
<td>1</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

**Total Score**: 42

**Pros:**
- Considers requirement priority
- Provides finer resolution in scoring

**Cons:**
- Requires a functional benchmark
- Complexity
5. General Tips

**Questions for Your Own Selection Process**
1. Does everyone understand each concept to be considered?

2. Will you use a benchmark (datum), or relative scoring only?

3. What scoring scale will you use? How many values will it have?

4. Did you remember to include an objective/requirement for **feasibility** or **manufacturability**?

**Note:** As mentioned in the assignment, you are expected to organize your scoring by **subsystem**, not complete systems. You will then try to combine the “winning” ideas into a complete system solution.
5. General Tips

- **Coarse Screening: Why Does Something Fail?**
  Don’t just disregard something because it can’t meet a given spec. Is there any minor change you could make that would correct the problem? Can you combine one or more “almost successful” ideas?

- **Fine Screening: More Possible Score Values Are Better**
  The more score values you have at your disposal, the easier it will be to distinguish your concepts from each other.

- **Use Multiple Rounds of Scoring**
  Especially important if multiple concepts have the same or very similar scores.

- **Still Not Satisfied? Brainstorm Again!**
  Bad scores don’t necessarily mean your system is too coarse or harsh. Go back and reassess.

- **Finally, Does the Winning Idea Make Sense?**
  You’ll prove things with your analysis later, but layout a solid conceptual framework for why your chosen concept is a viable solution. Does your logic stand up?
6. Why This Process Can Be Difficult

- Inherent difficulty of comparing very different concepts to meet wide variety of project requirements.

- **Biases** can tinge our objectivity, including:
  
  **Self-Preservation Bias:**
  Connecting sense of self-worth to opinion of your ideas (i.e., “taking it personally”)

  **Belief Bias:**
  Evaluation of the logical strength of an argument is biased by personal belief in the truth or falsehood of the conclusion.

  **Overconfidence Bias:**
  Someone's subjective confidence in their judgments is reliably greater than their objective accuracy, especially when confidence is relatively high.

  **Example:** In some quizzes, people rate their answers as "99% certain" but are wrong > 40% of the time.
7. Get Started

• Plan a selection system with your team.

• Create your spreadsheets.

• As a group, score each system (and as necessary subsystem) concept.