

# 1.8 Solution Selection

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## Summary

Students learn a method for selecting a solution based on ranked criteria. They practice this method for an example case and then apply it to their selected design problem.

## Learning Objectives

After this class, students will be able to:

- Identify and rank important design requirements using a pairwise comparison chart to create design criteria.
- Use a decision matrix to select a solution to a design problem.

## Materials

- Computers with Excel or other spreadsheet program are helpful, but not required.

## Time

80 minutes

## Procedure/Pacing

### Pairwise Comparison Chart

1. As a class, review how to set up and operate a pairwise comparison chart by going through the example below, or use one of your own. Since students should have watched the video explaining how to do this, let them lead this activity. Stress that a pairwise comparison chart will help us rank order the design criteria in order of importance.
2. Example: Design a lunchbox that will keep hot things hot and cold things cold.
3. Begin by deciding on Design Criteria based on the requirements and constraints that have already been written. You can have students come up with their own criteria (usually about 5 is appropriate), or use the criteria provided. For the lunchbox problem, we will use:
  - A. Low cost
  - B. Compact size
  - C. Keeps temperatures within range
  - D. Does not leak
  - E. Durable
4. Set up a N by N matrix (where N is the number of criteria) and label the rows and columns with the criteria. Shade the diagonal, since we don't

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need to compare a criterion with itself. Include a “Total” column to the right of the table.

Design Criteria	A	B	C	D	E	Total
A						
B						
C						
D						
E						

5. Fill in the matrix by placing a 1 in the cell when the row criterion is more important than the column criterion. Place a 0 in the cell when the column criterion is more important than the row criterion. For example, if Criterion A is more important than Criterion B, the table entries would look like:

Design Criteria	A	B	C	D	E	Total
A		1				
B	0					
C						
D						
E						

6. Complete the table based on student responses for comparative importance of the criteria. Then sum the rows to give a total for each row criterion. The table will look something like:

Design Criteria	A	B	C	D	E	Total
A		1	0	1	1	3
B	0		0	1	0	1
C	1	1		1	1	4
D	0	0	0		0	0
E	0	1	0	1		2

7. So the criteria, in order of greatest to least importance are:
- 1) Keeps temperature within range
  - 2) Low cost
  - 3) Durable

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- 4) Compact size
- 5) Does not leak
8. Have students break into their groups and construct a pairwise comparison chart for their Design-Your-Life problem. (Part 1 of Assignment 1.8i)

### Decision Matrix

1. As a class, go through an example of how to set up and operate a decision matrix. Stress that this matrix will use the ranked design criteria to help us in deciding on a most promising solution. You may want to mention that these tables can be easily manipulated to select a favorite solution, so care should be taken to score solutions thoughtfully as a team and by consensus.
2. Be mindful of the Design Constraints (these are things the design must not do). If any of the possible solutions violates a constraint, it must be eliminated from further consideration.
3. Continuing with the above example, set up a decision matrix with the rank ordered design criteria as rows and the possible design solutions as column headings with a column for the raw score and one for the weighted score for each possible solution. About 5 or 6 solutions should be compared within one table.
4. Have students decide on weights for each of the design criteria. The most important criterion will have the greatest weight and the weights will decrease down to the least important criterion. Weights for the design criteria must add up to 1. See the example table with example weights below.

Criteria	Weight	Solution 1		Solution 2		Solution 3	
		Raw Score	Weighted Score	Raw Score	Weighted Score	Raw Score	Weighted Score
A	0.40						
B	0.30						
C	0.15						
D	0.10						
E	0.05						
Total	1						

5. As a class, score each of the possible solutions with a raw score of 0-5 for each of the criteria. A 0 means the solution does not meet that criterion at all and a 5 means that the solution is the best for meeting that criterion. When scoring it may be helpful to compare the solutions to an average or typical design. For our example, we might compare the solutions to an existing lunchbox. In this way, we can think score of

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0 as significant underperformance of the solution compared to the average, a 3 as about the same performance as the average, and a 5 as significant better performance than the average for the given criterion.

- Multiply the raw scores by the weight of the criterion to calculate the weighted score. Then add the weighted scores down the column to get the total for each solution. The solution with the best total is selected as the most promising solution. See example below:

Criteria	Weight	Solution 1		Solution 2		Solution 3	
		Raw Score	Weighted Score	Raw Score	Weighted Score	Raw Score	Weighted Score
A	0.40	4	1.6	2	0.8	0	0
B	0.30	3	0.9	1	0.3	5	1.5
C	0.15	4	0.6	0	0	4	0.6
D	0.10	5	0.5	5	0.5	3	0.3
E	0.05	3	0.15	5	0.25	4	0.2
Total	1		3.75		1.85		2.6

- Have students break into their groups and construct a pairwise comparison chart for their Design-Your-Life problem. (Part 2 of Assignment 1.8i)

### **In-Class Assignment**

Assignment 1.8i: Solution Selection

### **Resources**

Pairwise Comparison Chart and Decision Matrix Template

### **Homework**

Assignment 1.9h: Engineering Design Process Part 3 - Create

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