Problem Definition: Clarifying the Objectives (Ch. 4)

- Clarifying client's objectives by Objective Tree (Sec 4.1) - completed
- Rank-ordering objectives by Pairwise Comparison Chart (Sec. 4.3) - completed
- Measuring the achievement of objective by Metrics (Sec. 4.2 & 4.4)

Objectives:

- They are not equally important
- In addition to their relative importance, their achievements need to be measured.
- Some objects re in the "quantitative" category;
  For example, cost, weight and so on.
- Some objectives are in the "qualitative" category;
  For example, simplicity, durability, and so on.

How do we measure and compare the relative achievement of objectives?

By metrics.

Two issues: what to measure and how to compare.

<u>What to measure?</u>

- There are objectives that are "quantitative". They can be measured directly. For example, cost (by dollars), weight (by lbs) and so on.
- There are objectives that are "qualitative". For such objectives, surrogate metrics are used instead.
- Surrogate metrics should be measurable properties that are strongly related to the objective of interest.
- For example, simplicity would be measured by the number of parts, or by time taken to assemble the product.

<u>How to compare?</u>

- A common scale is needed. Since, for example, comparing dollar amount with number of parts is meaningless.
- Typically to compare is to assign or to award points to objectives.
- *VDI 2225 Guidelines* for awarding points based on perceived value of concept or idea: see Table 4.7.

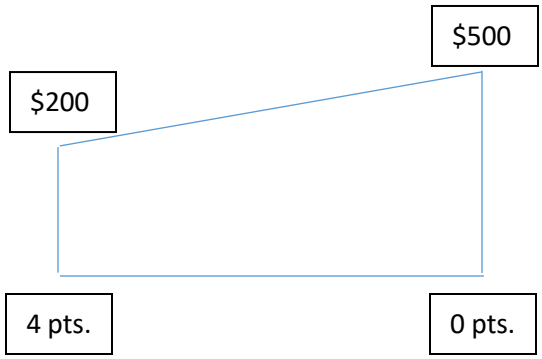
  From yellow sticky note posted on board:
  VDI: The Association of German Engineers
  VDI-2225 Design Engineering Methods – Tables for Engineering Design at Optimum Cost

Table 4.7 Scales or rulers for awarding points depending on perceived value of a solution (Use-Value Analysis) or perceived value of the idea or concept (VDI 2225 Guidelines)

Use-Value analysis		VDI 2225 Guidelines	
Solution Value	Points Awarded	Perceived Value	Pointed Awarded
		Unsatisfactory	
		Just Tolerable	
		Adequate	
		Good	
Very good			
Exceeds Requirements		Very good (ideal)	
Excellent			

How to compare (cont'd)?

- Generally speaking, Table 4.7 is applicable to objectives that are in the "qualitative" category. For example, the appearance of a product can range from unsatisfactory (0) to great (4).
- Table 4.7 can also be used on the "quantitative" objectives. For example, the estimated cost of a product can be given points based on if the estimated cost is "very expensive" (0) or "very inexpensive" (4).
- For "quantitative" objectives, it is typical to formulate a linear scale to award points
  For example, it is unacceptable for the cost of a product to be beyond $500; and research shows that it would be ideal to keep the cost below $200. Work out the scale for awarding points ranging 0 to 4.



C *for cost*

$C \leq \$200$	4
$\$200 < C \leq \$275$	3
$\$275 < C \leq \$350$	2
$\$350 < C \leq \$425$	1
$C \geq \$425$	0

etc.

or:

$C \leq \$200$	4
$\$200 < C \leq \$300$	3
$\$300 < C \leq \$400$	2
$\$400 < C \leq \$500$	1
$C > \$500$	0

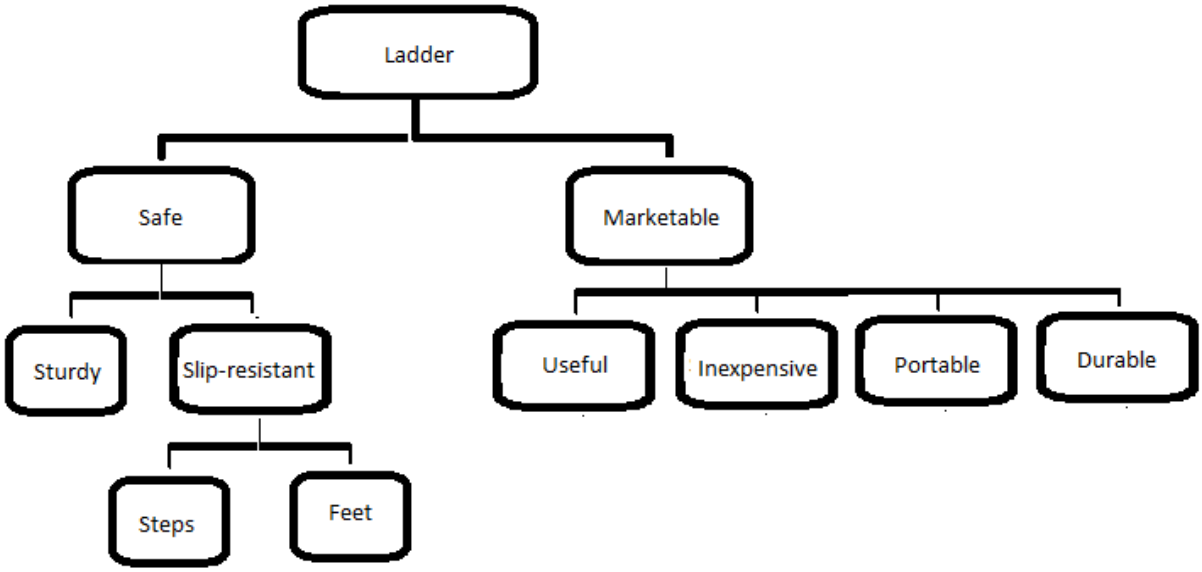
- Measuring the achievement of objectives by Metrics (Sec. 4.2 & 4.4)

Objectives

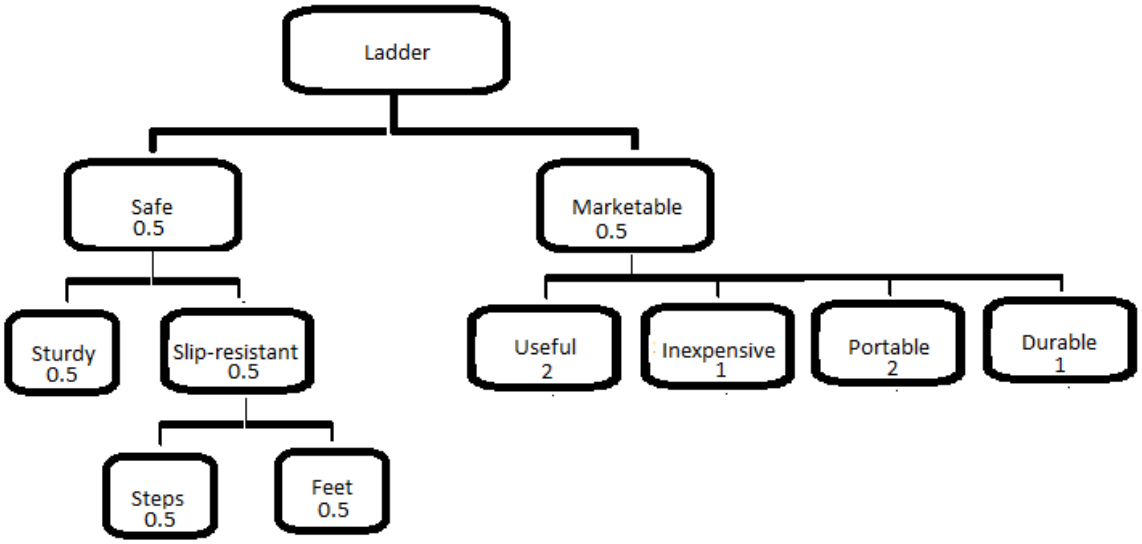
How do we measure and compare the achievement objectives?

Weighted objective tree

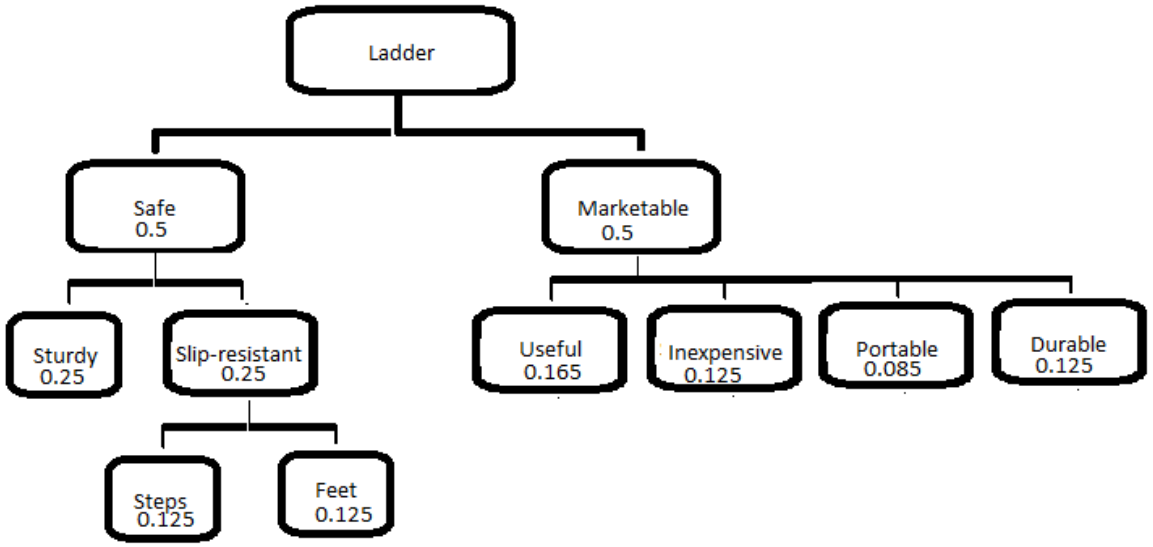
Summary



With PCC values assigned:



With weighted values assigned:



Objectives	Weights	Alternative 1		Alternative 2	
Sturdy	0.25	2	0.5		
Slip-resistant (steps)	0.125	0 ~ 4			
Slip-resistant (feet)	0.125	1	0.125		
Useful	0.165				
Inexpensive	0.125				
Portable	0.085				
Durable	0.125				
Total:	1				

Weighted Objective Tree, Example 2

Product

- Objective 1
  - Objective 1.1
  - Objective 1.2
- Objective 2
- Objective 3

Product (with PPC values)

- Objective 1 (1)
  - Objective 1.1 (0)
  - Objective 1.2 (1)
- Objective 2 (0)
- Objective 3 (2)

Product (next values – that add up to 1, arbitrary weighted values with consideration to criteria)

- Objective 1 (0.3)
  - Objective 1.1 (0.3)
  - Objective 1.2 (0.7)
- Objective 2 (0.15)
- Objective 3 (0.55)

Product (next values – total value for all doesn't exceed 1)

- Objective 1 (0.3)
  - Objective 1.1 (0.09)
  - Objective 1.2 (0.21)
- Objective 2 (0.15)
- Objective 3 (0.55)

Objectives	Weights	Alternative 1		Alternative 2	
Obj 1.1	0.09				
Obj. 1.2	0.21				
Obj. 2	0.15				
Obj. 3	0.55				
Total:	1				

Summary:

Design is about achieving the objectives, hence the need for measuring how successful the design is in achieving the objectives, or the metrics.

For every objective, there must be a metric (the measure and the points/scale)

It is desired for a design to achieve ALL objectives.

Reading Assignments
S 4.2, S 4.3
S 4.4 up to p.61, end of S 4.4.2
and Table 4.11 (part of S 4.5)
S 5.1 and S 5.2