List 3.1  SAFE LADDER Attributes List

Ladder should be useful
Used to string conduit and wire in ceilings
Used to maintain and repair outlets in high places
Used to replace light bulbs and fixtures
Used outdoors on level ground
Used suspended from something in some cases
Used indoors on floors or other smooth surfaces
Could be a stepladder or short extension ladder
A folding ladder might work
A rope ladder would work, but not all the time
Should be reasonably stiff and comfortable for users
Step deflections should be less than 0.05 in
Should allow person of medium height to reach/work at levels up to 11 ft
Must support weight of an average worker
Must be safe
Must meet OSHA requirements
Must not conduct electricity
Could be made of wood or fiberglass, but not aluminum
Should be relatively inexpensive
Must be portable between job sites
Should be light
Must be durable
Needn’t be attractive or stylish
3.3 SAFE LADDER Indented Objectives List

0. A safe ladder for electricians

1. The ladder should be safe
   1.1 The ladder should be stable
       1.1.1 Stable on floors and smooth surfaces
       1.1.2 Stable on relatively level ground
   1.2 The ladder should be reasonably stiff

2. The ladder should be marketable
   2.1 The ladder should be useful
       2.2.1 The ladder should be useful indoors
           2.2.1.1 Useful to do electrical work
           2.2.1.2 Useful to do maintenance work
       2.2.2 The ladder should be useful outdoors
   2.2.3 The ladder should be of the right height
   2.2 The ladder should be relatively inexpensive
   2.3 The ladder should be portable
       2.3.1 The ladder should be light in weight
       2.3.2 The ladder should be small when ready for transport
   2.4 The ladder should be durable
FIGURE 3.1  The objectives tree for the design of a safe ladder. It shows the first fruits of problem definition. Note the hierarchical structure and the clustering of similar ideas.
Figure 3.3 A combined tree (objectives in rectangles and constraints in ovals) for the design of a new beverage container. Here the goals for the new product are shown together with the constraints that apply to the object being designed.
Table 3.1 Measuring scales for testing and evaluating designs in the field of product design. Adapted from (Jones, 1992).

**Nominal scales**, such as colors, smells, or even professions (e.g., teachers, lawyers, engineers).

**Partially ordered scales**, such as grandparent, parent, and child, which array themselves somewhat in order of seniority.

**Ordinal scales**, such as first, second, third, etc.

**Ratio scales**, such as inches, seconds, or dollars. Ratio scales have natural reference points or base points.

**Interval scales**, such as degrees Centigrade, that have arbitrarily defined reference points or base points.

**Multidimensional scales or index numbers**, such as miles per gallon or kilometers per maintenance event, that are compounds of other scales of measurement.
<table>
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<th>Goals</th>
<th>Cost</th>
<th>Portability</th>
<th>Usefulness</th>
<th>Durability</th>
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