Terminology

-Need: description of unsatisfactory situation

-Goal: brief, general, ideal response to need

-Objectives: desired attributes/behavior; quantifiable (ex. light, safe, cheap)

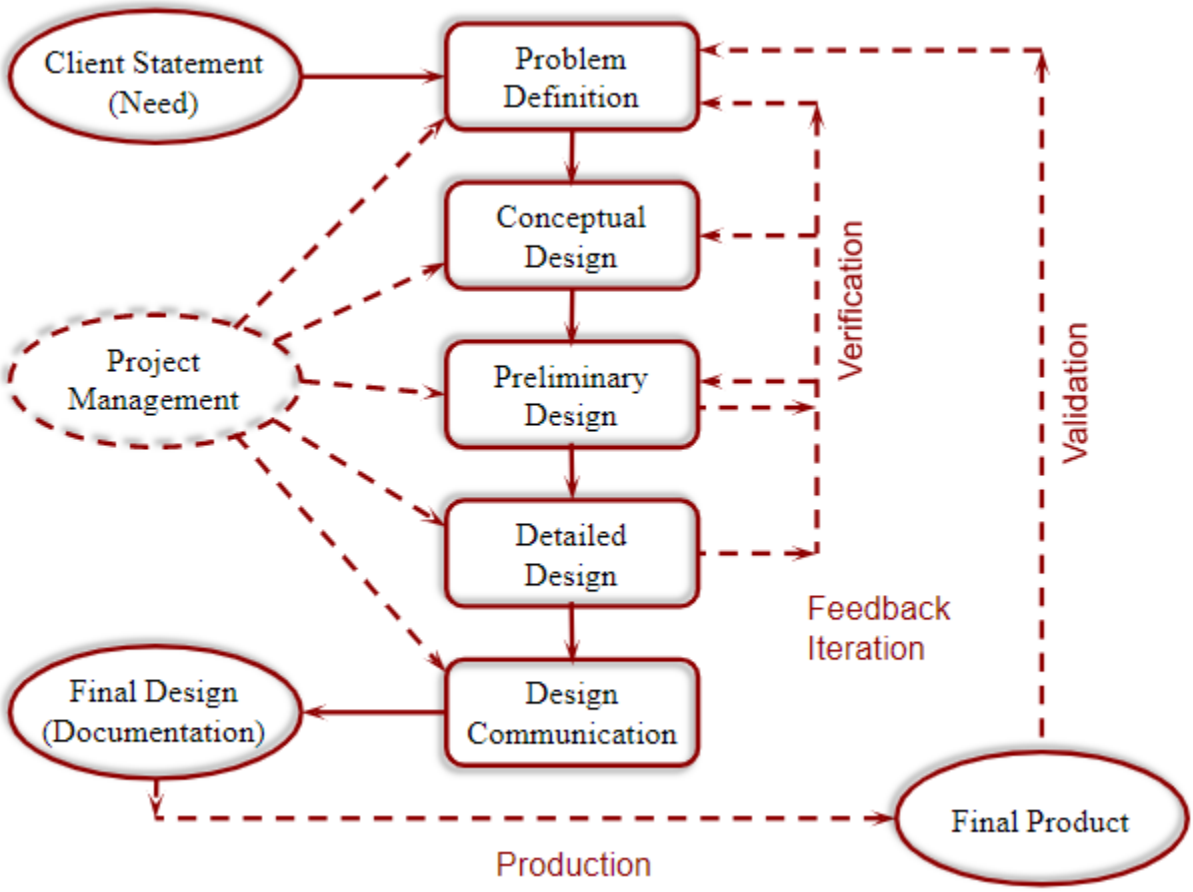
-Criteria: attributes that are the basis for deciding between designs (ex. cost, weight)

-Metrics: scales of the degree in which objectives/criteria are achieved (ex. Ultra-light = 5 points, …, heavy = 1 point)

-Constraints: yes/no restrictions on design parameters (ex. must not conduct electricity, must weigh less than 10lbs)

-Functions: services that must be provided by design/components (ex. must support weight, must alert user)

Design Process



Problem Definition

Input: client statement
Outputs: revised problem statement, objectives/criteria, constraints, weighted criteria tree

Design Problems Are:

-Ill-structured: no formula to solve the problem

-Open-ended: there is more than one solution

-Iterative: design process is not linear; feedback loops

Stakeholders

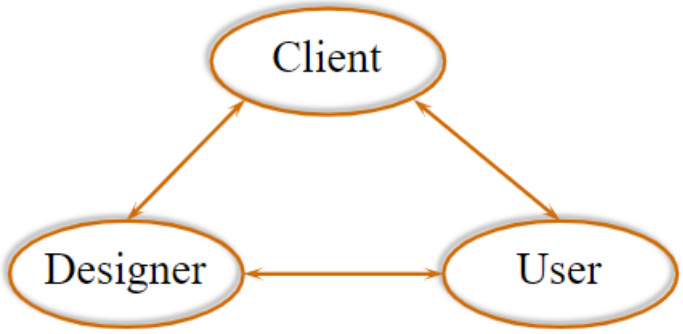


Figure 1. Stakeholder Triangle

-**Criteria tree** shows objectives
-**Pairwise comparison** ranks objectives
-**Weighted criteria tree** shows objectives with the appropriate weights

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Conceptual Design

Inputs: revised problem statement, objectives/criteria, constraints
Outputs: design and functional specifications, several conceptual designs

-Function Enumeration: create a list of all the functions that the product does
-Black/Transparent Boxes: graphic representation of system, showing input and outputs
-Function-Means Tree: functions are what you must do; means are how you might do it

Specifications

-Functional: what the product must do (ex. Ladder must support 300 lbs)
-Design: attributes the product must have (ex. Ladder must be made from Grade A fir)
-Procedural: (ex. Ladder must pass the XYZ Test)

Specification Documents

-Scope: what must the document cover?
-Intended audience: who is going to read it?
-Classification Scheme: specifications are classified with tags

Conceptualization

-Convergent/Vertical Thinking: focuses on the single, well-established answer
-Divergent/Lateral Thinking: focuses on creative ideas

Idea Generation

-6-3-5 Method: 6 team members write 3 ideas each; list circulated among remaining 5
-C-Sketch Method: each member sketches an idea, then sketch is circulated
-Gallery Method: each member draws an idea, all displayed, group discussion
-Synectics/Analogies: look at solutions for other, parallel problems

-**Morphological chart** continues the function-means tree by providing options for each function

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Preliminary Design

Input: several conceptual designs, specifications
Output: selected design, test results

Design Selection

-Quality Function Deployment/**House of Quality**: defines needs with technical requirements, examines interactions, compares against competition

-**Numerical Decision Matrix**/Weighted Objective Chart: uses weighted criteria tree/morphological charts to rank designs by judging how well they fulfil criteria/how important those criteria were

Testing

-Prototype: full-scale working model
-Physical Model: not scale, but similar functions that can be tested
-Proof of Concept: a model used specifically to test whether an idea works
-Alpha Testing: internal testing of software before beta

Detailed Design

Input: selected design, test results
Output: fabrication specifications, final design review for client

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Design Management

-Scope, Spending, Schedule

-**Work Breakdown Structures**: lists all tasks hierarchically
-Adds up to 100% of work/time
-No task too long; 80 hour rule

-**Linear Responsibility Chart**: lists tasks, matches them with people

-**Project Network**: flow chart of activities in logical order

-**Gantt Chart**: horizontal bar graph mapping design activities against time