PABLO

MECH 161 – INTRODUCTION TO COMPUTER AIDED DESIGN (CAD) I

WEEK 2 – ENGINEERING DESIGN PROCESS

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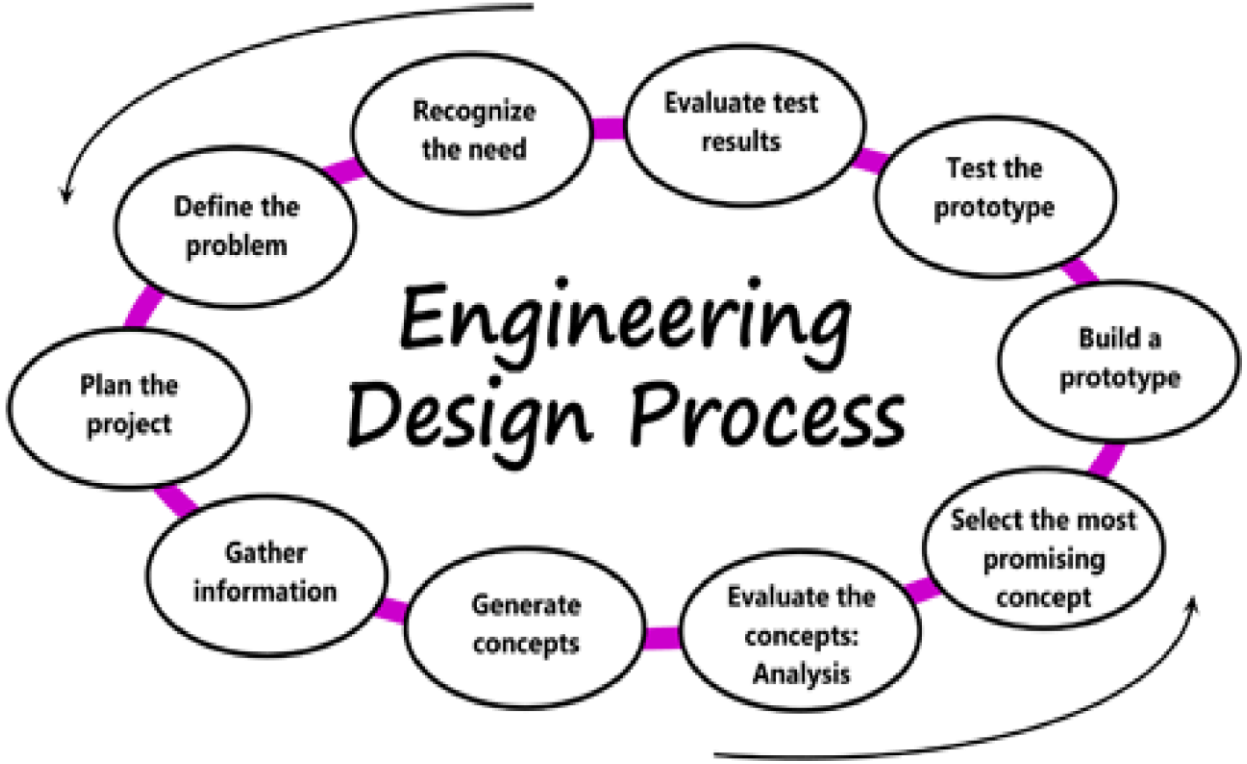
What is EngineeringDesign?

Engineering design **is a systematic, intelligent process in which designers generate, evaluate and specify designs for devices, systems or processes whose form(s) andfunction(s) achieve client's objectives and users' needs while satisfying a specific set ofconstraints.**



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History of Design

- People have been designing things for a longtime
- Examples of great designs from thepast
- Great Wall ofChina
- Mayan Cities andTemples
- Great Pyramids in Egypt
- Basic design method in the past > **Trial andError**

Mac ComputerEvolution

1976: AppleI

1980:AppleIII

1989: MacPortable

1998:iMac

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2000:PowerMac G4Cube

2003: iMacG4 2004: PowerBookG4 2004: iMacG5

Mobile PhoneEvolution

1980s 1990s 2000s 2010s

Automobile Evolution

Automobiles

Timeline

1769

1883

1899

1913

1934

1936

1948

1954

1955

1964

2007

The DesignProcess

- Scientists see things as they are and ask, **WHY?**
- Engineers see things as they could be and ask, **WHYNOT?**

- Essence of newdesign
- **Lessexpensive**
- **Faster**

- Better

Designs Can Be Different – Variation inUsage

A Variety of Possibilities for Designing aLadder

Generating Ideas for
- Innovations
- Solving Problems
- Meeting Needs
- Improving Efficiency
- Saving Resources
- …

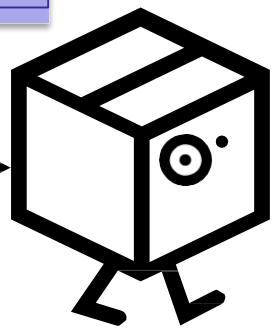
End Results of the Engineering Design
- Being in the form of Specifications for
  - Manufacturing Products
  - Carrying out Services

Idea

Design

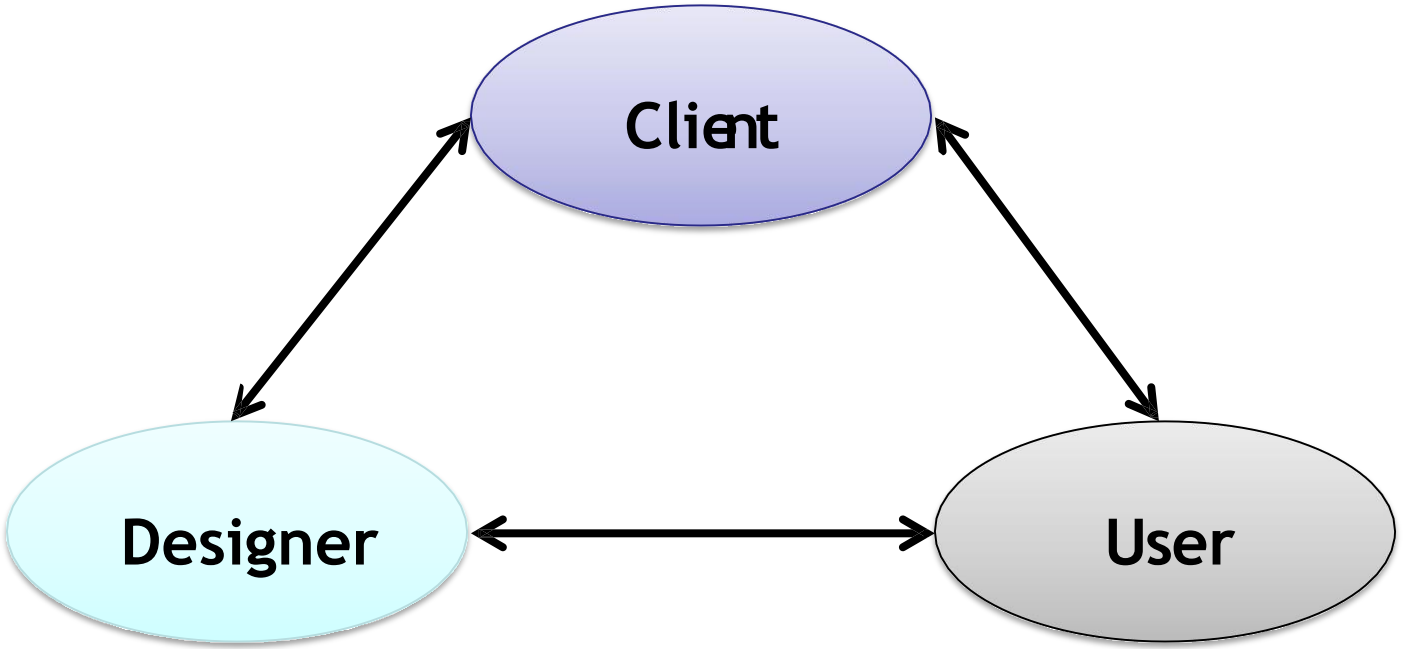
Specifications

Manufacture



Going through an Engineering Design Process
- Achieving Objectives
- Satisfying Constraints
- Leveraging on Available Knowledge, Skills & Technologies

Designer-Client-User Triangle



- **Client:** person or group or company that wants a designconceived

- **User:** The person who will actually use whatever is beingdesigned
- **Designer:** As its nameimplies

Engineering Design Addresses HardProblems

- Design problems are **ill structured** —their solutions cannot normally be found by applying math. formulas, methods, and procedures in a routineway.

- Design problems are open-ended —they typically have several acceptablesolutions.

Design Process as a Process ofQuestioning

- Suppose your client wants you to “design a safeladder”.

- There will be a lot of questionsarising:
- Why do you want anotherladder?
- How will it beused?
- How much can it cost?
- What do you mean by“safe”?

- ….
- Similar sets of questions arise if I simply ask you to “design an automated guided vehicle (AGV)”, without further specifications.

- The designer’s first task is to clarify what the client wantsso as to be able translate wishes into meaningful **objectives** and **constraints**.

Example: Design a SafeLadder

- Questionslike
- Why do you want anotherladder?
- How will itbe used?
- How much can it cost?

❾help **clarify and establishthe client's objective.**

- Questions like

- What does “safe”mean?
- What’s the mostyou’re willing to spend?

❾ help **identify the constraints**that govern the design.

Example: Design a SafeLadder

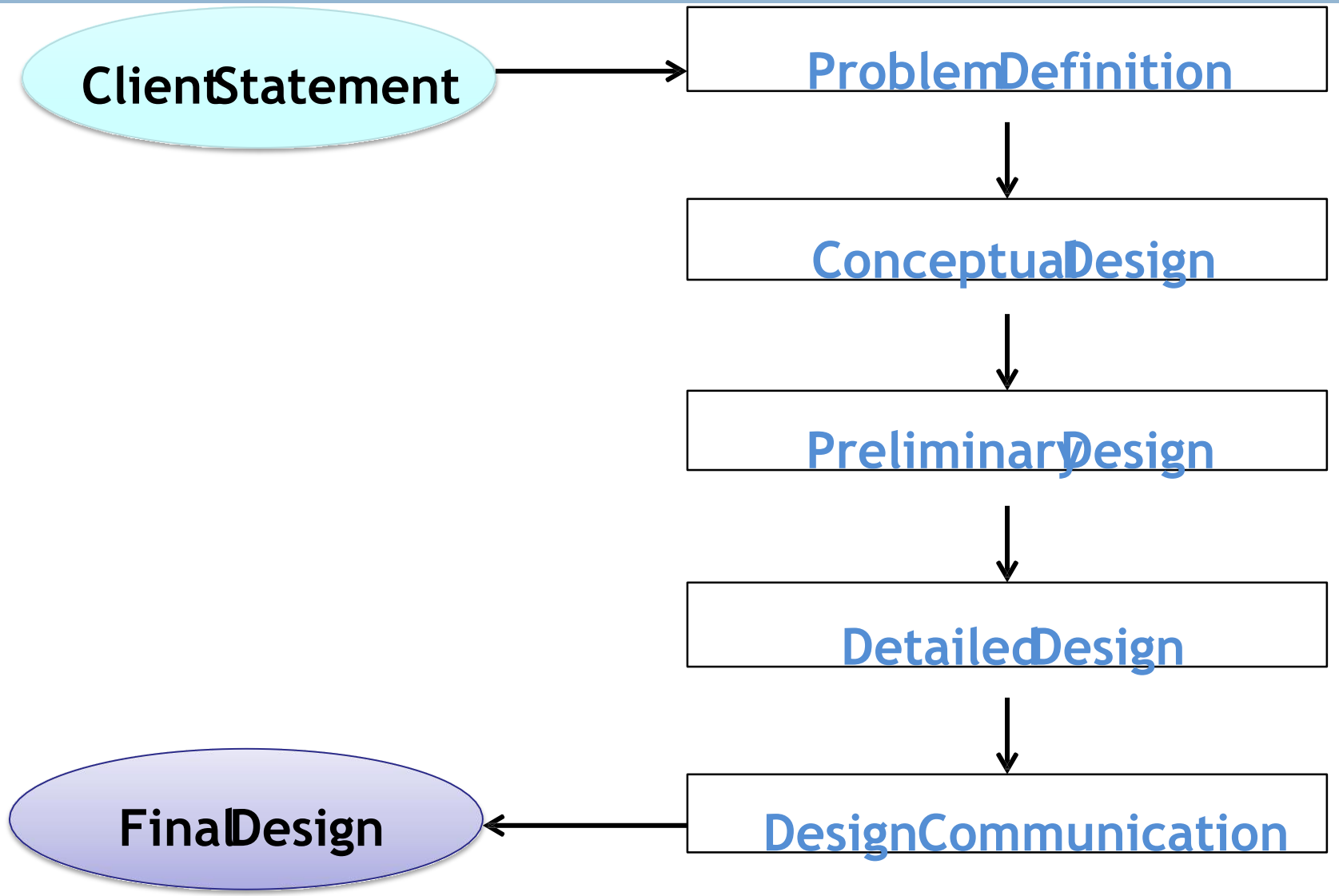
- Questionslike
- Can the ladder lean against a supportingsurface?
- Must the ladder support someone carryingsomething?

❾ help **establish functions** that the design must performand suggests **means** by which those functions can be performed.

- Questionslike
- How much weight should a safe laddersupport?
- Howhighshouldsomeone onthe ladderbeableto reach?

❾ help establish **requirements** for the design.

- Can you think about these questions for yourdesign?


Client Statement
Problem Definition
Conceptual Design
Preliminary Design
Detailed Design
Design Communication
Final Design

DesignProcess

Problem Definition

- A pre-processing stage that frames the problem by clarifying the client's original problemstatement

- What is the Problem?
  1. Collect information
  2. Interpret information
  3. Organize needs hierarchy

4. Determine relative importance of needs
5. Review outcomes and process

Conceptual Design

Different concepts are generated to achievethe client's objective

- Explore many solutions
  - Brainstorm
- Select the best solution

- Based on needs and constraints
- Use a decision matrix

- Creativity
  - Development of new ideas
- Innovation
  - Bringing creative ideas to reality

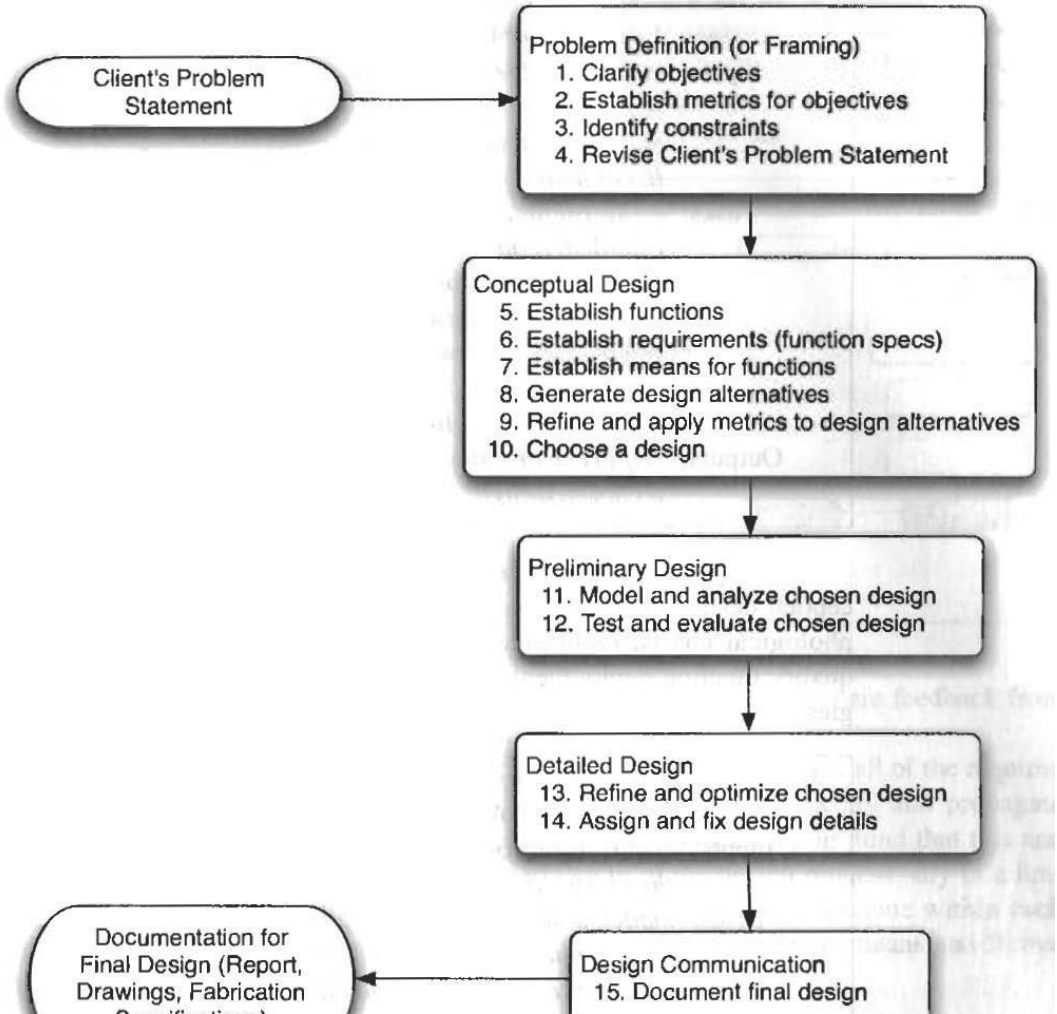
DesignProcess

- **Preliminary design**: examine preliminary choices of schemes
- For the ladder project, we may size the side rails and steps, and perhaps decide on how the steps are to be fastened to the side rails.

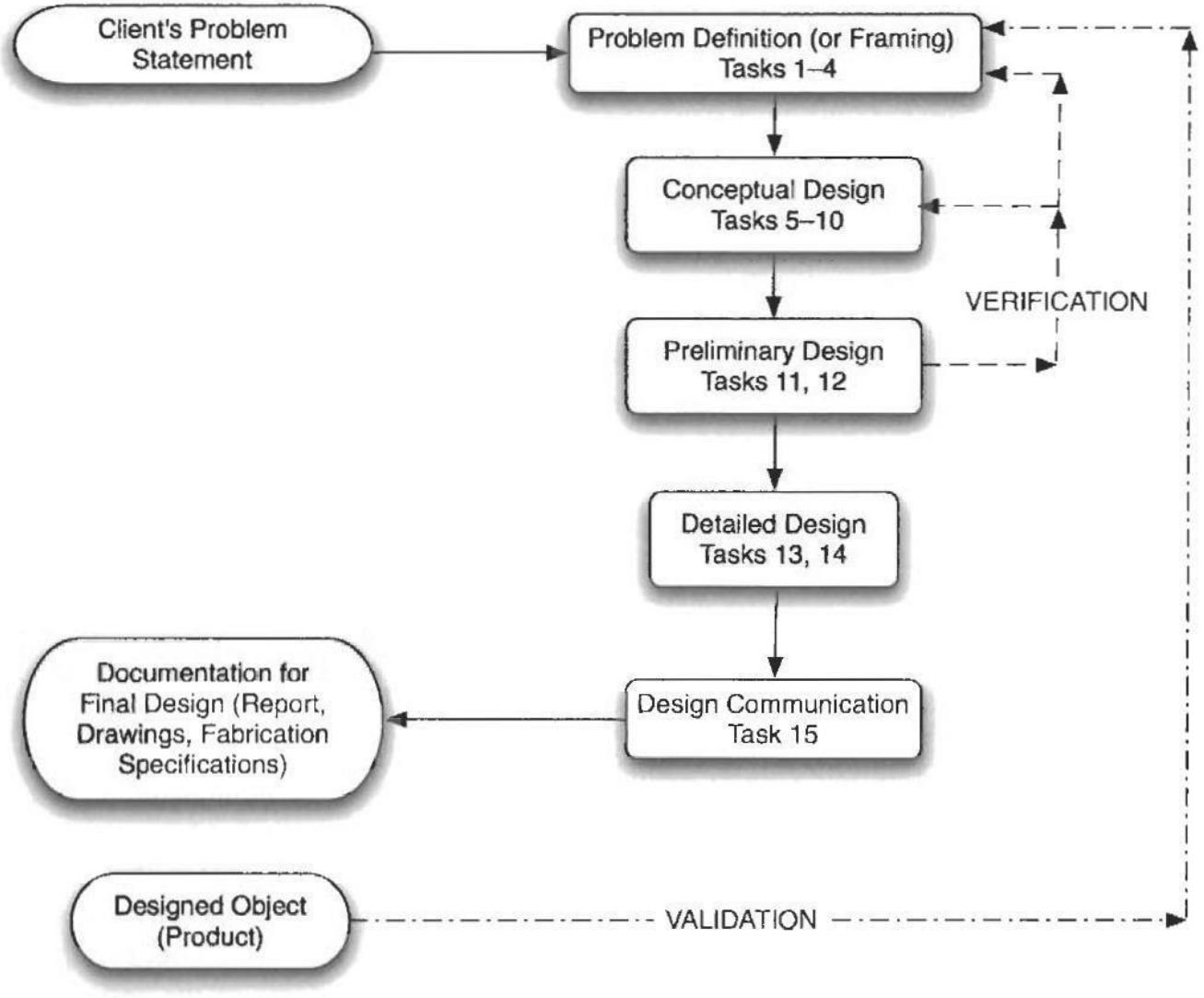
- **Detailed design**: refine the choices we made in preliminarydesign

- **Design communication**: a post-processing phase that identifies the work done tocollect, organize, present the final design

Specific Tasks of the DesignProcess


Client's Problem Statement
Problem Definition (or Framing)
1. Clarify objectives
2. Establish metrics for objectives
3. Identify constraints
4. Revise Client's Problem Statement
Conceptual Design
5. Establish functions
6. Establish requirements (function specs)
7. Establish means for functions
8. Generate design alternatives
9. Refine and apply metrics to design alternatives
10. Choose a design
Preliminary Design
11. Model and analyze chosen design
12. Test and evaluate chosen design
Detailed Design
13. Refine and optimize chosen design
14. Assign and fix design details
Design Communication
15. Document final design
Documentation for Final Design (Report, Drawings, Fabrication

Design Process isIterative



- A design process is not linear or sequential.
- We revise or modify the process from time totime.

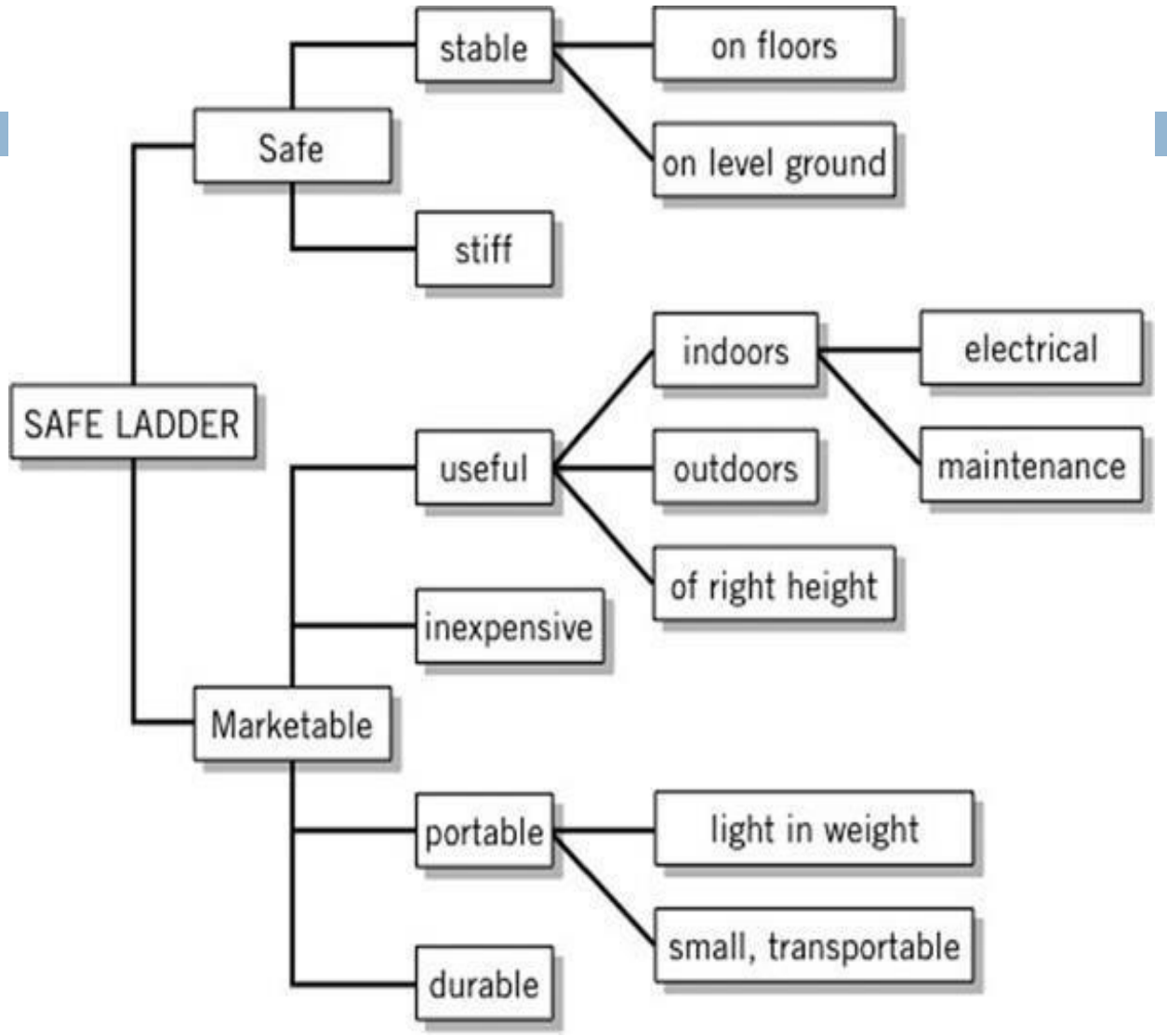
Problem Definition – Example: Design a SafeLadder

- Ladder should be useful
- Used to maintain and repair outlets in highplaces
- Used to replace light bulbs andfixtures
- Could be a stepladder or short extensionladder

Example: Design a SafeLadder

• Could be made of wood or fiberglass, but notaluminum	Means
• Step deflections should be less than 0.5inch	Function
• Must support weight of an averageworker	
• Must besafe	Constraint
• Must not conductelectricity	Objective
• Should be relatively inexpensive	
• Must be portable between jobsites	Objective
• Should belight	Constraint
Must bedurable	
• Need not be attractive orstylish	

Build an **objective tree** early, and modify it often while defining the problem



Questions