Generating and Developing Ideas

Engineering Design

Introduction

- Ideas
  - Incredibly important to business
  - Generate new or improved products
  - Cornerstone of innovation
- “The best way to have a good idea is to have lots of ideas”–Linus Pauling

Creative Thinking

- Creative thinking
  - Does not come easily to most people
- Education involves convergent or deductive thinking
  - Taught to look for “the right answer”
- No right or wrong answers, only ideas
- Vertical thinking
  - Each idea rests on another idea
  - Logical form
  - Also called high probability thinking
  - Allows us to make assumptions without analysis
- Lateral thinking
  - Follows unconventional paths
  - Also called low probability or “out of the box” thinking
  - Allows new ideas

Brainstorming

- Exchange of ideas in a group
  - Ideas used to stimulate more ideas
- Attempt to get away from conventional solutions
- Friendly environment where new ideas are welcome
- Limited time frame
  - As a group - Define the problem & make sure everyone understands it
  - Set relatively short time to generate ideas; be spontaneous, be outrageous, be imaginative
  - Listen carefully to others ideas and build on them
  - Go for quantity to ensure quality
  - Evaluate after “ideation” session ends – one person must be in charge of documenting the results

Sketching and Doodling

- Drawing is the language of all designers
- Sketching
  - Quick, freehand drawing
  - Fast, efficient way to get ideas out of your head
  - Forces you to develop idea in terms of relationships between components

Figure 4-6: A sketch for a solar home, and its realization.

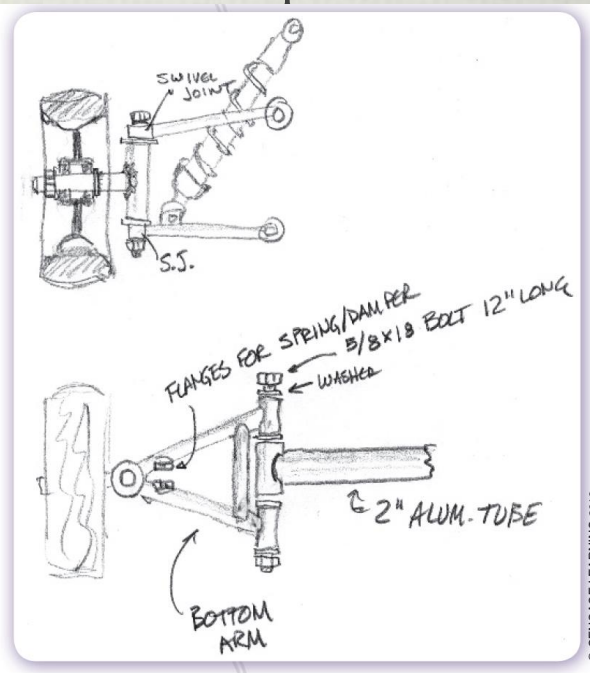


Figure 4-7: An example of an effective technical sketch.

Incubation Period

- The human mind is always working
  - Even when not consciously thinking about a problem
- Provide time for ideas to incubate
- During sleep
  - The mind sifts through information and categorizes it
- Record ideas when they come to you

Development Work

- Ideas need development
  - When a number of ideas with good potential have been generated
  - When final solution path has been selected
- Goal of early development
  - Determine if the idea is a workable solution to the design problem

Choosing the Best Solution

- Optimal solution
  - Best solution that can be achieved
  - Considers all requirements and constraints
- Choosing may be difficult in a complex system
  - Involves analytical thinking
- Best or optimal solution
  - Should be based on realistic, well-defined criteria
- Review original specifications

Development of the Team

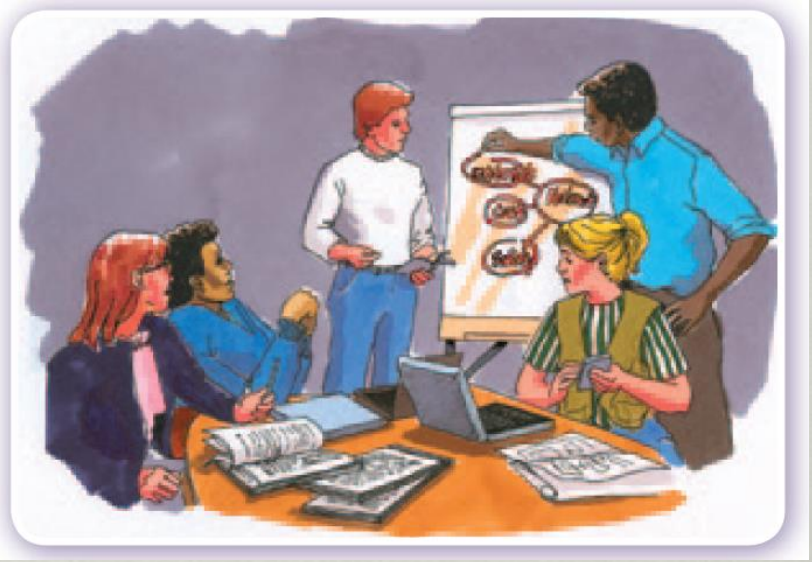
- Team structure
  - Based on the team goal
  - Composed of people who are experts in their own fields
  - Group must have a shared vision
  - Team may have a coach
- Team success depends on synergy
  - Everyone working together as a team
- Effective leadership is important
- Self-directed team
  - Led by the team itself
- Common vision
  - Leads to motivation, better teamwork

Group Norms

- Norms describe well-established behavior
- Team must agree together to change unacceptable norms
- Good norms to consider
  - Scheduling meetings
  - Recording written agendas and minutes
  - How to handle conflict
- Elements of a team charter
  - Identify team mission
  - Establish team values
  - Establish group norms
  - Identify strengths and weaknesses of team members

Communication

- Communication keeps all parts of the design process on track
- Poor communication Usually results in a crisis
- Two way process
- Positive, constructive feedback is necessary for personal and team growth

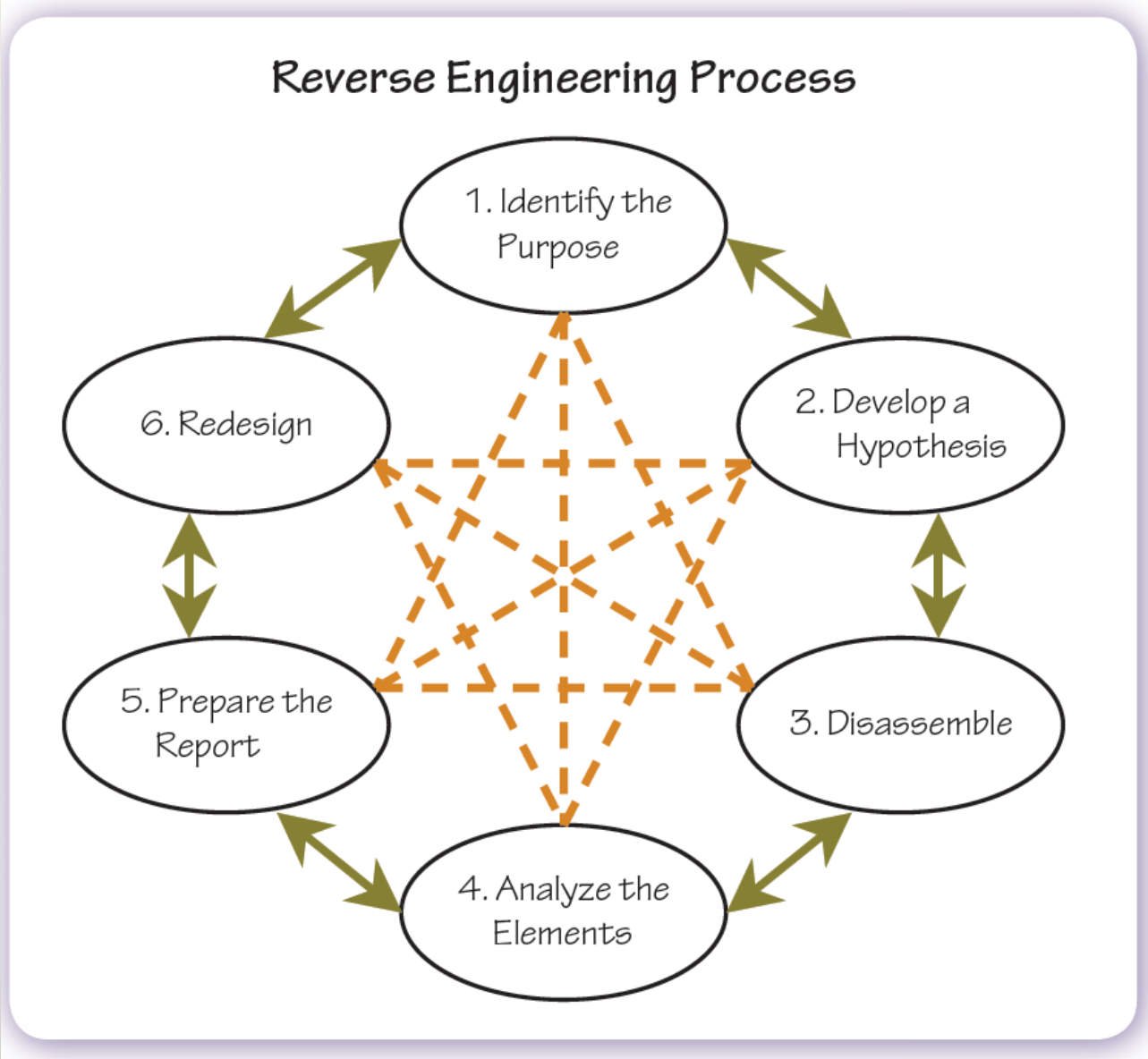


Reverse Engineering

Reverse Engineering

- Leads to A new understanding about products
- Research
  - Important step in the design process
- Reverse engineering
  - Process of analyzing a product's function and features
  - Begins with a product
  - Ends with understanding

The Big Picture



Identify the Purpose

- Determine what needs to be learned
- Record purpose in engineer's notebook

Develop a Hypothesis

- Hypothesis
  - Statement that suggests a possible, unproven answer to a question
- Describe hypothesis of product function
- Write down questions and possible answers

Disassembly

- Disassembly process called teardown
- Carefully disassemble to uncover internal components and mechanisms
- Must be done in organized fashion
  - Keep careful notes
  - Organize parts with labels and plastic bags
  - Take photos during the process

Analyze the Elements

- Attempt to answer the questions originally posed
- Four types of analysis
  - Functional
  - Structural
  - Materials
  - Manufacturing

Functional Analysis

- Discover how the product works
- Take measurements or perform tests on components
  - Tools: micrometers and calipers

Structural Analysis

- Determine purpose of each part
- Determine how parts interact with each other
- Finite Element Analysis
  - Used to learn more about structural qualities

Materials Analysis

- Identify material by its common name
- Useful to know what the manufacturing process is
- Material properties may be determined by testing
- Molded plastic parts may be labeled with the material type or symbol

Manufacturing Analysis

- Types of manufacturing processes
  - Forming
  - Separation
  - Joining

Product Redesign

- Communicate findings in a clear and concise manner
- Confirm purpose of the reverse engineering has been addressed
- Make recommendations for design change based on findings