Design Process

Conceptual Design Components and Ethics

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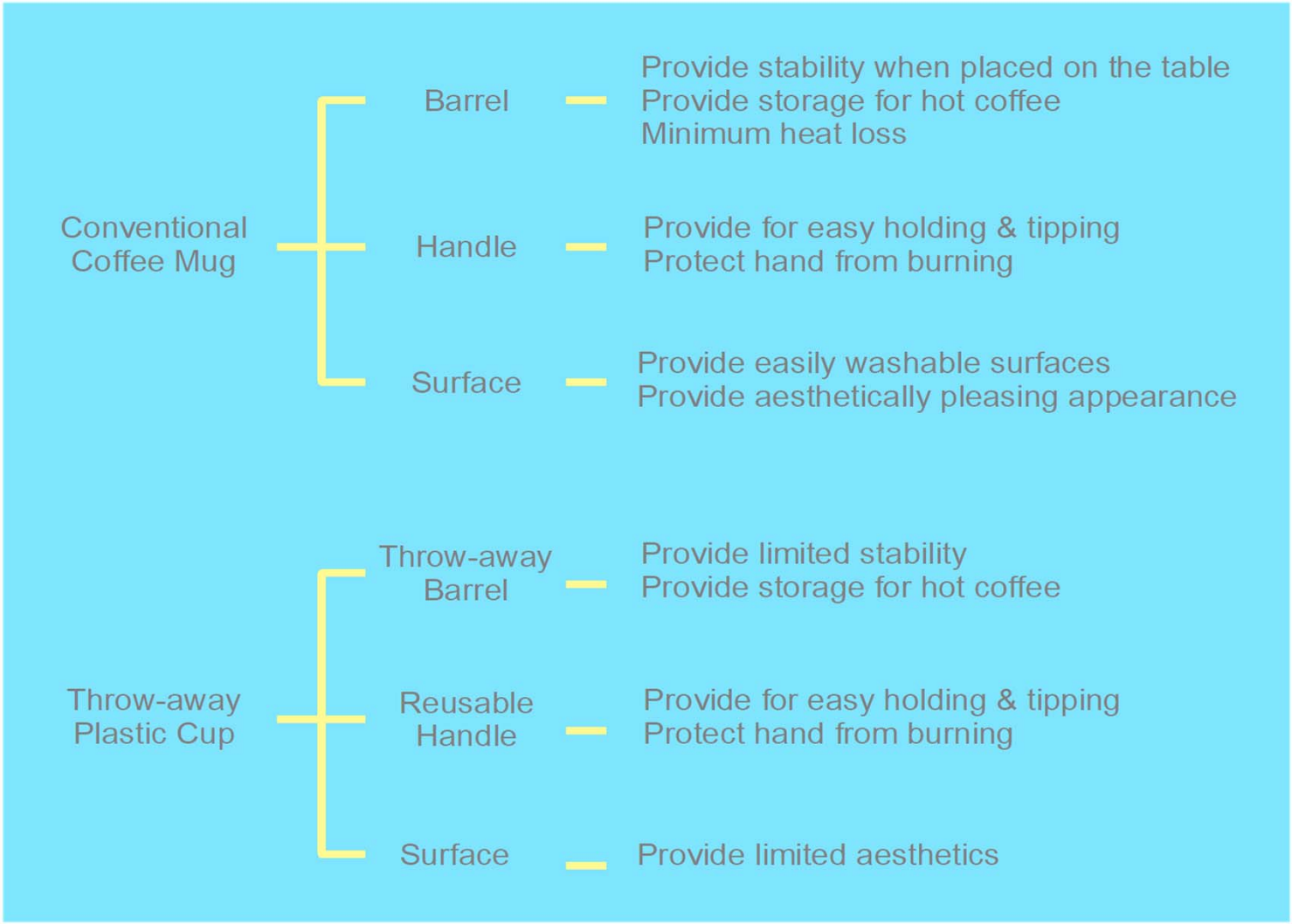
Conceptual Design

- **Conceptual Design (noun)** is the definition of 'means' groups (subsets) of functions from the overall list of functions which the product has to perform as given in the product concept or specification.
- **Conceptual Design (verb)** is the process of defining the sub groups of requirements and the means to provide them.
- It is achieved in two steps:
  - Grouping the functions for each sub-means
  - Establishing the sub-means which would integrate with other sub-means in harmony
- Conceptual design involves creativity

Difficulty with Conceptual Design

Example - Two Conceptual Designs



Difficulty with Conceptual Design

- **The means proposed may not be self-sufficient to provide the functions which are to be performed.**
- **They may need extra functions (secondary functions) to perform its original intended functions.**
- **The secondary functions may need secondary means.**

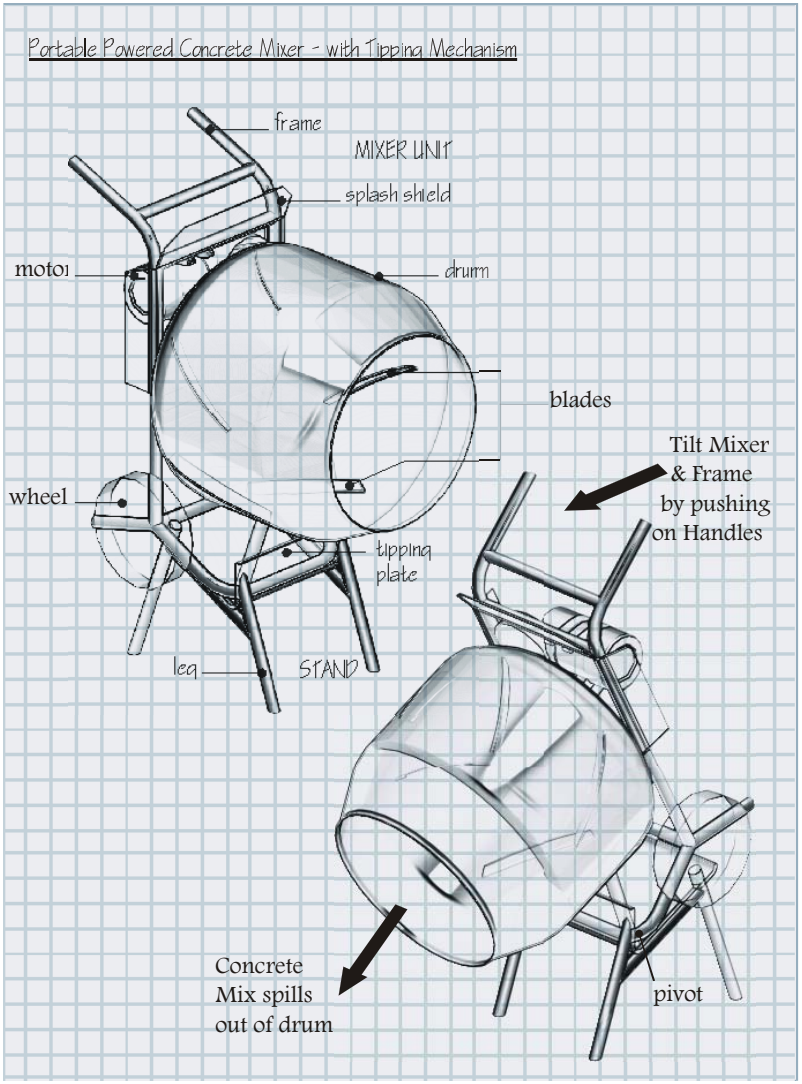
Difficulty with Conceptual Design
Example – Washing Machine Drum

Rotating Drum of a Washing Machine

- **Principal function is to agitate the clothes at specified speeds for specified times.**
- **Two secondary functions necessary are**
  - **A measuring function to sequence and control activities**
  - **A power regulating function to give the current required to get the speed.**

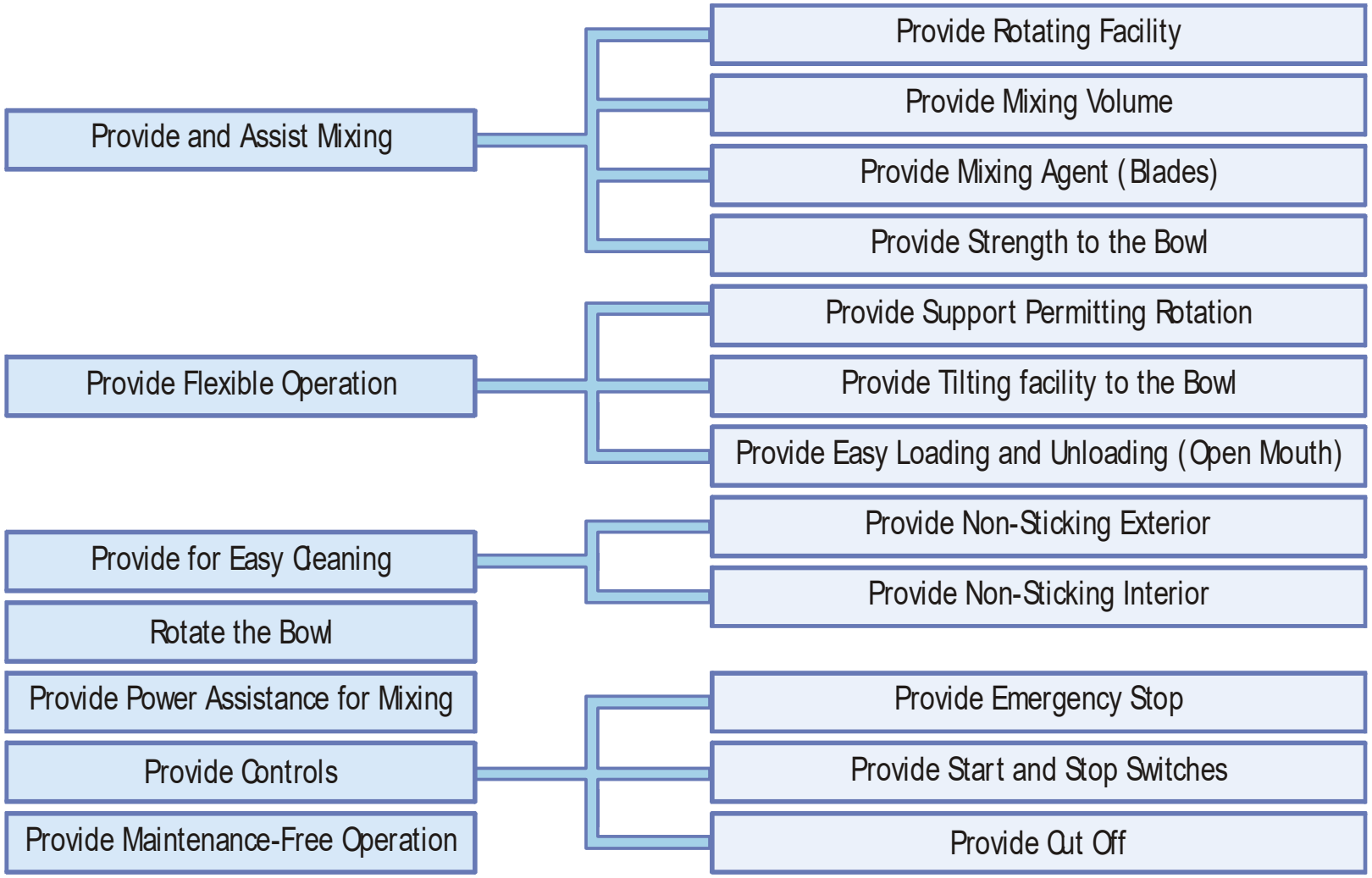
Difficulty with Conceptual Design

Example – Concert Mixer



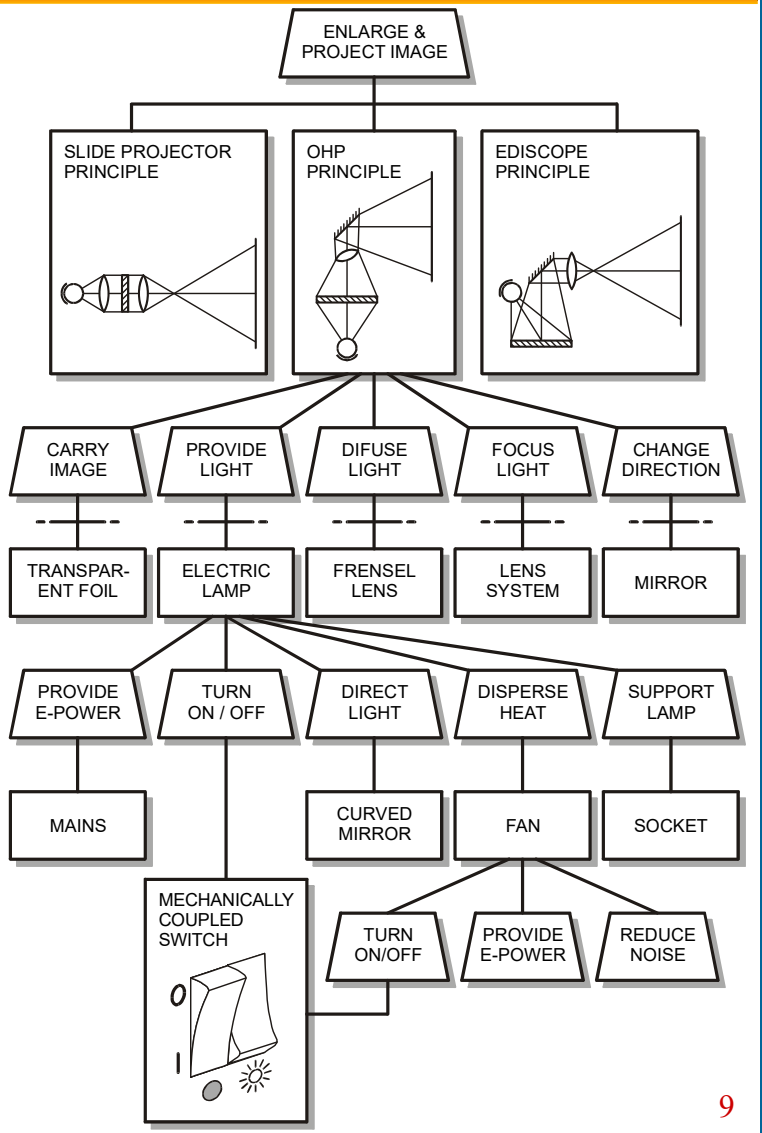
Difficulty with Conceptual Design

Example – Concert Mixer



Function Means Tree

- **Function Means Tree when completed is an effective way of showing the conceptual design.**
- **It is a useful method to develop conceptual designs**
- **It essentially has two components 'Functions' and 'Means'**



Function Means Tree

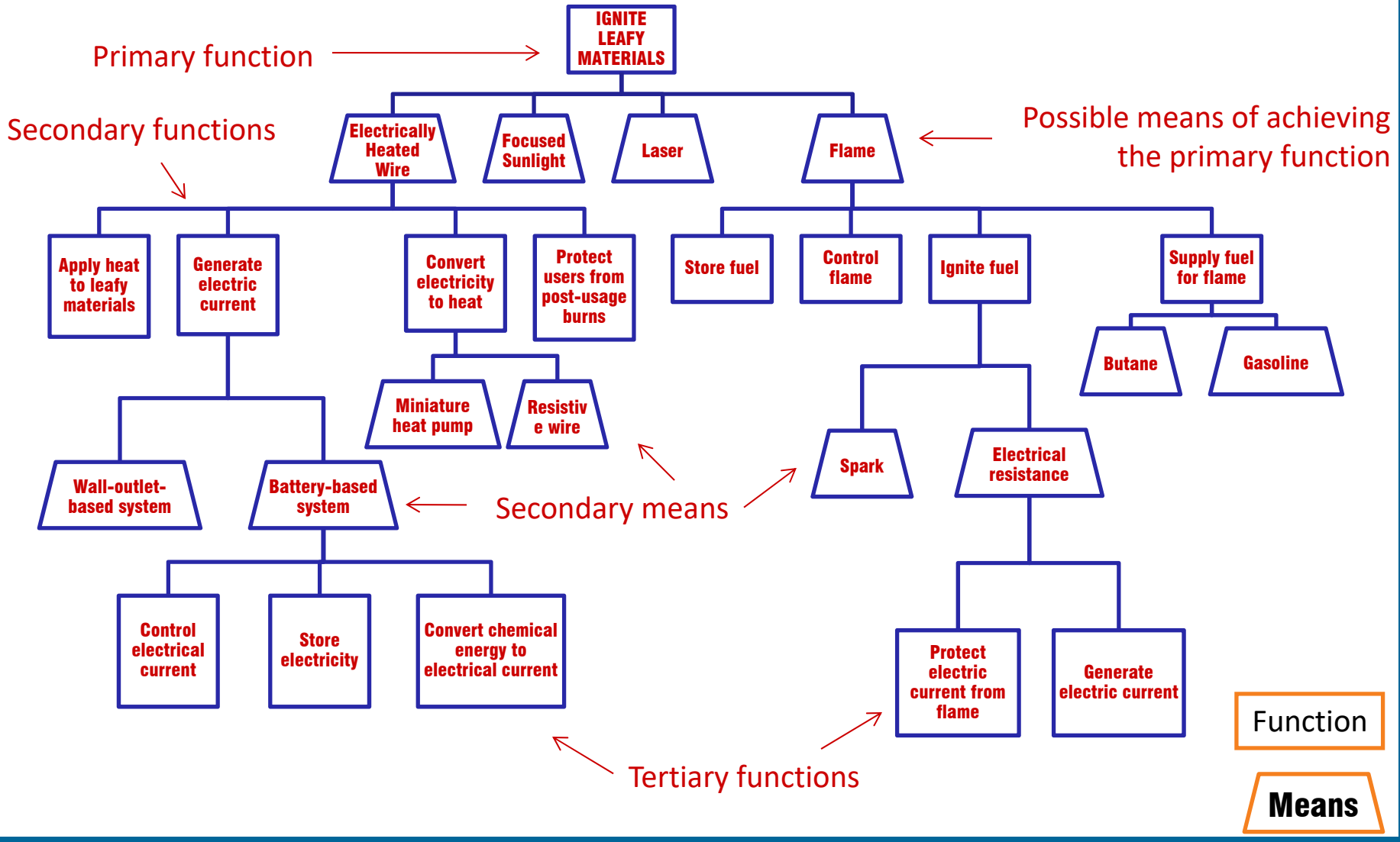
- It helps to go beyond the terminology and to know what you're really trying to do.
- Think of the "functions" as what you must do.
- Think of the "means" as how you might do it.
- The Function-Means Tree is a tool for listing the primary functions of a design and various means of achieving those functions.

Function Means Tree

- Before you start too far down the path of “brainstorming” various design alternatives…
- Determine the primary functions that are required.
  - Show these on the top level of the tree
- List various means by which each function may be implemented.
  - Show these on the next level of the tree
- Determine secondary functions that would result from implementing each of the means.
  - Show these on the next level of the tree
- The tree continues to alternate between means and functions until you reach a reasonable termination point.

Function-Means Tree

Example – Lighter

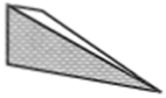
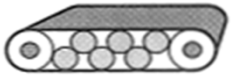
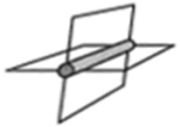
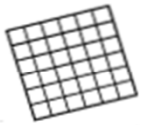
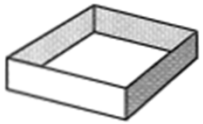
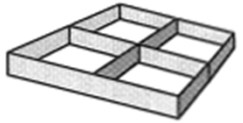


Morphological Analysis

- **Aims to generate the complete range of alternative design solutions for a product and hence to widen the search for potential new solutions.**
- **List the features or functions that are essential to the product.**
- **For each feature or function list the means by which it might be achieved.**
- **Draw up a chart containing all the sub-solutions.**
- **Identify feasible combinations of sub-solutions.**

Morphological Analysis

Example

	Option 1	Option 2	Option 3	Option 4
Vegetable picking device		 Triangular plow	 Tubular grabber	 Mechanical picker
Vegetable placing device	 Conveyor belt	 Rake	 Rotating mover	 Force from vegetable accumulation
Dirt sifting device	 Square mesh	 Water from well	 Slits in plow or carrier	
Packaging device				
Method of transportation		 Track system	 Sled	
Power source	Hand pushed	Horse drawn	Wind blown	Pedal driven

Morphological Analysis

Example

	Option 1	Option 2	Option 3	Option 4
Vegetable picking device		Triangular plow	Tubular grabber	Mechanical picker
Vegetable placing device	Conveyor belt	Rake	Rotating mover	Force from vegetable accumulation
Dirt sifting device	Square mesh	Water from well	Slits in plow or carrier	
Packaging device				
Method of transportation		Track system	Sled	
Power source	Hand pushed	Horse drawn	Wind blown	Pedal driven

Concept 1

Morphological Analysis
Example – Forklift Truck

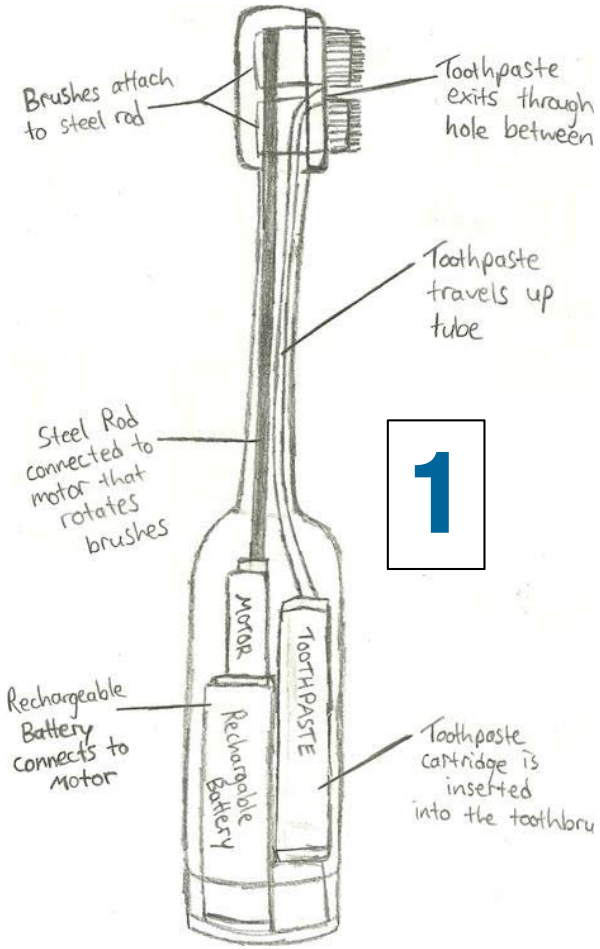
Param-eters	Possible Solutions				
Support	Wheels	Air cushion	Tracks	Slides	Spheres
Steering	Turning wheels	Rails	Air thrust		
Stopping	Reverse power	Brakes	Blocks under wheels	Drag a weight on the floor	
Moving	Air thrust	Power to wheels	Hauling along a cable	Linear induction motor	
Power	Electric	Bottled gas	Petrol	Diesel	Steam
Trans-mission	Hydraulic	Gears & shafts	Belts or chains	Flexible cable	
Lifting	Screw	Hydraulic ram	Rack & pinion	Chain or rope hoist	
Operator	Seated at front	Seated at rear	Standing	Walking	Remote control

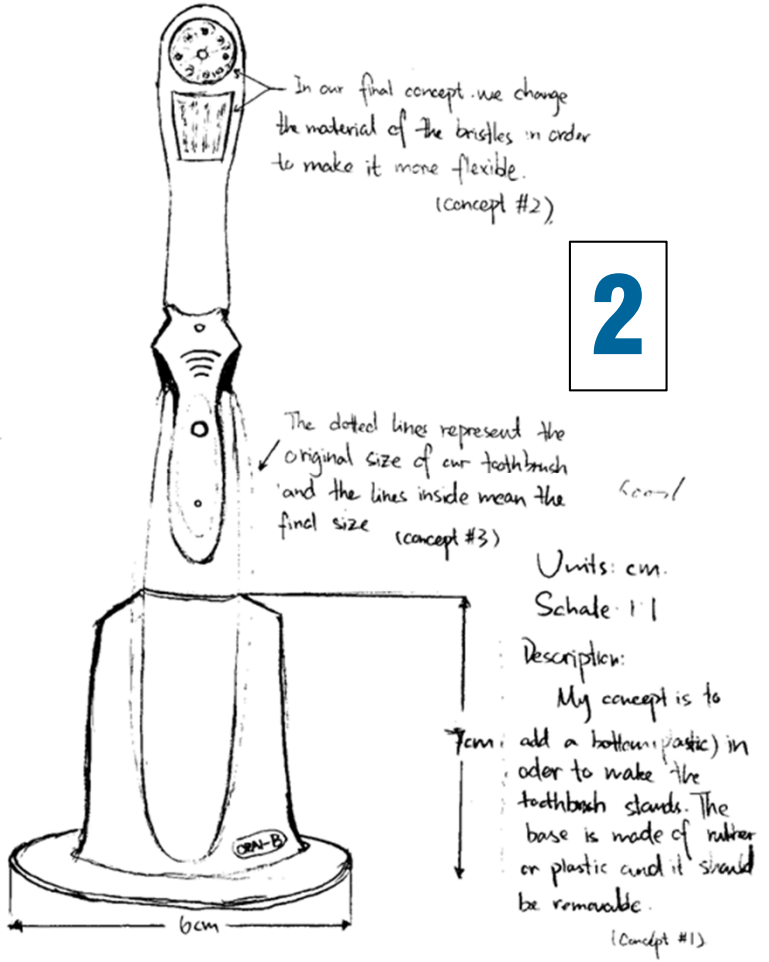
Embodiment Design

- **Product architecture**
- **Configuration design of parts and components (feature present like holes, ribs, splines, and curves are configured). Modeling and simulation may be performed. The generation of physical model of the part with rapid prototyping processes may be appropriate)**
- **Parametric design of parts and components (exact dimensions and tolerances, materials and processes, robustness)**
- **The Embodiment Design phase is the part of the design process which is concerned about the production of the product concept, the engineering and the economical feasibility. The production contains the parts making and the product assembling.**

Embodiment Design

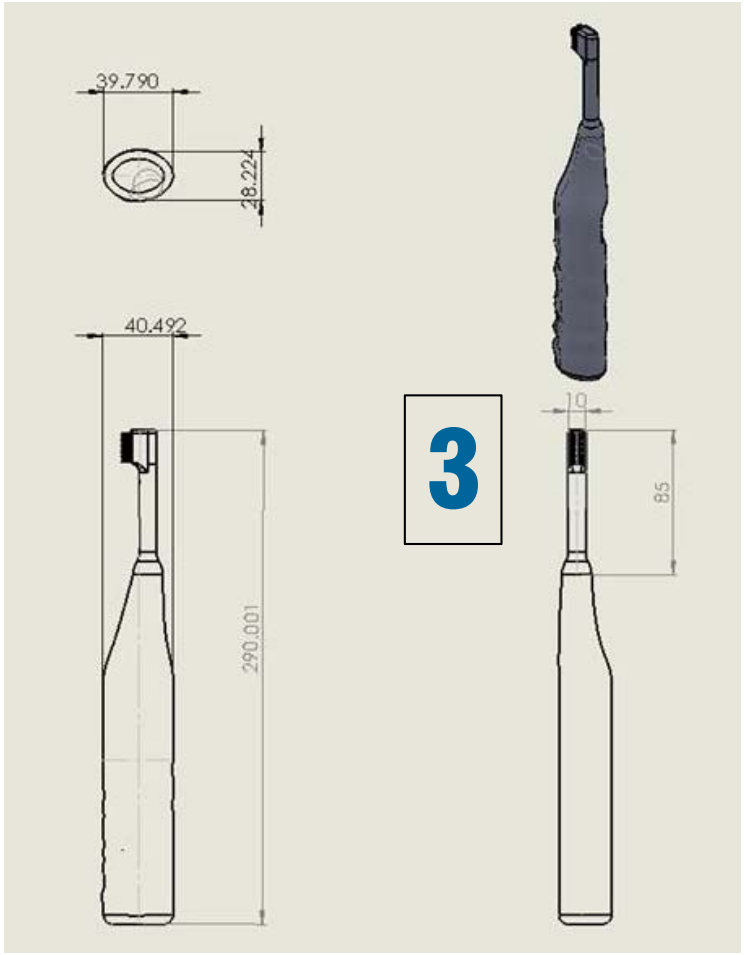
Example – Electric Toothbrush

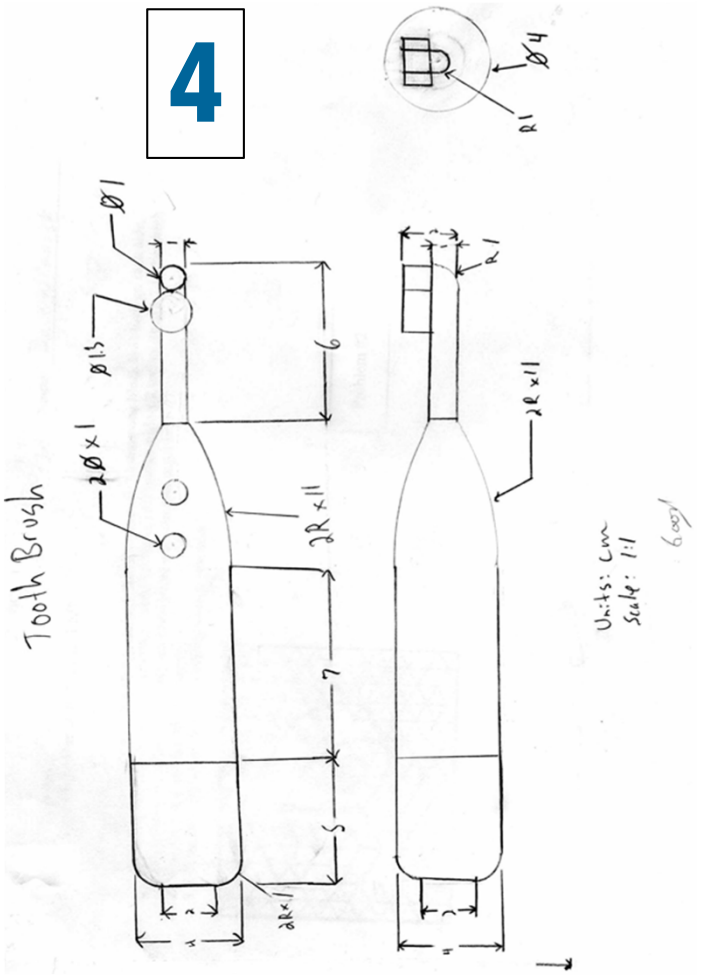




Embodiment Design

Example – Electric Toothbrush





Ethics at the Conceptual Stage

- **In your groups discuss how ethical issues or moral theories could be relevant at the conceptual stage**
- **Make a list of your findings and try to think of some examples**
- **We shall discuss it after you complete your group discussion**

Summary of the Lecture

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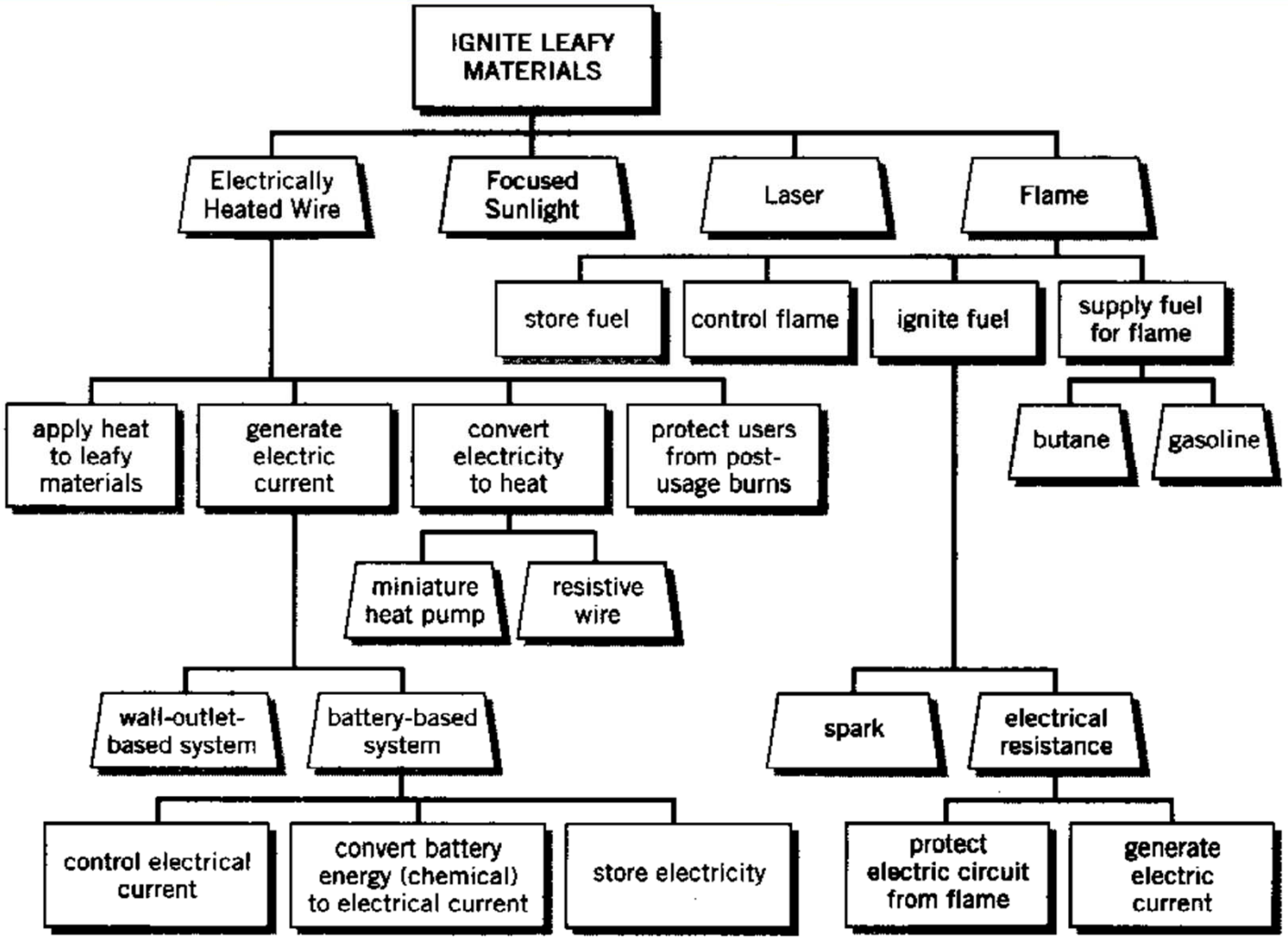
Backup


IGNITE LEAFY MATERIALS
Electrically Heated Wire
Focused Sunlight
Laser
Flame
store fuel
control flame
ignite fuel
supply fuel for flame
apply heat to leafy materials
generate electric current
convert electricity to heat
protect users from post-usage burns
butane
gasoline
miniature heat pump
resistive wire
wall-outlet-based system
battery-based system
spark
electrical resistance
control electrical current
convert battery energy (chemical) to electrical current
store electricity
protect electric circuit from flame
generate electric current