REIMAGINE WASTE 3
Hacking for a Clean Nation

WASTE IMPACT
CPDM · IISc
WAKE THE LAKE
United Way
United Way Bengaluru

Design @ HACKATHON

where re-imagination begins

Water, Waste & Livelihoods

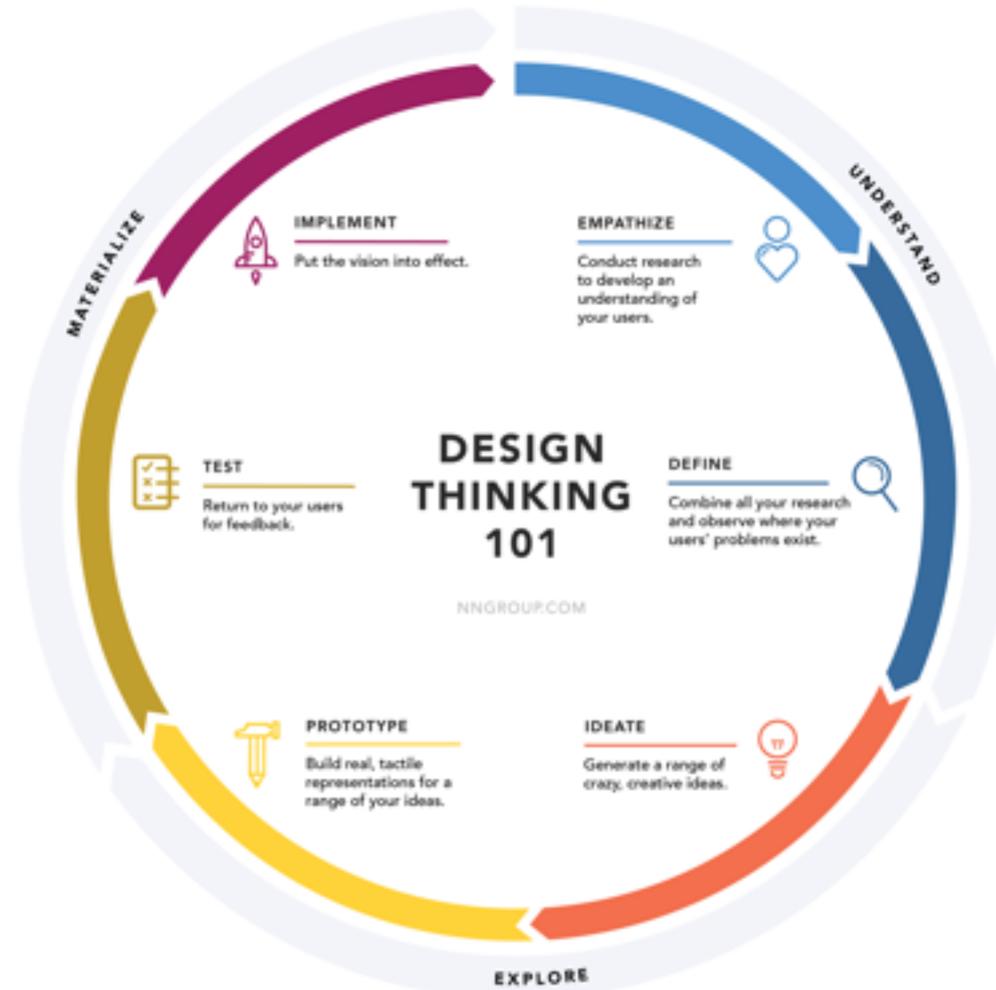
A lot of waste has flown into Water.
Its time we stop it!

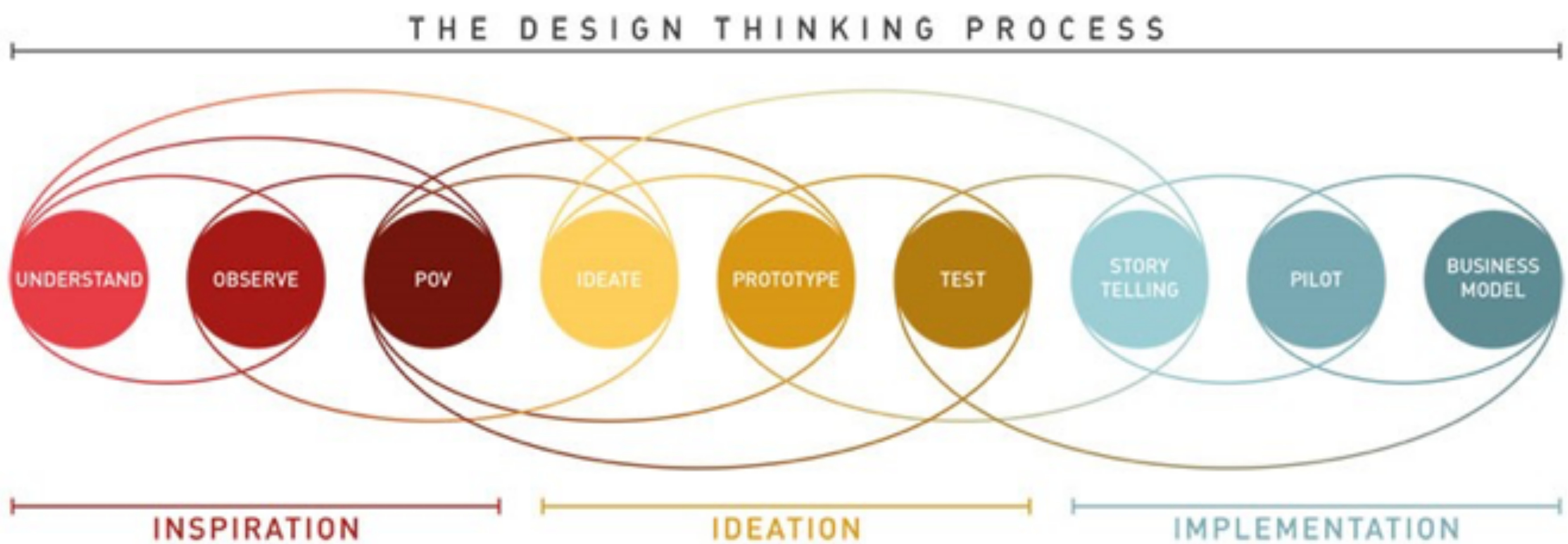
Calling all stake holders including Citizens, Innovators, Technologists, Designers & Entrepreneurs to collaborate and co-create innovative solutions to enhance Dignity, Empowerment and Better Livelihoods.

PRESENTED BY
SHAKUNTALA ACHARYA

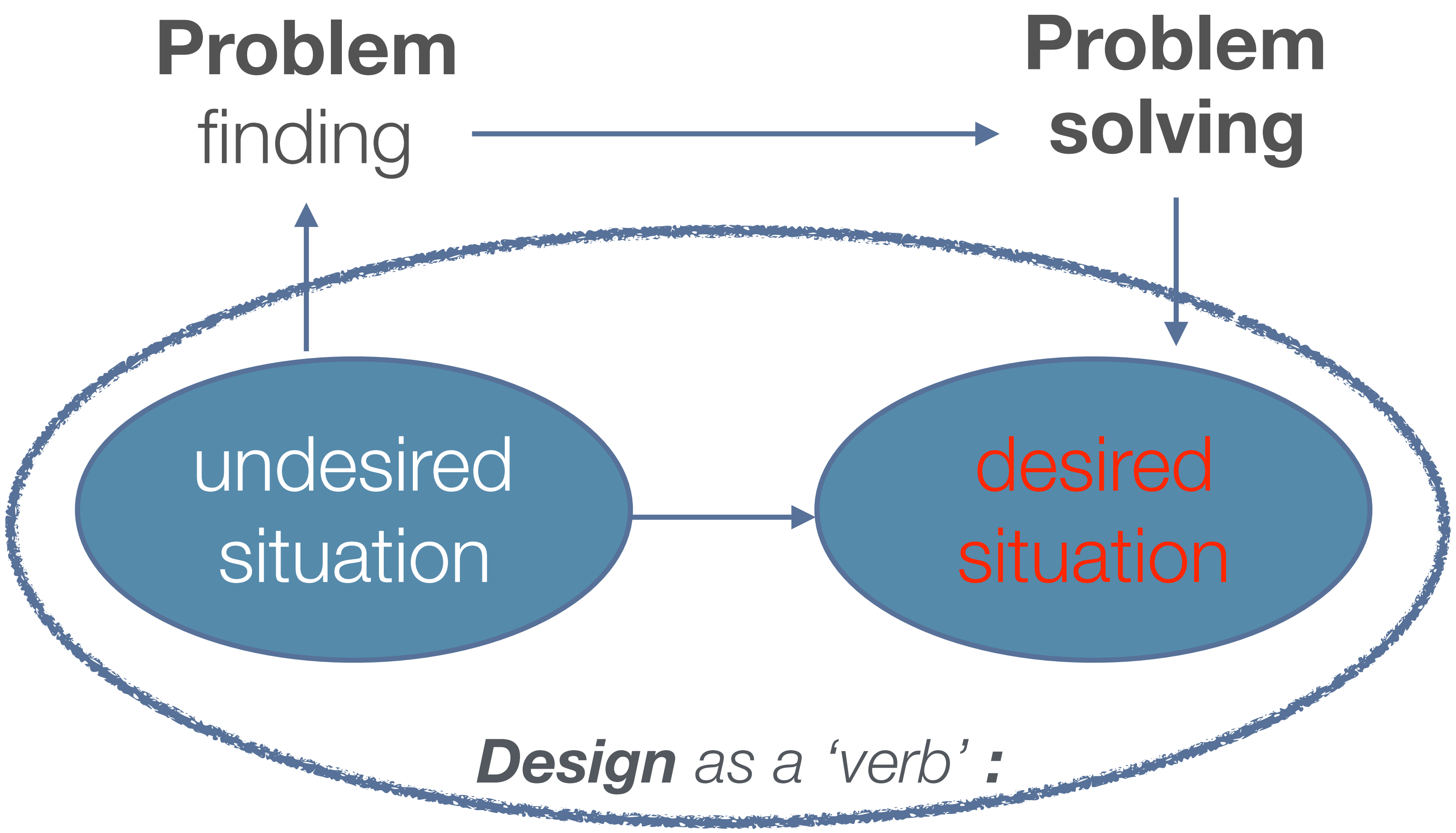
Design Thinking

is the method of emulating strategies designers use during the design process





what is **Design** ?



the process of design

Design *as a 'noun' :*
system - service, product, building, artefact

"changing existing situations into preferred ones"

– Herbert Simon, 1981

DESIGN / Stages Of Design

A 'design' evolves, from problem finding to solution seeking and finally to concept selection, **along four stages**

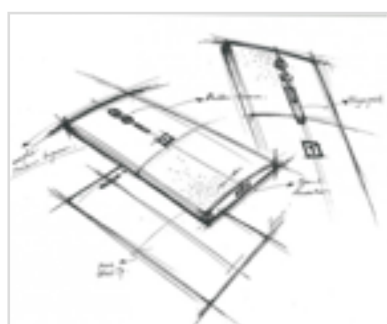
Design Stages

Task Clarification

Specification of information;
Task, Need

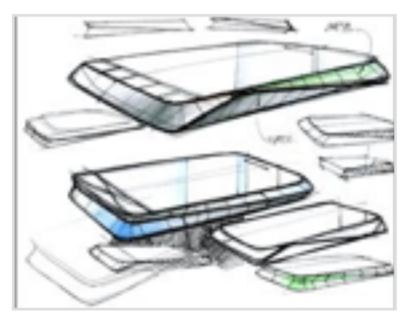
Conceptual Design

Specification of Principle Solution;
Concept



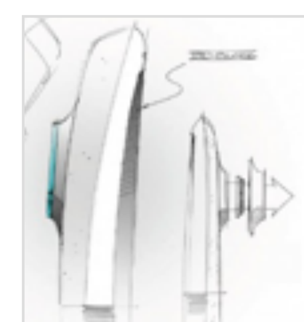
Embodiment Design

Specification of Construction;
Layout



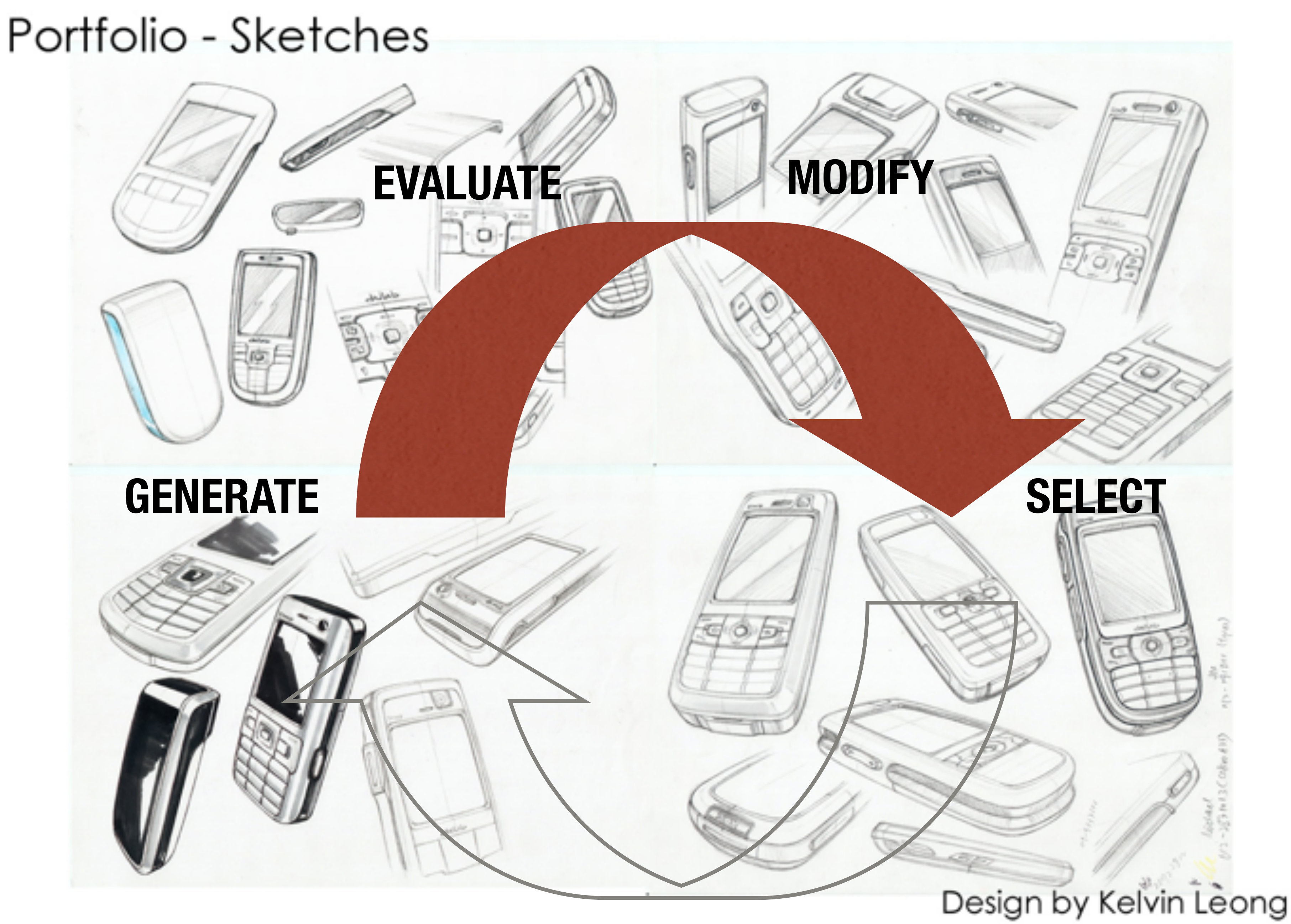
Detail Design

Specification of part/ assemblies,
Functional **Prototype**, Production Prototype



- Task Clarification (TC), Conceptual Design (CD), Embodiment Design (ED) and Detail Design (DD)

There are **4 activities** that occur iteratively during each stage of design ;



Design

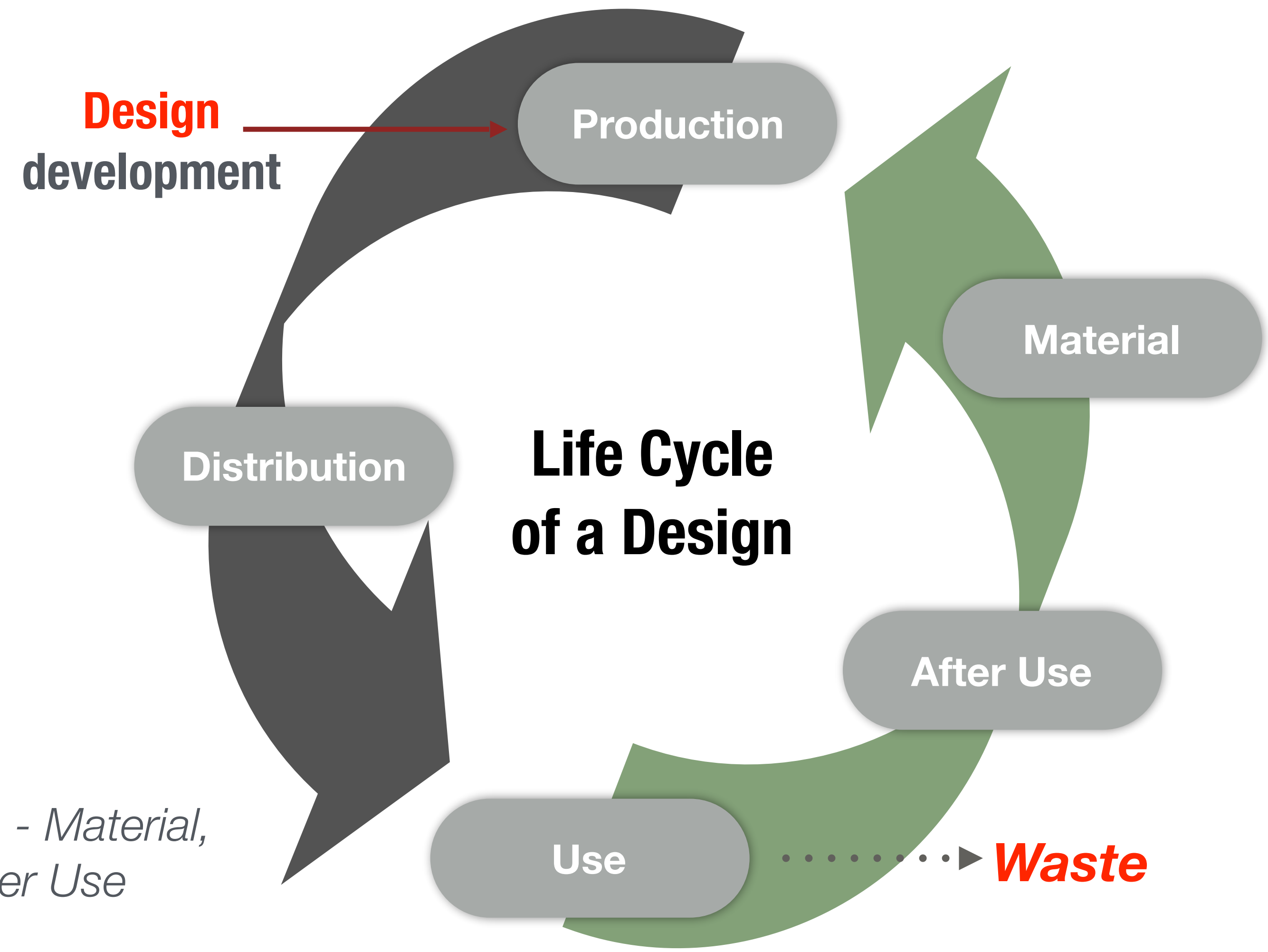
A *creative* activity – involves bringing into being something *new and useful* that has not existed before (Reswick, 1965)

Design determines the lifecycle of the product and in turn, the impact on the environment of that product

The imaginative jump from present facts to *future possibilities* (Page, 1966)

An *iterative*, decision-making activity to produce the plans by which resources are converted preferably optimally into systems or devices that *meet human needs* (Woodson, 1966)

Initiation of change in man-made things (Jones, 1971)



The life of a 'design' has five phases - Material, Production, Distribution, Use, and After Use

LifeCycle of a Design

An important concept where ***the whole life cycle***, i.e., the input–output exchange processes between the environment and the whole set of processes that entail over the entire lifetime of a given product, is considered during the Design development

How to assess a design - good or bad?

Indicators: way of telling how much can the system affect

- Toxicity (eco-toxicity, or human toxicity)
- Carbon footprint, GHGs emissions
  ➔ global warming potential
- Acidification
- Water depletion, ozone depletion

Impacts on human health, eco-systems, and resources

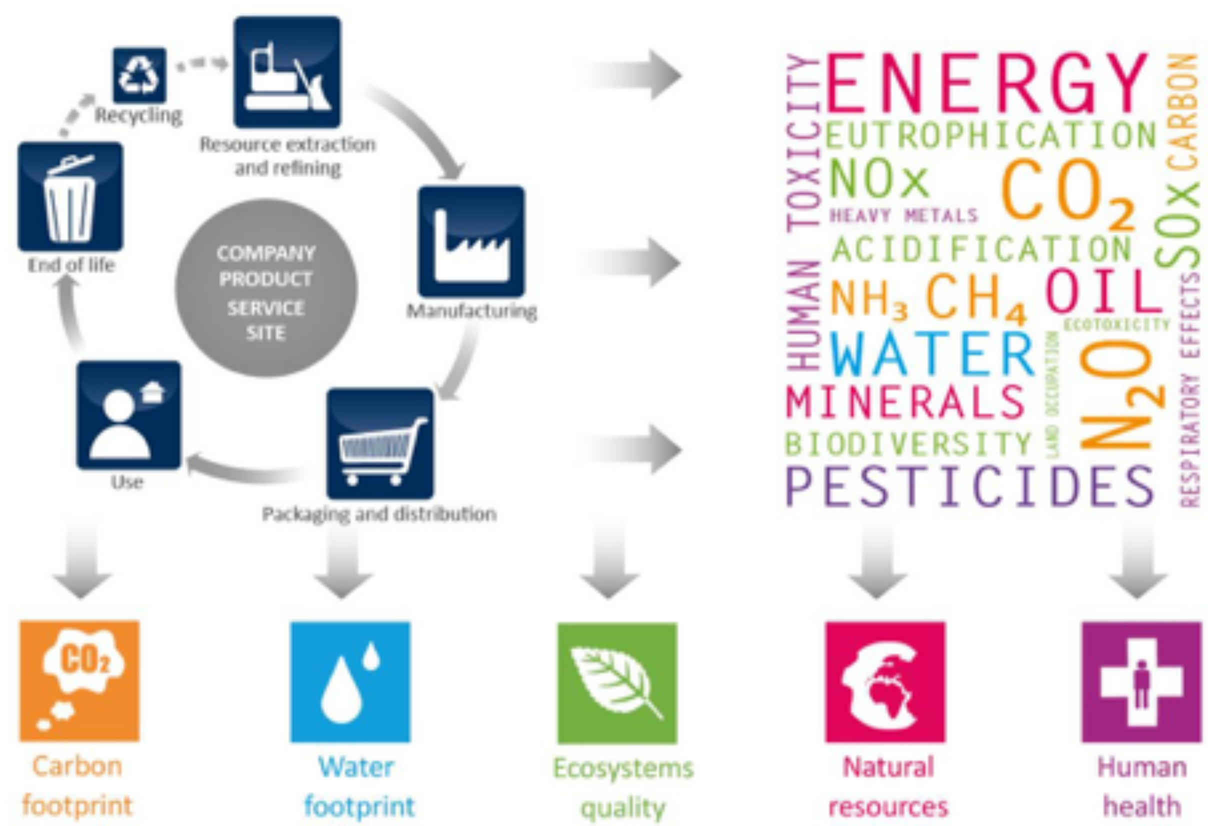


Image source: demeau-fp7.eu; LCA to assess environmental sustainability © Quantis

Mavallipura lake, Bangalore.

Garbage trucks near Subramanyapura lake, Bangalore.Jun 2018

Bellandur lake, Bangalore. 2015

Carbon footprint | Water footprint | Ecosystems quality | Natural resources | Human health

Design Methods

the designer's strategies

Task Clarification identifies the problem and lists the requirements for the solution (concept)

Design Stages

Task Clarification

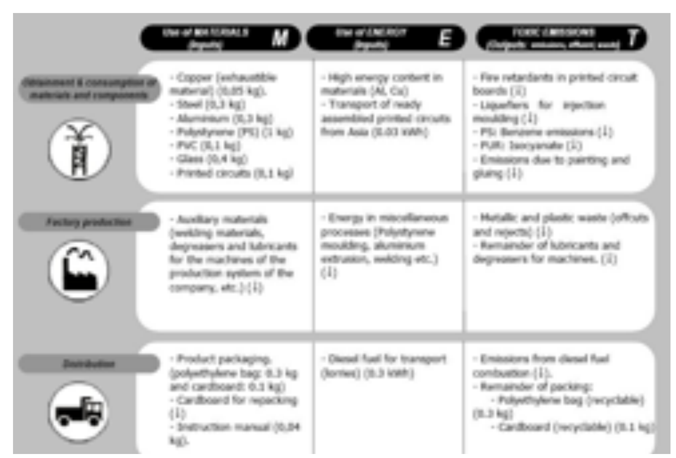
Specification of information;
Task, Need

Conceptual Design

Embodiment Design

Detail Design

Method : Stakeholder analysis



Method : M-E-T Matrix

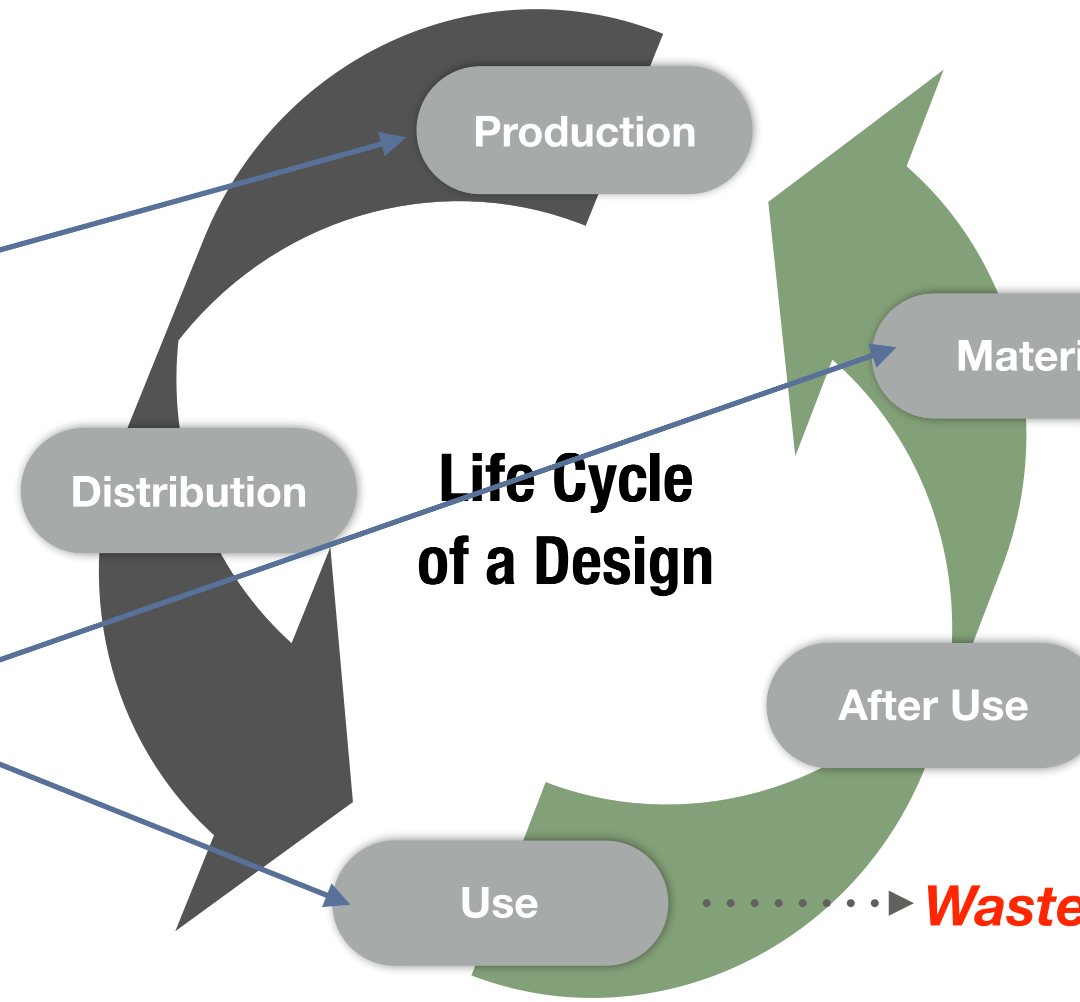
List of Requirements

Method : Prioritisation (Demand/Wish)

A **stakeholder** is any person, organization, social group, or society at large that has a stake, i.e., **vital interest or concern**, in a business, project or its activities.

Stakeholder name	***Identifie r***
funders (NIF)	f
Innovator	i
people with fear of failure (skeptics)	s
Trainers	tr
Trainees	te
Users	u
Government	g
raw material suppliers	r
machine builders	m
local artisans	la

Table 1 : List of Stakeholders



A list of possible stakeholders are arrived at using the lifecycle phases involved in design and tasks (so far clarified) as cues.

List of Requirements given	*i*	*u*	*tr*	*f*	*te*	*g*	*m*	*la*	*s*	*r*	
Provision for safe use of workshop		1	1	1	1	1	1				6
Machine specific training	1	1	1		1		1				5
Repeatability	1		1	1	1	1					5
Provision for differently abled innovators & user	1	1		1					1		4
Affordability	1	1					1			1	4
Training for different age & gender groups		1	1	1	1						4
Cultural acceptability		1			1			1	1		4
To remove dependency on sophisticated manufacturing systems for building initial prototypes and prove out of initial build parts			1			1	1	1			4
To promote the zeal of technopreneurship among the innovator	1			1		1			1		4
Provision for disposal of generated wast	1					1		1		1	4
Prioritized stakeholder	10	9	8	7	7	6	6	5	3	2	

Table 2 : Prioritising based on stakeholder's stake in Requirements

Stakeholders are prioritised (Table 2) on comparing them pair-wise for mutual importance; weights are assigned in both the exercises above to indicate the priority of the requirement and the stakeholder.

A MET matrix is a tool to analyse the product's impact on the environment throughout its lifecycle.

The MET matrix is a means of organizing an analysis of all the types of environmental problems that a product could cause.

	Use of MATERIALS (Inputs) M	Use of ENERGY (Inputs) E	TOXIC EMISSIONS (Outputs: emissions, effluent, waste) T
Obtainment & consumption of materials and components	- Copper (exhaustible material) (0,05 kg). - Steel (0,3 kg) - Aluminium (0,3 kg) - Polystyrene (PS) (1 kg) - PVC (0,1 kg) - Glass (0,4 kg) - Printed circuits (0,1 kg)	- High energy content in materials (Al, Cu) - Transport of ready assembled printed circuits from Asia (0.03 kWh)	- Fire retardants in printed circuit boards (↓) - Liquefiers for injection moulding (↓) - PS: Benzene emissions (↓) - PUR: Isocyanate (↓) - Emissions due to painting and gluing (↓)
Factory production	- Auxiliary materials (welding materials, degreasers and lubricants for the machines of the production system of the company, etc.) (↓)	- Energy in miscellaneous processes (Polystyrene moulding, aluminium extrusion, welding etc.) (↓)	- Metallic and plastic waste (offcuts and rejects) (↓) - Remainder of lubricants and degreasers for machines. (↓)
Distribution	- Product packaging. (polyethylene bag: 0.3 kg and cardboard: 0.1 kg) - Cardboard for repacking (↓) - Instruction manual (0,04 kg).	- Diesel fuel for transport (lorries) (0.3 kWh)	- Emissions from diesel fuel combustion (↓). - Remainder of packing: - Polyethylene bag (recyclable) (0.3 kg) - Cardboard (recyclable) (0.1 kg)
Use or utilisation	- **OPERATION** - Paper filters (7,3 kg) - Coffee used (65 kg)* - Cleaning materials (↓) - Water for cleaning (10.950 l)	- Energy consumption (375 kwh) a.- Heating: 281,25 kwh b.- Maintenance: 93,75 kwh **	- Waste from consumables (filter with coffee dregs, etc.) (72,3 kg) - Waste water from cleaning (10.950 l). - Emissions deriving from energy consumption (2305 kg CO_2).
	MAINTENANCE - Parts which are easily breakable (↓).	- Transport of maintenance providers (↓)	- Remainder of replaced parts (↓).
End of life system. Final disposal			**RECYCLING** - Glass (0,4 kg) - Plastics (1,1kg) - Instruction manual (0,04 kg) **DISPOSAL** - Printed circuit board (0,1 kg) - Copper (0,05 kg) - Aluminium (0,3 kg) - Steel (0,3 kg)

Material-Energy-Toxic Emission Matrix

The Key output of Task Clarification is a List of Requirements (LoR)

- Requirements are noted either as Demands - requirements that must be met, and Wishes - requirements that are optional/desirable

- Requirements noted as 'Wish' are further assigned Weightage - High, Medium, Low- to help prioritise

GARDEN EQUIPMENT COMPANY		DESIGN SPECIFICATION Grass Cutter Project	Issued: 11 Jan 1993 Page: 1
D W	Wt	REQUIREMENTS	Keyword
		GEOMETRY	
W	M	o Maximum storage size: 600x600x300 mm	Storage
D		o Minimum width of cut: 300 mm	Cut width
W	M	o Adjustable cutting depth: 5 - 50 mm	Cut depth
		KINEMATICS	
W	H	o Easily manoeuvred	Manoeuvre
W	L	o Cutting speed up to 2 m/s	Cut speed
		FORCES	
W	H	o Maximum weight not greater than 100 N	Weight
W	M	o Force to move not greater than 50 N	Move force
W	M	o Withstand fall on to hard surface from 2 m	Robust
		ENERGY	
W	M	o Power requirement - maximum up to 1 kW	Power
D		o Power source - electricity	P/source
D		o Maximum noise level not to exceed 85 dB	Noise
		MATERIAL	
W	L	o Suitable for a life expectancy of 5 years	Life
W	L	o Must not corrode within design life	Corrosion
		SIGNALS	
D		o Simple to start/stop	Start/stop
W	L	o Indication when cuttings storage needs emptying	Storage
W	L	o Maintenance instructions on the machine	Maint instr
		SAFETY	
D		o Electrical safety to BSI specification	Elec safety
D		o No accessible sharp edges or hot spots	Sharp/hot
D		o Cutting blade protection	Blade prot
W	M	o Automatic electical cut-out	Auto cut-out
		ERGONOMICS	
D		o Easy to operate and control	Easy oper
W	M	o Simple cutting height adjustment (in 1 minute with no special tools)	Cut adjust
W	H	o Pleasant appearance	Appearance
		ECONOMICS	
W	H	o Target selling price not more than £75	Price

Conceptual design specifies the path to the principle solution (concept)

Design Stages

Task Clarification

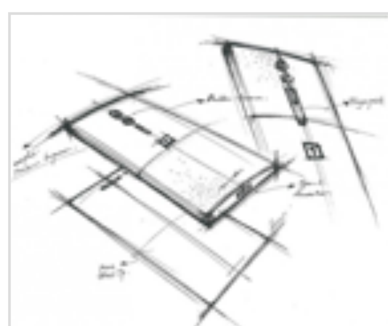
Conceptual Design

Embodiment Design

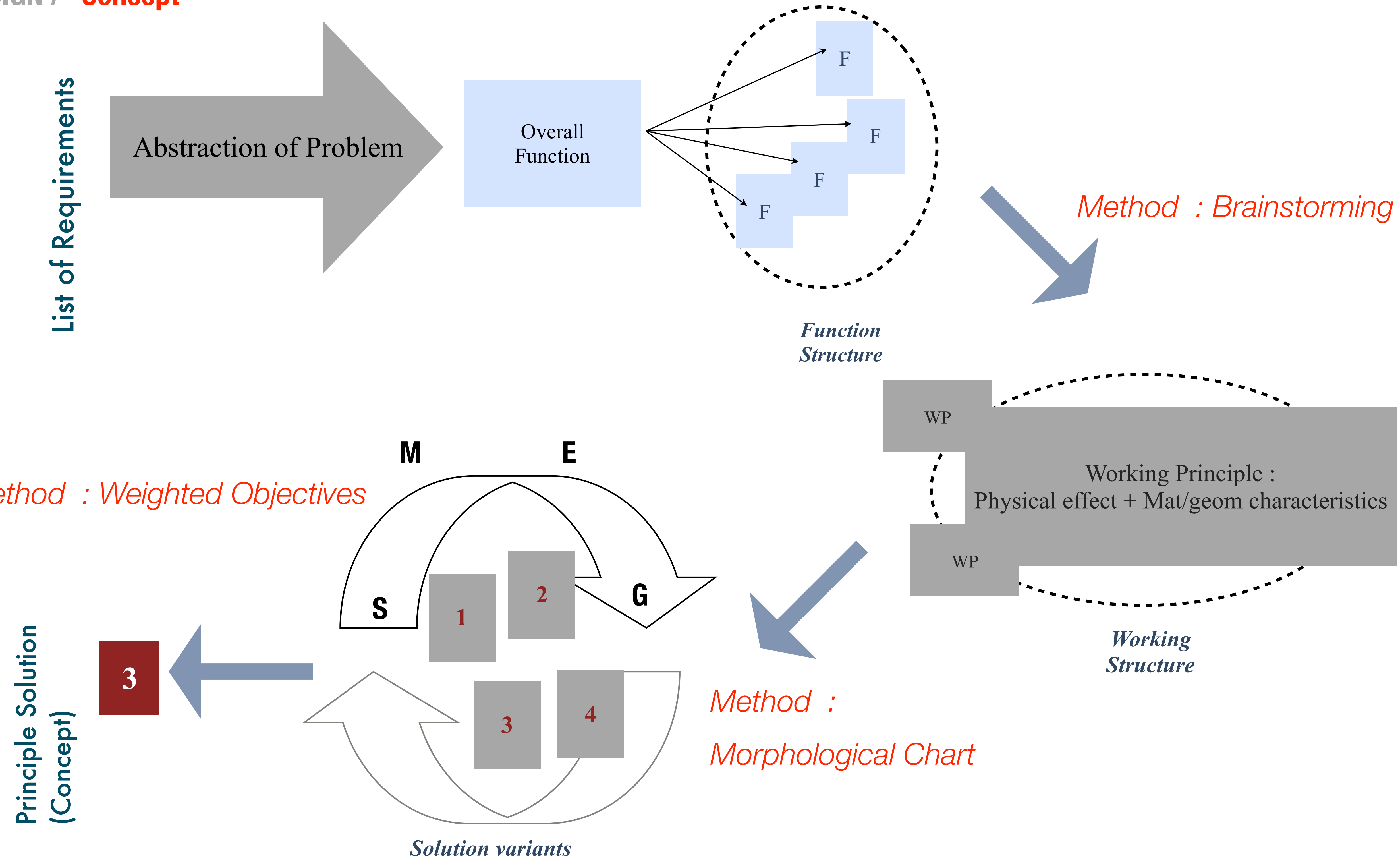
Detail Design

Specification of Principle Solution;

List of Requirements



Concept is the final selected solution, i.e., the principle solution, from amongst the other solution(-variants) that is eventually embodied into a product.



Conceptual design specifies the path to the principle solution (concept)

A group ideation technique (Osborn)

Group: leader plus 5-15 members from diverse fields,made up of equals
Leader: first outlines the problem, invites ideas from members. (S)he never leads in the expression of ideas. (S)he sees that the rules are observed and a free and easy atmosphere prevails

Procedure: The ideas are displayed, listed and passed on to members for further suggestions, if any. Then they are submitted for evaluation to another group of experts. The whole session up to 45 minutes

Rules to be observed during the session:

- Members must shed their inhibitions: **avoid rejecting ideas** as absurd, stupid, embarrassing or false
- Members **must not criticize** ideas generated (killer phrases forbidden)
- Members encouraged to freely change, develop further or combine other ideas
- All ideas to be recorded and displayed, and practicality of ideas is ignored
- The wilder the idea, the better it is (easier to tone down wilder ideas than to improve mediocre ideas)

The aim of the Morphological chart method is to generate the complete range of alternative solutions for a product, and hence to widen the search for potential new solutions.

The procedure for the method is as follows (Cross 2000: Engineering Design Methods) :

1. List the features or functions or requirements that are essential to the product.
   i. **List must not be too long, although,**
   ii. List must be comprehensive, i.e., cover all the important features of the product, at an appropriate level of generalization

2. For each feature, list the means or solution by which it might be achieved.
   i. **One might list only existing ideas, solutions**
   ii. **One might list existing and new ideas, solution**

4. Draw up a chart containing all the possible sub-solutions. This chart is called morphological chart.
   i. **This chart represents total solution space for the product for the product, made up of combination of sub-solutions.**

5. Identify feasible combinations of sub-solutions.
   i. **The total number of possible combinations may be very large, and**
   ii. **so search strategies may have to be guided by constraints or criteria.**

Support	Wheels
Propulsion	Driven wheels
Power	Electric motor
Transmission	Belt
Steering	Rails
Stopping	Brakes
Lifting	Screw
Operator	Remote control

Feature	Means				
Support	Wheels	Track	Air cushion	Slides	Pedipulators
Propulsion	Driven wheels	Air thrust	Moving cable	Linear induction	
Power	Electric	Petrol	Diesel	Bottled gas	Steam
Transmission	Gears and shafts	Belts	Chains	Hydraulic	Flexible cable
Steering	Turning wheels	Air thrust	Rails		
Stopping	Brakes	Reverse thrust	Ratchet		
Lifting	Hydraulic ram	Rack and pinion	Screw	Chain or rope hoist	
Operator	Seated at front	Seated at rear	Standing	Walking	Remote control

Figure 61 One selected combination of sub-solutions from the morphological chart

Ref. :Cross (2000) "Engineering Design Methods"

Aim: ***Compare alternative design proposals on the basis of their performance against differentially weighted objectives.***

Input: Objectives (Requirements / Functions) with their relative weights, Solution variants (design proposals).

Output: Relative scores for the solution variants - **top scorer wins!**

Assigning weights :

	k1	k2	k3	k4	Sum
k1		1	1	.5	2.5 (1)
k2	0		.5	.5	1.0 (3)
k3	0	.5		0	0.5 (4)
k4	.5	.5	1		2.0 (2)

Procedure:

1. Select the criteria according to which the selection will be made. These criteria should be derived from the programme of requirements (note that probably not all requirements are applicable at this stage of the design process).
2. Choose 3 to 5 concepts for selection.
3. Assign weights to the criteria. The criteria should be appointed weights according to their importance for the evaluation. To determine the weight factor of the criteria it is recommended that you compare the criteria in pairs to attribute a weight factor. Rank each of the weights on a scale from 1 to 5 (you can also decide on a total sum of the weights of the criteria, for example 100). Make sure you discuss the tradeoffs between the criteria. Trade-offs will have to be made when weights are assigned to the individual criteria (when you are determining which of the weights are more important).
4. Construct a matrix, with the criteria in rows, and the concepts in columns.
5. Attribute values to how each concept meets a criterion. Rank the scores of the concepts from 1 to 10.
6. Calculate the overall score of each concept by summing up the scores on each criterion (make sure you take into account the weight factor).
7. The concept with the highest score is the preferred concept.

	C1	C2	C3	C4	C5	C6	Sum
ki	20	40	12	5	15	8	
A1	8	6	9	1	6	3	627
A2	9	4	7	1	2	8	523
A3	3	9	3	8	8	6	664

a few thoughts…

Feedback to Design & Manufacturers

Is it enough?

Considering and thinking about issues beforehand

Starting right during the design phase

Obsolescence management

How to improve?

Promote and support re-use, recycling, re-purposing

Recollect the waste from their system/product/service.

Collaboration and communication *amongst stakeholders*

Compliment and fulfil function for the others ➔ functioning like an eco-system.

THANK YOU!

Q & A