BASIC ENGINEERING DESIGN
Thinking Techniques

GEN- N1003
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Lecture 4

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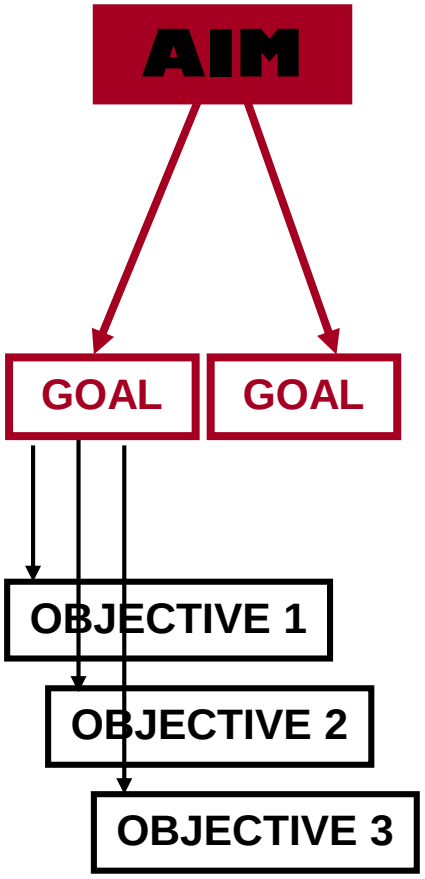
DESIGN PROCESS

1. Problem Identification
2. Data gathering
3. Data Analysis
4. Formulation of Goals & Objectives
5. Generating Ideas [alternative concepts]/ Elaboration of each Concept
6. Evaluation of Alternatives
7. Decision Making –Translation of Solutions into Policies

AIM, GOALS & OBJECTIVE



1. AIM الهدف الرئيسى

- The aim is a formulation of the problem solution in a single statement related to main purpose of the project
- **It can not be measured**

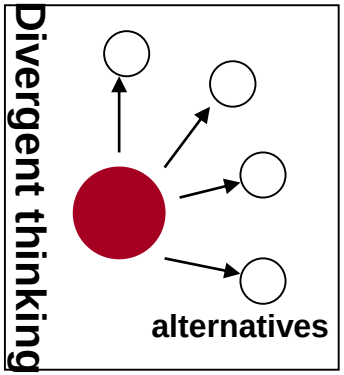
2. GOALS الأهداف المساعدة

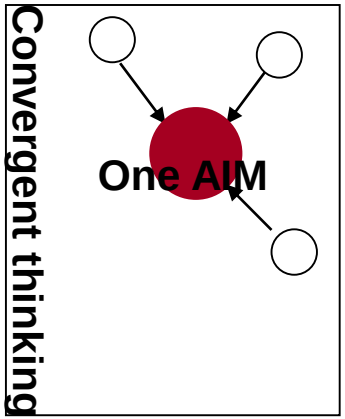
- The goals help achieving the aim
- They also **can not be measured**

3. OBJECTIVES الأهداف الثانوية

- The objectives lead to the fulfillment of the goals and aim
- They are **measurable and achievable**

Generating Ideas [alternative concepts]/ Elaboration of each Concept





- **Generating Ideas involves coming up with many new possibilities. This stage is viewed by many people as "creative"**

- **Divergent** thinking is used in **generating ideas**

- **Convergent** thinking is important after generating ideas to:
  - **-organize these ideas**
  - **-identify the optimum alternatives**
  - **-select among the ideas**

  This is not a final selection but you try to detect the promising ideas

- **After you summarize your thoughts you see if u need more ideas to be generated**

Generating Ideas [alternative concepts]/ Elaboration of each Concept

TECHNIQUES

- **ATTRIBUTE LISTING**
- **PROBLEM REVERSAL TECHNIQUE**
- **FORCED ANALOGY**
- **STORY BOARDING**
- **DISCONTINUITY PRINCIPLE**
- **UNCONSCIOUS PROBLEM SOLVING**
- **BRAIN STORMING**

Generating Ideas [alternative concepts]/ Elaboration of each Concept

TECHNIQUES

▪ATTRIBUTE LISTING

- **Breaking down the problem into smaller parts**
- **Ensures that all possible aspects of a problem have been examined.**

- List the **feature** of the product or situation in a table
- Beside each feature list as many **attributes** as you can think of
- Make **many random selections** among the alternates

From the combinations selected you will get new forms & ideas

ATTRIBUTE LISTING

4. Case study – The making of a new lamp [1].

The starting point for this might be to carry out a morphological analysis.

Step 1.

Set up the properties of the new product.

Properties of a lamp might be power supply, bulb type, light intensity, size, style, finish, material, shade, etc. Set these properties out as column headings on a table

Step 2.

Give possible variations for each property by brainstorming.

ATTRIBUTE LISTING

Step3. Set up a table.

Power Supply	Bulb Type	Light Intensity	Size	Style	Finish	Associated Material
Battery	Halogen	Low	Very Large	Modern	Black	Metal
Mains	Bulb	Medium	Large	Antique	White	Ceramic
Solar	Daylight	High	Medium	Roman	Metallic	Concrete
Generator	Coloured	Variable	Small	Art Nouveau	Terracotta	Bone
Crank			Handheld	Industrial	Enamel	Glass
Gas				Ethnic	Natural	Wood
Oil/Petrol					Fabric	Stone
Flame						Plastic

Beat Problem

- Two random students: each one should formulate a problem for the other one to form attribute listing.

- My right side, first row, third student from the wall.

- My left side, second row, first student from the wall.

Generating Ideas [alternative concepts]/ Elaboration of each Concept

TECHNIQUES

▪PROBLEM REVERSAL TECHNIQUE

- **Reversal thinking technique**
- **Try to see things in opposite**

- Make the problem statement negative
- Example:-state the bad things in the situation

  -do what everybody else didn't

-Military strategies

Innovative Ideas

PROBLEM REVERSAL TECHNIQUE

Practical Example: Suppose you want to start a new restaurant and are having difficulty coming up with ideas. To initiate ideas, try the following reversals:

1. **List all your assumptions about your subject**

   Some common assumptions about restaurants are:

   A. Restaurants have menus, written, verbal, or implied.
   B. Restaurants charge money for food.
   C. Restaurants serve food.[4]

2. **Reverse each assumption. What is its opposite?**

   The reverse assumptions could be:

   A. Restaurants have no menus of any kind.
   B. Restaurants give food away for free.
   C. Restaurants do not serve food of any kind. [4]

PROBLEM REVERSAL TECHNIQUE

3. **Ask yourself how to accomplish each reversal.** *How can we start a restaurant that has no menu of any kind and still have a viable business?*

A. A restaurant with no menu.
Idea: The chef informs each customer what he bought that day at the meat, fish and vegetable markets. He asks the customer to select items that he or she finds appealing and creates a dish with those items, specifically for that customer.

B. A restaurant that gives away food.
Idea: An outdoor café where customers pay for time instead of food. Use a time stamp and charge by the minute. Selected food items and beverages are free or sold at cost.

C. A restaurant that does not serve food.
Idea: Create a restaurant with a unique décor in an exotic environment and rent out the location. People bring their own food and beverages (picnic baskets, etc.) and pay a service charge for the location. [4]

4. **Select one and build it into a realistic idea.** *In our example, we decided to work with the "restaurant with no menu" reversal. We'll call the restaurant "The creative chef". The chef will create a dish out of the selected ingredients and name the dish after the customer. Each customer will receive a computer printout of the recipe [4].*

Beat Problem

- Two random students: each one should formulate a problem for the other one to form problem reversal.

- My right side, second row, first student from the wall.

- My left side, before last row, third student from the wall.

Generating Ideas [alternative concepts]/ Elaboration of each Concept

TECHNIQUES

▪FORCED ANALOGY

- **Useful & powerful technique**
- **Widen your vision**

- **Compare the problem with something else** that has little or nothing in common
- You' ll gain **new insights & new solutions** of the result
- This may be applied in following **new geometric relations in architecture**

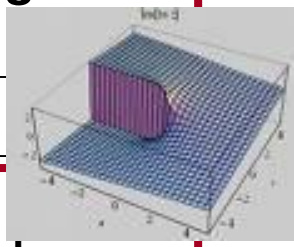
Generating Ideas [alternative concepts]/ Elaboration of each Concept

TECHNIQUES

▪STORY BOARDING

- Facilitates the creative thinking process
- Involves spreading of ideas individuals or group by **hanging ideas on board**

▪DISCONTINUITY PRINCIPLE



- Break your routine, make interruptions in your day, change working hours, listen to different radio station, read other books or magazines, work in another place.

▪UNCONSCIOUS PROBLEM SOLVING

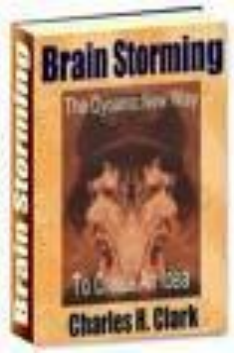
- Unconscious mind will be continually processing **inputs stored in memory**
- Some ideas may also come in mind during relax time & not under the stress of deadlines. → Sleeping on the beach at 4AM..

Generating Ideas [alternative concepts]/ Elaboration of each Concept

TECHNIQUES

▪**BRAIN STORMING**

- **Traditional approach to do creative thinking**
- **Generating ideas in a group situation based on a principle of suspending judgment**
- **Separating the generation phase from the judgment phase of thinking**



BRAIN STORMNG

TECHNIQUES

- **Freedom versus control**

- **The five rules for brainstorming:**

1- Generate as many solutions as possible-quantity matters

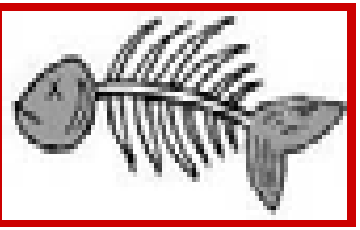
2- Wild ideas are welcome

3- "Hitch kicking" is encouraged-build on the ideas of others

4- No criticism is allowed- defer judgment until the evaluation phase

5- There are no dumb ideas or wrong answers

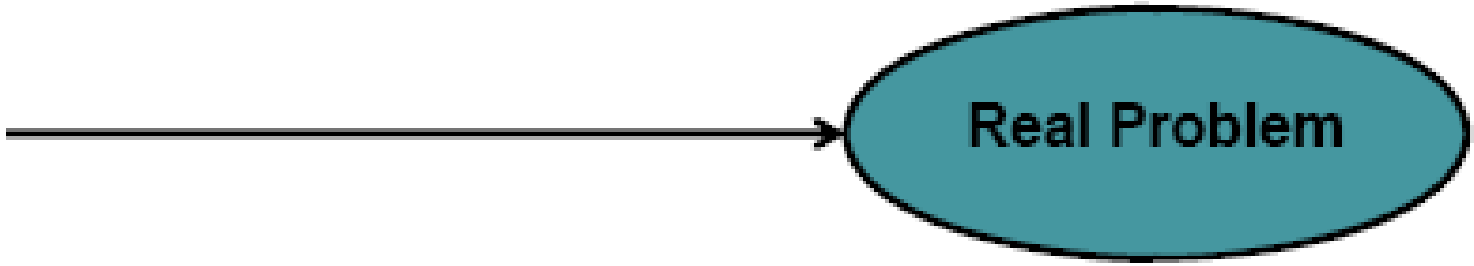
The Fishbone diagram



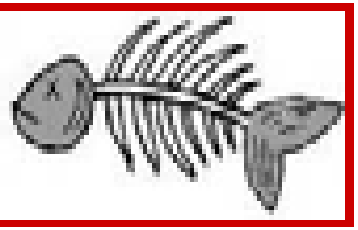
A graphical way to organize and record **brainstorming** ideas. The diagrams look like a fish skeleton.

- **To construct a fishbone diagram the following procedure is used:**

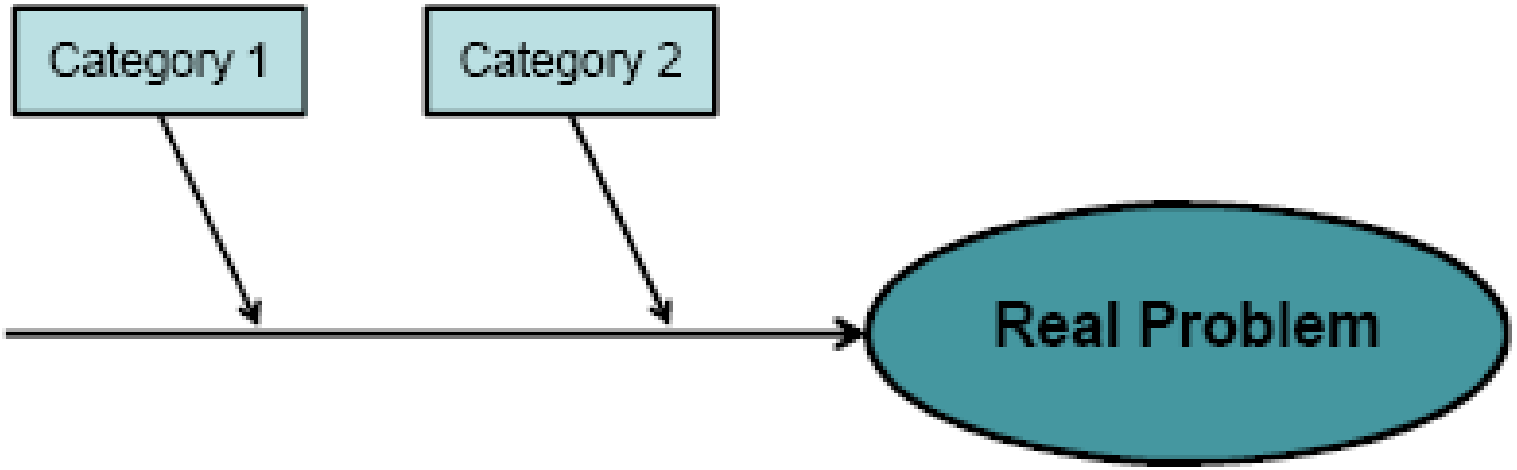
1 - Write the real problem in a box (or circle) to the right of the diagram, then draw a horizontal line (the backbone) extending from the problem to the left side



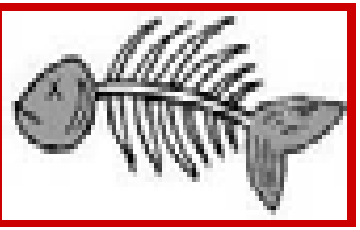
The Fishbone diagram



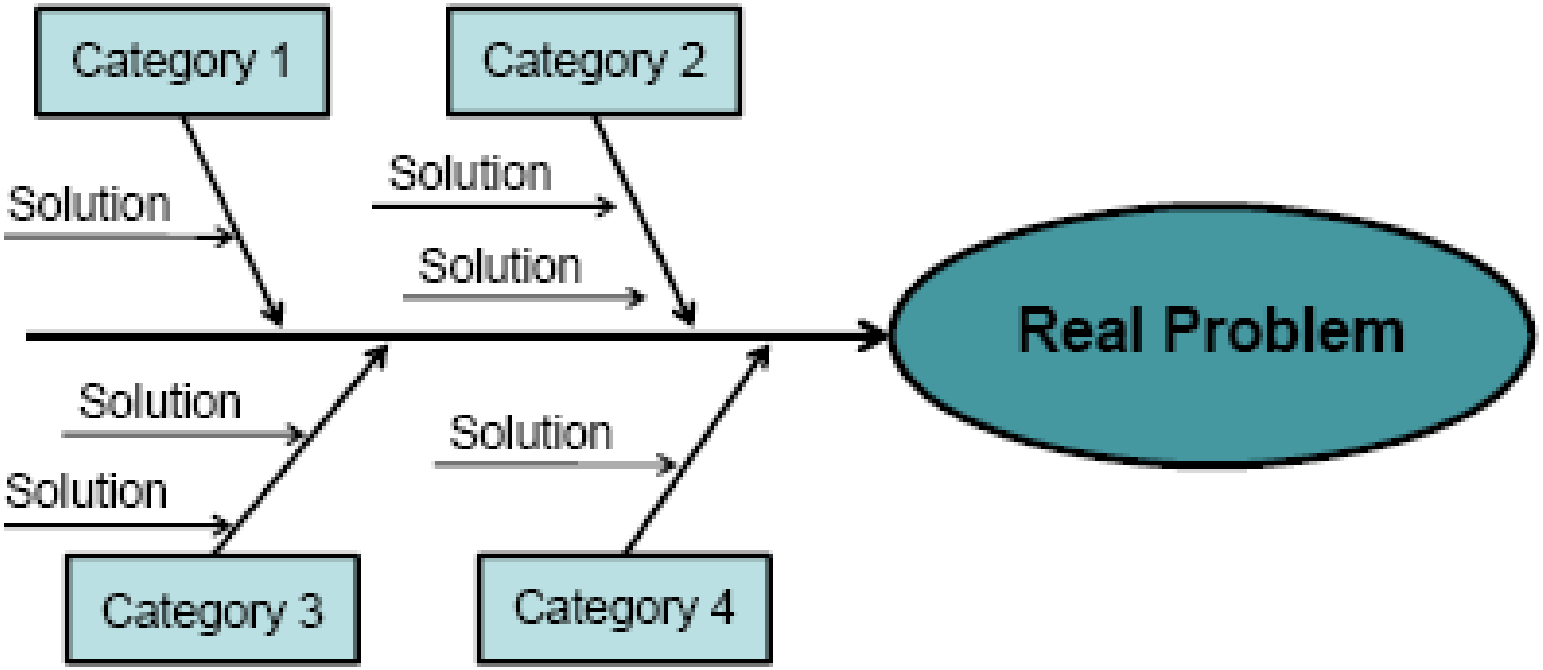
2. Brainstorm potential solutions to the problem
3. Categorize the potential solutions into several major categories and list them along the bottom or top of the diagram. Extend diagonal lines from the major categories to the backbone.
These lines form the basic skeleton of the fishbone diagram:

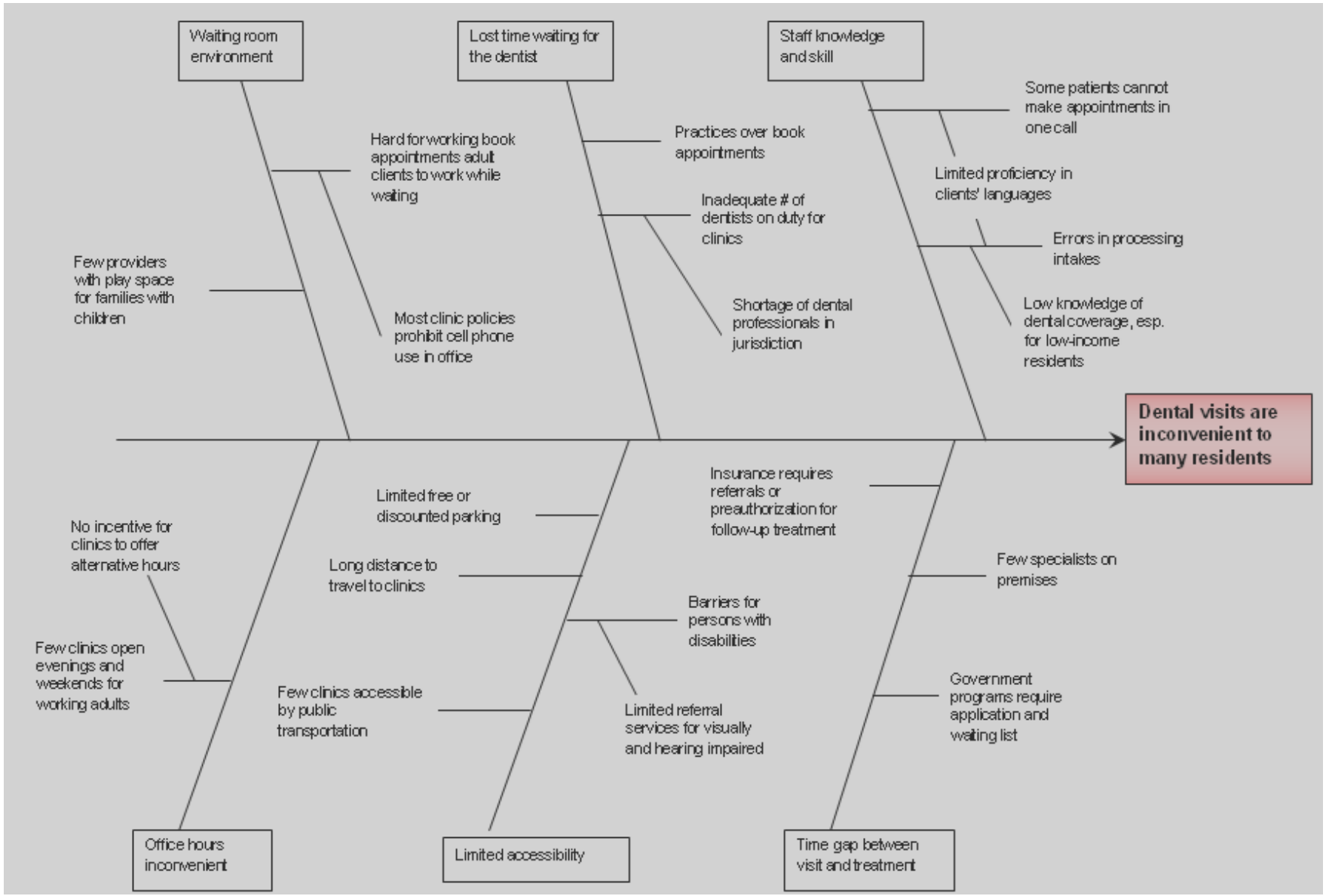


The Fishbone diagram



4. Place the potential solutions related to each of the major categories along the appropriate line (or bone) in the diagram





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Beat Problem

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- My left side, fifth row, first student from the wall.

GROUP PROBLEM

Problem Statement: **How could the rules of basketball be changed so that players under 180cm tall might be more competitive?**

- **Take five minutes to generate some ideas**

GROUP PROBLEM

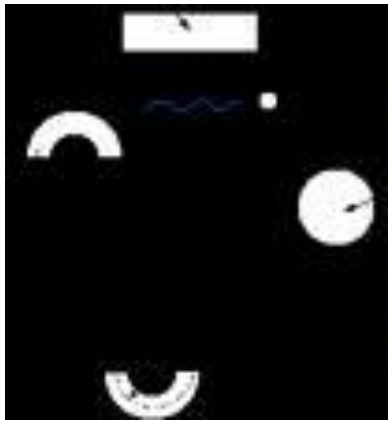
- Lower the height of the basket.
- Taller players are allowed outside the key.
- Platform tennis shoes
- Tall players can guard only tall players.
- Tall players must use a heavier ball.
- Tall players can’t jump.

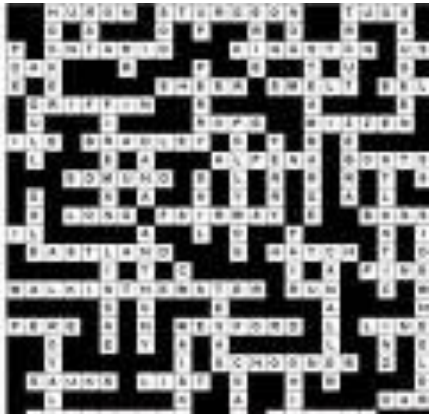
CHARACTERISTICS OF DESIGN SOLUTIONS

I. THERE IS **AN UNLIMITED NUMBER** OF DIFFERENT SOLUTIONS

II. THERE ARE **NO OPTIMAL SOLUTIONS** TO DESIGN PROBLEMS

III. DESIGN SOLUTIONS ARE **PART OF OTHER DESIGN** PROBLEMS





OPTIMUM SOLUTION VS. SATISFACTORY SOLUTION

Optimum Solution

- The solution that realizes the needs perfectly & highly
- The 100% solution

Satisfactory Solution

- Realizes the needs with a lower acceptable % such as 80%
- It allows other satisfactory solutions to become alternatives