Lecture 7.
Problem Formulation
Case Studies

SPRING 2016
Remember!

Before solving a problem, answer:

Why (very few know this)

How (some know this)

What (everyone knows this)

Customer Statement

Need Analysis
- Literature
- Interview/Survey
- Market Studies
- Focus Groups

Interpret and Summarize
- Specifications
- Objectives
- Constraints
- Criteria

Problem Formulation
Example 1:

Statement:
- Machine

Why:
- Wash clothes

How:
- Automatic

Needs:
- Device to wash clothes
- Can be easily operated
- Can be started by operating the timer manually
- Variation of rotating speed for different types of clothes
- Dry clothes
- Capacity up to 5 kg
- Can use voltage 110V/220V
- Low power consumption/wattage less than 100 Watts
- Portable washing machine
- Noise level must not exceed 65dB
- Must be safe
- Filter for the water
- Water inlet and outlet
- Cost must not exceed SR500
- Weight must be less than 100N
Constraints

- Capacity Up to 5kg
- Noise level less than 65 dB
- Size: 1mx 0.9mx0.5m
- Weight not more than 100N (10kg mass)
- Cost less than SR500
- After drying no water drop from the clothes
- 110/220 volts
- Portable
- Life more than 5 Years
- Electric consumption less than 100 W.h (Watt-hours)

Criteria

- High effectiveness of cleaning the clothes
- High durability
- Easy to use (simple)
- High number of cloth types
Safety specifications

• If overloaded, the machine shouldn’t start
• Maximum water level to prevent water waist and dangerous current short-cuts.
• Electrical grounding
• Stop spinner if the door is opened
• Kids protection by motor isolation
Design a simple washing machine that can wash different types of clothes and dry them by various spinning speeds. The machine should be 5 kg capacity and easily manipulated. Its size should be limited to 1 m/0.9 m/0.5 m and its weight is not to exceed 100 N. The washing machine must be portable and able to function using 110 V or 220 V voltage. The machine consumption and cost should be respectively limited to 100 watt-hours and to 500 SR. The minimum life duration of the machine should be 5 years.

The machine should have a water level to prevent water waste and be grounded to avoid electrical shortcuts. Besides, it shouldn’t start if overloaded and must stop spinning if its door is open. A motor isolation for kids protection is also a must.
Needed Information to be gathered:

• Motor power to be used
• Speed for various types of clothes
• Timing needed to clean common types of clothes and dry them
• Common types of clothes to be washed
• Characteristics of each type of clothes (spinning speed, adequate washing temperature...etc.)
Example 2

Statement: Need a simple device to crash cans

Needs Analysis:

• Design a simple device to crash cans (soft drinks)
• The final product is recycling (green design)
• Does not occupy large space
• High strength material
• It costs 80 – 100 S.R.
• High safety
• Design for kids
• Light weight (portable)
• Easy to use
• Easy to maintain
• Heavy and large base (does not tip over)
• Will be used by human power (foot, hands or both)
• Using available materials/components
Primary objective:
• To design a simple, easy to use device to crash cans

Secondary objective:
• The device should be easy to construct, easy to maintain, marketable and portable

Constraints:
• The cost should not exceed 100 S.R.
• The weight should not exceed 5 kg.
• Applied Force should be less than 30 N
• Does not tip over
Criteria:

- Low cost
- Light weight
- Low force
- High Safety
- Simple to manufacture

Needed Information:

- Type of materials used
- Typical existing devices in the market
- Different can sizes
- Mechanism for applying force
Example #3

Statement: Need a device for securing a coffee cup near the driver's seat of an automobile

Need Analysis
- Coffee cup holder for car (near the driver seat)
- Locking system to prevent the cup from spilling
- It does not interfere with the proper operation of the car
- Adaptable to a wide variety of vehicles
- Detachable (Designed to be unfastened or disconnected without damage)
- Easy to use
- Durable material for various temperatures
- No need to modify car interior
- Cost not exceed SR 50
- Flexibility of coffee cup size
Primary Objectives

- A device for securing a coffee cup near the driver’s seat of an automobile

Secondary Objectives:

- The device should be detachable
- No modification of car interior is needed
Constraints

- Spilling free
- Does not interfere with the driver
- Size max 200 x 150 x 150 mm (HxWxL)
- Weight not to exceed 0.5 kg
- Cost less than SR 50
- 2 years lifetime

Criteria

- Simple
- Easy to install and dispatch
- Durable
- Strong attachment to the car
- High adaptability to car types
- High adaptability to cup sizes
Problem Formulation

Design a **simple device** for **securing a coffee cup** near the driver’s seat of an automobile that **prevents** the **cup from spilling**. The **device should not interfere** with the proper operation of the **driver** and should be **adaptable** to a wide variety of vehicles and coffee cup size. The device should be easy to install and detach and no interior modification of the car should be needed. The maximum size and weight if the device are respectively **200 x 150 x 150 mm³** and **2 kg**. It should also be **durable** offering a minimum of two years lifetime and cost less than **50 SR**.
Needed Information

- Average amount of coffee in cup
- Average coffee cup size and weight
- Coffee cup material
- General car interior layout/design
- Temperature inside the car (max/min)
- Available relevant holder design in the market