GE105: Introduction to Engineering Design

Need Analysis – 2/2

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February 21, 2015

Buildings zoning requirements

Some design requirements might be Enforceable by the State such as this western home earth quake requirements

Requirement Analysis

Customer needs a solution to a problem

↓

Assess needs

↓

Statement of problem

↓

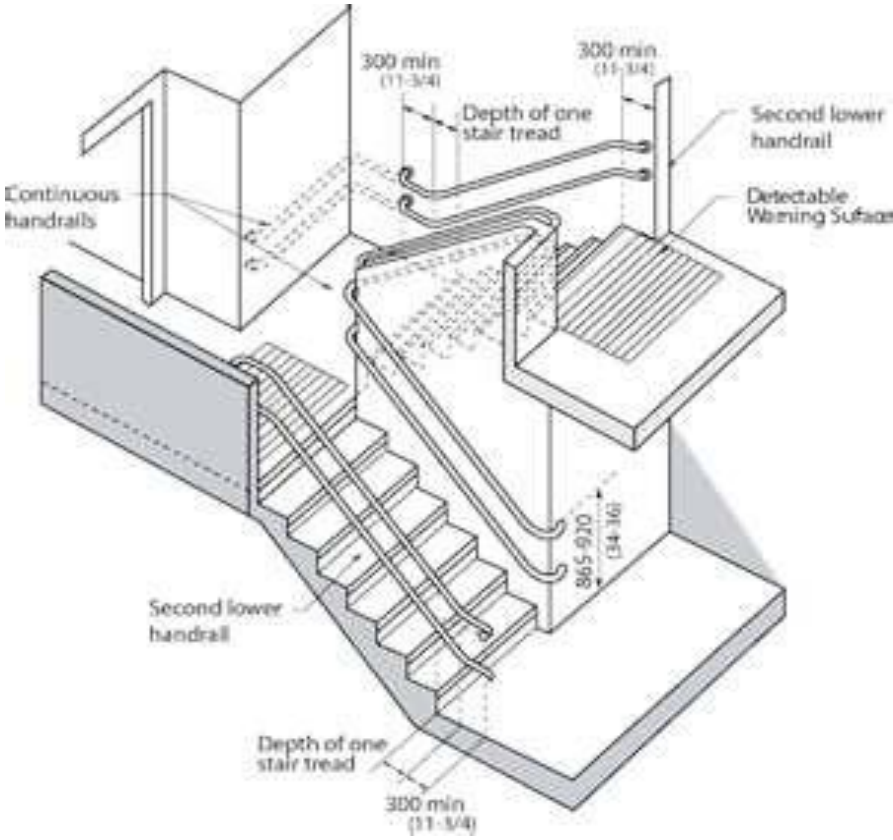
Specify design requirements

↓

Requirement specifications

Specify Design Requirements

- Translating client and user needs into terminology that helps us find ways to realize those needs and measure how well we met them
  - How will everyone that take part in the design know that it is done?
  - It turns the problem statement into a technical, quantified specification
- Sets out criteria for verifying that the design meets its intended objectives
- Describes the test for verification (confirmation)



Stair Design Criteria Sketched

Requirement Analysis

Buildings zoning requirements

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Requirement specifications

Requirement Specifications

GARDEN EQUIPMENT COMPANY		DESIGN SPECIFICATION Grass Cutter Project	Issued: 11/1/1999 Page: 1
D/W	**Wt**	**REQUIREMENTS**	**Keyword**
		GEOMETRY	
W	M	• Maximum storage size: 600x600x300 mm	Storage
D		• Minimum width of cut: 300 mm	Cut width
W	M	• Adjustable cutting depth: 5 - 50 mm	Cut depth
		KINEMATICS	
W	H	• Easily manoeuvred	Manoeuvre
W	L	• Cutting speed up to 2 m/s	Cut speed
		FORCES	
W	H	• Maximum weight not greater than 100 N	Weight
W	M	• Force to move not greater than 50 N	Move force
W	M	• Withstand fall onto hard surface from 2 m	Robust
		ENERGY	
W	M	• Power requirement - maximum up to 1 kW	Power
W	M	• Power source - electricity	P/source
D		• Maximum noise level not to exceed 85 dB	Noise
		MATERIAL	
W	L	• Suitable for a life expectancy of 5 years	Life
W	L	• Must not corrode within design life	Corrosion
		SIGNALS	
D		• Simple to start/stop	Start/stop
W	L	• Indication when cuttings storage need emptying	Storage
W	L	• Maintenance instructions on the machine	Maint instr
		SAFETY	
D		• Electrical safety to BSI standards	Elec safety
D		• No accessible sharp edges or hot spots	Sharp/hot
D		• Cutting blade protection	Blade prot
W	M	• Automatic electrical cut-out	Auto cut-out
		ERGONOMICS	
D		• Easy to operate and control	Easy operation
W	M	• Simple cutting height adjustment in under 1 min	Cut adjust
W	H	• Pleasant appearance	Appearance
		ECONOMICS	
W	H	• Target selling price not more than £75	Price

Figure 9: Part of a design specification for a grass cutter

W: Wish
D: Demand
Wt: Weighting (importance)
H: High
M: Medium
L: Low

Can be a long list of required specifications detailing what is required from the design to achieve…

Specifications

- How can I express what the client wants in terms that helps me as an engineer
- Expressible as numbers and measures
- Precise description of the properties of the object being designed

Specification Types

- **Design Specs :** provide basis for evaluating the design

Example: Pin Remover

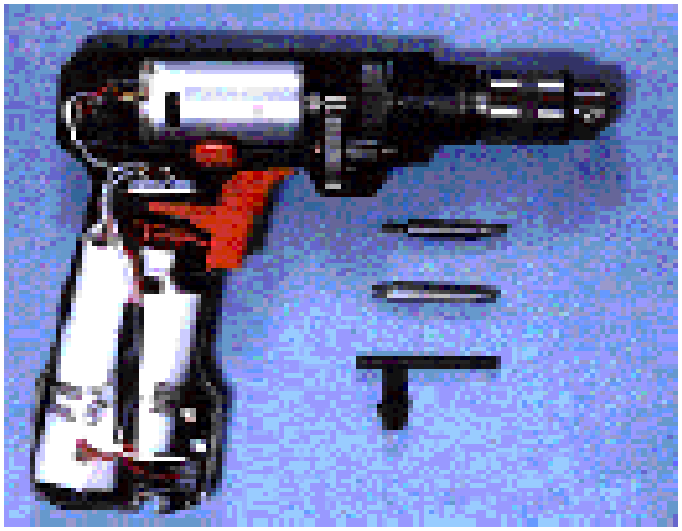
- The pin-remover is to be light.
- The pin-remover must work in a wet, cold, and dusty environment.
- The Pin-remover must be safe
- The Pin-remover must have a 3-year warranty.
- The PR is to be rugged.
  - … must work with air pressure.
  - … is be easy to use.
  - … is to pass "HTS" tests.
  - … is to last 5 years in normal usage.
  - … is to be easy to carry
  - … is to sell for less than $150.
  - … is to cost less than $50 to make.
  - … is to have low maintenance needs.
  - … is to be difficult to use as a hammer.
  - … must not infringe on patented devices.
  - … Production volume is to be 300 per year

Specification Types

- **Functional Specs:** what the thing must do?

Example: Power Drill

- Functions
  - – Used with Drill Bits to create or enlarge holes
  - – Other uses including
    - Grinding
    - Buffing/Polishing
    - Wire brushing
    - Power screw driver

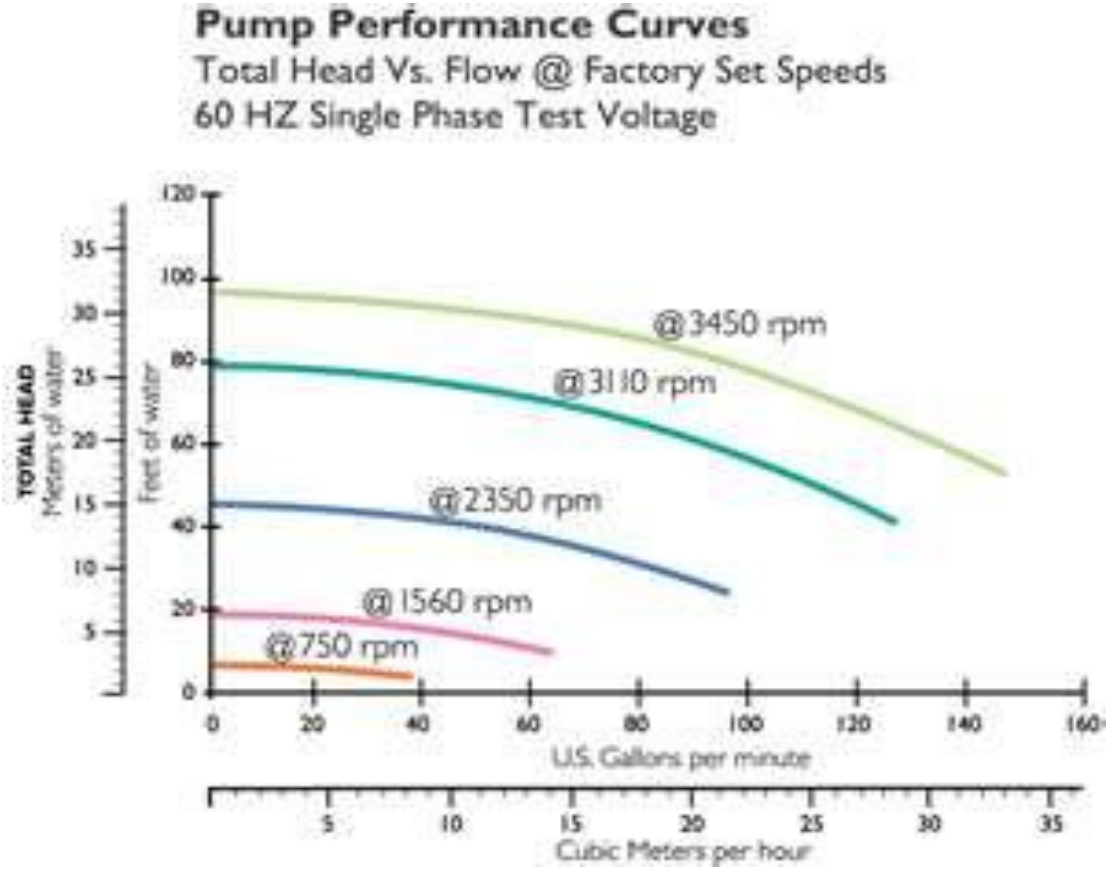


Functional Specification

- Drill size
- Speed
- Power
- Size
- Weight
- Battery charging time
- Cost

Specification Types

- **Performance specs:** tells us how well the design is
- **Metrics :** Tools for testing and measuring the performance



Metrics: Are indicators of performance

Water Pump Performance

Example 1: Problem

- I don't want my iron to tip over easily causing water to spill out and possibly breaking the iron should it fall off the ironing table.

Example 1: Solution - Need Analysis

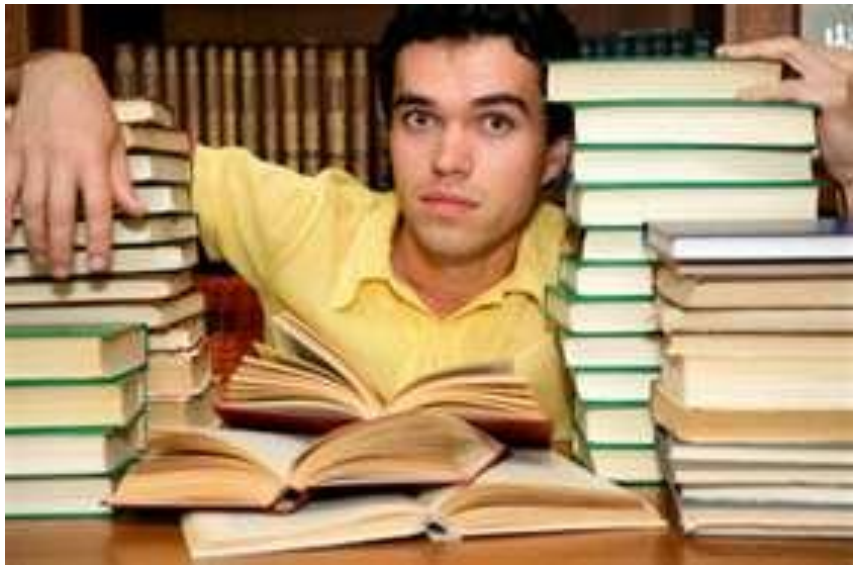
- Can be retrofitted to existing irons
- Does not damage ironing table
- Easy to install and remove
- Cannot occupy a large area on ironing table
- Cannot interfere with operation of iron
- Cannot be damaged by iron (heat, water)
- Should not cost more than $2, should probably be included with ironing table or iron.

These could be the ideas coming to your mind on how to achieve the objective

Target market: People who iron clothes on an unstable ironing surface

Example 2: Problem

- I want to store books in my car while providing plenty of room for passengers.



A smart student wondering what to do with his books

Example 2: Solution

- Must store typical load and size of books for a college student (10 kg)
- Must resist degradation from sunlight, moisture, extreme cold and heat.
- Cannot occupy floor or seat space
- Cannot interfere with operation of any controls (radio, a/c, steering, gearshift, pedals, movement of seats) or passengers' freedom of movement.
- Easy to install and remove
- Cannot damage the car
- Should not allow books to eject during a severe crash
- Should not cost more than $15

These could be the ideas coming to your mind on how to achieve the objective

Target market: People who transport books and other people at the same time

Example 3: Problem

- There is a need in underdeveloped countries for building materials. One approach is to make building blocks (10x15x30 cm) from highly compacted soil.

- Your assignment is to design a block-making machine with the capacity for producing 1000 blocks per day at a capital cost of less than SR 5000.

- Develop need analysis, a definitive problem statement, and a plan for the information that will be needed to complete the design.

Brick making in Pakistan

Brick making by a young boy

Example 3: Solution

- **Needs Analysis:**
  - Must be capable of being constructed with local materials and labor.
  - Blocks of 10x15x30 cm
  - Total cost is less than SR 5000.
  - Should be easily transported to different locations.
  - Powered with human labor.
  - Cannot count on availability of electricity.
  - Hydraulic components may be invalid because cost and/or maintenance (sand in seals, etc.)

Notice how the need analysis is extracted from the problem while expanding it to include how the solution would be in this case, therefore, you will find some more information in it that was not given in the original problem!

This is how we can assess how good did you understand the problem "Scenario" which is why open ended problems are usually disliked by some students!

Example 3: Solution – Need Analysis

- **Musts**

  - Cost less than SR 5000
  - Weight less than 700 N.
  - Human powered
  - Made from local materials
  - Easily manufactured.
  - Produce 10x15x30 cm blocks
  - Produce 600 blocks/day

- **Wants**

  - Able to make tiles of 5x15x30 cm
  - Easily maintained.
  - Easy and safe operation.
  - Available to a variety of soil mixes.

Analyses of the need to determine what we must have and what is nice to have!

Example 3: Solution - Problem Formulation

The objective of this project is the design and construction of a prototype model of a block-making machine.

The blocks are to be made of soil cement and are 10 x15 x 30 cm.

The machine must be human powered, weigh less than 700 N, cost less than SR 5000, and be capable of producing 1000 blocks per day with a 5 person crew.

The machine should be easily constructed of local materials with local labor. The machine also should be capable to a variety of soil cement mixtures and to making tiles 5cmx10 cmx30 cm.

A crew of three persons should be capable of operating the machine to produce 600 blocks per day.

Notice how the problem formulation when it is to be written by you, the student is simply re-writing the original problem with added information that you probably obtained from the imaginary customer.

Note how some of the points added are really suitable to be objectives and others may have come from the need analyses!!

Example 3: Solution - Information Needed

- Determination of the processing conditions for making blocks.
  - What pressures must be generated? Curing temperature and time? Effect of different soil mixes on pressure.
- Mechanism for generating pressure.
- Human factors in design: Magnitude of force that can be exerted without causing human fatigue.
- Materials handling.
- Available construction materials and properties.

What manufacturing, product, safety, legal, market and technical information do we need to succeed in our design?