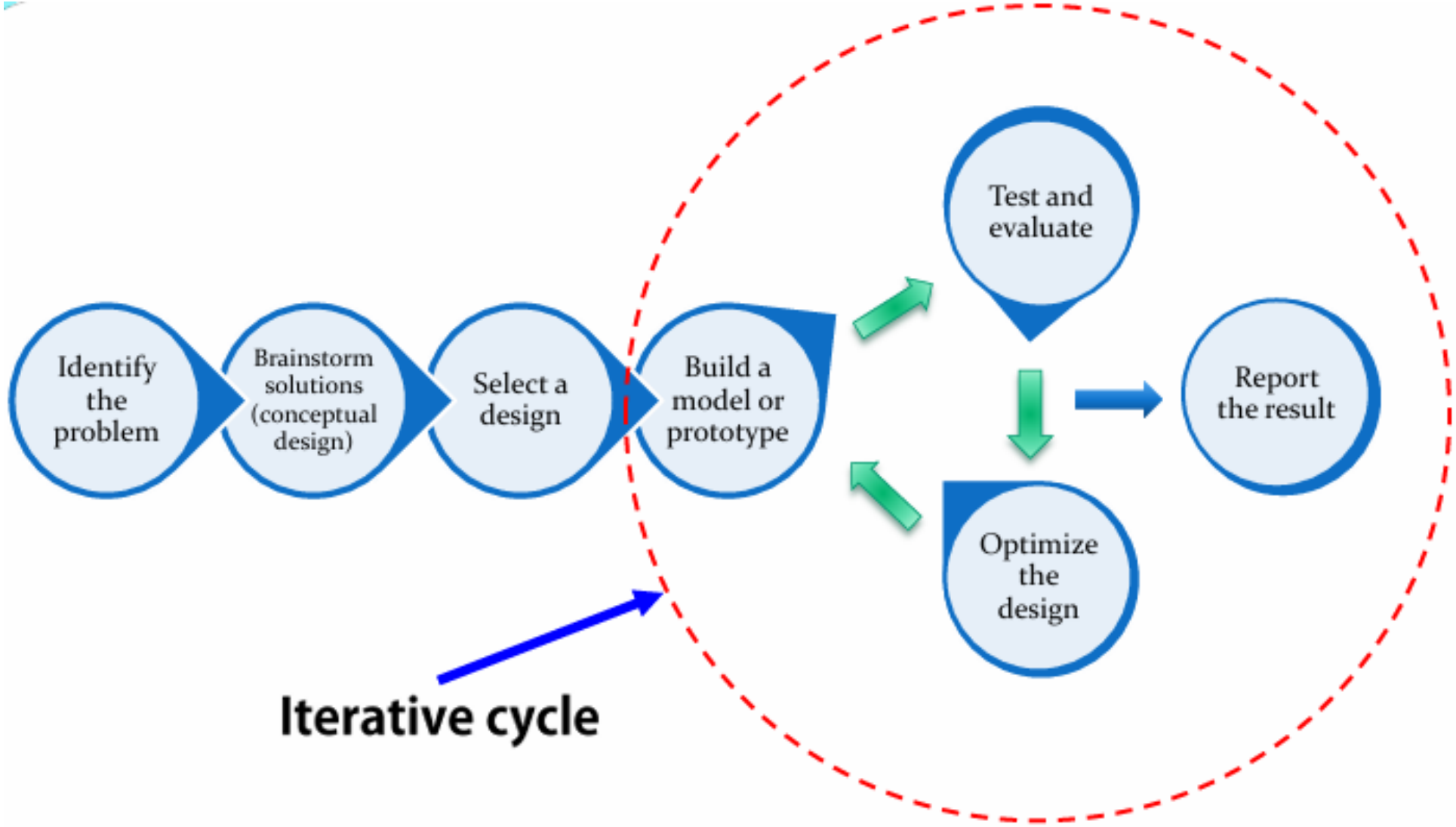
* What is the steps of engineering design process ?



What elements need to be identified to identify the problem?

- objective.
- Constraints.
- Criteria (Measures of Success).
- users / stakeholders.

Recognize the Need

Construction workers in hot climates face fatigue and heat stress, reducing productivity and risking health

Define the Problem

Objective:

*Design a **portable personal cooling device** that helps construction workers stay safe and comfortable while working in high heat.*

Constraints:

- *Must weigh less than **2 kg** so workers can wear it easily.*
- *Cost must not exceed **200 SAR per unit**.*
- *Must operate for **at least 6 hours** without recharging.*
- *Must be durable against dust, sweat, and impact.*

Criteria (measures of success):

- *Reduces body temperature by at least **2–3°C**.*
- *Battery life is reliable in outdoor conditions.*
- *Easy to wear with safety gear (helmets, harnesses).*

Users/Stakeholders:

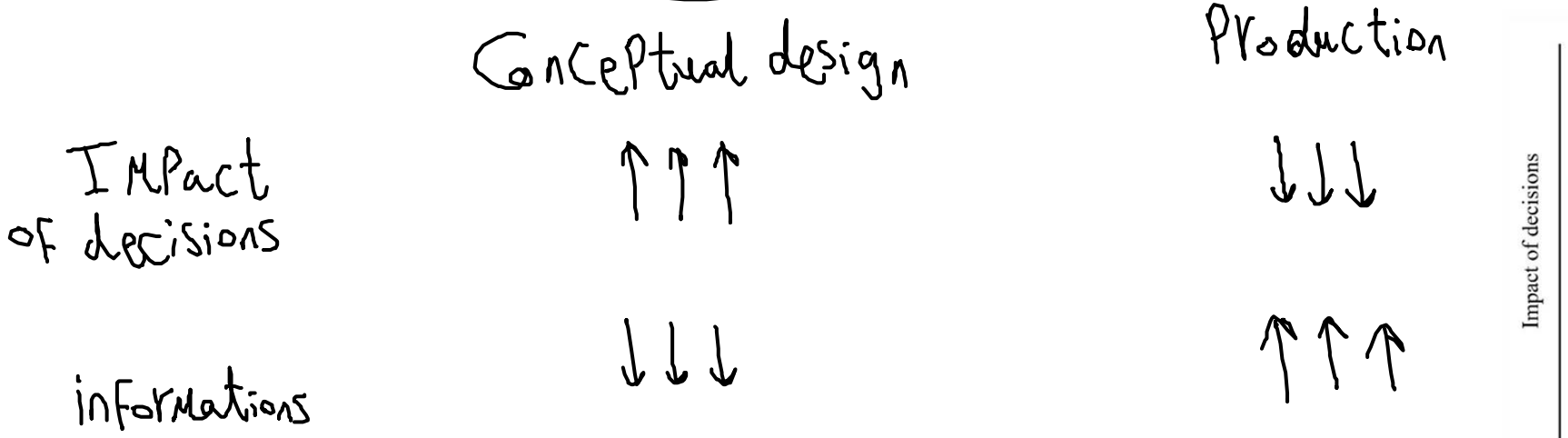
- *Primary: Construction workers.*
- *Secondary: Contractors and companies (who buy the devices).*

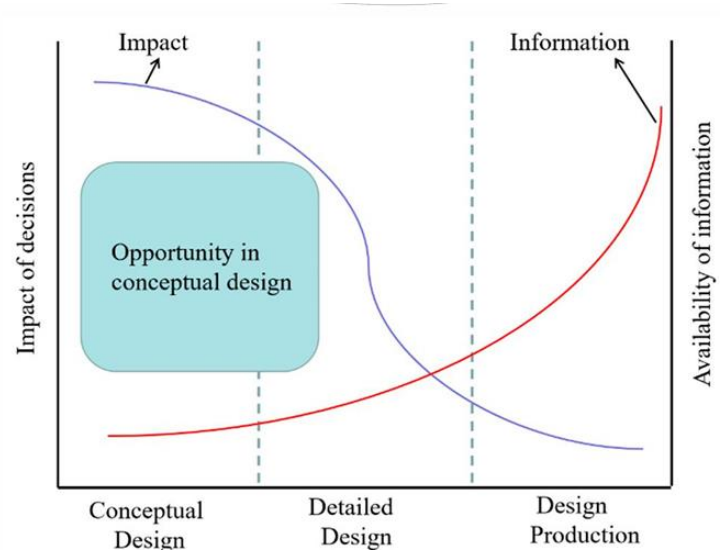
What is the conceptual design?

- Conceptual design is the early stage of the design process where engineers, designers, or innovators develop and explore different ideas, models, and concepts before committing to detailed design.

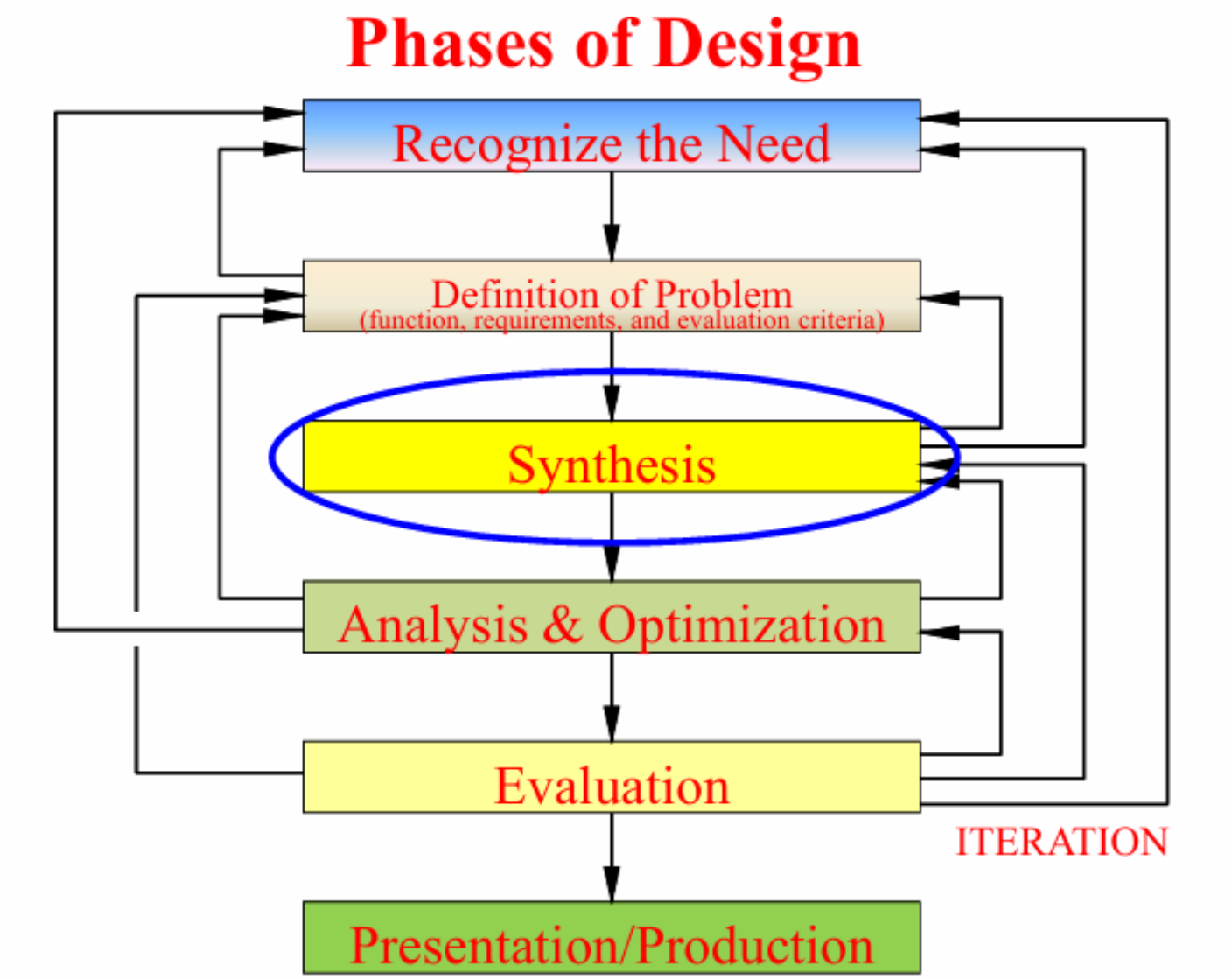
What is the basic requirement of conceptual design?

- The conceptual design must fulfill the functionality of the need.





What are the phases of design?



What does synthesis mean in designing process?

- Synthesis means making a model through experimental procedure, prototyping, or mathematical modeling.

What are the requirements should be in good design?

Design/Products/system should

- Functional
- Safe
- Reliable
- Competitive
- Usable
- Manufacturable
- Marketable
- Environment friendly

✳ Name some factors that should be considered in good design.

1	Functionality	14	Noise
2	Strength/stress	15	Styling
3	Distortion/deflection/stiffness	16	Shape
4	Wear	17	Size
5	Corrosion	18	Control
6	Safety	19	Thermal properties
7	Reliability	20	Surface
8	Manufacturability	21	Lubrication
9	Utility	22	Marketability
10	Cost	23	Maintenance
11	Friction	24	Volume
12	Weight	25	Liability
13	Life	26	Remanufacturing/resource recovery

✳ What is the factor of safety and its importance in design process?

- It is the ratio between the strength of a component and the actual working load or stress.
- Importance : Prevents failure - Covers uncertainties in loads and materials - Improves safety and reliability.

✳ Name two types of failures.

1. **Design failure**: due to improper design consideration
2. **Material failure**: due to the selection of improper material/manufacturing processes

✳ What are the Responsibilities of Professional design Engineer?

- Be competent
- Keep current in field of practice
- ***Keep good documentation***
- Ensure good and timely communication
- Act professionally and ethically

Define: Standards – Codes.

- Standards
  - A set of specifications for parts, materials, or processes
  - Intended to achieve uniformity, efficiency, and a specified quality

Why we need standards?

- Codes
  - A set of specifications for the analysis, design, manufacture, and construction of something
  - To achieve a specified degree of safety, efficiency, and performance or quality

Why we need codes?

مستقل

Breakeven point method can only be achieved in independent alternatives? [True / False]. Explain your answer.

- This is False. Breakeven point can only be achieved in dependent alternatives, since it is an intersection point of alternatives functions.

What does reliability of design means?

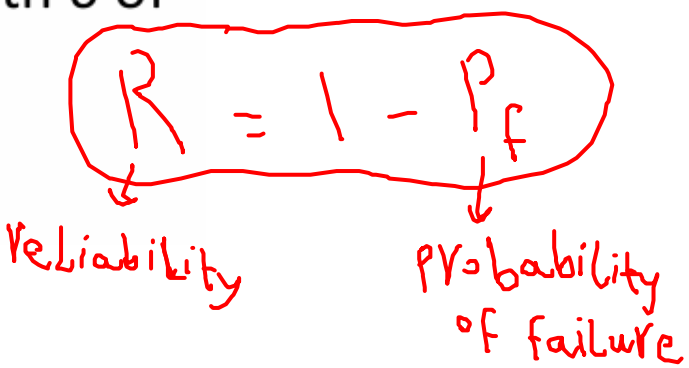
- Reliability is a confidence level (measure in probabilistic percentage) that the product will complete its life span.

What does Probability of Failure of design means?

- Probability of Failure, pf– the number of instances of failures per total number of possible instances.

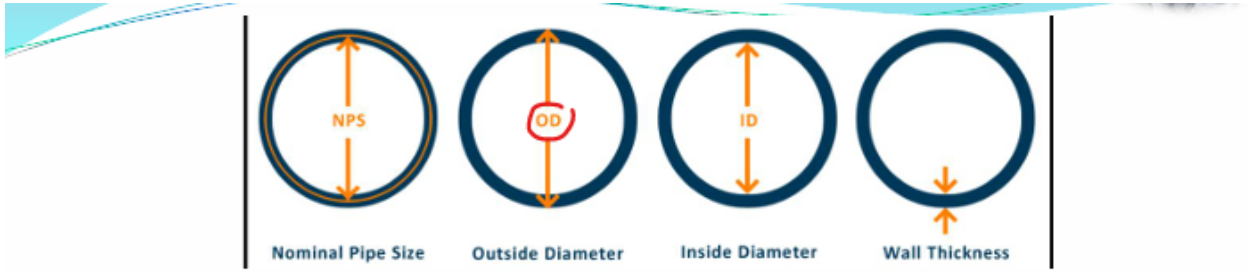
- **Example:** If 1000 parts are manufactured, with 6 of the parts failing, the reliability is

$$R = 1 - \frac{6}{1000} = 0.994$$ or 99.4 %



- Example: A shaft with two bearings having reliabilities of 95% and 98% has an overall reliability of

$$R = R_1 R_2 = 0.95\ (0.98) = 0.93 \quad \text{or } 93\%$$



Nominal size – Nominal size of pipes is a standardized way of referring to the diameter of pipes, but it does not always equal the exact inside or outside diameter.

Limits – The stated maximum and minimum dimensions

Tolerance – The difference between the two limits

Bilateral tolerance – The variation in both directions from the basic dimension, e.g. 1.005 ± 0.002 in.

Unilateral tolerance – The basic dimension is taken as one of the limits, and variation is permitted in only one direction, e.g. $1.005\ ^{+0.004}_{-0.000}$ in

* Define : Clearance - Diametral Clearance - Radial Clearance - Interference

- *Clearance* – Refers to the difference in sizes of two mating cylindrical parts such as a bolt and a hole.
  - ✓ Assumes the internal member is smaller than the external member
  - ✓ *Diametral clearance* – difference in the two diameters
  - ✓ *Radial clearance* – difference in the two radii
- *Interference* – The opposite of clearance, when the internal member is larger than the external member

✳ How interference fit parts can be assembled together?

Press Fit → Parts are Pushed together using a Press or hydraulic Machine.

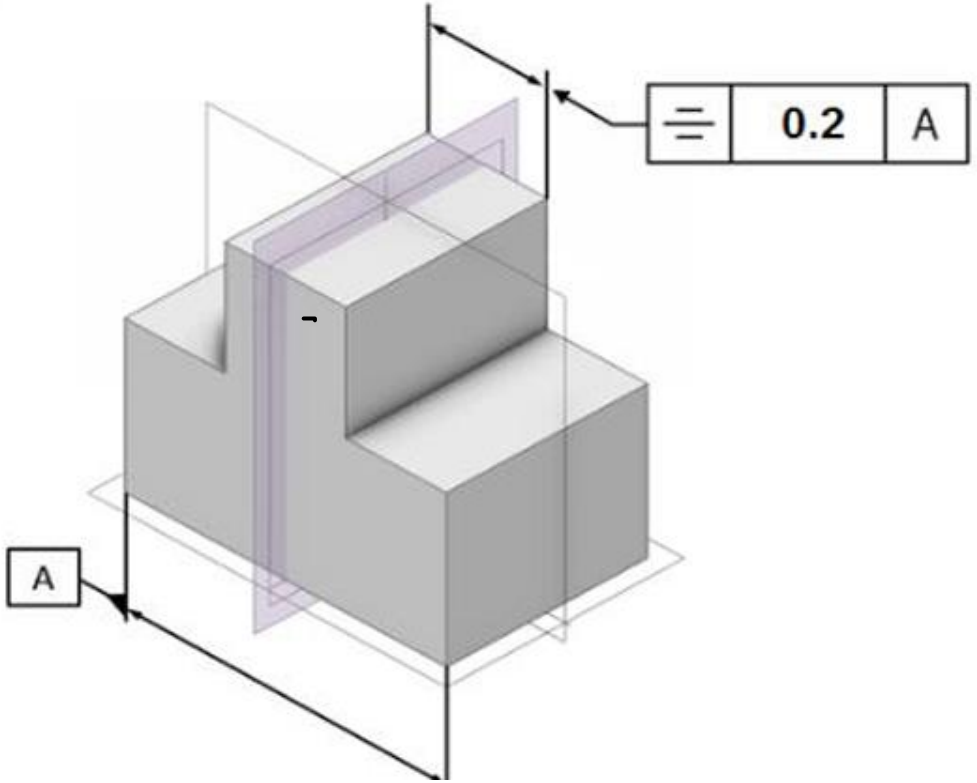
Shrink fit → The outer Part is heated so it expands or the inner Part is Cooled so it Contracts, then assembeled.

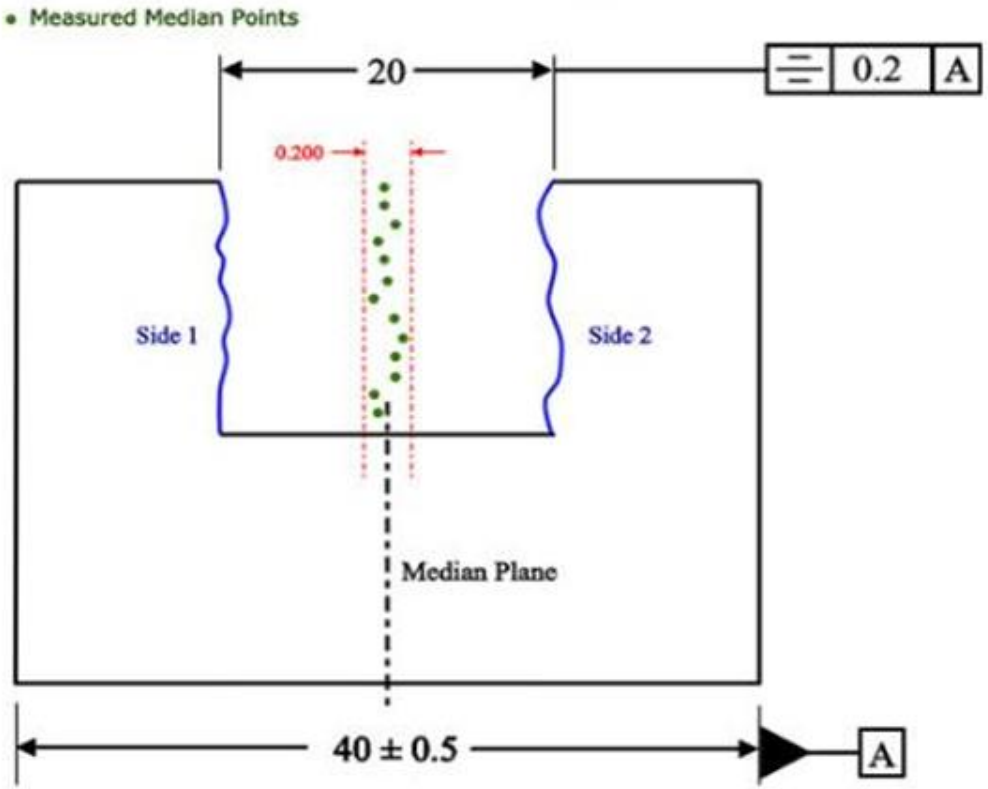
✳ Define: Allowance - GD&T

- *Allowance* – The minimum stated clearance or the maximum stated interference of mating parts

- *GD&T* – Geometric Dimensioning and Tolerancing, a comprehensive system of symbols, rules, and definitions for defining the theoretically perfect geometry, along with the allowable variation.

WHAT is the Symmetry tolerance & WHY it's important?





→ Symetry tolerance: is a GD&t Control that limits how much a feature can deviate from the perfect symmetry.

* What is MMC? and its' importance?

- Maximum Material Condition or for short, MMC, is a feature of size symbol that describes the condition of a feature or part where the maximum amount of material (volume/size) exists within its dimensional tolerance.
- If you want to ensure that ***two parts never interfere or limit the amount of interference between the parts when they are at their worst tolerances***, MMC can be called out. Take a shaft that must go through a hole with clearance between the two

Importance