Machine Design I
(MCE-C 203)

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Aims

This course is provided to give the student the knowledge to **Produce** a useful **machine/device/product** that is **safe**, **efficient**, **economical**, and **practical** to manufacture.

Course Outlines

- Design procedures.
- Factors affecting design details.
- Selection of materials.
- Modes of loading.
- Safety factors and allowable stresses.
- Design of detachable joints: (threaded joints , keys and splines).
- Design of permanent joints: (welding, interference fitting, riveting, riveting, adhesion).
- Design of some machine elements: springs, power screws, Thin pipes and pressure vessels, Seals and design of hydraulic and pneumatic cylinders.
- Application of computer aided design.
- Introduction to power transmission elements.

Teaching and Learning Methods

- ❑ Power Point Lectures.
- ❑Assignments.
- ❑ Quizzes.

Weighting of Assessment

Final Exam	60
Mid Term Exam	20
Home Work Assignment	20
Total Marks	100

Machine Design

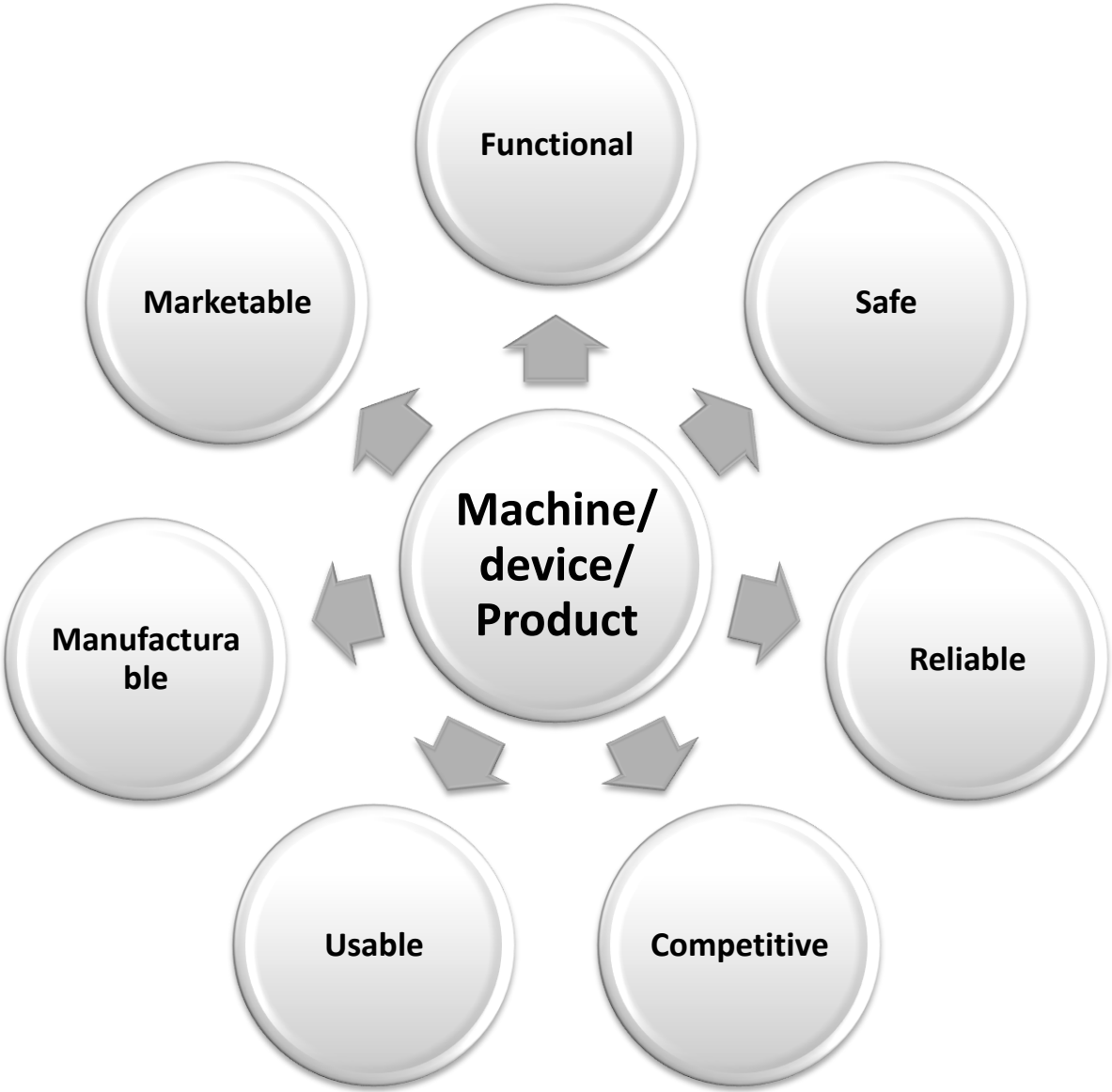
What is Machine Design?

Creation of new and better machines AND

Improving existing ones

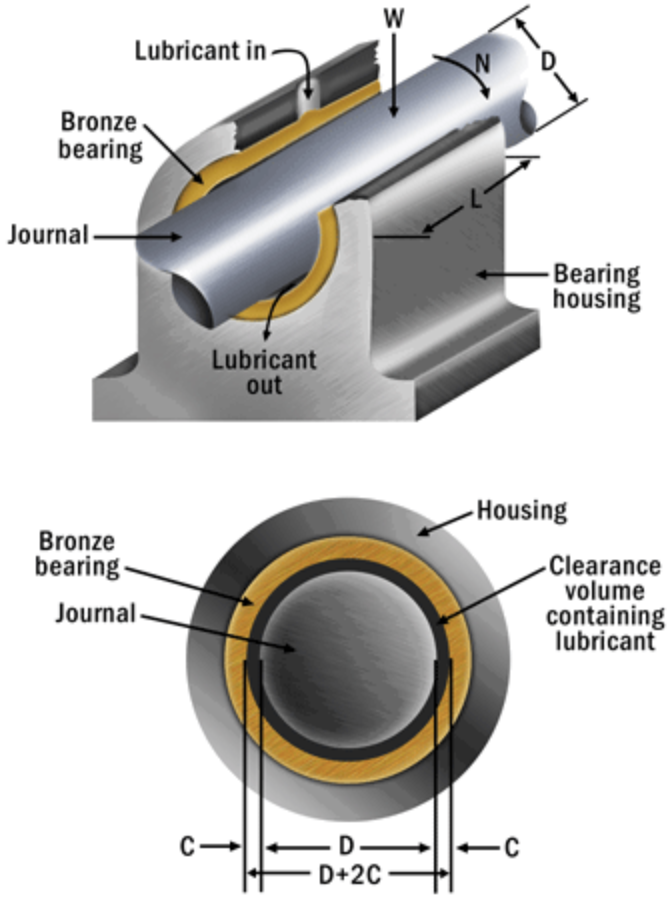
So that it is **economical** in the cost of production and operation.

Machine/device/Product



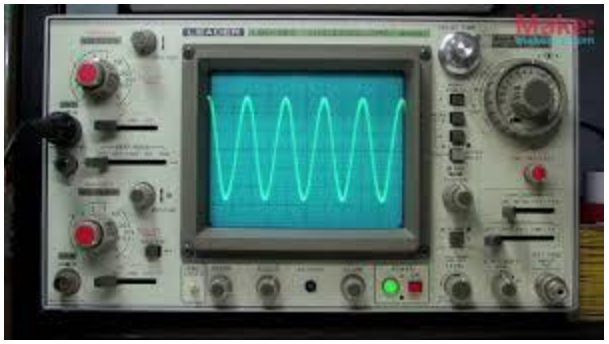
Design

Involve all the discipline of mechanical engineering.



- Fluid flow,
- Heat transfer,
- Friction,
- Energy transport,
- Material selection,
- Statistical descriptions,
- ……., etc.

Machine/device/Product



Design Process

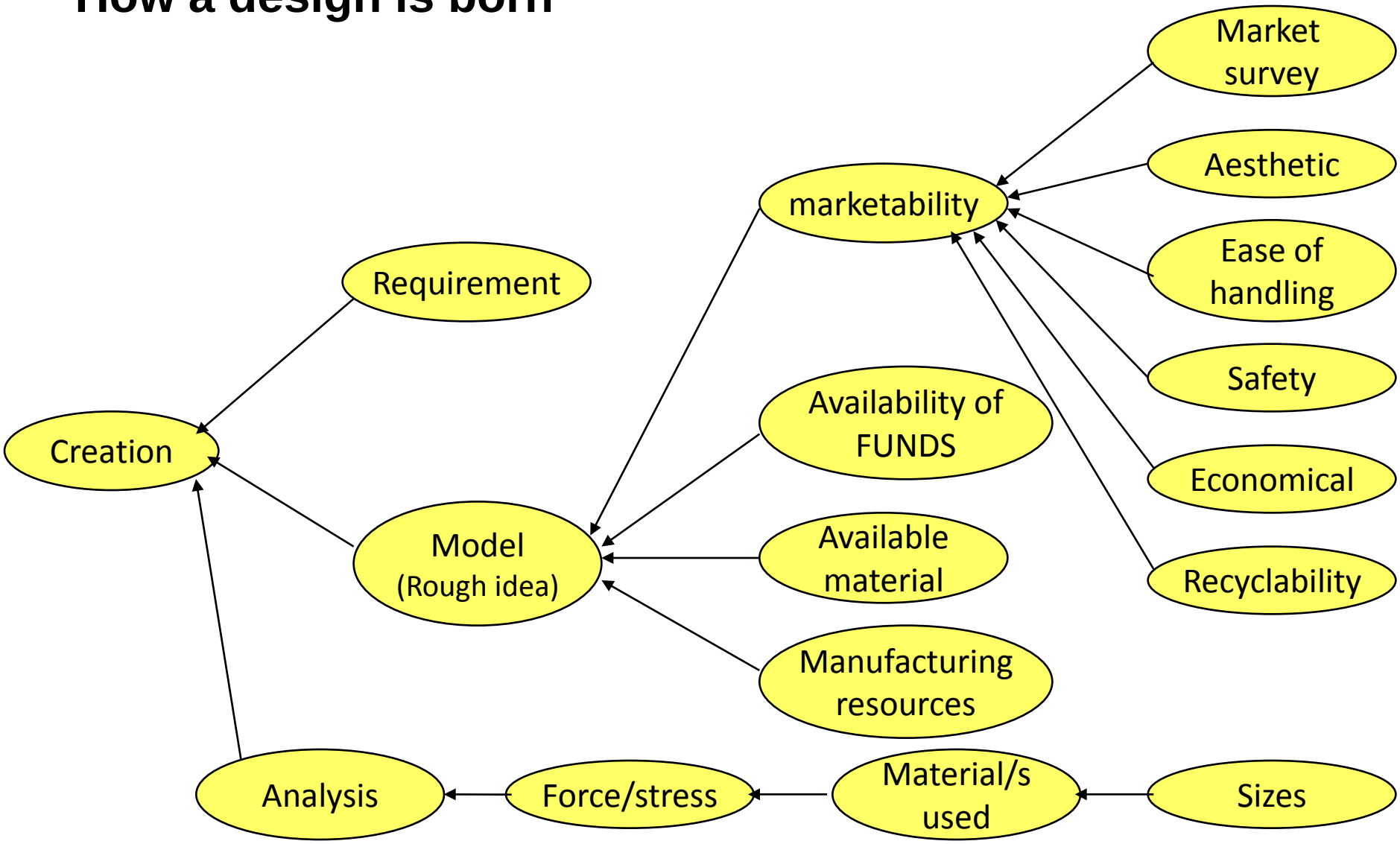
- Identify Customer Requirements.
- Define functions of the device.
- State design requirements.
- Define evaluation criteria.
- Propose several alternative design concepts.
- Evaluate each proposed alternative.
- Rate each alternative against each evaluation criteria.
- Select the optimum design concept.
- Complete detailed design of the selected concept.

The Engineering Design Process:
(Core of Engineering)

- Problem Identification: Get with Customer.
- Conceptual Design: Ideas, Sketches and Solution Lists.
- Refinement: Computer Modeling, Data Base Development.
- Testing: Analysis and Simulation of All Design Aspects.
- Prototyping: Visualizing and Improving the Design.
- Communication: Engineering Drawings, Specifications.
- Production: Final Design, Manufacturing, Distribution.

Machine Design

How a design is born



What is the basic knowledge required for Machine Design?

- Mathematics
- Engineering Mechanics
  - Mechanics of Machines
  - Mechanics of Materials
  - Fluid Mechanics & Thermodynamics
- Strength of Materials

- Workshop Processes
- Engineering Drawing

- Computing
- Finite Element Analysis, Computational Fluid Dynamics etc

Important considerations in Machine Design

1. Type of **LOAD** and **STRESS**es caused by the load

- Dead loads
- Live loads
  - Steady loads
  - Variable loads
- Shock loads (suddenly)
- Impact loads (applied with some velocity)

- Stress and strain (Tensile, compressive, shear)
- Thermal stresses
- Torsional stresses
- Bending stress

Important considerations in Machine Design…..

2. **KINEMATICS** of the machine (Motion of the parts)

Find the simplest arrangement that would give the most efficient motion that is required.

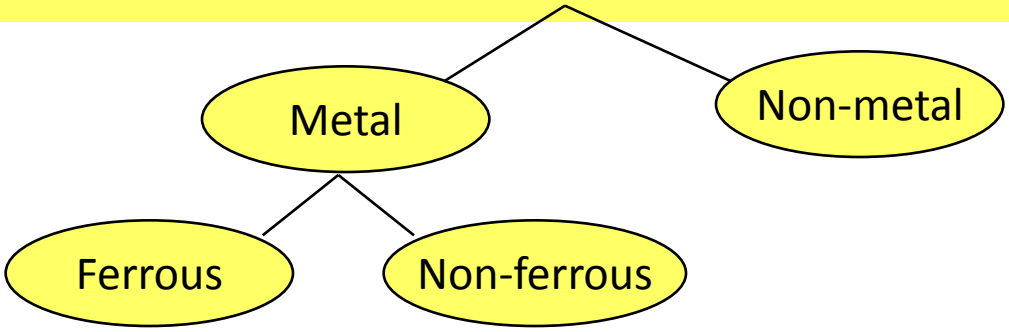
3. Selection of **MATERIAL**s

Knowledge of the **properties of the materials** and their **behaviour under working conditions** is required.

Strength, hardness, durability, flexibility, weight, resistance to heat and corrosion, electrical conductivity, machinability, etc.

Important considerations in Machine Design…..

3. Selection of **MATERIAL**s



Physical properties: Density, Melting point, Elec/thermal properties

Mechanical properties:

- STRENGTH – resist externally applied loads without breaking or yielding
- STIFFNESS – resist deformation under stress
- ELASTICITY – regain original shape once the force is removed
- PLASTICITY – property which retains deformation (required for forging etc)
- DUCTILITY – ability to be drawn into a wire by a tensile force
- BRITTLENESS – sudden breaking with minimum distortion
- TOUGHNESS – resist fracture due to high impact load
- CREEP – deformation under stress and high temperature
- FATIGUE – ability to withstand cyclic stresses
- HARDNESS – resistance to wear, scratching, deformation, machinability etc

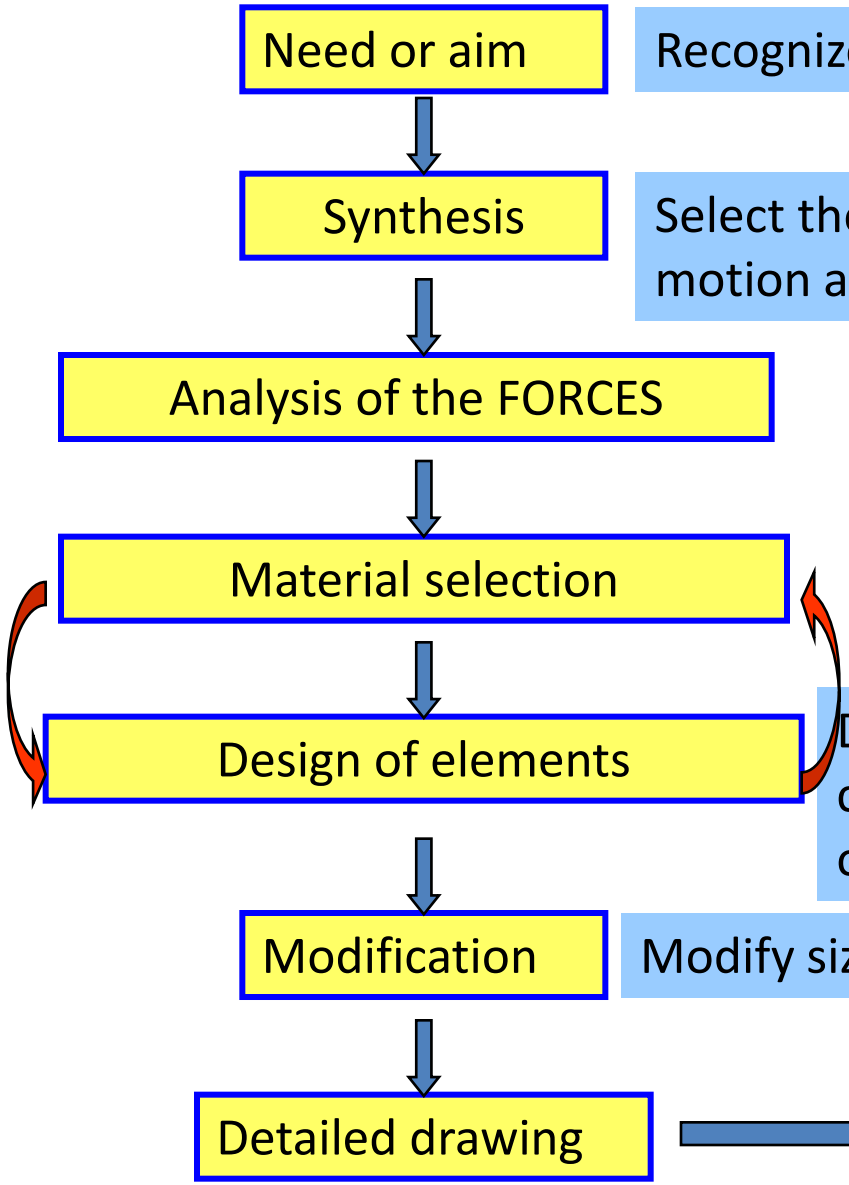
Important considerations in Machine Design…..

4. **Form and size** of the parts

Use I-beam or Angle-iron?

The size will be determined by the forces/torques applied (stresses on the object) and the material used such that failure (fracture or deformation) would not occur

General procedure in Machine Design…..



Design Skills Required

- Technical Drawing
- Computer-Aided Engineering (CAE)
- Manufacturing Processes
- Statics, Dynamics, and Strengths of Materials
- Kinematics and Mechanisms
- Verbal and Written Communication

Computer Aided Engineering (CAE)

- Any use of the computer and software to aid in the engineering process
  - **Computer-Aided Design (CAD)**

    Drafting, 3-D solid modeling, etc.
  - **Computer-Aided Manufacturing (CAM)**

    CNC tool path, rapid prototyping, etc.
  - **Engineering analysis and simulation**

    Finite element, fluid flow, dynamic analysis, motion, etc.
  - **Math solvers**

    Spreadsheet, procedural programming language, equation solver, etc.

Acquiring Technical Information

- **Libraries**

  Engineering handbooks, textbooks, journals, patents.

- **Government sources**

  Government agencies, U.S. Patent and Trademark, National Institute for Standards and Technology, etc.

- **Professional Societies (conferences, publications, etc.)**

  ASME, Society of Manufacturing Engineers, Society of Automotive Engineers, etc.

- **Commercial vendors**

  Catalogs, technical literature, test data, etc.

- **Internet**

  Access to much of the above information

Design Presentation

- Develop a **specification** set that communicates effectively all **manufacturing information**, **safety information**, **usage information**, etc.
- Specifications sets include:
  - CAD Models
  - Drawings (Assembly, Detail, Stress Reports)
  - Bills-of-Material
  - Instructions:
    - Manufacturing
    - Assembly
    - Maintenance
    - Usage

The Engineering Method

- Recognize and understand the problem
- Accumulate data and verify accuracy
- Select the appropriate theory or principle
- Make necessary assumptions
- Solve the problem
- Verify and check results

Problem Presentation

- Problem Statement
- Diagram
- Theory
- Assumptions
- Solution steps
- Identify results and verify accuracy