I.1 Introduction

Mechanical construction is an applied science focused on solving design problems across a variety of industrial fields: agriculture, drilling, automotive, precision, etc. Construction technologies are limited to the study of technical objects and their functions. Indeed, each technical object is defined by its roles within a system, often guaranteed by the specifications of its own structure.

I.2. General construction rules

When designing a machine, the constructor keeps in mind the criteria of safety and economy. Safety-related questions concern both operation and handling. Economy is the tendency to achieve maximum success with minimal expenditure. For success in construction, the constructor must have extensive knowledge and skills in several fields, the most important of which are:

1. Industrial Drawing: This is a language of communication for the constructor. Drawing is the most important means by which the constructor fixes their ideas. Two types can be distinguished: the definition drawing and the assembly drawing.

The definition drawing *presents a single part with its geometric characteristics (dimensions, surface condition, and precision) as well as the nature of the material.*
The assembly drawing *presents a set of mounted parts, with the dimensions and certain essential measurements.*

2. Standardization: Growing globalization creates an increasingly complex economic environment, especially for exchanges. The search for reliable transaction tools becomes necessary; standards have been created to avoid repeatedly solving the same problems. The goal of standardization is to achieve an organized and rational work process.

3. Mechanics: This refers to the broad sense of the term, encompassing classical mechanics, which includes kinematics, dynamics, statics, etc., as well as mechanics that involves machines and their functions.

4. Material Resistance: Its roles include determining the stresses and deformations of elements and the dimensions of elements based on the mechanical characteristics of materials.

5. Materials Science: The selection of an appropriate material for an element requires knowledge of the general behaviors of materials.

6. Manufacturing Processes: When designing a machine, the builder always considers the method of obtaining the components. The manufacturing process affects not only the precision of dimensions and surface finish but also the shape of the part.

7. Design: A technical image should not be oriented solely toward utility but should also present an appealing vision. The judgment of beauty is relative and depends on personal feelings, attitudes, and intelligence.

I.3 Design of a Mechanical Product

The design of a mechanical product goes through several stages. The initial stage involves defining a specification document and establishing a contract between the client and the company. The specification document details all the needs that the client wishes to see in the final product. Among these different needs, we can cite: the product's service functions, its operating duration, production lead time, the cost of the finished product, competitiveness, the value of the product defined by the ratio of product quality to its cost, weight, reliability and durability of the final product, aesthetics, ease of handling, ease of disassembly and reassembly of the product parts to facilitate maintenance or repair operations, and product safety. The next stage involves designing the product within the design office while strictly adhering to the guidelines defined in the specification document. The final stage is the manufacturing of the product and the presentation of a prototype to the client. If the client is satisfied with the finished product, series production is then launched by the company. Figure I.1 presents the closed loop of the various stages involved in the realization of a mechanical product.

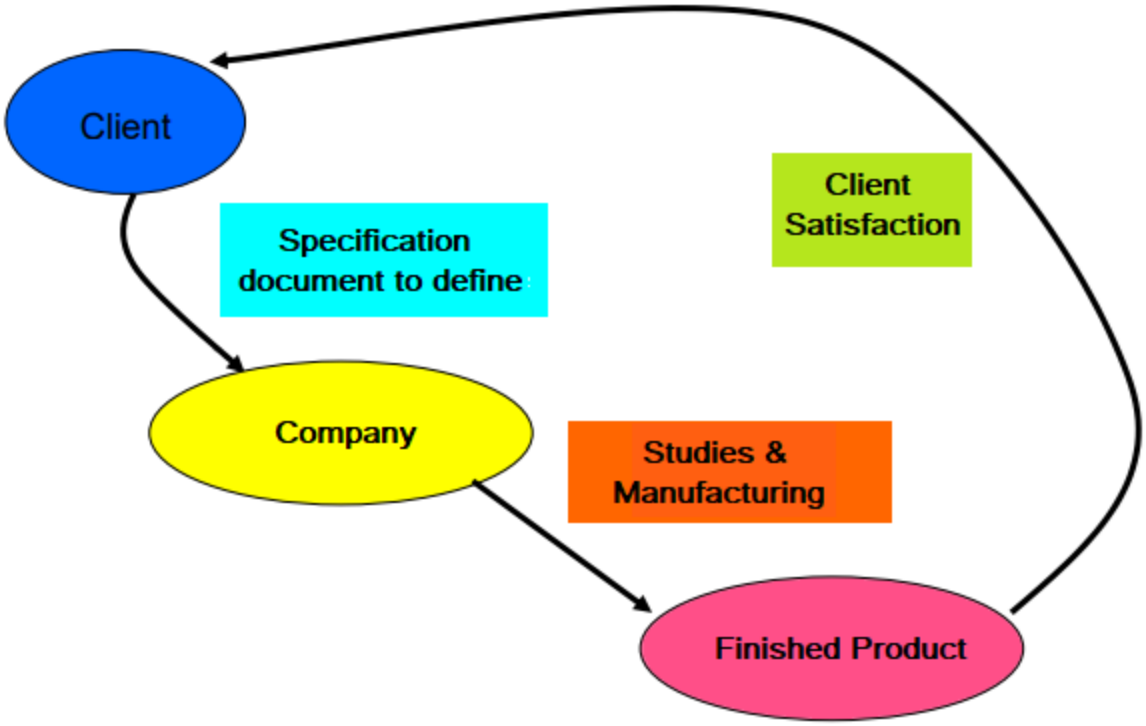


Figure I.1: Stages of Mechanical Product Design

I.4 Standards and Regulations

This term comes from the Latin word "norma," which means rule or square. An industrial standard is a reference published by a standardization body, such as AFNOR, DIN, ISO, etc. It is established by consensus and approved by a recognized organization. In some cases, the manufacturer must adhere to certain standards, for example, following standards for manufacturing a nuclear power plant or producing children's toys. Some international standard organizations include:

- **ISO**: International Organization for Standardization
- **AFNOR**: French Standardization Association
- **ANSI**: American National Standards Institute
- **ASTM International**: American Society for Testing and Materials
- **DIN**: Deutsches Institut für Normung (German Institute for Standardization)
- **JSA**: Japanese Standards Association

The added value from the use of standards can be summarized in the following points:

− Define a common language among professionals in a sector.
− Harmonize practices and rules, enabling market development.
− Promote technical compatibility of systems.
− Streamline production by controlling the technical characteristics of products.
− Enable the transfer of new technologies in essential areas for the company and society.
− Provide means of proof of compliance with regulations.
− Serve as a basis for assessment, particularly in the context of certification.
− Define a level of quality and safety for products.

I.4.1 Different Types of Standards

There are four main types of standards:

1. **Fundamental standards** that concern terminology, symbols, and metrology.
2. **Testing standards** that describe testing and analysis methods and measure characteristics.
3. **Specification standards** that set the characteristics of a product or service, performance thresholds to be achieved, and suitability for use.
4. **Organizational standards** that focus on describing a function within the company or a mode of operation.

I.4.2 The Most Well-Known Standards

ISO 9000: Quality Management
ISO 22000: Food Safety Management
ISO 31000: Risk Management
ISO 50001: Energy Management
ISO 29110: Standard related to systems and software engineering
ISO 4217: Currency Codes
ISO 14000: Environmental Management

I.5 Connections of Mechanical Parts

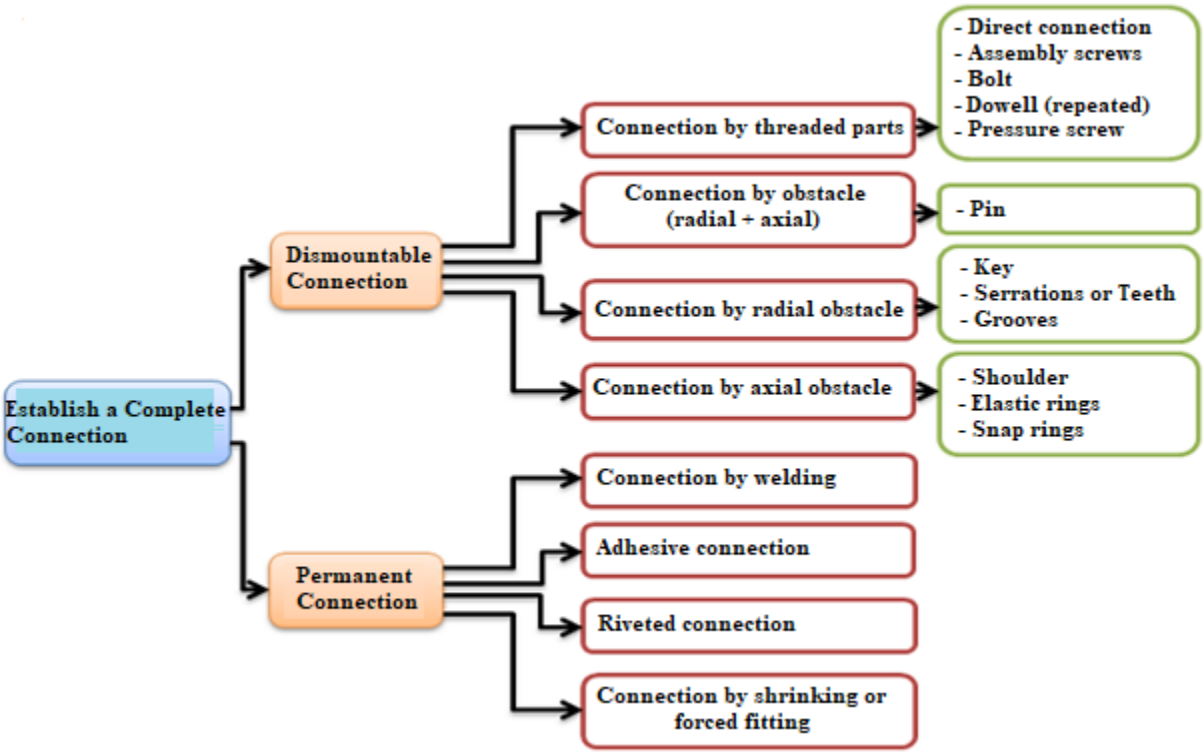


Figure I.2 Connections of Mechanical Parts

I.5.1 Permanent Connection

A complete non-dismountable connection is a permanent assembly of parts that does not allow them to be separated without destruction. This type of connection can be achieved through:

- Crimped connection
- Welded connection
- Adhesive connection
- Riveted connection
- Press-fit connection (Interference fit)

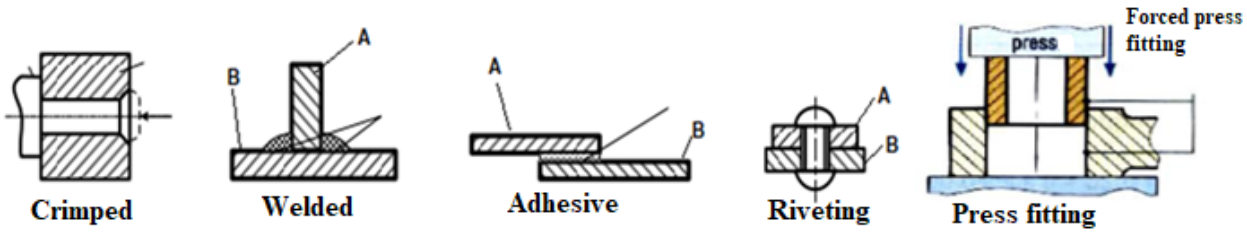
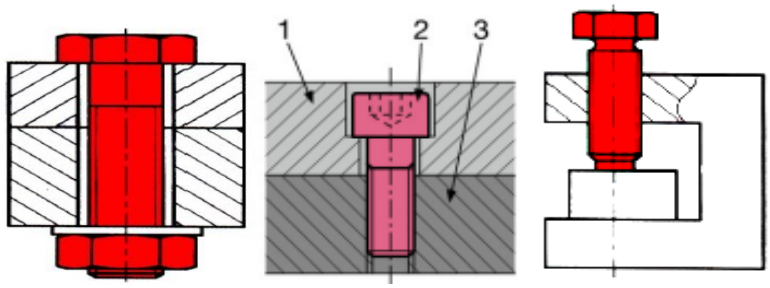
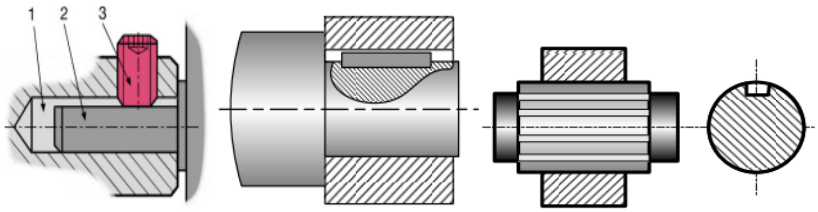
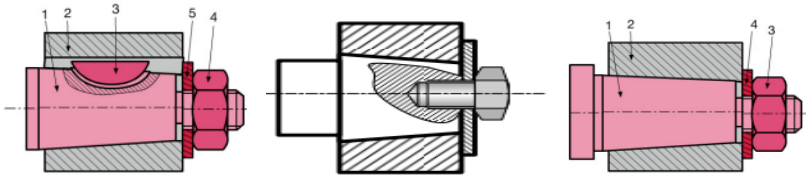
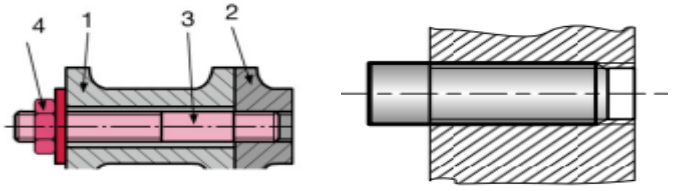


Figure I.3 Types of Complete Non-Dismountable Rigid Connections

I.5.2 Dismountable Connection

A dismountable connection is a connection whose assembly or disassembly of the components can be done without affecting or damaging the connected parts.

To achieve a complete connection, various fastening components (threaded or non-threaded) can be used to assemble components (flat, cylindrical, etc.), which are generally considered incomplete connections.

Case of the Assembly	Figure
1/ Bolt 2/ Assembly screws 3/ pressure screw	**A) Plan-to-Plan Assembly** 
1/ Screw 2/ Key 3/ Grooves	**A) Cylindrical Assemblies** 
1/ Nut + Disc Key 2/ Screw 3/ Nut	**A) Conical Assembly** 
1/ Nut + Dowell 2/ Screw Tightened to the Bottom of the Thread	**B) Helical Assembly** 

I.5.3 Symbols of Mechanical Connections

There are other standardized connections besides the pivot connection and the sliding connection. We have listed them in Figure I.4.

Symbols of Mechanical Connections NF EN 23952 / ISO 3952-1 NF EN ISO 3952-1

Connection Type	Translations	Rotations	Degrees of Freedom	Main Plane Representations (Orthogonal)	Perspective Representations	Example
Embedding or fixed connection	0	0	0	variante 1 variante 2		soudure
Pivot	0	1	1	variante 1 variante 2		
Sliding	1	0	1			
Helical	1 ↔ 1 Combinées (fonction du pas)		1	filet à droite		écrou vis
sliding pivot	1	1	2			
spherical or finger joint	0	2	2			cannelures bombées
ball joint or spherical	0	3	3			
flat support	2	1	3			
Linear rectilinear *	2	2	4			
sphere cylinder or annular linear	1	3	4			sphère dans cylindre
Sphere - Planar or Point Contact	2	3	5			

(*)Old Standard NF E04-015

Figure I.4 Symbols of Mechanical Connections