RQF LEVEL 3

MATMF301

MANUFACTURING TECHNOLOGY

MECHANICAL FASTENING

TRAINEE'S MANUAL

October, 2024

MECHANICAL FASTENING

KOICA Korea International Cooperation Agency

TQUM TVET Quality Management Project

2024

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COORDINATION TEAM

RWAMASIRABO Aimable
MARIA Bernadette M. Ramos
NIKUZE Bernadette

Production Team

Authoring and Review

RIBERAKURORA Eugene

TURINAMAHIRWE Jean Baptiste

Validation

NIZEYIMANA Maurice

NKUNDIZANYE Marie Patience

Conception, Adaptation and Editorial works

HATEGEKIMANA Olivier

GANZA Jean Francois Regis

HARELIMANA Wilson

NZABIRINDA Aimable

DUKUZIMANA Therese

NIYONKURU Sylvestre
KAMERE Raban

Formatting, Graphics, Illustrations, and infographics

YEONWOO Choe
SUA Lim
SAEM Lee
SOYEON Kim
WONYEONG Jeong
NDAYISABA Olivier

Financial and Technical support

KOICA through TQUM Project

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ACRONYMS

3D: Three Dimension

BOM: Bill of Materials

CBC: Competence-Based Curriculum

GD&T: Geometric Dimensioning and Tolerance

HSS: High-Speed Steel

KOICA: Korea International Cooperation Agency

MSDS: Material Safety Data Sheets

PPE: Personal Protective Equipment

RQF: Rwanda Qualification Framework

RTB: Rwanda TVET Board

TQUM: TVET Quality Management

TVET: Technical and Vocational Education and Training

UV: Ultra Violet Rays

CO2: Carbon Dioxide

HPACs: High-Pressure Air Compressors

LPACs: Low-Pressure Air Compressors

INTRODUCTION

This trainee's manual includes all the knowledge and skills required in manufacturing technology specifically for the module of **"Mechanical Fastening".** Trainees enrolled in this module will engage in practical activities designed to develop and enhance their competencies. The development of this training manual followed the Competency-Based Training and Assessment (CBT/A) approach, offering ample practical opportunities that mirror real-life situations.

The trainee's manual is organized into Learning Outcomes, which is broken down into indicative content that includes both theoretical and practical activities. It provides detailed information on the key competencies required for each learning outcome, along with the objectives to be achieved.

As a trainee, you will start by addressing questions related to the activities, which are designed to foster critical thinking and guide you towards practical applications in the labor market. The manual also provides essential information, including learning hours, required materials, and key tasks to complete throughout the learning process.

All activities included in this training manual are designed to facilitate both individual and group work. After completing the activities, you will conduct a formative assessment, referred to as the end learning outcome assessment. Ensure that you thoroughly review the key readings and the 'Points to Remember' section.

MODULE CODE AND TITLE: MATMF 301 MECHANICAL FASTENING

Learning Outcome 1: Prepare for mechanical fastening
Learning Outcome 2: Carry out mechanical fastening operations
Learning Outcome 3: Perform post-operation activities

Indicative contents
1.1. Introduction to mechanical fastening **1.2. Identification of mechanical fastening materials, tools and equipment** **1.3. Pre-operation activities for mechanical fastening**

Key Competencies for Learning Outcome 1: Prepare for Mechanical Fastening

Knowledge	Skills	Attitudes
• Definition of key terms • Description mechanical Fastening methods • Description of tools, materials and equipment for mechanical fastening • Description of advantages, disadvantages and applications for mechanical fastening • Description of properties of materials	• Apply safety and security measures at the workplace • Selecting tools, materials and equipment • Adjusting mechanical fastening tools and equipment	• Being attentive for applying safety and security measures • Have critical thinking for Selecting tools, materials and equipment • Being Time manager for Adjusting mechanical fastening tools and equipment

Duration: 8 hrs

Learning outcome 1 objectives:

By the end of the learning outcome, the trainees will be able to:

1. Define properly key terms as used in mechanical fastening.
2. Describe clearly fastening methods in mechanical fastening
3. Explain properly the advantages and disadvantages of mechanical fastening
4. Apply correctly the safety measures in mechanical fastening.
5. Select properly tools, materials and equipment as used in Mechanical fastening
6. Conduct correctly the adjustment of tools and equipment in pre-operation activities

Resources

Equipment	Tools	Materials
• PPE (Overall, safety boot, hand grooves, eyes goggles, ear muffs, cups) • Drilling machine • Riveting machine • Compressor • Tightening machine • Bolting machine • Hydraulic press • Bench vice	• Clamps • Mallet • Hand saw • File, pencil • Marking gauge • Try square • Taps • Dies, • Wrenches, • Drill bit • spanners • Allen key • Screw drivers	• Nuts • Bolts • Screws • Washers • Keys • Studs • Rivets • Anchors • Nails • Inserts • Retaining rings, • Clevis pins and cotter pins, drill bits • Water • Soap

Indicative content 1.1: Introduction to Mechanical Fastening

Duration: 3 hrs

Theoretical Activity 1.1.1: Description of key terms used in mechanical fastening.

Tasks:

1: You are requested to answer the following mechanical fastening terms:

- ✓ Fastening
- ✓ Riveting
- ✓ Seaming
- ✓ Bolting
- ✓ Screwing

2: Provide the answer for the asked questions and write them on papers or flipchart.

3: Present the findings/answers to the classmate or trainer

4: For more clarification, read the key readings 1.1.1. and ask questions where necessary.

Key readings 1.1.1.: Description of key terms used in mechanical fastening.

Understanding the definitions of key terms helps clarify the specific processes and techniques involved in joining components together using mechanical means.

Here are definitions of key terms used in mechanical fastening:

- ✓ **Fastening:** Fastening refers to the process of joining or securing two or more components together either permanently or non-permanently by using mechanical means. It involves the use of various methods and techniques, such as riveting, seaming, bolting, or screw into create a secure and reliable connection between the components. Fastening is temporary or permanent joining process that employs additional elements to mechanically assemble or attach two or more parts together. Additional mechanical elements that are used for fastening is called fasteners.
- ✓ **Riveting:** Riveting is a fastening method that involves joining two or more components by inserting a rivet through aligned holes and deforming the end(s) to form a permanent head(s). The deformed rivet creates a strong and secure connection, commonly used in applications where high strength and vibration resistance are required. In this process, the metallic parts to be joined do not undergo any change in their physical structure and atomic structure. However, force is required for riveting. Riveting is mostly done for low thickness sheet metal and aluminium Metal.
- ✓ **Seaming**: Seaming is a method of joining components by folding or bending overlapping edges and securing them together. It typically involves creating

interlocking or intermeshing joints, commonly used in sheet metal fabrication or closure of containers and enclosures. is a metalworking process that uses a similar process of rolling sheet metal over and onto itself, except it uses a seam to join the two layers. With seaming, the edge of sheet metal is folded but it doesn't sit flush. Rather, the two layers of the folded sheet metal are joined using a seam.

- ✓ **Bolting:** Bolting is a fastening method that uses bolts and nuts to create a connection between components. Bolts are inserted through pre-drilled holes in the components, and nuts are threaded onto the bolts to secure the joint. Bolting allows for disassembly and reassembly if required.
- ✓ **Screwing:** Screwing is a fastening method that involves using screws to join components together. Screws have helical ridges called threads that engage with corresponding threads in the receiving component. By rotating the screw, it advances into the material, creating a secure connection. Screws are commonly used for a wide range of applications due to their versatility and ease of use.

Theoretical Activity 1.1.2: Description mechanical fastening methods, the application, advantages and disadvantages of mechanical fastening.

Tasks:

1: You are requested to answer the following mechanical fastening questions:
   a) What should be the mechanical fastening methods?
   b) What do you think as the applications of mechanical fastening?
   c) What should be the advantages of fastening a mechanical product in manufacturing process?
   d) What should the disadvantages of fastening a mechanical product in manufacturing process?
2: In group, provide the answer for the asked questions and write them on papers.
3: Present the findings/answers to the whole class or trainer
4: For more clarification, read the key readings 1.1.2. and ask questions where necessary.

Key readings 1.1.2 Description of mechanical fastening methods, the application, advantages and disadvantages of mechanical fastening.

- **Mechanical fastening methods**

These fastening methods provide different options for joining components, each with its own advantages and applications. Choosing the appropriate method depends on factors such as the materials being joined, required strength, ease of assembly/disassembly, and specific industry requirements**.** Here are descriptions of mechanical fastening methods, including integral fasteners, threaded fasteners, non-threaded fasteners, and stapling.

- ✓ **Integral Fasteners:** are components designed with built-in fastening features. These features eliminate the need for separate fasteners and provide a convenient and efficient way to join components. Examples of integral fasteners include tabs, hooks, clips, or interlocking mechanisms that allow components to be easily connected or secured without the use of additional hardware.

1,2,3: exhaust and muffler hungers

4.stampings and hinges

5,7,8: wire bending parts

6.Gear lever.

✓ **Threaded Fasteners:** Threaded fasteners, such as screws, bolts, and nuts, rely on threads to create a secure connection. They consist of a threaded shaft (screw or bolt and nut, studs and insert) that engages with a threaded hole (nut or tapped hole) to join components together. Threaded fasteners offer versatility, allowing for adjustable or removable connections. They are widely used in various industries and applications due to their reliability and ease of use.

Threaded screw are the principal device used where assembling, disassembling and reassembling of components are required, and they are usually grouped into three main categories:

- **Bolts :** a bolt has a head on one end and threads on the other end and it is paired with a nut.

Types of bolts

- **Screws:** screws are used to join two mating parts together and similar to bolts. they have head on one end and threads on the other end. however, screws usually have long threads than bolts, also they can be made with slotted head.

Screws are sometimes divided into two sub-categories; Cap Screws and Machine Screws. Machine screws are generally smaller in size than cap screws and they are used for screwing into thin materials.

Types of screws

- **Studs:** A stud is a rod that is threaded on both ends and joins two mating parts. A nut may be used on one end.

Types of studs

- **Nuts**

It is a small block of metal or other material commonly square or hexagonal in shape. It has internal threads to receive a bolt. Bolts are mostly used with the help of nuts. According to their working position. There are several different types of nuts for use in different applications.

Types of nuts

- **Inserts**

These are the type of strong threads and are usually cylindrical in shape also known as thread bushings. They are used for many applications such as securing long-lasting connections between different materials or repairing stripped threads.

The typical application of this fastener is to distribute loads from the smaller diameter of the screw to the larger diameter of the insert

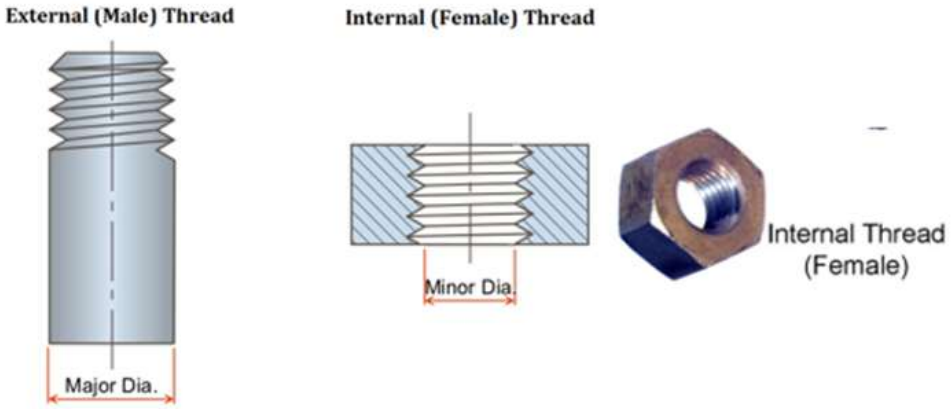
- **Type of threaded insert:**

Threaded Rod

Helicoil Threaded Inserts

Threads can be either external or internal:

- **External Thread:** External threads are on the outside of a member (such as the treads of bolts and screws). A chamfer on the end of the screw thread makes it easier to engage it into a hole or a nut.
- **An external thread is usually cut using a die**
- **Internal Thread:** Internal threads are on the inside of a member (such as the threads of nuts and holes). Usually, threaded holes have a chamfer on the side from which the screw will enter to make its engagement easier.
- **An internal thread is usually cut using a tap**



- ✓ **Non-Threaded Fasteners** are mechanical fasteners that do not rely on threads for their connection. They include various types such as rivets, pins, clips, snaps, and clamps, keys, nails, rings and washers. Non-threaded fasteners often

provide a quick and secure means of joining components, especially in applications where disassembly is not required or where high-strength and vibration resistance are needed. They are commonly used in industries such as automotive, aerospace, and construction

Common non –threaded fasteners include:

- **Keys**

A key is a machine element that connects a rotating machine element to a shaft and enables torque transmission. The key helps to prevent relative motion between two parts.

With the help of a key, the gear or pulley cannot move on their shaft but the shaft and gear or pulley move together as one unit. A key is inserted between a shaft and a wheel in the keyway.

This makes the shaft and gear or pulley (or we can use the term “wheel”) one unit. Keys are generally made of good quality steel in order to withstand (bear) the stresses

Types of keys:

- **Pins**

Pins are inserted in the holes to hold parts together. These are used to keep the components of machines in precise position or alignment.

Types of pins

Non Threaded Clevis Pin

Hair Pin Cotter Pin

Split Pin

Circle Cotter Pin

Bow Tie Cotter Pin

- **Retaining rings**

The retaining rings are types of fasteners used to hold shafts or assemblies in place. They are usually designed in different shapes. They are used in many applications in machinery

it is also used to hold the assembly together in the high-pressure fuel pump of a diesel generator. Most retaining rings are one-time use and replaced when machinery is repaired but some can be reused

Types of retaining rings

E-style Retaining Rings

External Shaft Retaining Rings

nternal Housing Retaining Rings

Bowed-E Retaining Rings

Nails

It is a small metal spike with a wide flat head, which is pushed into the wood to hold things together or used as a hook. Nails have been used since the early years and they have now become a household item.

You can easily understand the difference between a screw and a nail because a nail does not have threading on its body. The different types of nails take their names from their applications, which can help you find the right type of nail for the job you are looking for.

- **Types of nails**

Rivets

Rivets are regarded as permanent fasteners, unlike removable. Rivets are generally used to hold plates or sheet metal together.

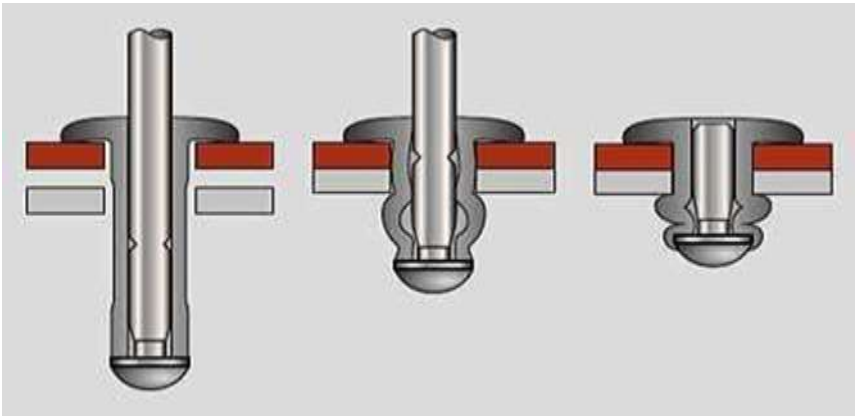
Rivets are usually made of mild steel but sometimes they are also made of brass, copper and aluminium, etc. The rivet consists of only three parts, which are the head, shank or body, and tail. Rivets are used in a very wide variety of applications ranging from aircraft structures to civil steel structures to automobiles to boats and ships to clothing, etc.

Types of rivets

There are many different types of rivets where each type is more suitable for certain types of applications. The most_common and distinct two types of rivets are the Solid rivets and the Pop rivets

Solid rivets are one of the oldest and most reliable types of rivets. They consist simply of a cylindrical shank with a single head. When the shank it is inserted inside the hole, the other end of the rivet is deformed with a hammer or rivet gun.

Pop rivets (*also called blind rivets*) are the most widely used type of rivets for general purpose applications. The installation of pop rivets is very easy and fast, and one of the major advantages of this type of rivets is that the installation does not require access to both sides of the assembly. Pop rivets are tubular and are supplied with a mandrel through the center. After the rivet is inserted into a hole drilled through the parts to be joined, a specially designed tool is used to draw the mandrel into the rivet. This expands the blind end of the rivet and then the mandrel snaps off, as illustrated in the figure. However, such rivets are not very reliable and they are not capable of supporting large loads



Washers

Washers are commonly used under the heads of bolts and screws and they are used under nuts as well

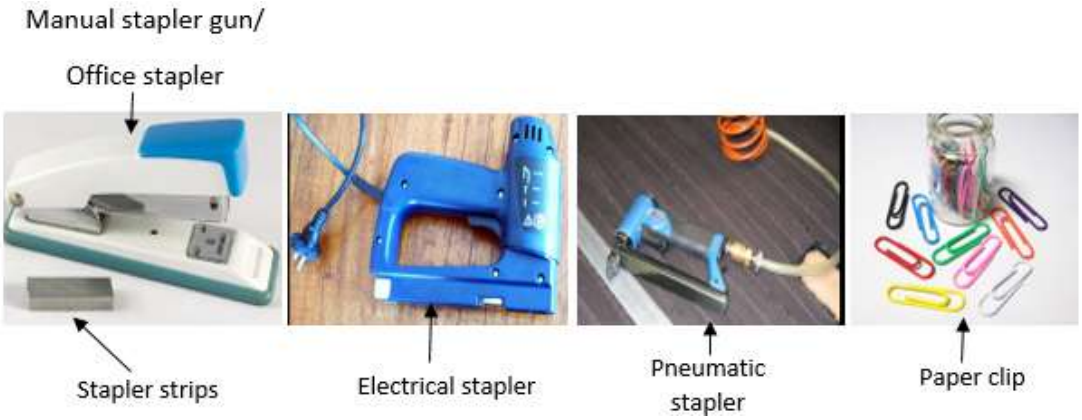
It is used to ensure the tightness of a joint, screw, etc., and make it easier to unscrew the nut and bolt and keep their threads secure

The use of washers also prevents the sharp corner of the hole into which the bolt or screw is being inserted from biting into bolt head fillet where that can cause the failure of the bolts during service

Type of washers:

- ✓ **Stapling:** is a fastening method that uses staples, typically made of metal, to secure materials together. Staplers drive the staples into the materials, creating a reliable and quick connection. Stapling is widely used in industries such as office supplies, upholstery, packaging, and construction for joining papers, fabrics, and other lightweight materials. Large staples might be used with a hammer or staple gun for masonry, roofing, corrugated boxes and other heavy-duty uses.

Some types of staplers:



- **Application of mechanical fastening**

Mechanical fastening finds application in a wide range of industries and scenarios. Some common applications include:

- ✓ **Automotive Industry:** Mechanical fastening is extensively used in the automotive industry for joining various components, such as body panels, chassis, interior trim, and engine parts. Threaded fasteners, rivets, and adhesive bonding are commonly employed to ensure structural integrity, vibration resistance, and ease of assembly.
- ✓ **Aerospace Industry:** The aerospace industry relies on mechanical fastening to secure critical components, including aircraft frames, wings, panels, and engine parts. High-strength fasteners, such as bolts, rivets, and specialty fastening systems, are used to withstand extreme loads, temperature variations, and aerodynamic forces.
- ✓ **Construction:** Mechanical fastening plays a vital role in construction projects, including building structures, bridges, and infrastructure. Fasteners are used to connect structural elements, such as beams, columns, trusses, and panels. Bolts, screws, and nails are commonly employed, ensuring stability, durability, and ease of construction.
- ✓ **Furniture and Cabinetry:** Mechanical fastening is widely used in furniture and cabinetry manufacturing. It involves joining wood, metal, or composite materials to create various furniture pieces, cabinets, and fixtures. Screws, dowels, cam locks, and adhesives are utilized to ensure secure and long-lasting connections.
- ✓ **Electronics and Electrical Assemblies:** Mechanical fastening is crucial in the assembly of electronic and electrical components, circuit boards, and enclosures. Fasteners, such as screws, bolts, and clips, are used to secure components in place, facilitate maintenance and repairs, and ensure electrical connectivity.

- ✓ **Consumer Products:** Mechanical fastening is prevalent in the production of consumer products, including appliances, toys, electronics, and sporting goods. It allows for the assembly of different components, enables disassembly for maintenance or battery replacement, and ensures product reliability and user safety.
- ✓ **Packaging:** Mechanical fastening methods, such as staples, adhesives, and interlocking tabs, are widely used in packaging and shipping applications. They secure boxes, cartons, corrugated materials, and other packaging components, ensuring product protection and safe transportation.

- **Advantages of mechanical fastening**

It is important to consider these advantages when selecting and implementing mechanical fastening methods, taking into account the specific requirements, materials, and conditions of the application.

- ✓ **Strength and Durability:** Mechanical fastening methods, such as threaded fasteners, rivets, can provide high-strength and durable connections, capable of withstanding heavy loads, vibrations, and harsh environmental conditions.
- ✓ **Versatility:** Mechanical fastening offers a wide range of options for joining different materials, including metal, plastic, wood, and composite materials. It allows for the assembly of components with varying shapes, sizes, and geometries.
- ✓ **Disassembly and Repair:** Many mechanical fastening methods allow for easy disassembly and reassembly, facilitating maintenance, repair, or component replacement. This is particularly advantageous in industries where servicing or upgrading of equipment is required.
- ✓ **Flexibility and Adjustability:** Threaded fasteners and some other mechanical fasteners provide the ability to adjust the tightness or position of the connection, allowing for fine-tuning and alignment of components during assembly or later adjustments.
- ✓ **Cost-Effective:** Mechanical fastening methods often offer cost advantages compared to other joining methods, such as welding or adhesive bonding. They generally require simpler equipment and have lower material and labor costs.
- ✓ **Lower product weight:** Several industries are now turning to lighter, more agile products to reduce manufacturing costs, improve their appearance and make objects easier to handle and use. Small screws are perfect for these items, as they meet the basic fastening requirements and lower the product's weight
- ✓ **Reduced waste:** Many products require the assembling of multiple parts and components. Fasteners enable companies to complete the process with fewer materials, which generates less waste and lowers production costs. Manufacturers only need to create small, pre-drilled holes to accommodate screws, nuts and bolts to facilitate the final assembly.

- **Disadvantages of Mechanical Fastening:**
  - ✓ **Stress Concentration:** Some mechanical fastening methods, such as drilled holes or rivet heads, can create stress concentrations in the joined components, which may weaken the structure and potentially lead to failure under certain conditions.
  - ✓ **Reduced Aesthetic:** Mechanical fasteners can create visible joints or protrusions, which may be undesirable in applications where aesthetic is important, such as in certain consumer products or architectural designs.
  - ✓ **Assembly Time:** Depending on the complexity of the assembly and the number of fasteners required, mechanical fastening methods can be time-consuming, requiring careful alignment and tightening of multiple components.
  - ✓ **Surface Preparation and Compatibility:** Mechanical fastening may require proper surface preparation, including cleaning, deburring, or pre-drilling of holes, to ensure optimal performance. In some cases, compatibility issues between different materials being joined may need to be addressed.
  - ✓ **Fatigue and Corrosion:** Mechanical fastening connections can be prone to fatigue failure over time due to cyclic loading. Additionally, if not properly designed or protected, fasteners and joints can be susceptible to corrosion, which can compromise their strength and longevity.

Theoretical Activity 1.1.3: Description safety and security measures at workplace.

Tasks:

1: You are requested to answer the following questions related to the safety and security measures

a) What are the types of materials used in mechanical fastening works according to your concern?

b) What are the types and uses of tools used in mechanical fastening works according to your concern?

c) What are the types and uses of equipment used in mechanical fastening works according to your concern?

2: Provide the answer for the asked questions and write them on papers.

3: Present the findings/answers to the whole class

4: For more clarification, read the key readings 1.1.3. In addition, ask questions where necessary.

Key readings 1.1.3: Description of safety and security measures at workplace.

While mechanical fastening is generally considered as safe and reliable method, there are still potential hazards associated with these processes, Identifying and addressing these hazards is critical to maintaining a safe and healthy work environment. Here are some types of hazards in mechanical fastening:

- **Types of hazards**

✓ **Mechanical hazard:** are those associated with power driven machine weather automated or manually operated machines driven by manual, hydraulic or electrical power.

Examples of mechanical hazards:

- **Pinch and crush hazards** can occur when workers' body parts get caught or compressed between moving parts or during manual handling of components. Proper guarding, safe work practices, and use of appropriate PPE are important to mitigate these hazards.
- **Cutting and Tearing:** A cut occurs when a body part comes in contact with a sharp edge. The seriousness of cutting or tearing depends on how much damage is done to the skin, veins, arteries, muscles, and even bones.

- **Shearing:** Injury occurs mechanical force that acts on an area of skin in a direction parallel to the body's surface. It depends on the pressure exerted.
- **Crushing:** Injury occurs when body part is caught between two hard surfaces. that progressively move together, thereby crushing anything between them. It is mostly painful, and difficult to heal.
- **Puncturing:** Puncturing results when an object penetrates straight into the body and pulls straight out, creating a wound in the shape of the penetrating object.

✓ **Physical hazard:** A physical hazard is an agent, factor or circumstance that can cause harm with or without contact.

Examples of physical hazards

- **Noise hazards**: Power tools and equipment used in mechanical fastening processes can generate high levels of noise, potentially causing hearing damage or stress-related health issues if adequate hearing protection is not used.
- **Sharp object hazards** are prevalent when handling fasteners such as screws, bolts, or rivets. Workers should exercise caution to avoid cuts, punctures, or injuries caused by contact with sharp edges.
- **Heat and fire hazards** can arise from fastening methods like welding or torch brazing. Proper fire prevention measures, fire extinguisher availability, and adherence to safety protocols are essential to prevent accidents and fires.
- **Slips, trips, and falls** can occur due to cluttered work areas, improper storage, or slippery surfaces. Maintain a clean and organized workplace, use appropriate footwear, and address potential tripping hazards to prevent such accidents.
- **Flying debris hazards** can result from drilling, riveting, or other fastening processes. Workers should wear protective eyewear and use shields or barriers to prevent injuries from flying particles or debris.
- **Tool and equipment hazards** can include electric shock, cuts, or impact injuries. Workers should receive proper training on tool usage, perform regular maintenance checks, and follow safety procedures to prevent accidents.

✓ **Ergonomic hazards** can arise from poor work posture, repetitive motions, or excessive force exertion during fastening tasks. Implementing ergonomic practices, providing ergonomic tools, and promoting regular breaks and stretching can help reduce the risk of musculoskeletal disorders.

✓ **Chemical hazards** may be present when using adhesives, sealants, or coatings during mechanical fastening. Ensure proper ventilation, use appropriate personal protective equipment, and follow material safety data sheets (MSDS) to minimize exposure risks.

- ✓ **Electrical hazards** may arise from powered tools or machinery used in fastening operations. Ensure electrical safety through proper grounding, inspection of cords and plugs, and adherence to electrical safety regulations.

- **Safety equipment**

When working with mechanical fastening tools and equipment, it's important to wear appropriate personal protective equipment (PPEs) to protect yourself from potential hazards. Here's a guide on how to wear PPPEs while working with mechanical fastening:

- ✓ **Personal Protective equipment (PPEs)**

Eye and Face Protection:

- ➢ **Safety Glasses:** Wear safety glasses with side shields or goggles to protect your eyes from flying debris, blowing dust, blowing particles, metal shavings, or sparks generated during fastening operations. Ensure they fit securely and provide proper coverage.
- ➢ **Face Shield:** For additional protection, especially when using high-impact fastening tools, consider wearing a face shield in combination with safety glasses. Face shields provide full-face coverage and protect against larger projectiles.

Hand Protection:

Work Gloves: Choose gloves that are suitable for the specific fastening task. Depending on the hazards involved, opt for gloves that offer cut resistance, impact protection, or dexterity, as required. Ensure they fit properly and allow for proper grip and finger movement.

you can choose gloves for different applications:

- ➢ Protection against cuts by sharp materials
- ➢ Protection against vibrations
- ➢ Protection against cold or heat
- ➢ Protection against biohazard risks
- ➢ Protection against chemicals hazards
- ➢ Protection against electrical hazards

Hearing Protection:

Earplugs or Earmuffs: When working with loud mechanical fastening tools, such as impact wrenches or nail guns, wear hearing protection to prevent hearing damage.

Use disposable earplugs or earmuffs that provide sufficient noise reduction. Ensure they fit well and seal the ears properly.

Safety hearing equipment protects ears against:

- Loud tools and machinery
- Poorly maintained equipment

Body protection

Clothing:

Long-Sleeved Shirt or Coveralls: Wear a long-sleeved shirt or coveralls to protect your arms and body from potential scratches, abrasions, or contact with sharp fasteners. Choose clothing made of durable and non-flammable materials that can withstand the hazards of the work environment.

Pants or Protective Leggings: Wear long pants made of heavy-duty fabric to protect your legs from potential injury. Consider wearing protective leggings or knee pads if kneeling or working in close proximity to fastening activities

Types of clothing used for body protection include:

- conventional and disposable overalls,
- suits, aprons,
- high-visibility clothing.

Overall apron

Safety overall or safety apron protect body against:

- Heat
- Fire
- Burn
- Radiation
- Excessive temperature
- spray from spray guns,
- impact or penetration,
- contaminated dust.

- **Foot protection**

Foot shoes or boots:

Safety Shoes or Boots: Wear safety shoes or boots with steel toes or composite toe caps to protect your feet from falling objects, heavy fasteners, wet surface, slippery surface, hot surface or accidental impacts. Choose footwear that is slip-resistant, durable, and suitable for the specific work environment

Safety boot/foot shoes protect feet against:

- Falling objects
- Rolling objects
- Sharp and heavy objects
- Wet surface

- Slippery surfaces
- Hot surfaces
- Uneven surfaces
- Electrical hazards
- Biohazards
- Chemical hazards

✓ **Another safety equipment is**: **Fire extinguisher:**

Fire extinguisher is a hand-held active fire protection device usually filled with a dry or wet chemical used to control small fires. To keep fire extinguisher at the workplace is required by low in many states, so it's important to make sure you have the right type of fire extinguishers on hand to put out the common workplace fires.

Using a fire extinguisher involves following a specific process to ensure its effective operation. Here's a detailed step-by-step guide on how to use a fire extinguisher:

- **Assess the fire:**
  - Evaluate the size and nature of the fire. If the fire is spreading rapidly, already large, or poses a threat to your safety, evacuate immediately and call the emergency services.
  - Ensure you have an escape route behind you in case the fire becomes uncontrollable.
- **Types of fire:**
  - **Class A:** Ordinary combustible materials such as wood, paper, or fabric.
  - **Class B:** Flammable liquids like gasoline, diesel, petrol, oil, or solvents.
  - **Class C:** Electrical fires involving energized equipment. (flammable gases such as butane, propane, methane, hydrogen etc.
  - **Class D:** Flammable metals like magnesium, titanium, potassium, etc.
  - **Class F:** Cooking oils such as olive oil, sunflower oil, butter etc.
- **Types of fire extinguisher:**
  - Water type fire extinguisher

Suitable for class Flammable materials (Class A fire)

Cannot be used on:

- Burning fat or oil (Class F fire)
- Burning metals (Class D Fire)
- Burning liquid (Class B fire)
- Electrical appliance fire

  - Dry powder type fire extinguisher

    Suitable for class A, B and C fires
  - Foam type fire extinguisher

    Suitable for class A and B Fires

Cannot be used on:

- Kitchen fires

- Flammable metals
- Fire involving electrical equipment

➢ CO2 type fire extinguisher.

Do not use on:

- Flammable materials (class A fire)
- Flammable metal (class D fire)
- Confined space

➢ Wet chemical type fire extinguisher
Designed on class fire F and A

Most fire extinguishers operate using the P.A.S.S. technique:

P. Pull the pin on the fire extinguisher in order to break the tamper seal.

A. Aim the fire extinguisher low, with the nozzle pointed at the base of the fire.

S. Squeeze the handle of the fire extinguisher to release the extinguishing agent.

S. Sweep the nozzle from side to side while pointed at the base of the fire until it is extinguished

- Identification of safety and security measures at workplace Safety and security measures at a mechanical fastening workplace are crucial to ensure the well-being of workers and the integrity of the processes. Here are some additional key measures that should be identified and implemented:

  ➢ **Training and Education:** Ensure that workers receive comprehensive training on safe work practices, including proper handling of tools and equipment, understanding the risks associated with mechanical fastening, and following safety procedures. Regular refresher training should be conducted as needed.

  ➢ **Machine Guarding**: Install and maintain machine guards to prevent access to moving parts and minimize the risk of entanglement or contact with rotating components. Guards should be designed to allow safe operation and routine maintenance while providing adequate protection.

  ➢ **Tool Safety:** Promote safe tool usage by providing well-maintained and properly calibrated tools and equipment. Regular inspections and maintenance should be conducted to identify and address any potential issues. Encourage the reporting of damaged or malfunctioning tools.

  ➢ **Ergonomics:** Design workstations and provide ergonomic tools and equipment to minimize strain and injury. Consider factors such as proper height and reach, adjustable workstations, and ergonomic handles for tools to reduce the risk of musculoskeletal disorders.

- **Hazardous Material Management:** Implement proper handling, storage, and disposal procedures for hazardous materials used in mechanical fastening processes. Ensure workers are trained in handling these materials safely, and provide appropriate ventilation and personal protective equipment for working with chemicals.
- **Fire Safety:** Maintain a fire-safe workplace by implementing fire prevention measures, such as proper storage and handling of flammable materials, regular inspections of fire extinguishers, and clearly marked exit routes. Conduct regular fire drills and provide fire safety training to workers.
- **Emergency Preparedness:** Develop and communicate emergency procedures, including evacuation plans, first aid protocols, and reporting mechanisms for accidents and incidents. Ensure that emergency equipment, such as first aid kits and emergency eyewash stations, is easily accessible and regularly inspected.
- **Workplace Housekeeping**: Maintain a clean and organized work environment by regularly cleaning up debris, oil spills, and other potential hazards. Adequate lighting should be provided to ensure clear visibility of work areas.

- **Safety sign and symbols.**

Safety signs and symbols are easily recognizable graphic labels that represent the general protocol and safety instructions in either workplaces, establishments, or public spaces.
Safety signs and symbols are used to communicate important safety information and warnings to individuals in various settings.

These signs typically use a combination of colors, symbols, and text to convey their messages. There are several types of safety signs, including:

- ✓ **Warning Signs (Yellow or Amber)**:

Yellow equilateral triangle with black boundary

Yellow equilateral triangle with red boundary

White equilateral triangle with red boundary

These signs alert people to potential hazards or dangerous situations.
Examples include "Caution: Wet Floor," "Warning: High Voltage," and "Danger: No Entry."

- ✓ **Prohibition Signs (Red)**:

  Red Circle with diagonal bar

  Prohibition signs indicate actions or behaviors that are not allowed.
  Examples include "No Smoking," "No Entry," and "No Parking."

- ✓ **Mandatory Signs (Blue)**:

  Blue circle sign

  These signs instruct people to carry out a specific action or follow a particular procedure for safety.
  Examples include "Wear Eye Protection," "Wear Safety Gloves," and "Keep Out."

- ✓ **Emergency Signs (Green)**:

  Emergency signs provide information about emergency exits, first aid stations, and safety equipment.
  Examples include "Emergency Exit," "Fire Extinguisher," and "First Aid."

- ✓ **Fire Safety Signs (Red)**:

  Red square or rectangle

Square / Rectangle

These signs indicate the location of firefighting equipment and firefighting facilities.

Examples include "Fire Alarm," "Fire Hose Reel," and "Fire Assembly Point."

- ✓ **Informational Signs (White or Blue)**:

  Informational signs provide general information, directions, or guidance.

  Examples include "Restroom," "Exit," and "Office."

- ✓ **Radiation Signs (Magenta or Yellow)**:

  These signs warn about the presence of ionizing radiation sources.

Practical Activity 1.1.4: Applying safety and security measures at workplace

Task:

You are requested to go to the manufacturing workshop to apply safety and security measures required for fastening steel table by rivets of 30*40cm

1: Select all requirements needed to apply safety equipment (PPEs, fire extinguisher) safety measures at workplace and sign and symbols.
2: Apply safety equipment, safety measures, safety sign and symbols required during mechanical fastening operation.
3: Present your work to the trainer or whole class
4: Read the key reading 1.1.4.
5: Perform the task provided in application of learning 1.1

Key readings 1.1.4: Applying safety and security measures at workplace

Applying safety equipment and security measures in mechanical fastening operation.

To be better being able to control hazards at workplace you have to follow the following steps

Step1: Selecting appropriate PPEs

Step2: wearing PPEs correctly

Step3: selecting appropriate type of fire extinguisher based on the identified class of fire.

Step4: Use PASS methods

P. Pull the pin on the fire extinguisher in order to break the tamper seal.

A. Aim the fire extinguisher low, with the nozzle pointed at the base of the fire.

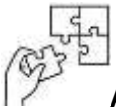
S. Squeeze the handle of the fire extinguisher to release the extinguishing agent.

S. Sweep the nozzle from side to side while pointed at the base of the fire until it is extinguished

Step5: Selecting the safety sign and symbols and fix it in the appropriate location.

Points to Remember

- Remove safety pin when using fire extinguisher
- Safety and sign symbol placed in place where are more visible due to assigned purpose



Application of learning 1.1.

In your school workshop, a mechanical fastening team is preparing to fabricate steel table of 30*40 by using rivets. The mechanical fastening team want to apply the safety and security measures required for fastening table by rivets . Ask trainees to:

i. Allocate fire extinguisher
ii. Allocate safety sign and symbols
iii. Prepare required PPE
iv. Arrange materials, tools and equipment at workplace
v. Prepare first aid kits

Indicative content 1.2: Identification of Mechanical Fastening Materials, Tools and Equipment

Duration: 3 hrs

Theoretical Activity 1.2.1: description of materials, tools and equipment

Tasks:

1: You are requested to answer the following questions concerning to tools materials and equipment used in mechanical fastening.
   a) What are the types of materials used in mechanical fastening works according to your concern?
   b) What are the types and uses of tools used in mechanical fastening works according to your concern?
   c) What are the types and uses of equipment used in mechanical fastening works according to your concern?
   d)
2: Provide the answer for the asked questions and write them on papers.
3: Present the findings/answers to the whole class.
4: For more clarification, read the key readings 1.2.1. In addition, ask questions where necessary.

Key readings 1.2.1.: Description of tools, materials and equipment used in mechanical fastening.

- **Materials used in mechanical fastening**

In mechanical fastening, various materials are used to create secure and reliable connections between components or structures. The choice of materials depends on factors such as the application, load requirements, environmental conditions, and desired properties.

✓ **Material properties.**

The properties of the materials play a big role to determining the strength, reliability, and durability of the fastened joint.

Mechanical properties:

➢ **Strength:** The strength of the materials used in fastening determines the load-carrying capacity of the joint. It is important to select materials with sufficient

strength to withstand the applied forces and prevent failure or loosening of the fastened joint.

- **Hardness:** The hardness of the materials affects their resistance to deformation, wear, and damage during the fastening process. Harder materials are typically more resistant to indentation and provide better load-bearing capabilities.
- **Corrosion Resistance:** Corrosion resistance is crucial, especially when fastening materials that are exposed to environmental conditions or corrosive substances. Materials with high corrosion resistance, such as stainless steel or certain coatings, help prevent degradation and maintain the integrity of the fastened joint over time.
- **Ductility**: Ductility refers to the ability of a material to deform plastically without breaking. In certain fastening applications, materials with higher ductility, such as certain types of steel or aluminum alloys, are preferred to accommodate any slight movement or dynamic loads.
- **Thermal Expansion:** The coefficient of thermal expansion of the materials used in fastening should be considered, especially in applications where temperature variations occur. Matching the thermal expansion characteristics of the joined materials helps to minimize stress, distortion, or loosening of the fastened joint due to temperature changes.
- **Electrical Conductivity or Insulation:** Depending on the specific application, the electrical conductivity or insulation properties of the materials used in fastening may be important. Conductive materials may be desired for electrical grounding or connectivity, while insulating materials may be necessary to prevent electrical contact or interference.
- **Compatibility:** Compatibility between the materials being fastened is critical to ensure a reliable joint. Materials with similar properties and coefficients of expansion are often preferred to minimize the risk of differential movement, stress concentrations, or galvanic corrosion.
- **Environmental Resistance:** Consideration should be given to the environmental conditions the fastened joint will be exposed to. Materials should be selected to withstand factors such as moisture, chemicals, UV exposure, or extreme temperatures, ensuring the long-term performance and durability of the fastening connection.
- **Fusibility:** the characteristic of becoming liquid when a metal is heated.
- **Toughness:** this enables the material to be bent or twisted to resist to shock without breaking.
- **Malleability:** is a property of a material by which it can be beaten to form thin sheets. Most metals are malleable. Examples of malleable metals are zinc, iron, aluminium, copper, gold, and silver.

- **Elasticity:** is the ability of a metal to go back to its original shape or size after being stretched, compressed or deformed, as in spring for example.
- **Brittleness:** the property of materials that fractures when subjected to stress but has a little deformation, poor capacity to resist to resist impact and vibration of load, high compressive strength and low tensile strength.

Physical properties of materials:

Physical properties are those that can be observed without changing the composition of the material. For example, some of the most important physical properties of metals are

- Density
- Color
- Size and shape
- Specific gravity of the material

- **Tools used in mechanical fastening**

There are various tools used in mechanical fastening, depending on the specific fastening method and application. It's important to select the appropriate tools for the specific fastening task, ensuring they are in good working condition and used safely according to the manufacturer's instructions. Additionally, proper training and understanding of the tools' limitations are essential to ensure accurate and secure mechanical fastening. The tools are grouped into some groups according to their work.

There are:

✓ **Threading tools**

Threading tools are also known from other name such as threading tape and dies. the threading tools are basically metal cutting tools these tools are used for making a thread on the workpiece.in order to use treading tools they must be mounted on the head mill. other type of threading tools such as threading heads, threading mill cutter and thread cutting abrasive are also widely in use these days.

Types of Thread Taps / Types of Tapping Tools

There are a variety of threading taps, including hand taps, plug taps, spiral point taps, power taps, just to name a few.

Hand Taps: (Types of Thread Taps)

Hand taps are a universal type of threading tools which are found in the market (**local hardware stores**). Despite the fact that these hand taps are so widely used, they are not generally used for CNC operations. Hand taps are said to be one of the cheapest threading tools available because they give satisfactory performance at a reasonably low investment.

Here are same types of hand taps:

- **Taper Taps**

Taper taps are ideal tools for thread cutting. It is accompanied by a various type of tapers in order to simplify the threading cutting operation. There wide availability is their big advantage.

Taper Taps

- **Bottoming Taps**

Bottoming taps are not fabricated with a narrowing end because it is primarily for threading the base of its reach. The threading achieved with bottoming tap is best suited for threading blind holes. However, it should be taken care that the hole should be threaded with the taper tap first and then the bottoming tap should be used on it.

Bottoming Taps

- **Pipe Taps:**

Pipe taps are explicitly used for manufacturing pipe threads. They usually come in both tapered pipe taps and straight pipe taps. Straight pipe taps are employed the pipe thread is required to be straight whereas tapered pipe taps are used when you want the pipe thread to be tapered

- **Plug Taps:**

Plug taps are tapered with a thread count of 3-5. Taper taps normally have more threads as compared to the bottoming taps. One must know that the bottoming tap is occasionally referred to as the plug tap in some places. Plug taps are sometimes also known as the second tap. This means that they are often applied afterwards.

- **Forming Taps:**

Forming type is entirely distinct from other types of taps. Forming taps compels the displacement of metal into thread shape after being twisted into the hole in spite of cutting metal from the sides of the hole like the general cutting taps. Forming taps can be used only for malleable metals like aluminium or mild steel. Due to this reason the threads formed by forming taps are strong and tough as compared to the threads which are formed by cutting

- **Spiral Flute Taps:**

Spiral flute taps closely resemble the end mills because of the open spirals. Spiral flutes are used for emitting chips out of the hole. Spiral flute taps are especially helpful while working with blind holes. Also, the spiral flute taps can be easily controlled, which makes them perfect for holes with interruptions. In comparison with the hand taps the spiral flute taps are essentially handier despite there are attributes that overlap.

- **Extension Taps:**

This type of tap has extended hanks. Such design is explicitly for the objective of allowing reach to holes that are very deep. Because of the nature of these taps, extension taps are also known as the long shark taps.

- **Interrupted Thread Taps:**

For an interrupted thread tap, a tooth is present for every other thread. The extraction of chips is conducted very smoothly owing to its unique design. Also, interrupted thread taps are quite alike the power taps because both of them permit chips to exit very easily.

- **Threading Die:**

Threading die (also known as thread cutting die) is a tool used to cut external threads on cylindrical or tapered surfaces. They are made of HSS or hardened tool steel and have sharp internal cutting edges.

Types of threading dies:

There are basically 2 types of threading dies.

Solid dies (or hand operated dies)

Self-opening dies

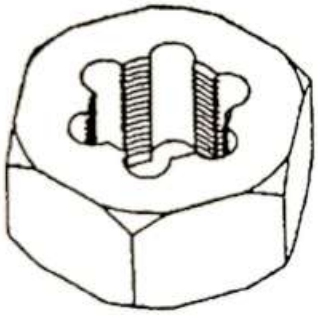
Let's see each of these threading dies one by one.

Solid dies (or hand operated dies)

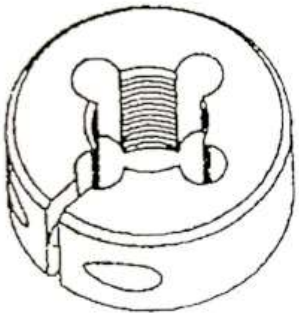
The solid dies are classified as;

- Fixed die (or Solid die)
- Adjustable die (or Spring die)
- Split die
- Pipe die

Solid die: Solid die is generally used for cutting threads that have small pitch and small diameter.

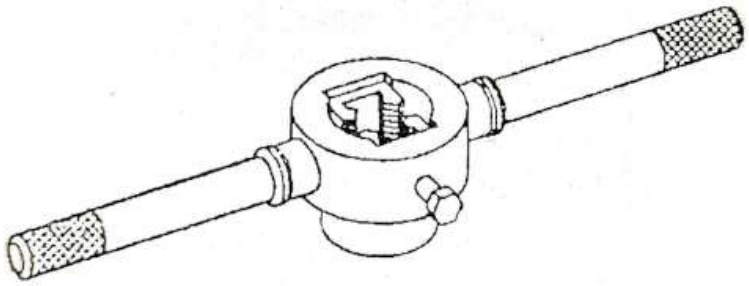


Spring die: Spring die consists of a die ring with a slit which enables slight reduction in bore and so it can cut the thread with lesser force on the hands.



Split die: Spilt die is made into two pieces. One part of the split die is fixed and the other part is movable. The movable part is adjustable within the cavity of the handle so that it can cut relatively larger and fine threads.

Pipe die: Pipe die is used to make threads on pipes that have a large diameter but small pitch. This is performed by manual rotation of the wrench which has a die fitted in it.



The solid dies are easy to use and they can be used even by a semi-skilled worker.

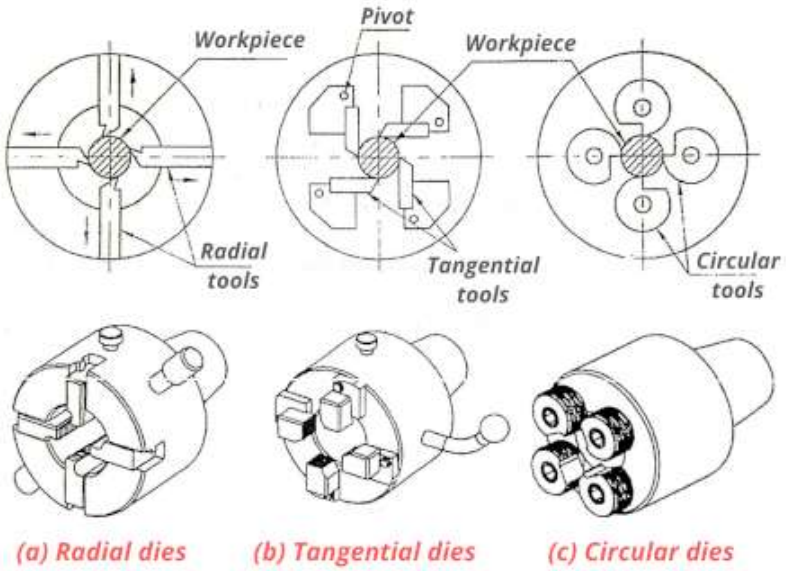
But the disadvantage of solid die is that it must be unscrewed from the work piece to disengage the work piece and die. Thus, these dies are not suitable for high-speed thread cutting operations.

Self-opening dies

The self-opening dies are the type of dies that open automatically on disengaging from the work piece. Hence self-opening dies are widely used on turret lathes, screw machines and other special types of threads.

There are 3 types of self-opening dies;

- Radial chaser type
- Tangential chaser type
- Circular chaser type



All these 3 types of self-opening dies consist of four sets of chasers (i.e multi point adjustable cutters). These multipoint cutters can also be removed for sharpening as well as replacing them for different thread sizes. In turret lathes, the self-opening dies are mounted in the turret and then the turret is moved towards the rotating work piece. When the thread cutting operation is done, the die disengage automatically and freely returns back from the work piece.If you are using a self-opening die for thread cutting, then there is no need for reverse rotation for its removal.

- ✓ **Drilling tools:**

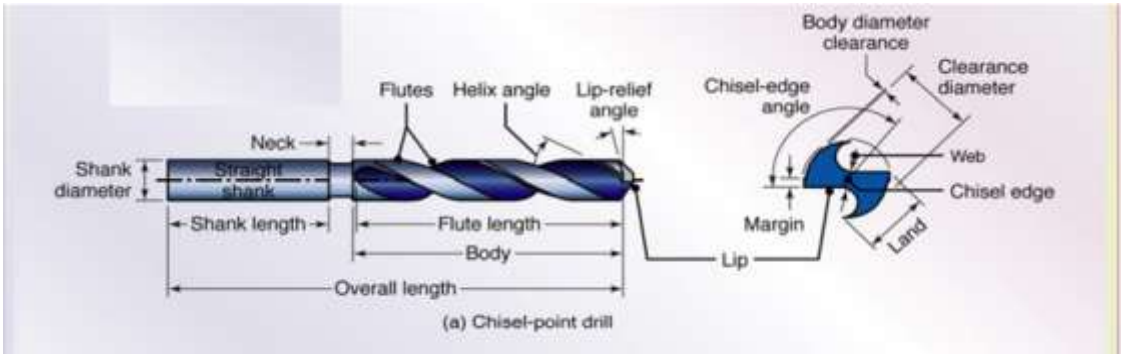
In the context of mechanical fastening, a drilling tool is a specialized tool used to create holes or openings in materials, such as metal, wood, or plastic, in preparation for inserting fasteners like screws, bolts, rivets, or nails. These holes are necessary for securely attaching one material to another or joining different components together.

Drilling tools are also known as drill bit, they are classified into different types:

- ➢ Flat Drill bit
- ➢ Straight fluted drill bit
- ➢ Twist drill bit
- ➢ Centre drill bit

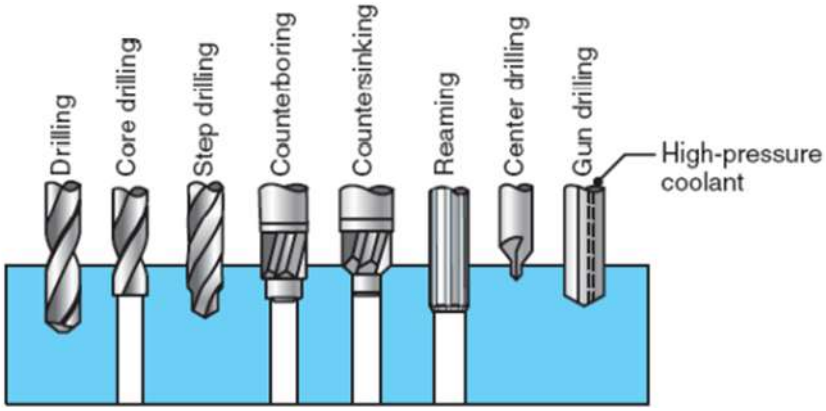
The most widely employed drilling tool is the twist drill which is available in diameters ranging 0.25 to 80 mm. Twist drill bits are the type generally used in shop work. They are made of High-speed steel (HSS) or High carbon steel. There are two types of twist drills namely (i) **Straight shank twist drill** and (ii) **Taper shank twist drill Bit**. The diameter of the

straight shank drill bit ranges from 2 to 16mm. Taper shanks is provided on drill bits of larger diameter.



i)straight shank twist drill

Note only twist drill exist, other drill-point geometries have been developed to improve drill performance and increase the penetration rate.

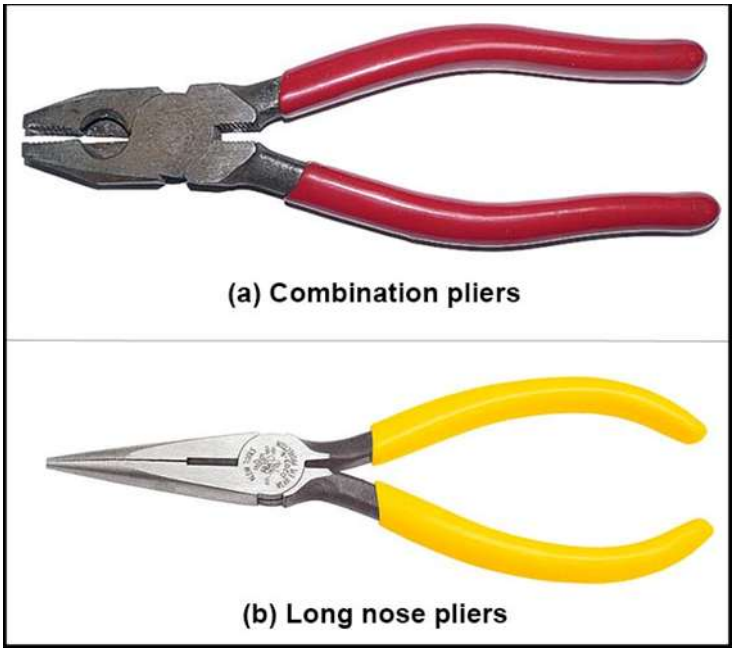


- ✓ **Tightening tools**

Tightening and loosing tools are hand tools with fixed or variable openings used for tightening and loosing nuts and bolts and for assembling and disassembling objects.

- **Pliers**

Pliers are namely ordinary needle noses and particular types of hand tools used to hold objects tightly. These are commonly used by fitters and electricians for holding wires and hot metals. Pliers are also helpful for bending and compressing a wide range of materials.



(a) Combination pliers

(b) Long nose pliers

- **Screwdrivers**

A screwdriver is a screw tightening tool. Screwdrivers are the most commonly used variety of screwdrivers shown in Fig. 2. They are generally used by hand for tightening the screws. A simple screwdriver has a handle, a shank, and a tip that the user inserts into the screw head to turn it.

Basic Screwdriver

It is also called flat blade or flathead screwdriver.

Phillips Head Screwdriver

- **Wrenches**

Wrenches are, commonly known as spanners, are used to provide grip in applying torque to turn objects, usually rotary fasteners, such as nuts and bolts, or keep both of them from turning. These generally come in sets and are commonly identified by size numbers. These

are of various types and a few general types involve open single-ended, open double-ended, closed-ended adjustable, ring spanner, offset socket, t-socket, box wrench, pipe wrench and Allen wrench.

Adjustable wrench

Combination (open and box) wrench

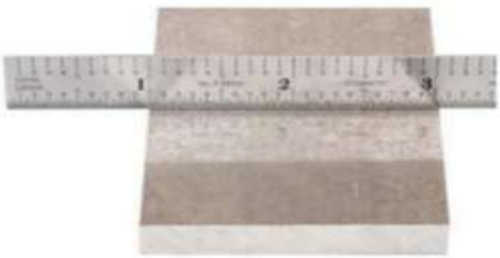
✓ **Measuring tools**

In the context of mechanical fastening, measuring tools are instruments or devices used to determine and verify various dimensions and parameters related to fasteners, materials, and the fastening process. These tools play a crucial role in ensuring the correct installation and performance of fasteners in mechanical assemblies.

- **Steel Ruler:**

A steel ruler is a straight-edged measuring tool made of stainless steel or other types of steel. It is designed for precision measurement of lengths, distances, and dimensions in various applications, particularly in fields where accuracy is crucial, such as engineering, drafting, architecture, and manufacturing.

For making marking out, measuring is required in short lengths; the steel rule is given preference in metalworking. It is handier and its graduation is precise than steel tape rule. The simplest length measuring tools are steel rule and steel tape rule. The steel rule (fig. below) has a length of 300 mm or 500mm. Some people confuse rules and scales. A scale is a measuring device used by architects and engineers that assists them in making drawings to a scale other than full size. A rule is used to measure actual sizes.

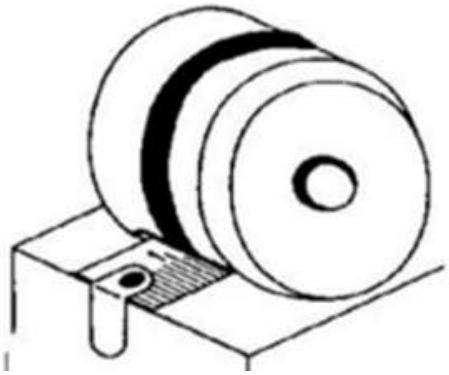


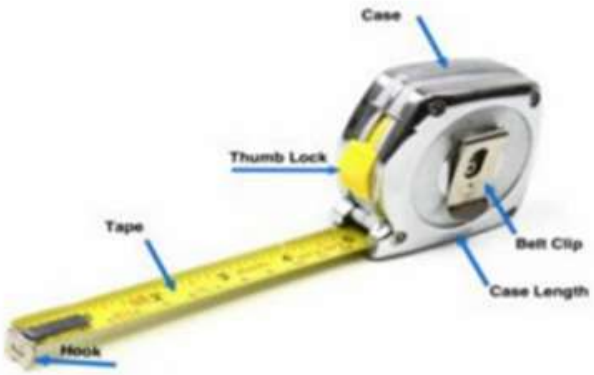
- **Tape measure:**

A tape measure, also known as a measuring tape, is a flexible, portable, and retractable measuring tool used for measuring distances, lengths, and dimensions.

It consists of a ribbon or strip of material marked with measurement increments and a mechanism that allows it to be easily extended and retracted for measuring various objects or spaces.

Steel tape measure rules have often a small sheet-metal angle which makes it easy to apply it at the work piece edge (fig. below).



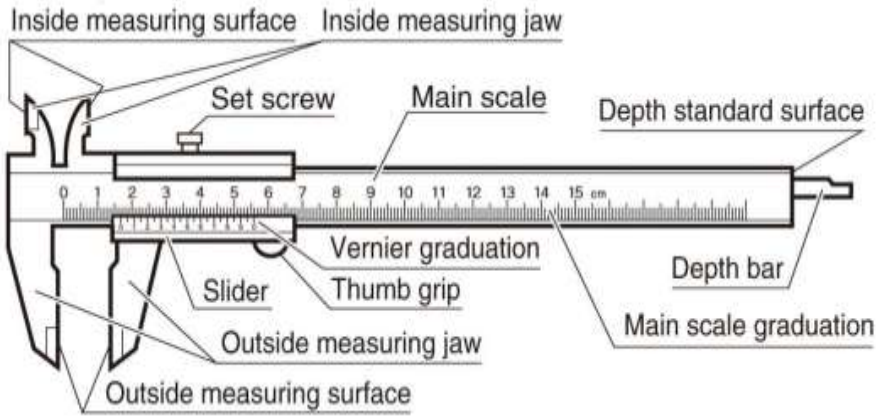


- **Vernier instruments**

A vernier instrument, often referred to as a vernier scale or vernier calliper, is a precision measuring tool used for accurately measuring lengths, dimensions, or distances with a high degree of precision. It consists of a primary scale and a secondary scale (vernier scale) that allows for precise measurements in both metric and imperial units.

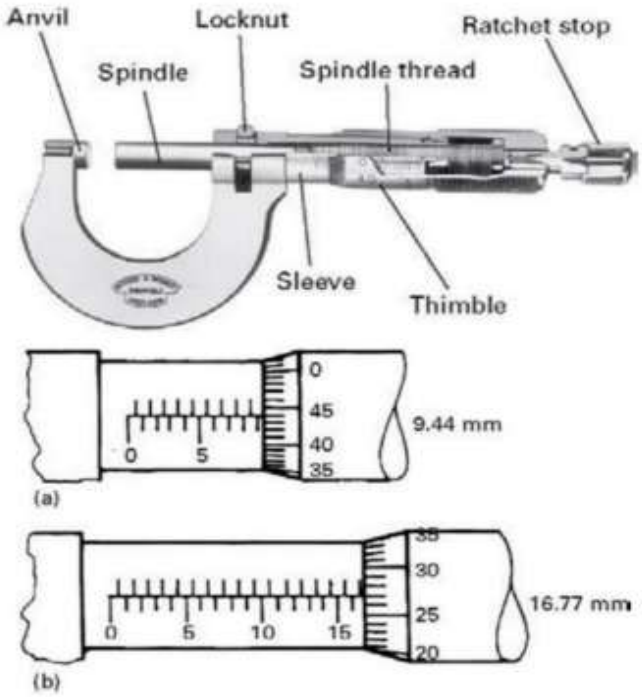
All instruments employing a Vernier consist of two scales: one moving and one fixed. The fixed scale is graduated in millimetres, every 10 divisions equalling 10mm, and is numbered 0, 1,2, 3, 4 up to the capacity of the instrument. If the two scales initially have their zeros in line and the Vernier scale is then moved so that its first graduation is lined up with a graduation on the fixed scale, the zero on the Vernier scale will have moved 0.02mm. The most common instrument using the above principle is the Vernier calliper. These instruments are capable of external, internal, step and depth measurements and are available in a range of measuring capacities from 150mm to 1000mm.

- **Vernier calliper:**



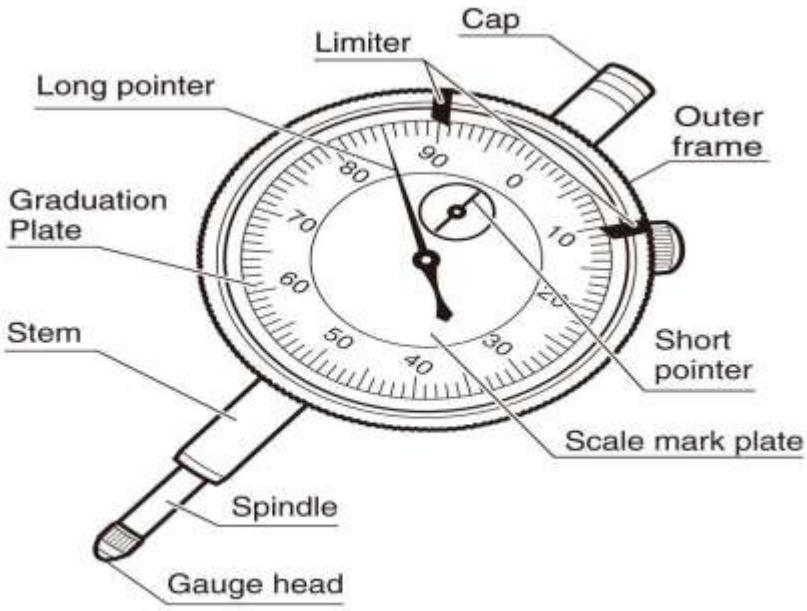
- **Micrometres**:

The micrometer is an improvement over the measurement of the vernier calliper scale discussed previously. The accuracy of vernier calliper remains to be 0.02 mm, but most of the engineering precision work demands greater accuracy with sensitivity for which an instrument having both these should be used.



2.3 Dial Indicator

Dial Indicator is the most commonly used mechanical comparator. It works on the principle of Rack and pinion system i.e.; the linear movement of the spindle is magnified by rack and pinion arrangement. It consists of a robust base whose surface is flat and a pillar supporting a bracket in which a spindle fitted with a pinion and a dial scale.



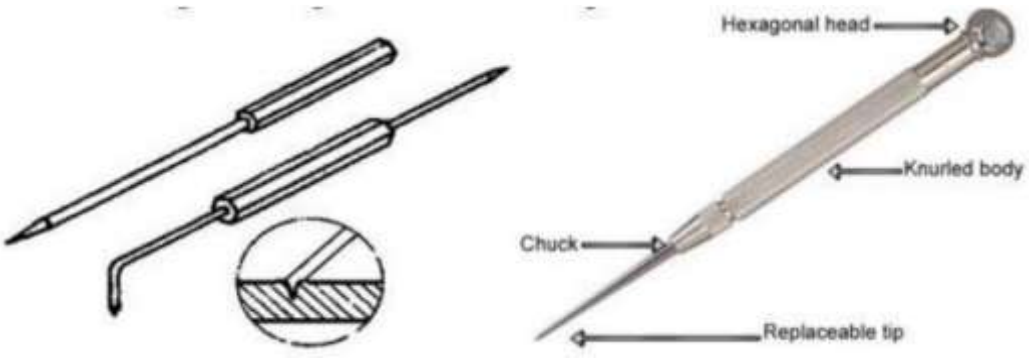
➢ **Try square**

Square: It is used for checking the straightness and the Squareness of a work piece. It can also be used for marking perpendicular lines onto a work piece.

✓ **Marking tools**

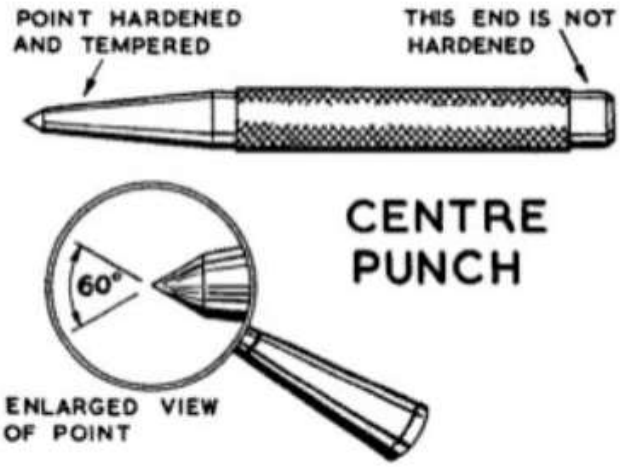
The marking tool is used to mark on a job or work piece to obtain accurate size and shape.

- **Scriber:** Scriber is the very most important marking out tools in mechanical workshop or fitting shop. This hardened tool is a sharp tool made of steel that is used to draw lines while marking on a metal job

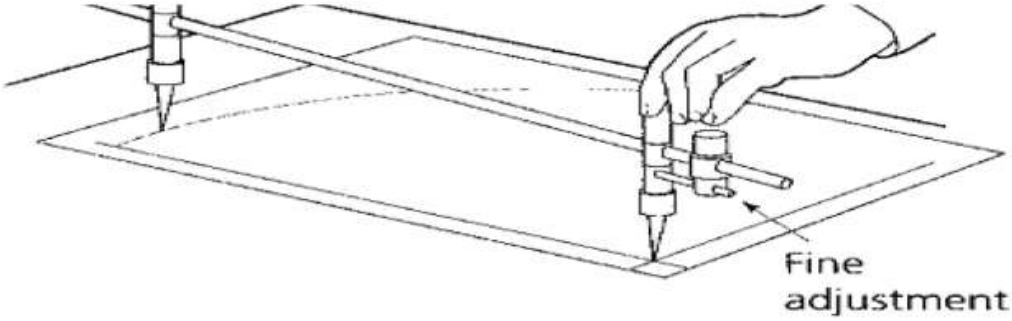


- **Divider:** This is a marking tool or marking out tools used to mark circles, segments, and other geometrical textures. It is also used to transfer textures. It is made of tool steel, and its points are hardened and tempered.

- **Center punch:** A center punch is used to mark the center of a point. It is usually used to mark the center of a hole when drilling holes. A center punch forms a large enough simple to "guide" the tip of the drill bit. Punch is used to provide a point from which a circle can be scribed by a divider or a location point for drilling a hole.



- **Trammel:** It is used to draw circles and circles with more radiuses that cannot be drawn by a divider.



✓ **Clamping tools**

Clamping tools, also known as clamps, are mechanical devices designed to hold, secure, or immobilize objects in place by applying force or pressure.

Here are examples of clamping tools:

- **Gripping pliers:** Combination pliers are heavy-duty, side-cutting pliers, also known as lineman pliers or side cutters, which are designed for all regular wire-cutting needs. They have gripping jaws, a cutting edge, and insulating handle grips that reduce (but don't eliminate) the risk of electric shock from contact with live wires.

- **Clamps:** A device designed to bind or to press two or more parts together so as to hold them firmly. And is any of various instruments or appliances having parts brought together for holding or compressing something.

C – Clamp

- **Vices:** Any of various devices, usually having two jaws that may be brought together or separated by means of a screw, lever, or the like, used to hold an object firmly while work is being done on it.

- **Equipment used in mechanical fastening**

In mechanical fastening, various types of equipment are used to facilitate and accomplish the fastening process. That equipment assists in preparing the materials, aligning the components, and applying the necessary force to secure and provide reliable connections.

- ✓ Drilling machine
- ✓ Nail gun
- ✓ Screwing machine
- ✓ Riveting machine
- ✓ Air compressor
- ✓ Bolting machine

- ✓ **Drilling machine**

Drilling machines play a crucial role in mechanical fastening processes. They are used to create holes in materials where fasteners like bolts, screws, or rivets will be inserted. Here are some ways in which drilling machines are utilized in mechanical fastening:

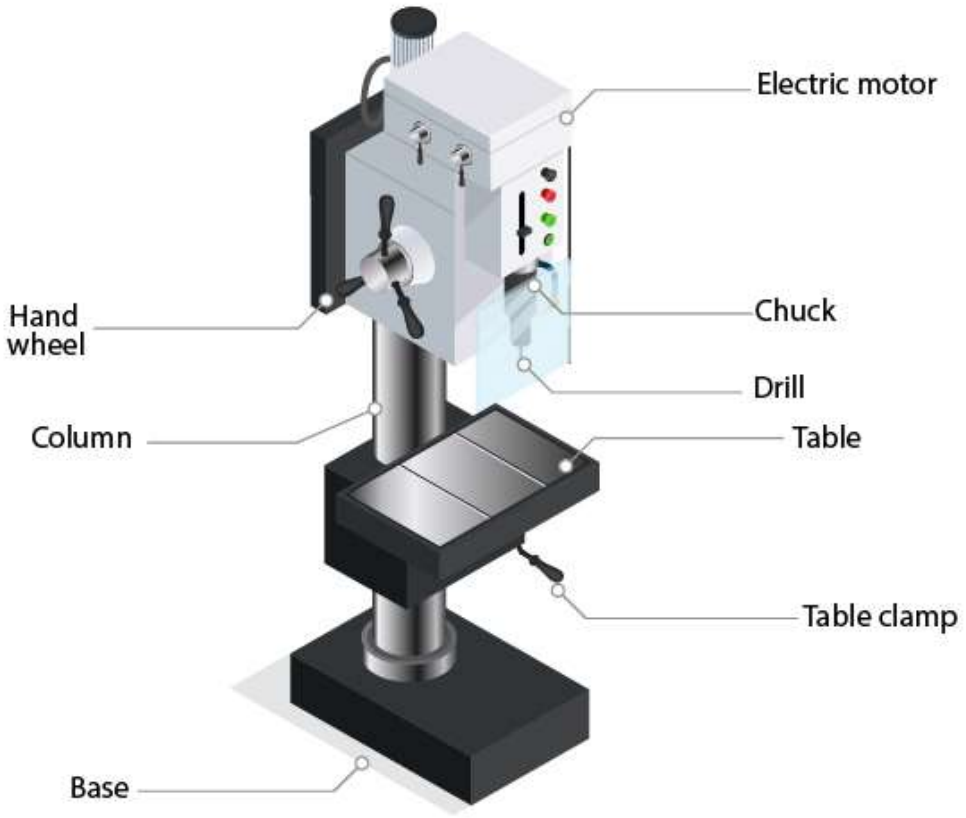
- **Hole Preparation:** Drilling machines are used to prepare holes in components or structures before inserting fasteners.

The size and depth of the hole are determined based on the specific fastener being used and the material being drilled. Properly sized and positioned holes ensure secure and reliable fastening.

- **Pilot Holes:** In certain applications, pilot holes are drilled before inserting fasteners. Pilot holes are smaller diameter holes that guide the fastener into the material and prevent splitting or damage. They are often used in woodworking or when fastening in delicate materials.
- **Clearance Holes:** In mechanical fastening, clearance holes are drilled to allow the fastener's shank or body to pass through the material easily. These holes are typically larger than the fastener diameter to accommodate any misalignment or clearance requirements.
- **Countersinking:** When using flathead screws or bolts, drilling machines can be equipped with countersinking tools. Countersinking creates a conical recess around the hole to allow the fastener head to sit flush with or below the surface of the material. This helps to prevent protrusions and allows for a smooth finish.
- **Counter boring**: Similar to countersinking, counter boring involves drilling a larger diameter hole around the fastener location. Counter boring allows the fastener head to be recessed further into the material, providing increased stability and a flush appearance.
- **Tapping:** Tapping is a process used to create internal threads in a drilled hole. Drilling machines can be equipped with tapping attachments or used in conjunction with tapping tools to create threaded holes for threaded fasteners. Tapping eliminates the need for separate nuts and provides a direct thread engagement.
- **Hole Alignment**: Drilling machines with precise positioning features, such as adjustable worktables or laser guides, aid in aligning the holes accurately for fastening. Proper alignment ensures proper fit and reduces the risk of misalignment or weakening of the joint.

Drilling machines provide the necessary capability to create holes with precision and accuracy, ensuring the effective implementation of mechanical fastening methods. They enable the proper placement and preparation of holes, allowing for secure and reliable fastening connections in various industries and applications.

Drilling Machine



✓ **Nail gun**

A nail gun, also known as a nailer or pneumatic nail gun, is a specialized tool used in mechanical fastening for driving nails into materials. It should be powered by compressed air, electricity, or gas and offers a more efficient and convenient alternative to manual hammering. Here are some key aspects of nail guns in mechanical fastening:

- **Types of Nail Guns**: There are different types of nail guns available, each designed for specific fastening applications. Common types include framing nailers, finish nailers, brad nailers, and roofing nailers. Each type is suited for different nail sizes and materials, ranging from heavy-duty construction to delicate woodworking.
- **Nail Loading:** Nail guns have a magazine or nail strip where nails are loaded for fastening. The magazine capacity can vary, and the nails are usually collated or connected together in strips, coils, or sticks, depending on the nail gun type.

- **Depth Adjustment:** Many nail guns have a depth adjustment feature that allows the user to control how far the nails are driven into the material. This ensures consistent and proper nail penetration, preventing overdriving or under driving.
- **Efficiency and Productivity**: Nail guns significantly increase the speed and efficiency of fastening operations compared to manual methods. They eliminate the need for repetitive hammering, allowing for faster installation and increased productivity on job sites.
- **Fastener Options:** Nail guns accommodate various types of nails, such as framing nails, brad nails, finish nails, and roofing nails. The nail length, gauge, and material can be selected based on the specific application and material being fastened.

✓ **Screwing machine**

Screwing machines, also known as screwdrivers or screw guns, are power tools specifically designed for mechanical fastening using screws. They provide efficient and precise driving of screws into materials. Here are some key aspects of screwing machines in mechanical fastening:

- **Types of Screwing Machines**

  There are different types of screwing machines available, each designed for specific fastening applications. Common types include handheld electric screwdrivers, cordless screwdrivers, and pneumatic screwdrivers. Each type offers different power sources and features to accommodate various fastening needs.
- **Screw Loading**: Screwing machines have a mechanism for loading screws, which can be done manually or automatically depending on the machine type. Some machines have a magazine or screw strip where screws are loaded, while others may use a screw tube or a feed system.
- **Power Source**: Screwing machines can be powered by electricity, batteries, or compressed air. Electric screwdrivers are typically corded and offer consistent power, while cordless screwdrivers provide portability and convenience. Pneumatic screwdrivers are powered by compressed air and are commonly used in industrial settings.
- **Torque Control:** Many screwing machines feature adjustable torque control, allowing the user to set the desired torque level for consistent and accurate screw fastening. This helps prevent over-tightening or stripping of screws, ensuring proper and secure connections.
- **Speed Control:** Some screwing machines offer variable speed control, allowing the user to adjust the driving speed based on the material being fastened and the screw size. This feature ensures optimal performance and reduces the risk of damaging the material or the screw.

- **Bit Compatibility**
  Screwdrivers have interchangeable bits that correspond to different screw types and sizes. Common bit types include Phillips, slotted, hex, and square drive. The bit can be changed easily to accommodate various screw fastening requirements.
- **Efficiency and Productivity**
  Screwdrivers improve the speed and efficiency of fastening operations compared to manual screw driving. They enable faster insertion and consistent driving of screws, resulting in increased productivity.

✓ **Riveting machine**

A riveting machine, also known as a riveter, is a specialized tool used in mechanical fastening for joining two or more materials together using rivets. Rivets are fasteners that consist of a cylindrical shaft with a head on one end and are commonly made of materials such as metal or plastic. Riveting machines automate the process of inserting and setting rivets, making it faster and more efficient compared to manual riveting.

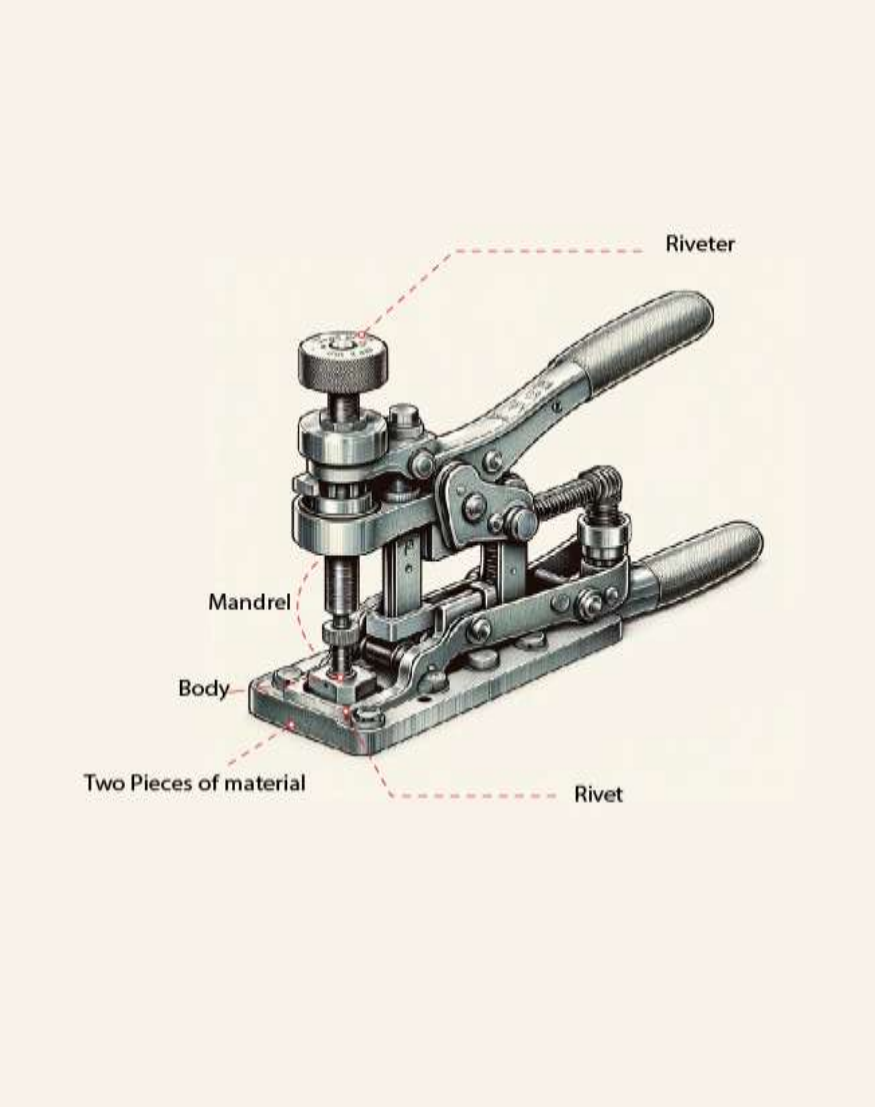
Here are some key aspects of riveting machines in mechanical fastening:

Types of Riveting Machines

There are different types of riveting machines available, each designed for specific riveting applications. Common types include pneumatic riveting machines, hydraulic riveting machines, and automated CNC riveting machines. Each type offers different power sources and features to accommodate various fastening needs.

- **Rivet Feeding Mechanism**
  Riveting machines have a mechanism for feeding rivets into the machine for insertion. This can be done manually, where the operator places the rivet into the machine, or automatically through a hopper or feeder system that supplies rivets in a continuous or intermittent manner.

- **Rivet Setting Mechanism**
  Riveting machines have a mechanism for setting or deforming the rivet to create a permanent joint. This can be achieved through various methods such as impact riveting, squeeze riveting, orbital riveting, or electromagnetic riveting, depending on the specific machine type and application.



- **Power Source**
  Riveting machines can be powered by compressed air, hydraulic systems, or electric motors. Pneumatic riveting machines are commonly used due to their compact size, high power-to-weight ratio, and ease of operation.
- **Control and Automation**
  Many riveting machines feature adjustable parameters such as rivet diameter, rivet length, setting force, and cycle time. Advanced automated CNC riveting machines offer precise control and programmability for complex riveting operations.
- **Versatility**
  Riveting machines can be used for various applications, such as joining metal sheets, fastening structural components, securing automotive parts, assembling furniture, and more. They are commonly used in industries such as automotive manufacturing, aerospace, construction, and metal fabrication.
- **Efficiency and Productivity:**

Riveting machines significantly increase the speed and efficiency of riveting operations compared to manual riveting methods. They provide consistent and reliable rivet insertion and setting, resulting in increased productivity and reduced labor costs.

- ✓ **Air compressor**

An air compressor is an essential piece of equipment used in mechanical fastening for providing compressed air power to pneumatic tools and systems. It converts electrical energy into potential energy stored in compressed air, which is then used to drive various pneumatic devices.

An air compressor is a pneumatic device that converts power (using an electric motor, diesel or gasoline engine, etc.) into potential energy stored in pressurized air (i.e., compressed air). By one of several methods, an air compressor forces more and more air into a storage tank, increasing the pressure. When the tank's pressure reaches its engineered upper limit, the air compressor shuts off. The compressed air, then, is held in the tank until called into use. The kinetic energy provided by the compressed air can be used for a variety of applications such as pneumatic to,ol as it is released air and the tank depressurizes. When tank pressure reaches its lower limit, the air compressor turns on again and re-pressurizes the tank. An air compressor must be differentiated from a pump because it works for any gas/air, while pumps work on a liquid.

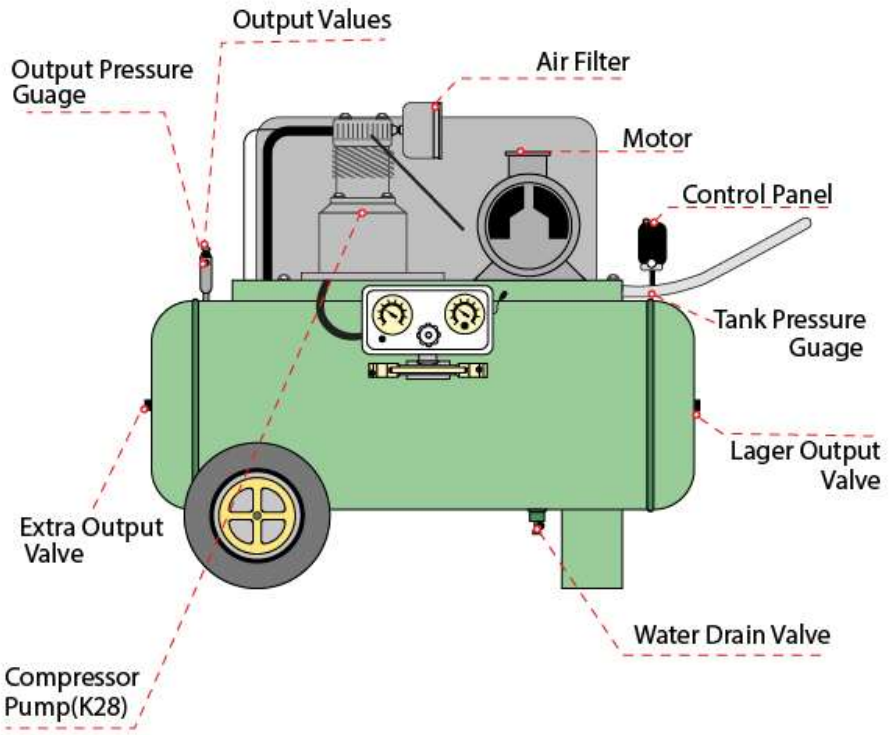
Types of Air Compressors

There are different types of air compressors available, including reciprocating air compressors, rotary screw air compressors, and centrifugal air compressors. Each type operates on different principles and offers varying capacities, efficiency, and power options.

Power Source,

Air compressors are typically powered by electricity, either from a standard electrical outlet or a dedicated power supply. Some compressors may be powered by gasoline or diesel engines for portable or remote applications.

AIR COMPRESSOR PARTS



Classification of air compressor.

- Low-pressure air compressors (LPACs), which have a discharge pressure of 150 pounds per square inch (10 bar) or less.
- Medium-pressure compressors which have a discharge pressure of 151 to 1,000 pounds per square inch (10.4 to 68.9 bar.
- High-pressure air compressors (HPACs), which have a discharge pressure above 1,000 pounds per square inch (69 bar).

✓ **Bolting machine**

A bolting machine, also known as a torque wrench or bolt tightening machine, is a specialized tool used in mechanical fastening for applying a precise amount of torque or tension to bolts or fasteners. It ensures that the bolts are tightened to the specified requirements, resulting in secure and reliable connections.

Types of Bolting Machines

There are different types of bolting machines available, each designed for specific bolting applications. Common types include hydraulic torque wrenches, pneumatic torque wrenches, electric torque wrenches, and manual torque wrenches. Each type offers different power sources and features to accommodate various bolting needs.

Torque Application

Bolting machines apply torque, which is a rotational force, to tighten or loosen bolts. They are designed to provide controlled and accurate torque application, ensuring that the bolts are tightened to the required specifications. Some bolting machines have built-in torque measurement or control systems to monitor and maintain the desired torque level.

Torque Control and Monitoring

Advanced bolting machines may have torque control and monitoring features, such as digital displays or data logging capabilities. These features enable the user to set and track the applied torque, ensuring consistent and accurate tightening results.

Versatility

Bolting machines can be used for various applications, such as assembling machinery, installing structural components, fastening flanges, and more. They are commonly used in industries such as oil and gas, power generation, manufacturing, construction, and automotive.

Practical Activity 1.2.2: Selecting tools, material and equipment used in mechanical fastening

Task:

1: You are requested to go to the workshop to select tools, materials and equipment required for fastening steel and tubes table by using rivets in mechanical fastening based on selection criteria.
2: Apply safety precautions (Wear the PPE).
3: Select tools, materials and equipment required for fastening steel and tubes table by using rivets.
4: Present your work to the trainer and whole class.
5: Read key reading 1.2.2 and ask clarification where necessary.
6: Perform the task provided in application of learning 1.2.

Key readings 1.2.2: Selecting materials, tools and equipment

The selection of tools, materials, and equipment for mechanical fastening operations is critical to the efficiency and safety of the process. Several factors influence these choices, and considering these factors is essential for successful fastening operations. Here are some key factors affecting the selection of tools, materials, and equipment for mechanical fastening:

- **Application and Purpose**:

  The specific application and purpose of the fastening operation will determine the type of fasteners, tools, and equipment needed. For example, different fasteners and tools are used for woodworking, metalworking, automotive assembly, and construction.

- **Material Compatibility**:

  The materials being joined must be compatible with the fasteners and equipment used. The choice of fasteners should match the materials being fastened to ensure a strong and durable connection.

- **Load and Stress Requirements**:

  The expected loads and stresses that the fastened joint will experience are crucial. Different applications may require fasteners and equipment capable of withstanding different levels of tension, compression, shear, or torsional forces.

- **Environment and Conditions**:

  The operating environment, including factors like temperature, humidity, exposure to chemicals, and corrosion potential, can influence the selection of materials and coatings for fasteners and equipment.

- **Size and Dimensions:**

  The size and dimensions of the components being fastened, as well as the desired appearance and aesthetics, play a role in choosing fasteners, tools, and equipment. Size, thread pitch, and length are essential considerations.

- **Accessibility and Space**:

  The workspace's size and accessibility can affect the choice of tools and equipment. In tight spaces, smaller or specialized tools may be necessary to perform the fastening operation effectively.

- **Speed and Efficiency**:

The desired speed and efficiency of the fastening operation may influence the choice of power tools, automated equipment, or manual tools. For high-production environments, speed is a critical factor.

- **Safety Requirements**:

  Safety is paramount in mechanical fastening operations. The choice of equipment and tools should align with safety standards and regulations. For example, if there are risks of pinch points or flying debris, appropriate guards and safety measures should be in place

  Considering these factors and conducting a thorough analysis of the requirements of the mechanical fastening operation will help ensure that the right tools, materials, and equipment are selected, leading to efficient and safe assembly processes.

Points to Remember

• To select tools, materials, and equipment for mechanical fastening require attentions that you can select the tools related to the task you are assigned on.
• Refer to the volume of the work and complexity

Application of learning 1.2.

In your school workshop, the fastening team want to fasten the steel and tube table of 30*40cm and height of 40 cm . Asks trainees to:

i. Select materials,
ii. Select tools
iii. Select equipment

Required for performing the activity.

Indicative content 1.3: Pre-Operation Activities for Mechanical Fastening

Duration: 2 hrs

Practical Activity 1.3.1: Adjusting mechanical fastening tools and equipment

Task:

1: you are requested to go in Manufacturing workshop and adjust equipment and tool required for fastening steel and tube table of 30*40cm and 40 cm of height by rivets.
2: Adjust tools and equipment
3: Present your work to the trainer, or whole class
4: Read the key reading 1.3.1.
5: Perform the task provided in application of learning 1.3

Key readings 1.3.1 : Adjusting mechanical fastening tools and equipment

In the context of Pre-operation activities for mechanical fastening, the term "**adjustment**" refers to the process of preparing and fine-tuning the fastening equipment, tools, and components before beginning the actual fastening procedure. These adjustments are made to ensure that all elements involved in the mechanical fastening process are set up correctly and are in the optimal condition to achieve a secure and reliable connection.

- **Importance of making adjustment before starting mechanical fastening operation.**

Adjustment before starting a mechanical fastening operation is of significant importance for several reasons:

- ✓ **Ensures Precision and Accuracy:** Pre-operation adjustment allows for the fine-tuning of tools, equipment, and components to achieve the necessary levels of precision and accuracy. This is crucial for achieving a secure and reliable fastening connection.
- ✓ **Prevents Over-Tightening and Under-Tightening:** Adjusting tools, such as torque wrenches, helps ensure that fasteners are tightened to the correct specifications. Over-tightening can lead to damage or failure of the fastener or the components being joined, while under-tightening can result in loose connections and reduced structural integrity.
- ✓ **Reduces the Risk of Component Misalignment:** Proper alignment of components is critical for fastening. Adjustments made to ensure that components fit together correctly prevent issues like misalignment, which can result in weakened connections or assembly errors.

- ✓ **Enhances Safety:** Safety is paramount in mechanical fastening operations. Pre-operation adjustments include safety checks and the calibration of safety measures, ensuring that personnel are protected from potential hazards during the fastening process.
- ✓ **Improves Product Quality:** Accurate adjustments contribute to the overall quality of the final product or assembly. High-quality fastening operations are essential for product reliability, longevity, and performance.
- ✓ **Minimizes Fastener and Component Damage:** Correctly adjusted tools and equipment reduce the risk of fastener and component damage. This is particularly important for expensive or critical components in manufacturing and construction.
- ✓ **Saves Time and Resources:** While it may seem like an extra step, Pre-operation adjustments can save time and resources in the long run. Properly adjusted equipment and tools minimize the need for rework or repairs due to fastening errors.
- ✓ **Facilitates Consistency:** Consistency in fastening operations is essential for ensuring uniform quality across multiple products or components. Adjustment procedures help maintain consistent results.
- ✓ **Reduces the Risk of Fastening Failures:** Pre-operation adjustments are an important step in preventing fastening failures, which can have serious consequences in applications like construction, automotive manufacturing, aerospace, and more.

Pre-operation adjustments in a mechanical fastening operation involve preparations and actions taken before the actual fastening process begins. These adjustments are essential to ensure that the operation proceeds smoothly, efficiently, and safely.

- **Adjustments to consider before starting a mechanical fastening operation:**

✓ **Safety Checks**:
Conduct a safety inspection of the work area, equipment, and tools. Ensure that all safety measures are in place, including personal protective equipment (PPE), machine guards, and safety interlocks.

✓ **Tool and Equipment Inspection**:
Inspect all tools, fasteners, and equipment to ensure they are in good working condition. Check for any visible damage or signs of wear and tear. Perform any necessary maintenance or repairs.

✓ **Material Inspection**:
Examine the materials to be fastened for defects, damage, or inconsistencies. Ensure that they are suitable for the application and meet quality standards.

✓ **Tool Calibration**:
Calibrate torque wrenches, power tools, or other equipment to the desired torque settings to ensure accurate and consistent fastening.

✓ **Fastener Preparation**:
Verify that the selected fasteners are clean, free of contaminants, and properly sized

for the application. If necessary, apply lubrication or anti-seize compounds to facilitate fastener installation.

- ✓ **Fastener Sorting and Organization**:
  Organize and arrange fasteners for easy access during the fastening process. This can include labeling or color-coding fasteners based on size, type, or application.
- ✓ **Environmental Controls**:
  Ensure that the work environment is at the appropriate cleanliness for easy fastening operation.
- ✓ **Workpiece Fixturing and Positioning**:
  Set up fixtures, jigs, or clamps to hold the workpiece in the correct positions and alignments to avoid misalignment or distortion during fastening.
- ✓ **Tool Ergonomics**:
  Adjust tool handles, grips, and ergonomic features to accommodate the operators' comfort and minimize fatigue during extended fastening tasks.

Points to Remember

- Adjustment helps the machine to work properly and increase the machine life
- Adjustment determines the quality and volume of work to be produced
- Follow step by Steps while adjusting tools and equipment for mechanical fastening

Application of learning 1.3.

At the start of each academic year, many general schools issue tenders for the production of durable beds to replace worn-out ones. Your school's production unit recently won such a tender.

You as trainee you are asked to adjust the fastening equipment used in bed production to ensure efficient and rapid assembly.

Learning outcome 1 end assessment

Theoretical assessment

Question1. Read carefully the following questions and circle the letter corresponding to the right answer

A. What is bolting
   i. Bolting is process of joining overlapped metal by drilling common holes into metals and insert bolts?
   ii. Bolting is a process of joining butt metals by using bolts and nuts?
   iii. Bolting is a process of joining metals by fusing the edges of metal to be joined?

B. In Seaming metal to be joined are:
   i. Heated at the end to make better joint
   ii. Fused together to provide large joint area
   iii. Are bended and pressed together
   iv. I and ii are right answer
   v. No right answer

Question 2: Read carefully the following questions and circle the right answer

A. The following are methods applied in mechanical fastening Except:
   I. Integral fasteners
   II. Weld fasteners
   III. Quenching fasteners
   IV. Threaded fasteners
   V. Stapling
   VI. I and V are correct answers

B. The following are advantages of mechanical fasteners
   I. Strength and Durability
   II. Surface Preparation and Compatibility
   III. Fatigue and Corrosion
   IV. I and II are correct answers

Question 3. Read carefully the following questions and answer them by using true or false

a. Personal Protective Equipment (PPE): Providing appropriate PPE to employees involved in mechanical fastening tasks, such as safety glasses, gloves, or hearing protection, to protect against potential hazards like flying debris, sharp edges, or excessive noise.

b. Hazard Assessment: Conducting a hazard assessment to identify potential risks associated with mechanical fastening, such as pinch points, potential injuries, or working at heights, and implementing control measures to mitigate those risks.

Question 4. Read carefully the following questions, there are many equipment, materials, and tools used in mechanical fastening, circle the letter indicating the appropriate answer

A. The following are equipment used in mechanical fastening except

i. Drilling machine
ii. Riveting machine
iii. Bolts

B. The following are materials used in mechanical fastening except

i. Drilling machine
ii. Nuts
iii. Bolts

C. The following are equipment used in mechanical fastening except

i. hammer
ii. drivers
iii. bolts

Question 5 Read careful the following questions and circle the letter corresponding with right answer

A. The importance of making adjustment before starting mechanical fastening operation are:
   i. Ensures Precision and Accuracy
   ii. Prevents Over-Tightening and Under-Tightening
   iii. I and ii are correct answers
   iv. There is no correct answers
B. The common adjustments to consider before starting a mechanical fastening operation are:
   i. Safety Checks
   ii. Tool and Equipment Inspection
   iii. Welded parts inspection
   iv. Machined parts inspection
   v. Both I and II are correct answers
   vi. Both III and IV are correct answers

QUESTIONS 6 Read carefully the following questions and Use true or false to answer the questions

A. Fastener Sorting and Organization means to organize and arrange fasteners for easy access during the fastening process. This can include labelling or color-coding fasteners based on size, type, or application.

B. Reduces the Risk of Component Misalignment means to Adjusting tools, such as torque wrenches, helps ensure that fasteners are tightened to the correct specifications. Over-tightening can lead to damage or failure of the fastener or the components being joined, while under-tightening can result in loose connections and reduced structural integrity.

QUESTIONS 7 Read carefully the following questions related to the properties of the materials used in mechanical fastening and answer the questions by true or false

I. Pplasticity is the ability of an object or material to resume its normal shape after being stretched or compressed. When a material has a load applied to it, the load causes the material to deform and materials return to its shape after removing the applied road
II. The physical properties of the materials include ability to conduct electricity and ability to conduct heat.
III. Fflammability, toxicity and chemical stability are examples chemical properties of the materials but A heat of combustion is not included in the properties of the materials.

Practical assessment

HOUJING Ltd is a company specialized in building bridges by using steel structures. They won a tender for fixing steel beams but they need to prepare workplace for preceding the remaining works.
You as technician of the company; the head technician ask you to apply safety precautions at the workplace, select the necessary tools, materials, and equipment and adjust equipment and tools for mechanical fastening.

END

References

Asfaw, A. (2020). Design of hydraulic rivet press machine.

Katariya, A. (2018). Mechanical fastening.

Issa, M. H. (2023). Drilling engineering.

Hayati, N. (2019). Mechanical fastening

Rachard G.Budynas And Jkeith Nisbett (2012) Screw Fasteners And The Design Of Non Permanent Joints

Saif M (2023) Drilling Machine Parts -Types And Operations

Indicative contents

2.1. Interpretation of drawing
2.2. Preparation of parts to be fastened
2.3. Application of mechanical fastening

Key Competencies for Learning Outcome 2: Carry-Out Mechanical Fastening

Knowledge	Skills	Attitudes
• Description of drawing • Description of Application of mechanical fastening	• Interpretation of drawing • Drilling the parts to be fastened • Threading the parts to be fastened • Cleaning the parts to be fastened • positioning the parts to be fastened • Joining parts by mechanical fastening	• Having critical thinking while interpreting drawing • Being attentive while threading the parts to be fastened • Being cooperative for positioning the parts to be fastened • Having self-confidence while joining the parts

Duration: 24 hrs

Learning outcome 2 objectives:

By the end of this learning outcome, the trainees will be able to:

1. Describe properly technical drawings according to product specifications in mechanical fastening.
2. Describe adequately the application of mechanical fastening methods.
3. Interpret effectively technical drawings in line with product specifications.
4. Drill properly parts to be fastened according to specifications.
5. Thread properly parts to be fastened, ensuring accuracy and quality.
6. Clean adequately parts to be fastened, ensuring they are free of contaminants.
7. Position properly parts to be fastened to meet alignment and design requirements.
8. Join effectively parts prepared for mechanical fastening.

Resources

Equipment	Tools	Materials
• PPE • drilling machine • riveting machine • compressor • tightening machine	• Clamps • Mallet • hand saw • File • Pencil • marking gauge • try square • taps • Dies • Wrenches • drill bit • spanners, • Allen key	• Nuts • Bolts • Screws • Washers • Keys • Studs • Rivets • Anchors • Nails • Inserts • retaining rings • clevis pins and cotter pins • drill bits

Indicative content 2.1: Interpretation of Drawing

Duration: 5 hrs

Theoretical Activity 2.1.1: Description of drawing

Tasks:

1: you are requested to answer the following questions:
   - What do you think is the meaning of part list?
   - What are the cutting list elements for mechanical fastening according to your concern?
   - What do you understand by fastener symbol?

2: Provide the answer for the asked questions and write them on papers.

3: Present the findings/answers to the whole class.

4: For more clarification, read the key readings 2.1.1. In addition, ask questions where necessary.

Key readings 2.1.1.: Description of drawing

- **Part list**

Parts list

Parts list, also known as a bill of materials (BOM) is a tabular list of the items used to make an assembly. Parts list is usually combined with the assembly drawing, but it is a separate and individual document and can be and provides a complete list of all parts needed to build the complete project.

The information associated with the parts list generally includes:

- ✓ **Item number:**
  Item numbers are based on the assembly structure, that is, the order in which parts are displayed in assembly.
- ✓ **Part number:**
  Part number or drawing number which is a reference back to the detail drawing.
- ✓ **Description:**
  Description is usually a part name or a complete description of purchase part or stock specification, including size and dimensions.
- ✓ **Quantity:**

The number of that particular part used on the assembly.

The four elements listed are the most common items and placed in the assembly drawing.

Parts list location:

When placed on the assembly drawing, the parts list can be located in the upper-left or upper-right corner of the sheet, above or to the left of the title block, or in a convenient location. The location also depends on company standard.

Example of parts list.

Parts list

Item	Part number	Description	Qty
1	ABC123-01	Fuel-injection tube	2
2	ABC123-02	Delivery-valve holder	1
3	ABC123-03	Delivery valve	1
4	ABC123-04	Barrel	1
5	ABC123-05	Control rack	1
6	ABC123-06	Plunger	2
7	ABC123-07	Guide sleeve	4
8	ABC123-08	Retainer	2
9	ABC123-09	Nozzle needle	1

- **Fastening symbols**

Fastening symbols, also known as fastener symbols are graphical symbols used in technical drawings and engineering documentation to represent and communicate specific information about the type, size, and characteristics of fasteners (such as bolts, screws, nuts, washers, and pins) used in assemblies and structures. These symbols are a standardized way of conveying important details related to fasteners without having to write out lengthy descriptions.

Fastening symbols typically include various elements that represent the following information:

- ✓ **Fastener Type:** The symbol's shape and appearance indicate the type of fastener being used, whether it's a bolt, screw, nut, washer, pin, or other fastening element.
- ✓ **Thread Type:** If relevant, the symbol may indicate the thread type, such as a standard thread, fine thread, or special thread type.
- ✓ **Size:** The symbol may include information about the size of the fastener, such as its diameter, thread pitch, and length.
- ✓ **Material:** In some cases, the material of the fastener may be specified using letters or abbreviations to indicate materials like steel, brass, aluminum, or others.
- ✓ **Head Style:** If applicable, the head style of the fastener (e.g., hex head, socket head, countersunk head) can be depicted in the symbol.

- ✓ **Finish or Coating:** Symbols may include information about the finish or coating of the fastener, such as zinc plating, galvanizing, or other surface treatments.
- ✓ **Threaded Length:** In some symbols, the threaded length may be indicated to specify the portion of the fastener with threads.
- ✓ **Special Features:** Symbols can also include additional details related to special features of the fastener, like washers, locking features, or other characteristics.

Fastening symbols help engineers, designers, and manufacturers convey critical information about fasteners on technical drawings, assembly diagrams, and other documentation, enabling accurate and efficient communication in the design and manufacturing processes. These symbols are often standardized to ensure consistency and clarity in engineering and technical documentation across different industries and regions.

Practical Activity 2.1.2: interpreting of drawing

Task:

1: you are requested to go in Manufacturing workshop and interpret drawing of parts to be fastened by basing on dimension, views and title block
2: Facilitate in group forming and select the required materials, tools that will help you to perform the task.
3: Individually, interpret drawing for mechanical fastening.
4: Present your findings to the trainer or whole classmate.
5: Read the key reading 2.1.2. and asks the questions where necessary
6: Perform the task provided in application of learning 2.1

Key readings 2.1.2: interpreting of drawing

Interpreting engineering drawings can be quite detailed, but it's a valuable skill for anyone working with mechanical machines. Here are some key points to be focused:

Title Block: Start by examining the title block, usually located in the bottom right corner. It contains essential information such as the part number, material, finish, scale, and the company or individual who created the drawing1.

Views and Projections: Understand the different views presented in the drawing. Common views include front, top, and side views. These are often accompanied by isometric views that provide a 3D perspective1.

Dimensions and Tolerances: Pay attention to the dimensions and tolerances. Dimensions indicate the size of the object, while tolerances specify the allowable variations in these dimensions1.

Symbols and Notations: Familiarize yourself with common symbols and notations used in engineering drawings. These can include welding symbols, surface finish symbols, and geometric dimensioning and tolerancing (GD&T) symbols1.

Material and Finish: Check the material and finish specifications to understand what the part should be made of and how it should be finished1.

Revision Block: Look at the revision block, usually found in the upper rig ock, usually found in the upper right corner, to see any changes that have been made to the

Points to Remember

- Refer to standard to interpret drawing
- While interpreting the drawing Pay Attention to Dimensions and Tolerances:
- Use a Scale: Drawings are often scaled down. Use the scale provided to understand the actual size of the part.
- Cross-Reference with the Bill of Materials (BOM): Ensure you have all the parts listed in the BOM and understand how they fit together.
- Use Digital Tools: Software like CAD programs can help you visualize and manipulate the drawing, making it easier to understand complex parts.
- Practice Regularly: The more you practice interpreting drawings, the more proficient you'll become. Try working on different types of drawings to broaden your experience

Application of learning 2.1.

Your school has the production unit which is fabricating best and strongest metal products including SILO. BUMBA Industry ordered three (3) metallic silos at your school.

As manufacturing trainee, you are asked to interpret drawing of the parts to be fastened for assembling those three (3) silos become easy.

Indicative content 2.2: Preparation of parts to be fastened

Duration: 12

Practical Activity 2.2.1: Preparing the parts to be fastened

Task:

1: You are requested to go in manufacturing workshop and prepare workpiece to be fastened by cleaning, drilling, threading, and positioning of the work. You need also to refer to trainer's demonstration.
2: Demonstrate your work to the trainer and the whole class.
3: Read the key reading 2.2.1 and ask for clarification where necessary.
4: Perform the task provided in application of learning 2.2

Key readings 2.2.1 Preparing the parts to be fastened

Preparing the parts to be fastened is a crucial in ensuring the success of a mechanical fastening operation. Proper preparation helps ensure that the fasteners create secure and reliable connections. Here there are different operations used in preparations of parts to be fastened.

- **Drilling**

Drilling involves creating holes in the components to accommodate fasteners such as bolts or screws.

Steps to be considered in drilling operation.

- ✓ **Inspection:** Begin by inspecting the parts to be fastened. Check for any defects, damage, or irregularities in the components. Ensure that they meet the required quality standards.
- ✓ **Cleaning:** Remove any dirt, debris, oil, grease, or contaminants from the surfaces that will come into contact with the fasteners. Clean the parts using appropriate solvents or cleaning agents.
- ✓ **Selecting the right Drill Bit:** Choose an appropriate drill bit based on the material of the component and the size of the desired hole. Drill bits come in various sizes and types, including twist drills, step drills, or specialized bits for specific materials.

- ✓ **Securing the workpiece:** Ensure that the component is securely clamped or held in place to prevent movement during drilling. This ensures accuracy and safety during the drilling process.
- ✓ **Mark the hole location:** Use a center punch to create a small indentation or mark at the exact location where you want to drill the hole. This will help guide the drill bit and prevent it from wandering.
- ✓ **Wear Safety equipment:** Put on appropriate personal protective equipment, including safety goggles, hearing protection (if drilling generates loud noise), and a dust mask if needed.
- ✓ **Prepare the Drill Press or Power Drill:** If using a drill press, set up the machine with the correct speed, feed rate, and depth of cut settings. If using a power drill, make sure it is properly charged or connected to a power source
- ✓ **Secure the Drill Bit:** Insert and securely tighten the selected drill bit into the drill chuck. Ensure that it is centered and straight in the chuck.
- ✓ **Start Drilling:** Position the drill bit over the marked hole location, making sure it is aligned correctly. Apply gentle pressure on the drill, start it at a slow speed, and gradually increase the speed. Maintain a consistent and controlled feed rate.
- ✓ **Use Lubrication (if applicable):** Some materials, like metal, benefit from lubrication or coolant to reduce heat and friction during drilling. Use an appropriate lubricant if recommended.
- ✓ **Clear Chips:** Periodically retract the drill bit to clear away chips and debris from the hole. This helps maintain drilling efficiency and prevents overheating.
- ✓ **Monitor Progress:** Continuously monitor the drilling process to ensure that you are on track, and the hole is being created as intended.
- ✓ **Complete the Hole:** When the desired depth is reached or the hole is fully formed, retract the drill bit slowly and turn off the drill press or power drill.
- ✓ **Deburr the Hole (if needed):** Use a deburring tool or file to remove any sharp or uneven edges around the hole's entrance.
- ✓ **Clean Up:** Remove the workpiece from the drilling area, and clean the workspace of any chips or debris. Properly store the drill bit and tools.
- ✓ **Inspect and Measure:** Inspect the hole for accuracy, size, and any defects. Measure the hole's dimensions to confirm they meet your specifications.

- **Threading:**

Threading involves creating internal or external threads on the components to allow for the use of threaded fasteners.

- ✓ **Threading methods**

- **Tapping:** Tapping is the process of creating internal threads. It involves using a tap, which is a cutting tool with threaded ridges, to cut the threads into a pre-drilled hole. The tap is inserted into the hole, and with the help of a tapping handle or machine, it is rotated to cut the threads.

- **Die-Cutting:** Die-cutting is used to create external threads on a cylindrical component. It involves using a die, which is a cutting tool with threaded ridges, to cut the threads onto the component. The die is secured in a die holder, and the component is rotated against the die to create the threads.

✓ **Steps to be followed in threading**

- Choose the appropriate tap for internal threading (creating threads inside a hole) or die for external threading (creating threads on the outside of a cylindrical workpiece).
- Clamp or secure the workpiece firmly to prevent it from moving during the threading operation.
- By using a center punch mark at the exact location where you want to start threading.
- Wear Safety appropriate PPEs, including safety goggles to protect your eyes from chips and debris.
- If you are making internal threads, drill a hole to the correct size and depth.
- If you are making external threading, ensure that the work piece's diameter is appropriate for the threading process.
- Insert the tap into a tap handle or the die into a die stock. Ensure that it is securely held and aligned with the workpiece.
- Lubricate the tap or die with cutting fluid to reduce friction and heat generation during the threading operation.
- Align the tap or die with the marked starting point. Threading.
- Turn the tool clockwise (right-hand threads) or counterclockwise (left-hand threads) while maintaining a consistent and controlled feed rate.
- Periodically use thread gouge check the thread's dimensions and pitch to ensure they are within the specified tolerances.
- Continue threading until the desired thread depth or length is achieved.
- Remove any burrs or sharp edges on the threads using a deburring tool or a file.
- Remove the workpiece from the threading area, and clean the workspace of any chips or debris. Properly store the tap, die, and tools.
- Inspect the threads for accuracy, size, and any defects. Measure the thread's dimensions to confirm they meet your specifications.

- **Cleaning**

It is essential to clean the surfaces of the components that will be fastened. Remove any dirt, grease, oil, or other contaminants that can hinder the adhesion or effectiveness of fastening methods such as welding or adhesive bonding. Cleaning can be done using appropriate solvents, degreasers, or cleaning agents based on the material and type of contamination.

✓ **Steps to be considered in cleaning the part to be fastened.**

- Look for any visible contaminants, such as dirt, grease, oil, rust, paint, or other foreign substances.
- Collect the right cleaning tools.
- Use Soft brushes, such as nylon brushes or paintbrushes, are useful for scrubbing away dirt or debris.
- Use Lint-free cloths or paper towels: to wipe and dry the cleaned surfaces.

- **Positioning of parts**

Ensure that the components to be fastened are properly aligned and fit together correctly. Verify that any holes, slots, or matching features for fasteners are correctly positioned and aligned for a secure and accurate assembly.

If the workpiece is small or lightweight, you may need to secure it using clamps, vises, or hold-downs to prevent it from moving during the fastening process. This is especially important when drilling or driving fasteners to avoid misalignment.

Points to Remember

- Always inspect parts for defects or irregularities before drilling, threading, or fastening. Clean surfaces thoroughly to remove dirt, grease, or contaminants that may affect the fastening process.
- Choose the correct drill bit, tap, or die based on the material and desired hole or thread size Use the right cleaning tools and solvents to ensure effective preparation.
- Clamp or secure parts firmly during drilling, threading, or positioning to prevent movement, ensuring accuracy and safety throughout the operation.
- Use a center punch to accurately mark drilling or threading locations. Proper alignment and positioning of parts are crucial for ensuring holes, threads, and fasteners fit correctly.
- Always wear appropriate personal protective equipment (PPE) during operations. After drilling or threading, deburr and inspect parts to ensure clean, accurate holes or threads free of sharp edges.

Application of learning 2.2.

Your school has the production unit which is fabricating best and strongest mechanical fastening products including plates for fixing 5 kW electrical motors. Hello technic Industry ordered ten (10) prepared plates at your school. As manufacturing trainee, you are asked to prepare the plates as per standard procedures.

Indicative content 2.3: Application of Mechanical Fastening.

Duration: 8 hrs

Theoretical Activity 2.3.1: Description of fastening defects.

Tasks:

1: you are requested to describe fastening defects by answering the following questions:
   - What do you understand by mechanical fastening defect?
   - What are the mechanical fastening defects according to your concern?
2: Provide the answer for the asked questions and write them on papers.
3: Present the findings/answers to the whole class.
4: For more clarification, read the key readings 2.3.1.and ask questions where necessary.

Key readings 2.3.1. Description of fastening defects

Mechanical fastening defect is anything that can cause the fastened products to fail.

- Types of mechanical fastening defects

✓ **Misalignment:**

When the screw holes of mating parts are misaligned, and only a section of the bottom screw hole is exposed, the screw will bind-up because the bottom screw hole is undersized. This causes the fastener to reach torque before the screw has correctly seated and clamped the product together

Misaligned Axis:

Causes of misalignment in Fastening

- High turning speed(rpm) installation
- Rough threaded surfaces
- Damaged threads
- Axis misalignment
- Angular misalignment

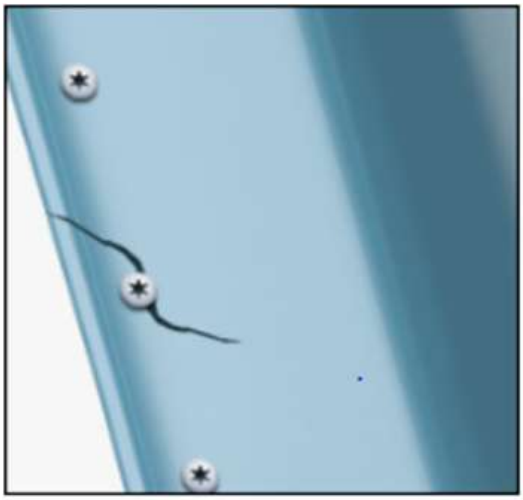
✓ **Deformation:**

In mechanical fastening, a "**deformation defect**" refers to a condition where the materials or components being fastened experience unintended or undesirable deformation during the fastening process.

✓ **Crack defect**

A crack defect in mechanical fastening refers to the presence of cracks or fractures in the materials, components, or fasteners used in a mechanical fastening joint.

Crack defects can occur for various reasons, including material properties, manufacturing processes, and loading conditions.



Factors that can lead to crack defects in mechanical fastening:

- **Material Properties:** Using materials with low ductility or high brittleness can increase the susceptibility to cracking. Brittle materials are more prone to fracture under stress.
- **Improper Material Selection:** Incompatibility between materials, such as using dissimilar metals or materials with significantly different coefficients of thermal expansion, can result in stress concentrations and potential cracks.
- **Stress Concentrations:** Uneven distribution of stress, sharp edges, notches, or irregularities in components can lead to stress concentrations, increasing the risk of cracks.
- **Excessive Loads:** Overloading a fastening joint, either due to high external forces or

excessive torque or tension applied during fastening, can induce stress that exceeds the material's strength, leading to cracks.

- **Fatigue:** Cyclic loading, as often seen in applications involving moving parts, can lead to fatigue cracking over time. Repeated stress cycles weaken the material and can cause cracks to propagate.
- **Manufacturing Defects:** Defects introduced during the manufacturing process, such as incomplete welds, forging defects, or heat treatment irregularities, can create areas of weakness that may develop into cracks.
- **Corrosion:** Corrosion or environmental factors can weaken the material and create conditions conducive to crack initiation and propagation.

To prevent crack defects in mechanical fastening, it is essential to consider the following:

- **Material Selection:** Choose materials that are appropriate for the application and p rovide adequate ductility and toughness to resist cracking.
- **Proper Design:** Design components and fasteners to minimize stress concentrations , avoid sharp corners, and provide smooth transitions.
- **Quality Control:** Inspect and test fasteners and components to ensure they meet m aterial and dimensional specifications, particularly for critical applications.
- **Avoid Overloading:** Apply appropriate torque or tension values, and ensure that th e fastening joint is not subjected to excessive loads.
- **Prevent Corrosion:** Use corrosion-resistant materials or apply coatings to protect ag ainst corrosion, particularly in harsh environments.
- **Monitor for Fatigue:** In applications with cyclic loading, monitor for signs of fatigue, and implement maintenance or replacement schedules as needed.

✓ **Loose connection**

In Fastening the term loose connection is referred to an imperfect parts connection. the m ost commonly used fasteners are loose due to:

Fastener loose cause

- **Over-tightening:** While insufficient torque can lead to lose connections, over-tight ening can also be a problem. Applying excessive torque can damage the fastener or the components being fastened, leading to an insecure connection.
- **Thread Damage:** Damage to the threads of the fastener or the mating threads on t he components can prevent the fastener from achieving a proper connection. Thre ad damage can occur due to cross-threading, wear and tear, or corrosion.
- **Lubrication Issues:** Insufficient or excessive lubrication can lead to lose connection
- **Material Deformation:** If the materials being fastened are too soft or prone to defo

rmation, the fastener may not maintain its grip over time. This is more common wi th softer materials or in applications with extreme temperature variations.

- **Vibration and Dynamic Loads**: In applications where components are subject to vib rations or dynamic loads, fasteners can gradually work loose over time. This is espe cially problematic in automotive, aerospace, or heavy machinery applications.
- **Environmental Factors:** Exposure to environmental factors temperature variations, and corrosive substances can lead to fastener degradation and weakened connecti ons.
- **Inadequate Fastener Selection:** Choosing the wrong type or size of fastener for the application can result in loose connections.
- **Improper Installation:** Errors made during the installation process, such as not alig ning components properly or failing to follow manufacturer guidelines, can result i n loose connections.

Prevention of loose connection defect:

- Using a calibrated torque wrench
- Inspecting and maintaining fasteners regularly
- Choose appropriate materials and fasteners for the specific application.
- Apply thread-locking compounds
- Use locking devices
- Adhere to manufacturer guidelines

Practical Activity 2.3.2: joining the parts

Task:

1: you are requested to use manufacturing workshop to join the parts by pressing and tightening chimney with the following specification 2m chimney having two halves joined by bolts and nuts
2: Apply safety precautions (Wear the PPE)
3: Join the halves of chimney by bolts and nuts and press where necessary.
4: Present your work to the trainer and whole class.
5: Read key reading 2.3.2 and ask clarification where necessary.
6: Perform the task provided in application of learning 2.3

Key readings 2.3.2 joining the parts

- **Pressing/ Hammering**

Pressing involves using a mechanical or hydraulic press to apply force and join parts together. This method is commonly used for press-fit connections, where one component is inserted into another with a tight interference fit. The pressing force ensures a secure and permanent assembly by creating an interference or friction fit between the mating surfaces. Examples of pressing techniques include:

- ✓ **Press-fit bearings**: Bearings are pressed into housings or onto shafts to create a tight fit and ensure smooth rotation.
- ✓ **Interference fits:** Components like bushings, sleeves, or pulleys are pressed into holes or bores to create a secure and rigid connection.

Hammering, also known as striking or pounding, involves using a hammer or mallet to forcefully join parts together. This method is often used for temporary or semi-permanent assemblies, where parts need to be secured quickly or easily disassembled if required.
Examples of hammering techniques include:

- ✓ **Nailing:** Using a hammer to drive nails into wood or other soft materials for joining or construction purposes.
- ✓ **Riveting:** Hammering a rivet into place to create a permanent connection, commonly used in sheet metal fabrication or structural applications.
- ✓ **Peening:** Hammering the end of a pin or shaft to create a secure and tamper-resistant connection.

Parts of a Hammer

- **Tightening**

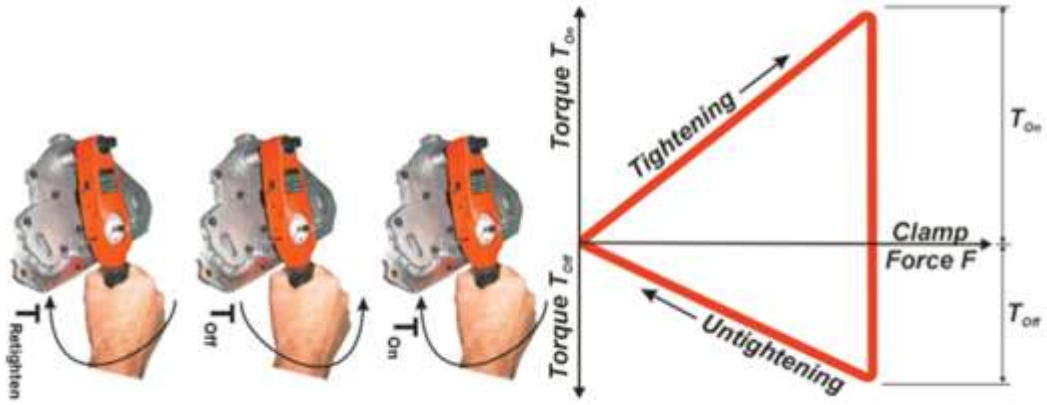
Tightening involves using tools such as wrenches, screwdrivers, or torque wrenches to tighten fasteners like bolts, screws, or nuts. The applied torque generates a clamping force, securing the parts together.

Examples of tightening techniques include:

Bolted joints: Bolts and nuts are tightened using a wrench or socket to create a clamping force that holds components together. Proper torque is essential to achieve the desired tightness and prevent loosening or overloading.

Screwed connections: Screws are tightened using a screwdriver or power tool to join parts, often used in furniture assembly, equipment mounting, or electrical installations**.**

Tightening illustration.



Joining metal parts using mechanical fastening involves several key steps to ensure a secure and reliable connection.

✓ **Essential steps for mechanical fastening:**

- **Select the Proper Fasteners:** Choose the appropriate fasteners (e.g., screws, bolts, nuts, rivets) based on the application's requirements, including load capacity, material compatibility, and environmental conditions.
- **Prepare the Metal Parts:** Ensure that the metal parts to be joined are clean and free from contaminants, such as rust, dirt, or oil. Cleaning the surfaces can improve the quality of the connection.
- **Drill or Create Holes:** If necessary, create holes or clearance for the fasteners to pass through the metal parts. Ensure that the holes are accurately aligned for a precise fit.
- **Thread the Fasteners:** In cases where threaded fasteners are used (e.g., screws, bolts), thread them into the holes or add nuts to the threads. If not threaded, ensure that the fasteners are compatible with the holes.
- **Align the Metal Parts:** Carefully align the metal parts to be joined, ensuring that holes and fasteners are properly matched.
- **Apply Torque Gradually:** Using a calibrated torque wrench, apply torque gradually

and evenly to the fasteners. Begin with a low torque and progressively increase it, following the recommended tightening sequence (for multiple fasteners). Ensure that the fasteners are tightened to the manufacturer's specified torque values. Avoid over-tightening, as this can damage the fasteners or the parts.

- **Use Locking Mechanisms:** Consider adding locking mechanisms such as lock washers, spring washers, or cotter pins to prevent fasteners from coming loose due to vibration or other factors.
- **Inspect the Connection:** After fastening, inspect the connection to ensure that it is secure and there is no visible damage or misalignment. Re-tighten if necessary.
- **Apply Lubrication (Optional):** In some cases, apply lubrication to the threads of fasteners to reduce friction and facilitate a more even distribution of torque during tightening.
- **Perform Quality Control Checks:** Implement quality control measures to verify that the fasteners are installed correctly and that they meet the required specifications. This may involve torque testing, dimensional checks, and visual inspections.
- **Consider Environmental Protection:** If the application is exposed to harsh environmental conditions, apply protective coatings or materials to the fasteners or metal parts to prevent corrosion and degradation.

Points to Remember

- Light hammering is needed to press parts to be joined
- Don’t over tighten the nuts to avoid threads damage
- To perform proper fastening, respect step by step of fastening

Application of learning 2.3.

Some of the kitchen staff of your school are suffering from lungs disease due to much fumes accumulated in the kitchen because it lacks the chimney to exhaust fumes. Referring to the previous activity 2.3.2, as trainee you are requested to assemble steel chimney by means of mechanical fasteners.

Learning outcome 2 end assessment

Theoretical assessment

Question 1 Read carefully the following questions for fastening symbol and answer them by TRUE or FALSE

A. Size, fastener type, threads types and materials are one of the information given by fastener symbol?

B. Item number: usually describe part name or a complete description of purchase part or stock specification, including size and dimensions numbers.

Answers

A. True

B. False

Question 2 Read carefully the following different questions and answer by Using true or false

A. Lubrication: Refer to the application of suitable cutting oil or lubricant during the tapping or die-cutting process that helps reduce friction and heat generation, prolongs the tool's life, and improves the quality of the threads.

B. Die-Cutting is the process of creating internal threads. It involves using a tap, which is a cutting tool with threaded ridges, to cut the threads into a pre-drilled hole. The tap is inserted into the hole, and with the help of a tapping handle or machine, it is rotated to cut the threads.

QUESTION 3: Use TRUE or FALSE to answer the following questions

A. Tightening refers to the process of securing fasteners (such as screws, bolts, or nuts) to hold components together.

B. Pressing involves using a mechanical or hydraulic press to apply force and join parts together. This method is commonly used for press-fit connections, where one component is inserted into another with a tight interference fit. The pressing force ensures a secure and permanent assembly by creating an interference or friction fit between the mating surfaces.

Question 4 Read carefully the following different question and answer by circle the letter corresponding the right answer

Fastening symbols typically include various elements that represent the following information:

i. Back, front and side of fastened parts

ii. Fastener Type, Thread Type and Size

iii. I and II are correct answers

iv. No correct answers

Question 5: Read carefully the following different questions and answer by circle the letter corresponding the right answer

A. Which among of the following process is not used in preparation of part to be fastened

i. Threading

ii. Digging

iii. Fastening

iv. Drilling

v. Machining

B. The following operations are performed during preparations of parts to be fastened except.

i. Drilling

ii. Threading

iii. Positioning of parts

iv. All of above are operations of preparing the parts to be fastened

C. The operation of preparing the parts to fastened made by creating a hole into the workpiece is:

i. Cleaning
ii. Threading
iii. Cutting
iv. Drilling
v. All of above are true

QUESTION 6: Read carefully the following different question and answer by circle the letter corresponding the right answer

All are mechanical fastening defect except:

i. Loose connection

ii. Misalignment

iii. Deformation

iv. Holding

Practical assessment

Rwanda Fogging Group Ltd wants to build a tower to support a water tank, composed of 12 stages of structure parts. But they don't have a specialized person to prepare those parts to be fastened together to make tower tank support. As qualified and competent worker in mechanical fastening, referring to the given drawing, they are requesting you to prepare those parts by: Drill two hole at every part end, cleaning the parts , positioning the parts, and join all parts by tightening the bolts and nuts, the work should be done not more than 3 hours.

END

References

Amanuel Asfaw (2020) Design Of Hydraulic Rivet Press Machine

Akshay Katariya.(2018),Mechanical Fastening

Avail at work place: drilling machine, Threading and the tools, materials and equipment that should be used in cleaning

Moubarrack Hissein Issa (2023) Drilling Engineering

Nurthuda Hayati (2019) Mechanical Fastening

Rachard G.Budynas And Jkeith Nisbett (2012) Screw Fasteners And The Design Of Non Permanent Joints

Saif M (2023) Drilling Machine Parts -Types And Operations

Indicative contents

3.1 Finishing of fastened product
3.2 Storing of tools and equipment
3.3 Reporting

Key Competencies for Learning Outcome 3: Perform post-operation activities

Knowledge	Skills	Attitudes
• Description of cleaning methods • Identification of painting techniques • Identification of storing method • Identification of cleaning tools	• Finishing of fastened product • Storing of tools and equipment • Reporting the work done	• Being attentive while finishing fastened product • Having critical thinking while storing tools and equipment • Being Time manager for reporting the work done

Duration: 8 hrs

Learning outcome 2 objectives:

By the end of the learning outcome, the trainees will be able to:

1. Finish properly the fastened product in mechanical fastening.
2. Store correctly equipment and tools according to storage conditions in mechanical fastening.
3. Report clearly the performed work as handed over per reporting procedures.

Resources

Equipment	Tools	Materials
• PPE • Drilling machine • Riveting machine • Compressor • Tightening machine,	• Washers • Keys • Clamps, • Mallet • Hand saw • Spanners • Allen key, screw drivers • Hammer • Try square • Taps • Dies • wrenches	• File • Pencil • Marking gauge • Drill bit • Papers, • Pen • Rivets, anchors • Nails, inserts • Retaining rings, clevis pins and cotter pins, drill bits • Nuts • Bolts • Screws

Indicative content 3.1: Finishing of fastened product

Duration: 5 hrs

Practical Activity 3.1.1: finishing of fastened products.

Task:

1: You are requested to go to the manufacturing workshop to finish the fastened product of steel sheet and tube table having 40*60 cm and 30 cm of height and 2mm thick joined by bolts by cleaning and protecting.
2: Apply safety precautions (Wear the PPE)
3: Finish the fastened steel sheet and tube table by cleaning and protecting the fastened product
4: Present your work to the trainer and whole class
5: Read key reading 3.1.1 and ask clarification where necessary
6: Perform the task provided in application of learning 3.1

Key readings 3.1.1 finishing of fastened products.

- **Cleaning fastened products**

Cleaning a fastened product after it has been assembled is important to maintain its functionality, appearance, and hygiene. Cleaning a fastened product involves some **specific steps** to ensure that the product is cleaned effectively without damaging the fasteners or the components being fastened.

- ✓ **Assessment:** Evaluate the product to identify the areas that need cleaning and assess the type and extent of contamination. Consider the materials, components, and fasteners used in the product.
- ✓ **Apply Safety Precautions**: Put on the appropriate personal protective equipment (PPE) to ensure your safety, which may include gloves, safety glasses, and protective clothing.
- ✓ **Select the Cleaning Method:** Choose an appropriate cleaning method based on the materials, contaminants, and fasteners used in the product. Common cleaning methods include:
- **Air pressure cleaning:** it involves cleaning by using a pneumatic air compressor
- **Cleaning with cloth lugs:** this is carried out by using cloths lugs for cleaning process.
- **Brushing:** this type of cleaning involves using wire brushes for cleaning process.

- **Remove Loose Debris:** Use a soft brush, compressed air, or a vacuum cleaner with a nozzle attachment to remove any loose debris, dust, or dirt from the product's surface. Ensure that you do not push contaminants into hard-to-reach areas.
- **Lubrication:** if necessary, apply lubrication to fasteners, hinges, and moving parts to reduce friction, prevent wear, and ensure smooth operation.

Protecting a product after it has been assembled using mechanical fasteners is essential to ensure its longevity, performance, and appearance.

- **Protecting fastened product**

Some considerations to protect the fastened product after its assembly:

✓ **Protective Coatings:** Applying protective coatings involves painting.

- **Importance of painting the fastened product:**
  - Painting the product Protect structure or product contamination.
  - Adequate painting prolongs the lifespan of metal surfaces.
  - Painting improves aesthetics of the product,
  - Saves money
  - Protects the environment
- **Painting techniques:**

The first step in painting process involves mixing red oxide and solvent or paint thinner in order to have a complete mixture to paint.

- **Brushing:** after mixing red oxide with solvent, therefore it is time to paint by using brush.
- **Spray techniques:** spray painting is a painting technic where a device sprays a coating(paint) through the air onto the surface.

Types of Fasteners Finishing Treatments

The trends in fastener finishing vary across industries. For example, fasteners that are used in cars and other automobiles are exposed to high physical stress levels and extreme temperature. However, fasteners used in food and pharmaceutical applications need to withstand daily cleaning.

Hence depending upon the usage there are various kinds of fastener finishing and coating types available in the market. They are as follows:

- **Anodizing:** A thin, transparent oxide layer is created on the fastener by electrolytic passivation. The oxide layer provides excellent adhesion for secondary processes like coating.
- **Black Oxide:** This treatment is performed over stainless steel and ferrous metal fasteners to produce a black finish. During the process, the fasteners are dipped into the oil which improves its corrosion resistance.
- **Zinc electroplating:** This treatment involves the depositing of zinc coating over the metallic surface by immersing it in a plating bath and passing an electric current through it. The zinc electroplating improves the visual brilliance of fasteners.

- **Dip-Spin Coatings:** As the name suggests, a fastener is placed in a mesh basket, dipped in coating solution and spun to remove excess coating. This finishing treatment helps in improving the corrosion resistance of fasteners.
- **Chromate Coating:** Zinc and aluminum fasteners require chromate coating to improve their resistance against corrosion. This treatment helps minimize their surface oxidation. It is commonly used for adhesive applications due to the excellent bonding properties it provides.
- **Hot Dip Zinc:** The finishing produces a heavier and an irregular coating in the thread roots and internal corners of the metals. It involves dipping the metals into pure molten zinc. The process also provides a distinct advantage over other corrosion protection methods.
- **Iridite:** For the zinc and cadmium coated metal part, iridite coating produces a protective chromate conversion film for additional corrosion protection. This coating has an olive drab or a dull gray.
- **Passivation:** This process produces a passive corrosion-resistant finish. It involves dipping the stainless-steel parts in nitric acid, which in turn removes the particles, and brightens the finish.

Points to Remember

- **Galvanizing is the best fish for protecting fastened products**
- **Cleaning agents are harmful to the human being handle them with care**

Application of learning 3.1.

Your school is expending class rooms and needs five steel sheet and tube table (5) having 40*60 cm and 30 cm of height and 2mm thick joined by bolts by cleaning and protecting. Asks trainees to finish the fastened products (five steel sheet and tube table) by

I. Cleaning the products
II. Protecting the products

Indicative content 3.2: Storing of Tools and Equipment

Duration: 2 hrs

Practical Activity 3.2.1: Storing of tools and equipment

Task:

1: you are requested to use the school mechanical fastening workshop and store tools, materials and equipment
2: Collected the tools, materials and equipment required to be stored.
3: As per trainer's demonstration store tools, materials and equipment.
4: Demonstrate your work to the trainer or learners
5: Read key reading 3.2.1
6: Perform the task provided in application of learning 3.2

Key readings 3.2.1: Storing tools, materials and equipment

- **Procedures for storing tools material and equipment:**

✓ **Clean and Inspect:** Before storing, clean each tool or piece of equipment thoroughly to remove dirt and debris by using proper cleaning techniques
✓ **Maintenance and Repairs:** Repair damaged tool or equipment before its store
✓ **Organize and Sort:** Organize tools and equipment according to the following tips:

- According to the sizes:
- According to their types
- According to the size
- According to their use

✓ **Labeling**: Label containers or use a labeling system to identify the contents and location of each tool or piece of equipment.
✓ **Secure Storage:** Store tools and equipment in a secure area that is protected from theft, unauthorized access.
✓ **Hanging Tools**: Consider hanging tools with hooks, pegboards, or wall-mounted racks to prevent damage and make them easily accessible.
✓ **Lock and Secure:** If necessary, lock tool storage containers or rooms to prevent unauthorized access and protect valuable tools from theft.

- ✓ **Proper Storage Orientation:** Store tools and equipment in a way that minimizes stress on their components.
- ✓ **Electrical Equipment:** Unplug and coil cords neatly. Store electrical equipment in a dry and cool place to prevent damage and overheating.
- ✓ **Store safety equipment** such as goggles, gloves, and helmets in clean and easily accessible locations.

Points to Remember

- **Before storing tools and equipment make sure that are clean and free from burrs**
- **The tools, material and equipment are stored separately**
- **Refer to the tips for storing tools**
- **Label tools, material and equipment to avoid confusion**

Application of learning 3.2.

The school has acquired 100 new hand and power tools of various sizes, shapes, and functions, along with 10 pieces of equipment differing in size, shape, and purpose. These tools and equipment need to be organized and stored on a stand with 15 shelves. The school requests you as trainee to store them. The storage and organization process be completed within 2 hours.

Indicative content 3.3: Reporting

Duration: 1 hrs

Practical Activity 3.3.1: reporting the work done

Task:

1: You are requested to provide a report on the mechanical fastening work performed on a steel sheet and tube table. The table has dimensions of 40x60 cm, a height of 30 cm, and a thickness of 2 mm. The components are joined using bolts, and the report should cover the process up to the stages of cleaning and protection.

2: Report the work done by referring to the procedures of reporting mechanical fastening work done.

3: Present your work to the trainer and whole class

4: Read key reading 3.3.1 and ask clarification where necessary

Key readings 3.3.1 reporting the work done

- **Procedures of reporting mechanical fastening work done.**

Reporting mechanical fastening work is crucial for documenting and communicating the assembly or fastening process, ensuring quality control, and maintaining accurate records.

Step-by-step guide on how to report mechanical fastening work done:

- ✓ **Define the Purpose of reporting:** Determine the purpose of your report. document a specific assembly process, report on quality control measures, or provide an overview of fastening work within a project.
- ✓ **Identify the Audience:** Understand your target audience, whether it's internal team members, supervisors, clients, or quality control personnel. Tailor the report to their technical background and expectations.
- ✓ **Choose the Report Format:** Decide on the most suitable format for your report. Common formats for reporting mechanical fastening work include written documents, digital reports, checklists, and inspections.
- ✓ **Gather Information:** Collect all relevant information, including assembly instructions, fastener specifications, inspection data, and any deviations or issues encountered during the fastening process.
- ✓ **Organize the Report:**

- Start with a clear and descriptive title.
- Include a date or time period covered by the report.
- Structure the report with an introduction, the body of the report, and a conclusion.
- Use headings and subheadings to organize content logically.

- **Write an Introduction:**

  Begin with a concise introduction that provides context and explains the purpose of the report. State the scope and background information.

- **Detail the Mechanical Fastening Work:**

  Describe the mechanical fastening work that was completed. Include information about the types of fasteners used, assembly techniques, and any specialized tools or equipment.

- **Quality Control and Inspections:**

  Document any quality control measures taken during the fastening process. Include details on inspections, tests, or verification steps to ensure that the fasteners are properly installed.

- **Include Visuals:**

  Utilize photographs, diagrams, or sketches to illustrate the fastening process and any issues encountered. Visual aids can enhance the clarity of the report.

- **Data and Metrics:**

  Provide relevant data, such as the number of fasteners installed, torque values, measurements, or any other quantitative information related to the fastening process.

- **Challenges and Solutions:**

  Discuss any challenges, issues, or deviations encountered during the fastening work. Describe the solutions or corrective actions taken to address these challenges.

- **Use Clear and Precise Language:**

  Write in a clear and precise manner, especially when describing technical aspects of the fastening process. Define any technical terms or jargon used.

- **Proofread and Edit:**

Carefully proofread your report for accuracy, spelling, grammar, and formatting errors.

- **Distribute or Archive:**

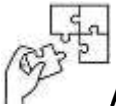
  Distribute your report according to your organization's procedures. This may involve sharing it electronically, archiving it for future reference, or submitting it to relevant parties.

- **Follow Up:**

  Monitor and follow up on any actions or decisions arising from the report. Ensure that any recommended improvements or corrective actions are implemented.

Points to Remember

- **Before reporting make sure that you have appropriate format with the work**
- **During the work report you have to obey hierarchy of staff to be reported**



Application of learning 3.3.

The school tractors backlight had a functional fail, to keep it in good working condition again, it was disassembled, inspected, cleaned, repaired, lubricated where necessary and replacing the highly damaged parts and reassembled. You are requested to prepare the report of this work done within 1hour.

Learning outcome 3 end assessment

Theoretical assessment

Question 1. Read the following questions and circle the letter corresponding the correct answer

A. The following are the factors to Consider When Choosing Bolt Finish
   i. Corrosion Resistance
   ii. Aesthetic Requirements
   iii. Temperature Tolerance
   iv. Cost
   v. All of above are correct

B. What are the activities that should be done during finishing of the fastened products are**:**

i. Cleaning and Protecting
ii. Cleaning and cutting
iii. Rolling and protecting
iv. Forming and protecting
v. No correct answer

Question 4 Read the following questions and circle the letter corresponding the correct answer

a) Adequate space stand for :

I. Ensuring that sharp tools like chisels or saws are stored to protect the sharp edge and not present a hazard.

II. Shelving units usually made of wood or metal and items which are easy to be accessible.

III. Ensuring enough space to store all tools without them being crowded or stacked on each other.

IV. I and ii are the correct answer

b) Portable Toolbox is:

i. Tool bag made from fabric and generally have soft sides.

ii. a compact, handheld storage container typically made of metal or plastic.

iii. storage units designed for a workshop setting, often on wheels.

iv. designed to store larger tools like garden tools, brooms, or mops.

Question 6 4 Read the following question concerned with format for reporting and circle the letter corresponding the correct answer

The following are components of format for reporting finished work

i. Title page, summary, table of content and introduction

ii. Body, conclusion and appendices

iii. Title page, summary, book, table of content and introduction

iv. I and II are the correct answer

Question 2 Read the following questions and use true or false to answer the questions

i. Before applying any finish, thorough cleaning is crucial. Remove dirt, grease, and contaminants from the fastener surface.
ii. Degreasing: Removes oils and greases using solvents or alkaline cleaners.
iii. Abrasive Cleaning: Removes rust and oxidation through electrolysis.

Question 3 Read carefully the following questions concerned with storing tools and equipment and use true or false to answer the questions

i. Is not necessary to Label and Assign Locations when storing tools, materials and equipment.
ii. Clean tools before storing them by removing dirt and debris for preventing damage.
iii. Toolboxes and Chests are containers designed specifically for storing tools.
iv. Clean Tools Before Storing involves grouping tools according to their type or function helps quickly locate them when needed. For example, keeping all screwdrivers in one place and all pliers in another can save time and prevent clutter.

Question 5 Read carefully the following questions concerned with reporting and use true or false to answer the questions

I. Non-Conformance Report is the report created when finished product doesn't meet with quality standards.
II. Feedback Loop is like Non-Conformance Report because helps to identify area of improvement.
III. Certificates of Conformance typically include product details, test results, and authorized signatures.

Practical assessment

BATAB Company Ltd located in Musanze District has bought 20 new cars in auction. Those cars need new vehicle registration plates. CLEMB Manufacturing Company Ltd is awarded a tender of fastening the registration of plate number. The Operation Manager orders the mechanical fastener to fix the registration plate number on those new cars. As a qualified mechanical fastener, you are requested to fix registration plates on eight (8) cars within 3 hours

The plates have the following specifications

1. Plates are made in galvanized sheet metal of 1.25mm thickness
2. Two Rectangular plate of 510x110mm each
3. Two Square shaped plate 220x220mm each
4. Make 6 rivets on each rectangular plate
5. Make 4 rivets on each square plate
6. Rivet diameter 4mm

The tasks are described as follow

a. Finishing the fastened product
b. Storing tools and equipment used in this activity
c. Reporting the work done

END

References

Amanuel Asfaw (2020) Design Of Hydraulic Rivet Press Machine

Akshay Katariya.(2018),Mechanical Fastening

Moubarrack Hissein Issa (2023) Drilling Engineering

Nurthuda Hayati (2019) Mechanical Fastening

Rachard G.Budynas And Jkeith Nisbett (2012) Screw Fasteners And The Design Of Non Permanent Joints

Saif M (2023) Drilling Machine Parts -Types And Operations

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