RQF LEVEL 3

MATPO301

MANUFACTURING TECHNOLOGY

Punching Operation

TRAINEE'S MANUAL

October, 2024

PUNCHING OPERATION

KOICA Korea International Cooperation Agency

TQUM TVET Quality Management Project

2024

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ACRONYMS

CBA: Competency-Based Curriculum

CBT: Competency-Based Training

HSS: High Speed Steel

KOICA: Korea International Cooperation Agency

MAT: Manufacturing Technology

PPE: Personal Protective Equipment

RTB: Rwanda TVET Board

TQUM Project: TVET Quality Management Project

TVET: Technical and Vocational Education and Training

HSS: High Steel Speed

CNC: Computer Numerical Control

CAD: Computer Aided Design

mm: Millimetre

INTRODUCTION

This trainee's manual includes all the knowledge and skills required in Manufacturing Technology specifically for the module of **"Punching Operation".** 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: MATPO301: PUNCHING OPERATION

Learning Outcome 1: Prepare for punching operation.
Learning Outcome 2: Carry out punching operation.
Learning Outcome 3: Perform post-operation activities.

Learning Outcome 1: Prepare for Punching Operation.

Indicative contents

1.1 Introduction to punching operation

1.2 Identification of safety and security measures

1.3 Identification of material, tools and equipment

1.4 Pre-operation activities of punching equipment

Key Competencies for Learning Outcome 1 : Prepare for Punching Operation

Knowledge	Skills	Attitudes
• Explanation of punching operation as used in manufacturing • Explanation of advantage and disadvantages of punching operation. • Explanation of applications of punching operation • Identification of safety and security measures for punching operation • Identification of Materials, tools and equipment for punching operation • Explanation of punching equipment working principle. • Description of basic maintenance activities for punching equipment.	• Applying punching equipment safety tips. • Selecting PPEs for punching operation • Selecting materials, tools and equipment for punching operation • Performing basic maintenance of punching equipment	• Having attention to details while Applying punching equipment safety tips. • Having Self-confidence while applying punching equipment. • Being active while maintaining punching equipment • Being organizer while selecting materials, tools and equipment

Duration: 8 hrs

Learning outcome 1 objectives:

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

1. Explain clearly the term punching as used in manufacturing.
2. Explain properly the advantages and disadvantages of punching operation
3. Explain appropriately the applications of punching operation.
4. Identify appropriately the safety and security measures for punching operation
5. Identify properly the tools, materials and equipment as used in punching operation
6. Explain clearly the working principle of punching equipment
7. Describe clearly the basic maintenance activities for punching equipment
8. Apply effectively the punching equipment safety tips.
9. Select appropriately the PPEs for punching operation
10. Select correctly the materials, tools and equipment for punching operation
11. Perform correctly the basic maintenance of punching equipment.

Resources

Equipment	Tools	Materials
• Overall, safety boot safety helmet, leather gloves, safety glasses • punching machines • Benches • Angle grinder • Anvil • Vices • Shear machine • Cut-off machine • Material handling • Equipment bending machine	• Rulers • Dies • Punches • Sand papers • Files • Reamers • Cutting tools • Clamping tools • Paint brush • Measuring tools • Marking tools • Common tools	• Oil • Grease • Metals

• Rolling machine • Air compressor • Material handling • Equipment bending machine • Rolling machine • Air compressor	• Tightening tools (hummer, screw driver, pliers, spanners, wrench, Allen key) • Cleaning tools (cloths rugs, wire brushes, bloom, spray gun)	

Indicative content 1.1: Introduction to Punching Operation

Duration: 3hrs

Theoretical Activity 1.1.1: Introduction to punching operation

Tasks:

1: Answer the following questions:

i. What do you understand by Punching?
ii. Explain the advantages and disadvantages of punching operation.
iii. Explain the applications of punching operation.

2: Write the answers on flipchart/paper.

3: Present the findings/answers to the whole class

4: Follow actively the trainer's clarification and ask questions where necessary.

5: For more information, read the key readings 1.1.1.

Key readings 1.1.1 Introduction to punching operation

- **Definition of Punching**
  Punching is a forming process that uses a punch press to force a tool, called a punch, through the workpiece to create a hole via shearing. Punching is applicable to a wide variety of materials that come in sheet form, including sheet metal, paper, vulcanized fibre and some forms of plastic sheet.

- **Advantages of punching operations.**

  ✓ **High Speed:** Punching operations are fast and efficient, allowing for high-volume production within a short time frame.
  ✓ **Low Cost:** Punching processes are relatively inexpensive, making them cost-effective for mass production. The tools used in punching operations have a long lifespan, reducing overall production costs.
  ✓ **Precision and Accuracy:** Modern punching machines are capable of achieving high precision and accuracy, ensuring that parts are produced to exact specifications with minimal errors.

- ✓ **Versatility:** Punching operations can be used on a wide variety of materials, including metals, plastics, and composites. This versatility makes it applicable across different industries.
- ✓ **Complex Shapes:** Punching can create intricate and complex shapes, enabling the production of various components and parts with different designs.
- ✓ **Reduced Material Waste:** Punching operations minimize material wastage since they optimize the layout of components on the raw material, maximizing the use of the material sheet.
- ✓ **Automation:** Punching processes can be easily automated, leading to improved production efficiency, reduced labor costs, and increased output.
- ✓ **Scalability:** Punching operations are easily scalable, making them suitable for both small-scale and large-scale production runs.
- ✓ **Quick Setup**: Punching machines can be set up quickly for different jobs, reducing downtime and increasing overall productivity.
- ✓ **Burr-Free Results:** Properly executed punching operations can produce parts without burrs or sharp edges, saving additional time and effort in post-processing.

- **Disadvantages of punching operation**
  - ✓ **High Initial Equipment Costs:** Acquiring and setting up a punching machine and associated tooling can be a significant upfront investment for a manufacturing operation.
  - ✓ **Noise and Vibrations:** Punching can generate substantial noise and vibrations, which may require additional measures for workplace safety and comfort.
  - ✓ **Limited Versatility for Thick Materials:** Punching becomes less effective and efficient as material thickness increases. For thicker materials, other processes like milling or drilling may be more suitable.
  - ✓ **Secondary Operations May Be Required:** Depending on the final product requirements, additional operations like bending, welding, or machining may be necessary after punching.
  - ✓ **Environmental Considerations:** The process may produce waste material in the form of punched-out sections, which may require recycling or disposal measures.
- **Application of punching operation**
  - ✓ **Automotive Industry:** Manufacturing of body panels, frames, and components for cars, trucks, and other vehicles.
  - ✓ **Aerospace Industry:** Fabrication of aircraft components such as fuselage panels, wing parts, and interior components.
  - ✓ **Electronics and Electrical Industry:** Manufacturing of enclosures, chassis, and brackets for electronic devices and equipment.
  - ✓ **Construction Industry:** Fabrication of metal roofing, siding, and cladding materials.

- ✓ **Appliance Industry:** Fabrication of metal parts for household appliances such as refrigerators, washing machines, and ovens.
- ✓ **Furniture Industry:** Manufacturing of metal frames, legs, and supports for office and home furniture.
- ✓ **Medical Equipment:** Fabrication of precision metal parts for medical devices and equipment, such as surgical instruments, trays, and diagnostic tools.
- ✓ **Packaging Industry:** Fabrication of metal containers, cans, and packaging materials.
- ✓ **Defense and Military:** Production of components for defense infrastructure and facilities.

Points to Remember

- Before performing any punching operation remember the operation becomes less effective and efficient as material thickness increases.

Indicative content 1.2: Identification of Safety and Security Measures for Punching Operation

Duration: 2 hrs

Theoretical Activity 1.2.1: Identification of punching equipment safety tips and PPEs used in punching operations.

Tasks:

1: You are requested to answer the following questions:

i. Describe the punching equipment safety tips.
ii. Identify PPEs which can be used in punching operation.

2: Write the answers of asked questions on flip chat/paper.

3: Present the findings/answers to the whole class

4: Follow actively the trainer's clarification and ask questions where necessary.

5: For more information, read the key readings 1.2.1.

Key readings 1.2.1: Identification of punching equipment safety tips and PPEs used in punching operations.

- **Punching equipment safety tips:**

✓ **Pre-Operation Safety Measures:**

- **Reading the punching equipment Manual.**
  - Always read and understand the manufacturer's manual and safety instructions before operating the equipment.
  - Keep the manual accessible for reference.
- **Inspection of punching equipment.**
  - Perform a thorough inspection of the punching equipment before each use.
  - Check for any damaged or worn parts and ensure all safety guards are in place and functional.
- **Selection of Personal Protective Equipment (PPE):**
  - Wear appropriate PPE, including:
  - Safety glasses to protect eyes from flying debris.
  - Gloves to protect hands from sharp edges and material handling.
  - Hearing protection if the equipment operates at high noise levels.

- Steel-toed boots to protect feet from falling objects.

Setting up the Work Area.

- Keep the work area clean and free of clutter to prevent accidents.
- Ensure adequate lighting in the workspace.
- Make sure emergency stops and fire extinguishers are easily accessible.

✓ **During Operation safety measures:**

Positioning:

- Stand in a safe position, keeping your body and limbs clear of the punch path.
- Maintain a balanced stance to avoid slipping or falling.

Securing the Material

- Properly secure the material to prevent movement during punching.
- Use clamps or other holding devices as necessary.

Use of Correct Tooling.

- Verify that the correct punch and die are installed for the specific material and operation.
- Ensure tooling is properly aligned to prevent mis-punches.

Avoiding Distractions.

- Focus solely on the task at hand.
- Avoid engaging in conversations or activities that could distract you during operation.

Keeping the Hand Safety.

- Keep hands and fingers away from the punching area.
- Use tools such as push sticks or holders to position and guide the material safely.

✓ **Post-Operation Safety:**

Turn Off Equipment.

- Always turn off the punching equipment and disconnect the power supply when not in use
- Follow proper shutdown procedures as outlined in the equipment manual.

Removal of Finished Parts.

- Carefully remove finished parts from the work area, being mindful of sharp edges.
- Place finished parts in a designated area to prevent clutter.

Cleaning of the work area and equipment.

- Clean the work area and equipment after use.
- Remove any debris or scrap material to maintain a safe workspace

✓ **Maintenance and Inspection.**

Preparation of Regular Maintenance

- Follow the manufacturer's maintenance schedule and guidelines.
- Conduct regular maintenance checks to keep the equipment in optimal condition.

Checking of Safety Devices.

- Regularly inspect and test safety devices, such as guards and emergency stops, to ensure they are functional.
- Replace any faulty safety devices immediately.

Lubrication of punching equipment.

- Keep the equipment properly lubricated to ensure smooth operation and reduce wear and tear.

Emergency Procedures.

- Familiarize yourself with the location and operation of emergency stop buttons.
- Ensure emergency stops are easily accessible and functional.

- **Personal protective equipment for punching operation (PPE)**

✓ **Safety helmet.**

Wearing a helmet offers protection and can prevent head injuries. Select a sturdy helmet that is adapted to the working conditions. You can choose extra options such as an adjustable interior harness and comfortable sweatbands

Safety helmet for head protection

Helmets protect head against:

- Falling objects or debris.
- Impact with other objects.
- Electric shock and rain.
- Flying object
- Overhead objects

✓ **Leather gloves.**

Hands and fingers are often injured, so it is vital to protect them properly. Depending on the

sector you work in; you can choose from gloves for different applications:

Leather gloves protect hand against:

- Cuts by sharp materials
- Vibrations
- Cold or heat

- Biohazard risks
- Chemicals hazards
- Electrical hazards

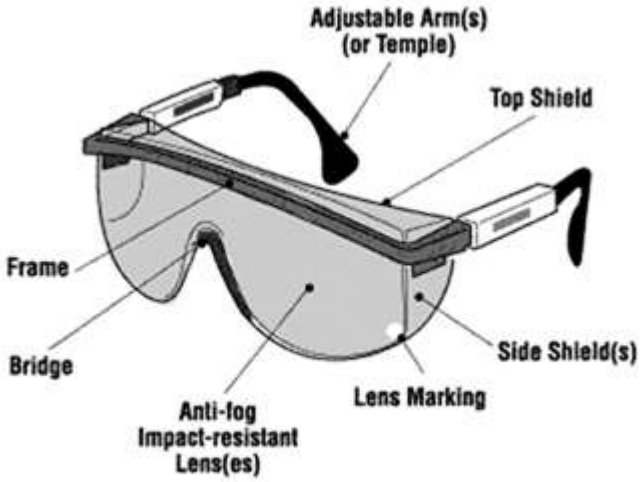
Safety hand gloves

✓ **Safety glasses and Goggles:**

Safety glasses are the most widely used type of eye protection. While they may look similar to regular glasses, they are much stronger and more resistant to impact and heat than regular glasses.

Goggles give more protection than safety glasses because they fit closer to the face.

- Safety glasses and goggles protects eyes against:
  - Blowing dust
  - Blowing particles
  - Metal shavings
  - Acid or caustic liquids
  - Fumes
  - Vapors
  - Powders
  - Mists



Safety glass

Goggles

- ✓ **Overall and apron**

  The purpose of wearing overall or apron in punching operation is to provide continuous coverage of a body.

  Types of clothing used for body protection include: Conventional and disposable overalls, Suits, Aprons, High-visibility clothing.

Overall apron

- Safety equipment for body protect body against:
  - Heat
  - Fire
  - Burn

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

✓ **Safety boot**

Wearing Protective Footwear When carrying out practical activities especially when using

chemicals or hazardous equipment you should wear enclosed footwear with firm uppers,

such as leather.

Footwear such as thongs, open weave type shoes, or shoes with openings at

toes or heels, platforms or high-heel shoes should not be worn in areas which present

hazardous situations. Where indicated by a risk assessment, the wearing of safety footwear

is mandatory.

Safety shoes protect feet and prevent injury or loss of toes. Some safety shoes are designed

to limit damage to your toes from falling objects. A steel plate is placed in the toe area of

such shoes so that your toes are not crushed if an object falls on them

- Safety boot/foot wear protect feet against:
  - Falling objects
  - Rolling objects
  - Sharp and heavy objects
  - Wet surface
  - Slippery surfaces
  - Hot surfaces

- Uneven surfaces
- Electrical hazards
- Biohazards
- Chemical hazards

Practical Activity 1.2.2: Applying safety tips and wearing personal protective equipment (PPE) during punching operations.

Task:

1: Go in the workshop at your school, apply safety tips and wear personal protective equipment (PPE) for punching plastic electrical switch plates of three (3) round holes of 8mm diameter.

2: Apply punching equipment safety tips

3: Wear Personal Protective Equipment for punching operation.

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: Applying punching equipment safety tips and PPEs for punching operation.

- **Procedures of applying safety tips on punching equipment**
  - ✓ **Pre operation safety measures:**
    - **Read the Manual:** Always read and understand the manufacturer's manual and safety instructions before operating the equipment.
    - **Inspect Equipment:** Check for any damaged or worn parts and ensure all safety guards are in place and functional.
    - **Wear Personal Protective Equipment (PPE):** Wear appropriate PPE, including:
      - Safety glasses to protect eyes from flying debris.
      - Gloves to protect hands from sharp edges and material handling.

- Hearing protection if the equipment operates at high noise levels.
- Steel-toed boots to protect feet from falling objects.

- **Setting up the Work Area: Keep the work area clean and free of clutter to prevent accidents.**

✓ **During operation safety measures include:**

- **Positioning:**
  - Stand in a safe position, keeping your body and limbs clear of the punch path.
  - Maintain a balanced stance to avoid slipping or falling.
- **Secure the Material:**
  - Properly secure the material to prevent movement during punching.
  - Use clamps or other holding devices as necessary.
- **Use Correct Tooling:**
  - Verify that the correct punch and die are installed for the specific material and operation.
  - Ensure tooling is properly aligned to prevent mis-punches.
- **Avoid Distractions:**
  - Focus solely on the task at hand.
  - Avoid engaging in conversations or activities that could distract you during operation.
- **Use Hand Safety:**
  - Keep hands and fingers away from the punching area.
  - Use tools such as push sticks or holders to position and guide the material safely.

✓ **Post-Operation Safety Measures Include:**

- **Turn Off Equipment.**
  - Always turn off the punching equipment and disconnect the power supply when not in use
  - Follow proper shutdown procedures as outlined in the equipment manual.
- **Remove Finished Parts.**
  - Carefully remove finished parts from the work area, being mindful of sharp edges.
  - Place finished parts in a designated area to prevent clutter.
- **Clean Up.**
  - Clean the work area and equipment after use.
  - Remove any debris or scrap material to maintain a safe workspace
- **Maintenance and Inspection.**
  - Regular Maintenance
  - Follow the manufacturer's maintenance schedule and guidelines.

- Conduct regular maintenance checks to keep the equipment in optimal condition.

Check Safety Devices.

- Regularly inspect and test safety devices, such as guards and emergency stops, to ensure they are functional.
- Replace any faulty safety devices immediately.

Lubrication.

- Keep the equipment properly lubricated to ensure smooth operation and reduce wear and tear.

Emergency Procedures.

- Familiarize yourself with the location and operation of emergency stop buttons.
- Ensure emergency stops are easily accessible and functional.

Points to Remember

- While selecting PPEs for punching operation don't forget earmuff/earplugs as punching operation produces much noise
- For keeping punching equipment in safe condition apply Pre-operation safety measures, during operations safety measure and post operation safety measures.
- When applying safety for punching operation respect the following safety measures mainly, reading the punching equipment manual, repair or replace any damaged or worn equipment part.

Application of learning 1.2.

Go in the manufacturing workshop at your school and carry out the following tasks related to punching operations:

i. Choose the suitable PPE for punching operations

ii. Apply punching equipment safety tips.

Indicative content 1.3: Identification of Materials, Tools and Equipment

Duration: 2hrs

Theoretical Activity 1.3.1: Identification of materials, tools and equipment for punching operation.

Tasks:

1. Answer the following questions related to the materials, tools and equipment used in punching operation.

i. What are the classifications of materials used for punching operation?
ii. Identify the properties of materials used for punching operation.
iii. Identify punching tools
iv. Identify punching equipment

Key readings 1.3.1: Identification of tools, materials and equipment for punching operation.

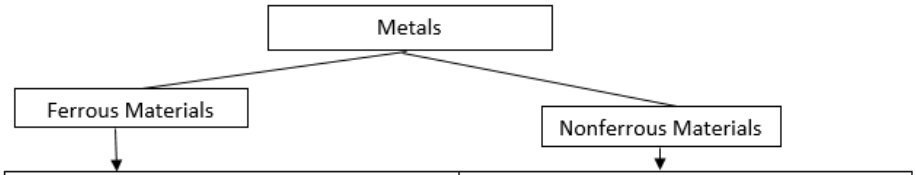
- **Classification of materials for punching operation.**

  The metals may be further classified as ferrous metals and non-ferrous metals

  The ferrous metals are those which have the iron as their main constituent, such as cast iron, wrought iron and steel.

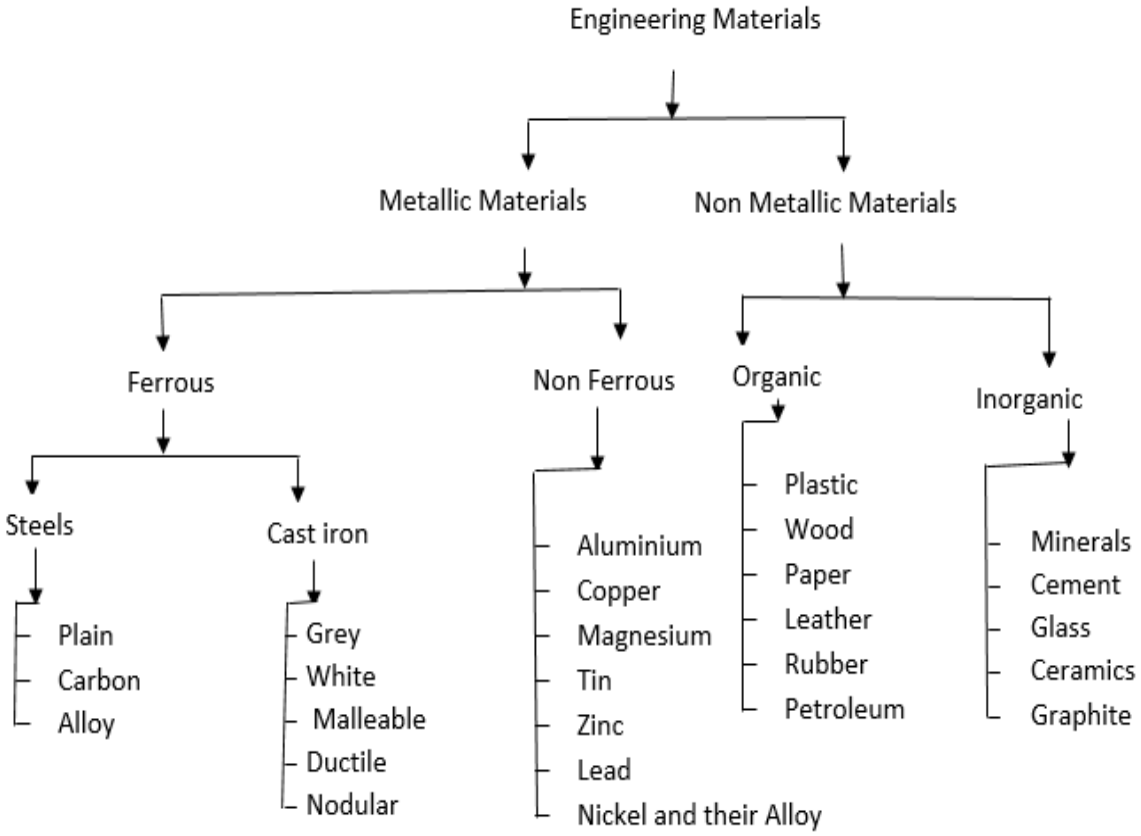
  The non-ferrous metals are those which have a metal other than iron as their main constituent, such as copper, aluminum, Brass, Tin, Zinc, Etc.

  ✓ **Classification of metals**



Cast Iron	Aluminum
Wrought Iron	Copper
Steel: Low Carbon Steel Medium Carbon steel High Carbon Steel Alloy Steel High Speed steel	Lead Nickel Tin Zinc Nonferrous alloys: Brass (Copper-Zinc Alloy) _ Bronze(Copper-Tin Alloy)

✓ **Classification of engineering materials**



- **Properties of materials for punching**
  - ✓ **Physical Properties of Materials.**
    - **Density:** Implies the weight of a material, with higher density rates implying heavier materials
    - **Melting point:** The minimum required temperature for a solid material to change into liquid
    - **Colour:** The reflective property of a material
    - **Boiling point:** The minimum required temperature for a liquid material to change into gas
  - ✓ **Mechanical Property of Materials:**

    The mechanical properties of the metals are those which are associated with the ability of the material to resist mechanical forces and load. The following are mechanical properties of metals:

    - **Strength.** It is the ability of a material to resist the externally applied forces without breaking or yielding.
    - **Stiffness**. It is the ability of a material to resist deformation under stress.
    - Elasticity. It is the property of a material to regain its original shape after deformation when the external forces are removed.
    - **Plasticity.** It is property of a material which retains the deformation produced under load permanently

- **Ductility.** It is the property of a material enabling it to be drawn into wire with the application of a tensile force. A ductile material must be both strong and plastic. The ductile material commonly used in engineering practice are mild steel, copper, aluminium, nickel, zinc, tin and lead.
- **Brittleness.** It is the property of breaking of a material with little permanent distortion. Cast iron is a brittle material. Brittle materials cannot be punched such as: Cast iron, Casted aluminium, Ceramics, Glass
- **Malleability.** It is a special case of ductility which permits materials to be rolled or hammered into thin sheets. A malleable material should be plastic but it is not essential to be so strong. The malleable materials commonly used in engineering practice are lead, soft steel, wrought iron, copper and aluminium.
- **Toughness.** It is the property of a material to resist fracture due to high impact loads like hammer blows. The toughness of the material decreases when it is heated. This property is desirable in parts subjected to shock and impact loads.
- **Machinability.** It is the property of a material which refers to a relative case with which a material can be cut. It may be noted that brass can be easily machined than steel.
- **Hardness.** It embraces many different properties such as resistance to wear, scratching, deformation and machinability etc. It also means the ability of a metal to cut another metal.

- **Properties of punching tools:**
  - ✓ Good wear resistance
  - ✓ High compression strength
  - ✓ High impact strength
  - ✓ Toughness
  - ✓ High fatigue strength
- **Tools used in punching operation:**
  - ✓ **Dies and punch**

Punches: are simple tools that are forced by a punch press through a workpiece, commonly sheet metal, to create quick, precise holes by shearing.

Punches are typically made of carbides or tool steel. Most presses are operated mechanically, but simple hand punches also are used. A punch frequently passes through the material and into a die.

A die holds the work piece, and determines the shape produced on it by the punch. Dies are usually customized to the particular item being produced.

- **Types of Punching Dies:**
  - **Simple Die.**

Also known as a single operation die, the simple die is a shaping tool that performs one operation per press slide stroke. This type of die is typically used for smaller applications

in the workplace. For example, it may be useful for the manufacturing of simple metal parts.

The benefit of a simple die is that it's an excellent option if you're looking for a tool that can handle blanking and piercing jobs.

It consists of a die block and stripper plate, which holds onto the metal sheet while the punch cuts a hole and removes the blanks. The main downside is that the simple die is less efficient and less suited for larger applications than other dies.

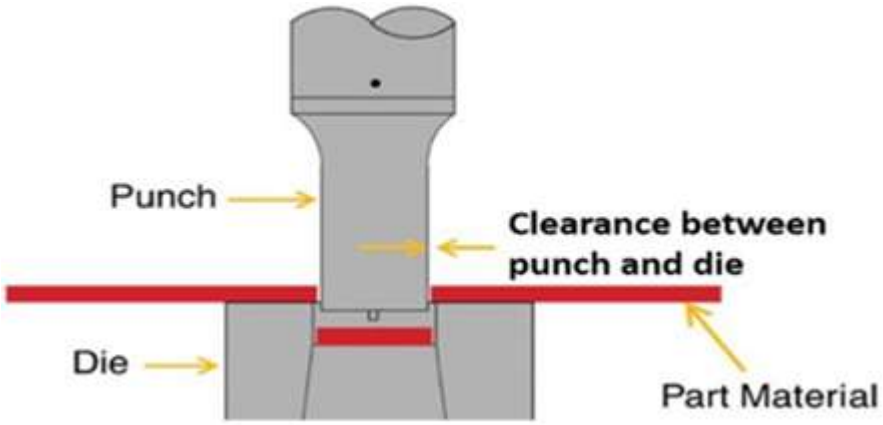


Fig1: Simple die

- **Compound Die.**

For more demanding or complex blanking and piercing applications, a compound die can do the job faster. Rather than handling just one operation at a time, the compound die can simultaneously complete the blanking and piercing processes.

The compound die is less useful for bending and forming operations, and it tends to require a higher level of force than some of the other options. That said, it's a more cost-effective option than the simple die when it comes to manufacturing washers and other flat metal parts.

If you're looking for types of punches and dies that you can use in general cutting applications, the compound die could be the solution you need.

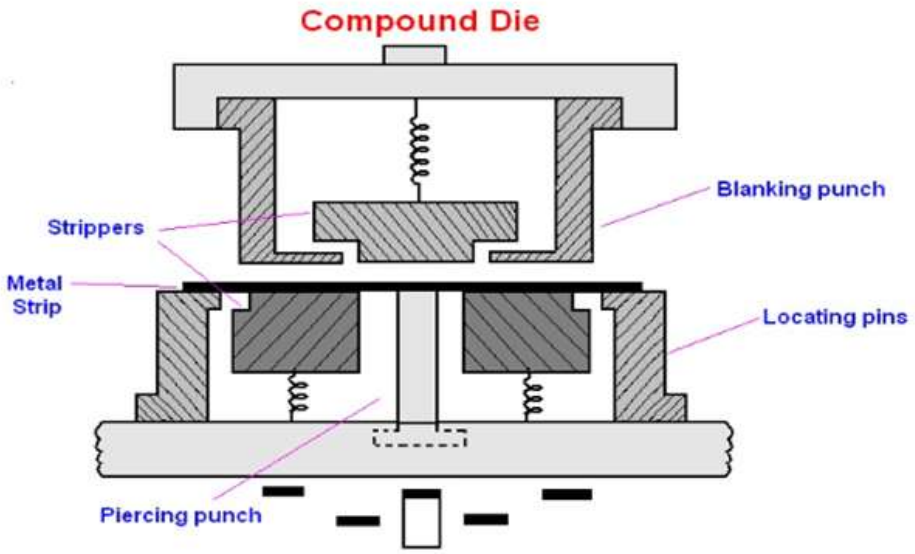


Fig2: Compound die

- **Progressive Die.**

While a progressive die can handle more than one operation at a time, it does so in several stages throughout multiple work stations. The progressive die's main advantage is that it's more efficient thanks to its high work speed and the reduced level of force.

While the multi-station design is more challenging to manage than the single-station unit, it's easier for the progressive die to maximize punching productivity. That's why engineers use progressive dies to make automotive parts, electronics and similarly complex components.

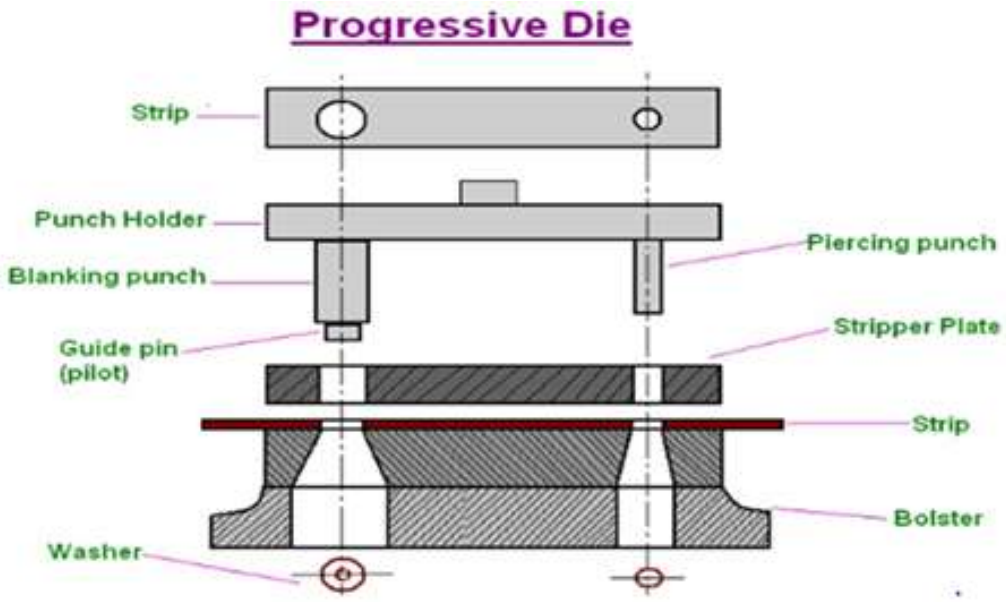
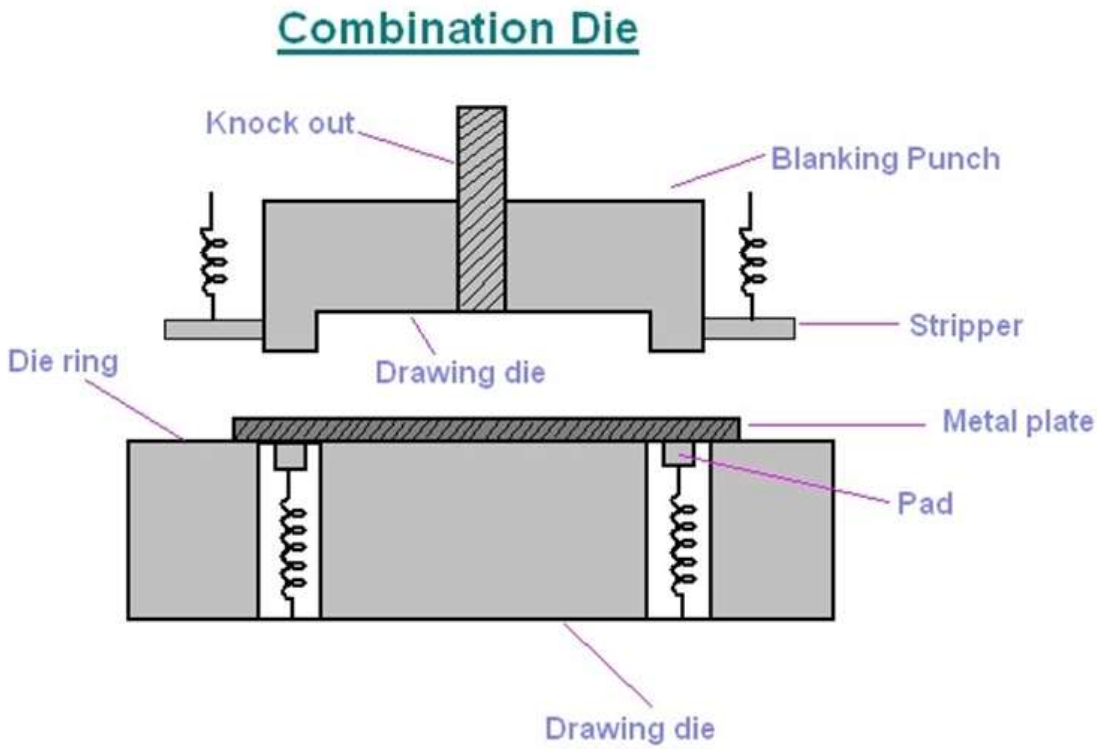


Fig3: progressive die

- **Combination Die.**

The combination die is similar to the compound die in terms of design and efficiency. It can handle more than one operation at once, which allows it to deliver faster, more reliable results. As an added bonus, the combination die is well-suited for both cutting and shaping applications.

If you need to complete a blanking or punching operation combined with a bending operation, the combination die will have you covered. This versatile tool can play a role in all types of metalwork applications, from mining equipment manufacturing to electronics and appliance development.



- **Classification and uses of different types of punches.**
  - ✓ **According to the Shape**

Punches are mostly classified according to the shape of their points. The most popularly used punch amongst these is the prick punch which is quite helpful for placing the reference marks on metal sheets. These types of punches are used to transfer the dimensions from a paper pattern directly on to the metal. In order to take the reference correctly you need to place the paper pattern directly on the metal that too in the orientation in which you need to obtain the results.

- ✓ **According to the Slider Movement**
  - Single action punch
  - Double action punch
  - Three actions punches

Types of Punches:

- **Prick Punch**

Prick punch is known as the most used and common type of punch in today's professional world. Most of the people are found using this punch while transferring the dimensions from a paper pattern on to the metal and then to use them as a point of reference for cutting or fabricating purposes. Prick punches are found to be similar to centre punches which can have a narrow point and are also used for marking a design or layout.

Shifting the dimensions is done by placing the paper pattern directly on the metal and in order to select its orientation properly and accurately. By hitting the punch lightly with a hammer, the pattern gets outlined on the metal which creates slight indentations on the metal

Fig4: Prick punch

- **Centre Punch.**

Centre punch are quite adequate when it comes to take the reference marks for metals, but there are some metal works which require a larger indentation. So, with a Centre punch, it can make indentation along with the reference marks in metal that seem to be quite large for drilling activities. The Centre punches are found to be heavier as compared to the prick punch and also have a point ground at an angle of 60 degrees. While striking a Centre punch as excessive force, an unnecessary protrusion and dimples around the created markings can be found. Centre punches are also used in order to mark the indentation for a guiding drill bit and to also identify a location on a surface. Centre punches are observed to be highly pointed, in order to obtain large circular indentations. These are also used as a prepping tool. The drill bit is found locking it against the punch mark after which the hole is made without any constraint. These types of punches are equipped with a knurled rod, which is an easy grip- tool and stops your drill from wandering.

Fig5: Center Punch

- **Drift Punch.**

Drift punches are Also referred to as drift pins and are mostly used to align bolt or rivet holes so that the fasteners can be inserted properly. In case there is a need to remove the damaged rivets, bolts, and pins which bound up in holes, then one must use a drive punch.

Drift Punch should be labelled as anti-drift tool as this member of the punch family is specifically designed to align the fastener holes.

Fig6: Drift Punch

- **Pin Punch.**

A pin punch: is found having a straight shank which has various applications in removing bolt or pin. The foremost purpose of pin punch is to finish the removal of bolts or pins from a hole which is already loosened up by a drive punch.

A Pin punch can entirely drive rivets and pins from a hole until they are taken out, which cannot be done by the drive punches. The removal of bolts or pins from holes can only be performed by the drive and pin punches. Pin punches are quite used in order to drive a pin into a mating bore.

A pin punch can be used when a small metal shaft is trapped in a hole.

Fig7: Transfer punch

- **Transfer punch.**

Transfer punches can be known to have a set shank diameter which is specifically designed in order to transfer the geometry of several tapped holes by fitting the bore with close tolerances and by also marking the Centre of the hole on any other surface.

For making drill-locating holes in a template can be easily done by the help of a transfer punch. The dimension of a transfer punch is normally kept around 4-inches which is sufficient to transfer the location of holes via pattern or a template on the metal. The transfer punch has a point which initially tapers and then subsequently runs straight for a lesser distance. This pointy tip of a transfer punch is somehow quite similar to the prick Punch

Fig7: Transfer punch

- **Ejector Pin Punch.**

Ejector punches are those mechanical devices which are designed to knock-the out material or to eject the parts after pressing or stamping operation. A punch is certainly built from an equally rigid metal which is shaped like a pen.

Fig8: Ejector punch

- **Marking Punch.**

Marking punches are referred to as those punches which are used to emboss or create a specific texture on the surface of a material or work piece.

Fig9: Marking punch

- **Pilot Punch.**

Pilot punches are found having an inner pin which is used for aligning the punch into an existing hole or also for allowing the outer point to cut out a larger hole. These punches are quite similar to solid or regular punches which have a solid flat point with no voids or internal bores.

Fig10: Pilot punch

- **Letter Punch**

A letter punch is also referred to as letter stamp in common language and is most commonly used in our day-to-day life as well as in various industries. The working of a letter punch is mainly done by embossing the letters or numbers into the work piece. The most common thing about this type of punch is that they are mostly the reversed images, which tend to give results in an immediately readable format.

Fig11: Letter Punch

- **Hollow Punch.**

Hollow punch is referred to as a mechanical device which is made from the hardened carbon steel. These instruments are designed to puncture a surface like metal sheet or leather for creating a hole. The working end can differ in shape or size in order to protect the work surface from being damaged.

These types of punches are found working in screw mounting plates, drain valves, locks and keys and many more.

Fig12: Hollow punch

- **Dot Punch.**

Dot punch can be termed as a lighter version of a centre punch which is used for the similar type of work, but is used wherever the required intensity for the indentation is less. This type of punches are given priority as they are found to be more accurate as compared to the centre punch.

A ball peen hammer is used to hit the head of the punch which delivers enough force directly to the point of the punch in order to put a small indentation into the surface of any material. It must be made clear that both the dot and Centre punch are found having similar type of applications.

Fig13: Dot punch

- **Automatic Centre Punch.**

An automatic center punch is referred to as a hand tool which is used in the production of a hole in a work piece. The type of material can be any, but mostly it is the metal sheet. This instrument is found performing the same function as that of an ordinary Centre punch that too without the need of a hammer.

It works in the following way:

Once it is pressed against the work piece the energy gets stored in the spring and gets released eventually, when it has an impulse that drives the punch in order to produce the hole. The impulse which is provided to the point of the punch is continuous which allows uniform impressions to be made.

Fig14: Automatic center punch

- **Bell Punch.**

A bell punch is a mechanical device which is used for punching purposes and is known to have accurate self-Centre on a round bar material. These instruments are found in varying sizes wherein the maximum diameter of a bell punch is found to be 35mm. A bell punch is completely machined in steel in order to create punch without being failed. Using this instrument is quite simple and easy by placing the sheet which needs to be punched, after which the hardened punch gets centralized

Fig15: Bell punch

- **Types of punches according to their cutting-edge shape.**
  - ✓ **Round Punch.**

Description: A cylindrical punch used to create circular holes.

Applications: Ideal for making holes for bolts, rivets, and other fasteners in sheet metal and other materials.

Fig16: Round punch

- ✓ **Square Punch:**

Description: A punch with a square cross-section for creating square holes.

Applications: Used in the production of grids, perforated screens, and various decorative patterns.

Fig17: Square punch

- ✓ **Rectangular Punch:**

Description: A punch with a rectangular cross-section for creating elongated holes or slots.

Applications: Commonly used in automotive parts, electronic enclosures, and other applications requiring rectangular slots.

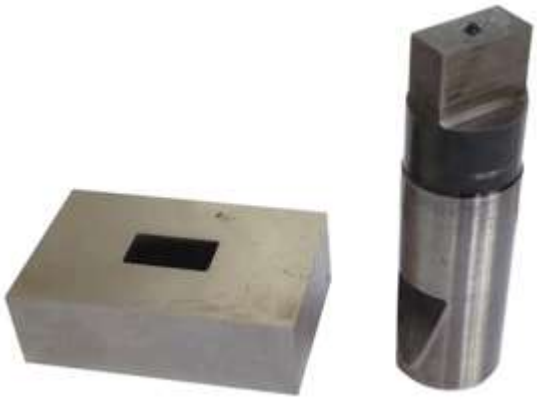


Fig18: Rectangular punch

- ✓ **Oblong Punch.**

Description: A punch designed to create oblong or oval-shaped holes.

Applications: Suitable for creating ventilation slots, elongated holes in machine components, and custom applications.

Fig20: Oblong Punch

- ✓ **Hexagonal Punch:**

Description: A punch with a hexagonal cross-section for creating hexagon-shaped holes.

Applications: Often used for honeycomb structures, decorative panels, and holes for hexagonal nuts and bolts.

Fig21: Hexagonal punch

- ✓ **Custom Shape Punch:**

Description: Punches designed to create unique, irregular shapes according to specific design requirements.

Applications: Used for custom parts in industries such as automotive, aerospace, electronics, and consumer goods.

The below tool is a custom punch for heart hole shaped

Fig 22: Custom punch

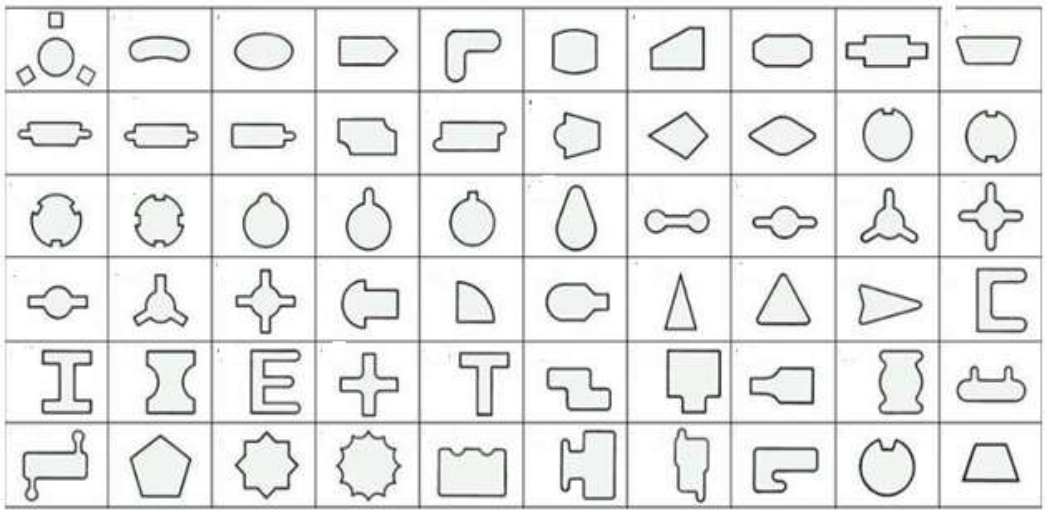


Fig23: Custom shapes:

- ✓ **Perforating Punch.**

Description: A punch used to create multiple small holes in a pattern across a material.

Applications: Used for making filters, speaker grilles, and decorative elements.

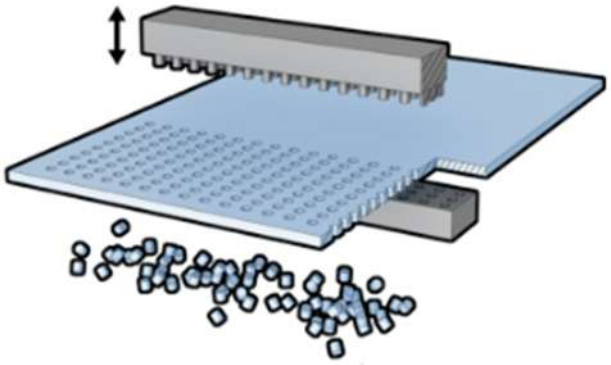


Fig24: Perforating punch

- ✓ **Notching Punch and its die:**

Description: A punch used to remove material from the edge or corner of a workpiece to create a notch.

Applications: Common in sheet metal work for creating interlocking pieces and preparing edges for welding.

The following tool is corner notching punch

Fig25: Notching punch

- ✓ **Lancing Punch.**
- **Description:** A punch that creates a slit and forms a tab without removing any material from the workpiece.
- **Applications:** Used for creating ventilation louvres, hooks, and tabs.

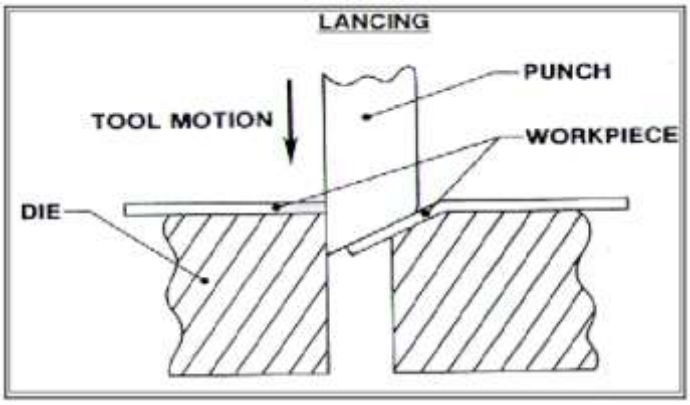


Fig26: Lancing punch

- ✓ **Nibbling Punch.**
- **Description:** A punch used in a nibbling machine to create a series of small, overlapping holes or notches for a continuous cut or complex shape.
- **Applications:** Suitable for cutting complex shapes and contours in sheet metal.

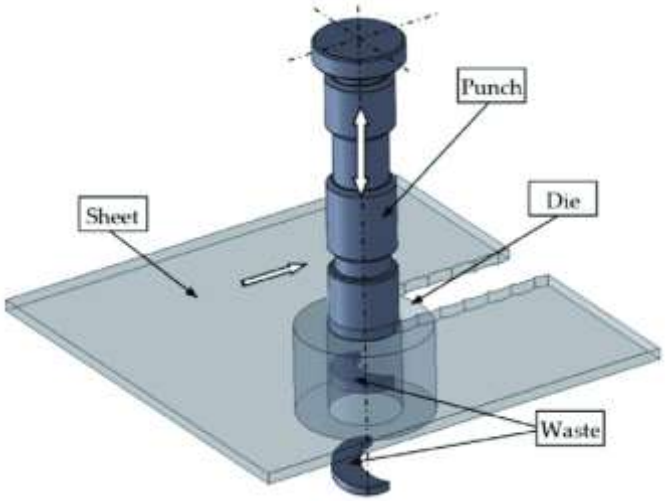


Fig27: Nibbling punch

- ✓ **Slitting Punch.**

Description: A punch designed to create long, straight cuts in the material.

Applications: Used to cut strips of material or to create separation lines.

Fig28: Slitting Punch

- ✓ **Piercing Punch.**
- **Description:** A punch used to create holes that do not remove any material, typically for decorative purposes or lightening components without compromising structural integrity.
- **Applications:** Used in decorative panels and lightweight structures.

Fig29: Piercing Punch /HSS Punches

- **Punching equipment.**
  - ✓ **Hand operated punching machine**

A metal handheld punching machine is a portable device that is used for punching holes in metal

sheets or other materials. It is typically designed to be operated by hand and does not require any

external power source, making it convenient for on-the-go applications or areas without access to

electricity.

- **Description:** Operated by hand, these machines use a lever or handle to punch holes.
- **Applications:** Suitable for low-volume production and light materials like plastic and thin metal sheets.
- **Advantages:** Simple to use, cost-effective, and requires no power source.
- **Example:** Handheld punch for creating holes in paper or thin metal sheets.

Fig30: Hand operated punching machine

- **Classification of punching machine according to the driving force of the slider.**
  - ✓ **Mechanical Punching Machine**
  - **Description:** Utilizes mechanical force, typically driven by a flywheel and crank mechanism.
  - **Applications:** Common in high-volume production environments, suitable for various materials.
  - **Advantages:** High-speed operation, suitable for repetitive tasks, and relatively low maintenance.
  - **Example:** Mechanical punch press used in automotive manufacturing.
  - **Working principle of mechanical punch:**
    - **Position the Material:** Place the material under the punch.
    - **Adjust Settings:** Set the punch height and stroke length.
    - **Start the Machine:** Engage the flywheel to build momentum.
    - **Punch the Material:** The crank mechanism drives the punch through the material.
    - **Reset:** Return the punch to its starting position and remove the material.

Fig31: Punch press

- ✓ **Hydraulic Punching Machine**

A die or mold is used to cut through the material in a hydraulic punching machine. The die is placed

over the material, and a hydraulic ram is used to force the die through the material. The ram applies

a large force to the die, which cuts through the material.

- **Description:** Uses hydraulic power to drive the punch through the material.
- **Applications:** Ideal for medium to heavy-duty punching tasks, capable of handling thicker materials.
- **Advantages:** Provides high force, suitable for larger and thicker materials, and offers precise control.
- **Example:** Hydraulic press for punching large holes in metal sheets.

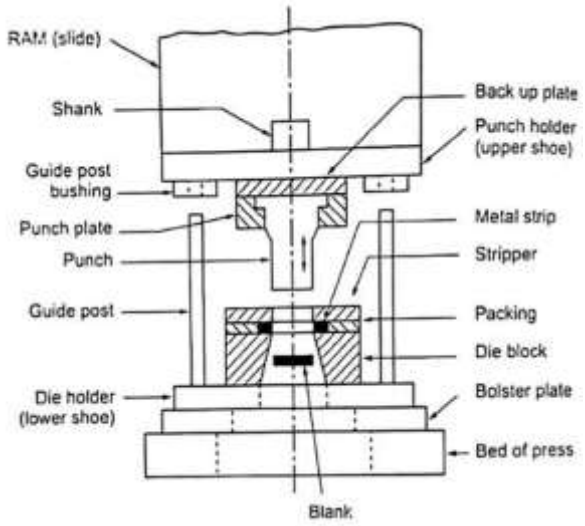


Fig32: Hydraulic punching machine

- **Working principle of hydraulic punching machine:**
  - **Position the Material:** Place the material on the die under the punch.
  - **Set the Parameters:** Adjust the hydraulic pressure settings based on material thickness.
  - **Activate the Machine:** Use the control panel to activate the hydraulic system.
  - **Punch the Material:** The hydraulic ram pushes the punch through the material.
  - **Release the Pressure:** Deactivate the hydraulic system and remove the punched material.

✓ **CNC turret punching Machine /automatic hole punching machine**

- **Description:** Controlled by computer numerical control (CNC) for precise and automated punching operations.
- **Applications:** High-volume, high-precision applications, and complex shapes.
- **Advantages:** High accuracy, flexibility, and automation capabilities. Can perform multiple operations in one setup.
- **Example**: CNC turret punch press used for creating complex patterns in metal sheets.

Fig33: CNC punching machine

- **Working principle of CNC punching Machine**
  - **Upload the Design:** Import the CAD file into the CNC machine.
  - **Set Up Material:** Place the material on the machine bed.
  - **Program the Machine:** Input parameters like punch location, depth, and sequence.
  - **Run the Program:** Start the CNC program to automate the punching process.
  - **Inspect Output:** Remove and inspect the punched material for accuracy**.**

Practical Activity 1.3.2: Selecting materials, tools and equipment for punching

Task:

1: You are requested to go in manufacturing workshop and select the right tools, materials, and equipment required for punching out a circular blank of 40mm of diameter from a mild steel sheet metal, based on the right selection criteria.

2: Select and Wear appropriate PPE related to the task.

3: List out the tools, material and equipment required in punching operations.

4: Select the right tools, materials, and equipment required in punching operations.

5: Present your work to the trainer, workshop assistant or your classmates

6: For more information, read the key reading 1.3.2.

7: Perform the task provided in application of learning 1.3

Key readings 1.3.2: Selecting materials, tools and equipment for punching operations.

Selecting the appropriate material for punching operations in manufacturing involves considering several critical factors to ensure optimal performance, quality, and cost-effectiveness.

- **key factors to be considered while selecting materials for punching:**
  - ✓ **Material properties:**
    - **Tensile Strength:** Materials with higher tensile strength require more force to punch, which can affect tool wear and machine capacity.
      - **Example:** High-strength steel (HSS) requires more force to punch compared to mild steel. This can lead to increased tool wear and necessitate the use of a more robust punching machine.
      - **Impact:** Higher tensile strength materials might need special tooling and increased maintenance schedules.
    - **Ductility:** Ductile materials are less likely to crack or fracture during punching, making them more suitable for the operation.
      - **Example:** Aluminum is highly ductile and less likely to crack during punching, making it suitable for complex shapes. In contrast, brittle materials like cast iron can crack easily.
      - **Impact:** Ductile materials facilitate smoother punching processes and reduce the likelihood of defects.
    - **Hardness:** Harder materials can cause increased tool wear and may require more robust punching equipment.
      - **Example:** Stainless steel, being harder than mild steel, causes greater wear on punches and dies. It often requires tools made from high-speed steel (HSS) or carbide.
      - **Impact:** Harder materials necessitate the use of durable, wear-resistant tooling, increasing initial tooling costs.
    - **Thickness:** Thicker materials need more punching force and can affect the choice of punching machine and tools.
      - **Example:** Punching a 10mm thick steel plate requires significantly more force and robust machinery compared to a 1mm thick sheet.
      - **Impact:** Thicker materials require more powerful punching machines and can lead to quicker tool wear.
    - **Work Hardening:** Materials that harden during deformation can affect the ease of punching and tool wear.
      - **Example:** Metals like stainless steel and some aluminum alloys harden when deformed. This makes subsequent punching operations more difficult and increases tool wear.

- **Impact:** Materials that harden during deformation may need frequent tool sharpening or replacement and more powerful machinery.

✓ **Tooling Considerations.**

- **Tool Material**: The material of the punch and die must be suitable to handle the selected material's hardness and toughness.
  - **Example:** Carbide tools are used for punching hard materials like stainless steel, while HSS tools may be sufficient for softer materials like aluminium.
  - **Impact**: The choice of tool material affects tool life and efficiency.
- **Tool Design:** The design of the punch and die should accommodate the material's properties to prevent excessive wear and ensure precise cutting.
  - **Example**: For punching aluminium, a simple punch and die set may suffice. However, for intricate shapes in hardened steel, a specially designed punch with reinforced edges might be necessary.
  - **Impact:** Proper tool design minimizes wear and ensures precise cutting.
- **Tool Coating:** Coated tools can reduce friction and wear, especially when working with harder materials.
  - **Example:** Titanium nitride (TiN) coatings on punches reduce friction and wear when punching stainless steel.
  - **Impact:** Coated tools can extend tool life and improve performance, especially with harder materials.

✓ **Punching Machine Capabilities.**

- **Machine Force Capacity:** The machine must provide sufficient force to punch through the material without excessive strain.
  - **Example:** A hydraulic punch press capable of exerting 200 tons of force can handle thick, high-tensile materials, whereas a mechanical press with lower force capacity may only handle thinner, softer materials.
  - CNC punching machines offer precision and are ideal for high-volume, complex shapes, while manual punching machines are better suited for simple, low-volume tasks.
  - **Impact:** The machine must match the force requirements of the material being punched.
  - The choice of machine affects accuracy, efficiency, and suitability for specific materials and shapes.

✓ **Production Volume:**

- **High-Volume Production:** For high-volume operations, materials that offer consistent quality and minimize tool wear are preferred to reduce downtime and maintenance costs.
- **Example:** In automotive manufacturing, high-volume production with consistent material like mild steel reduces tooling wear and downtime.
- **Impact:** Consistency and durability of the material are crucial to minimize

interruptions.

- ✓ **Quality Requirements.**
  - **Surface Finish:** Materials that yield a clean edge with minimal burrs are preferred to reduce post-processing steps.
  - **Example:** Brass produces a clean edge with minimal burrs, making it suitable for decorative and electrical applications.
  - **Impact:** Materials that result in a clean punch reduce the need for secondary finishing processes.
- ✓ **Dimensional accuracy**
  - **Dimensional Accuracy:** The material should maintain dimensional stability during and after punching to meet precise specifications.
  - **Example:** High-precision components in aerospace require materials like titanium, which maintain dimensional stability during punching.
  - **Impact:** The material must support precise tolerances and consistent quality.
- ✓ **Cost Considerations.**
  - **Material Cost:** The cost of the raw material must align with the project budget while meeting all other requirements.
    - **Example:** Mild steel is more cost-effective than stainless steel or titanium, making it suitable for budget-sensitive projects.
    - **Impact:** The material cost must align with the project budget without compromising quality.
  - **Tooling Cost:** Materials that require less expensive tooling or longer tool life can reduce overall production costs.
    - **Example:** Materials like stainless steel require expensive, wear-resistant tooling compared to softer metals.
    - **Impact:** Selecting materials that extend tool life can reduce overall production costs.

- **Key factors for selecting punches for punching operations:**
  - ✓ **Tool materials:**
    - Tool Steel is a Common Material used for general punching operations.
    - High-Speed Steel (HSS) is Durable it can handle high temperatures and wear.
    - Carbide is Hardness and Wear Resistance it is Excellently used for high-strength materials for stainless steel.
    - Coated Tools Reduce Friction, Coatings like Tin reduce wear.
    - Its extends tool life and improves cutting quality.

  - ✓ **Clearance:**
    - Proper Clearance Between punch and die ensures clean cuts.
    - A well-set clearance Reduces burrs and tool wear.
    - Mathematical relation used to calculate clearance between die and punch:

- Die = size of product punch = Die size - 2 clearance.
- An industry rule of thumb is for die clearance to be about 10% of the punched material's stock thickness.

Factors affecting Die Clearance:

- Punch & workpiece material type.
- Punch & workpiece material thickness.
- Punch & workpiece material hardness.
- Punched hole size & geometry and tolerance.
- Anticipated tool life.

General factors affecting the selection of punches and dies:

- Die clearance
- Dies and punches materials
- Shape required
- Materials to be punched

- **Tips for selecting punching machines**

✓ **Material size and thickness**

- The size of the workpiece should suit the machine bed for effective work to be done.
- Small machine bed sizes of 4ft x 4ft will suit similar or smaller workpiece.
- On the other hand, a bed size of 4ft x 8ft or 5ft x 10ft would be recommended for businesses that will handle bigger workpiece.
- Also, depending on the thickness of the material they intend to work with, a company should consider the tonnage of the machine they acquire.
- standard punching machines are offered in 20-ton or 30-ton configurations, with the 30-ton machine being suitable for thick materials of up to 30mm.

✓ **Material handling capabilities**

- If the business does not intend to incorporate labor in its production or when lights-out production is the goal, they can consider the punching machine's automation.
- Automation will increase efficiency and allow high-volume processing of materials.

✓ **Machine productivity**

- Machine productivity refers to the punching machine's production rate and is measured in strokes per hour.
- The punch press, for example, has a productivity of 5400 strokes per hour which is very high compared to the press brake, which has a productivity of 3000 strokes per hour.
- Knowing the productivity needs for each business would help them to select a machine that suits their workload.

✓ **Setup reduction and productivity**

- Part processing involves the development of a part with different tools.
- Faster machines will guarantee quicker processing of workpiece than slower machines.
- This is important when considering non-value-adding processing such as material loading, tool changing, and relocation clamps
- Over time, a machine that takes 20 seconds to work on a piece will be more efficient than one which takes 26 seconds.
- The difference of 6 seconds cumulatively adds up to a significant increase in productivity.

✓ **Part complexity**

- Depending on the part's complexity, the number of workstations can vary.
- Simple features will mean that each station has a small number of tools, for example 20.
- It translates to more workstations and, consequently, a smaller turret.
- Parts with more complex geometric features will require as many as 48 tools, and a larger turret

Points to Remember

- While identifying materials for punching consider should be consider material classifications (Metals, Polymers, Ceramics, Composites) and properties (physical and mechanical). Avoid brittle materials like Cast Iron, Casted Aluminum, Ceramics, and Glass, as they are unsuitable for punching.
- While identifying Punching Tools take into consideration of punching dies (Simple, Compound, Progressive, Combination) and punches (classified by cutting edge shape and slider movement) suitable for the operation.
- While identifying punching equipment Choose between handheld punching equipment for smaller tasks and industrial punching equipment for larger-scale operations.
- When selecting materials for punching remember to consider the materials properties
- While selecting punching tools such as punch and die consider the tool materials, tool design and tool coating.

- Material size and thickness, Machine productivity, set up reduction, part complexity and product quality requirement must be taken into consideration while selecting punching equipment.

Application of learning 1.3.

There are many manufacturing factories that fabricate chairs by assembling formed metals and punched plastic seats by using rivets. You are requested to visit one of these factories and carry out the following tasks:

i. Select materials required for fabricating the chair seat
ii. Select tools required for fabricating the chair seat by using rivets of 8mm of diameter.
iii. Select equipment required for punching the chair seat

Indicative content 1.4: Pre-operation Activities of Punching Equipment

Duration: 1hr

Theoretical Activity 1.4.1: Description of working principles and basic maintenance activities of punching equipment.

Tasks:

1: You are requested to answer the following questions:

i. Explain the working principle of punching equipment.
ii. Explain the following basic maintenance activities for punching equipment:
   a. Lubricating
   b. Cleaning
   c. Tightening

3: Write the provided answer on flip chart /paper

4: Present the findings/answers in whole class

5: Follow actively the trainer's clarification and ask questions if any.

6: For more information, read the key readings 1.4.1.

Key readings 1.4.1

Description of working principles and maintenance of punching equipment.

- **The working principle of punching is described as follow:**

When punching, the workpiece is placed on the lower tool which is called die.
The upper tool, the punch, is pressed against the workpiece with an applied pressing force.
Depending on the design of the workpiece, one or more subsequent strokes is needed.
A scraper ensures that the plate is detached from the punch if it gets stuck and is lifted up after the strike.
There are a variety of punching tools that can do everything from cutting straight lines and creating pre-tapped holes to Engraving and carrying out minor bending operations.
To punch out a hole the material is subject to shearing between the punch and die. During the punching process material is displaced and then loosen completely by material failure. This gives both the punched detail and bore, the typical cut surface seen in punching operations.

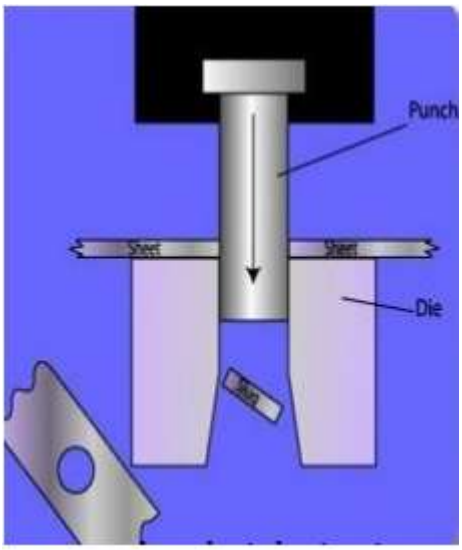


Fig34: Illustration of punching machine working principle.

- **Basic maintenance of punching machine:**
  - ✓ **Basic Maintenance activities of punching machine include:**

Lubricating: Lubricating refers to the process of applying a substance (lubricant) between two surfaces in relative motion to reduce friction, wear, and heat generation. Lubrication helps in the smooth functioning of mechanical systems by creating a thin film that separates the moving parts, preventing direct metal-to-metal contact. This not only enhances the efficiency and lifespan of the machinery but also aids in cooking, cleaning, and protecting the surfaces from corrosion and other forms of damage.

Types of Lubricants:

- **Oils:** Commonly used in engines and machinery for their fluidity and heat dissipation properties.
- **Greases:** Thicker than oils, greases are used in applications where lubrication needs to stay in place for a long time, such as in bearings.
- **Solid Lubricants**: Materials like graphite and Teflon are used in environments where liquid lubricants are unsuitable.
- **Gases**: In some high-precision or high-speed applications, gases like air or nitrogen are used as lubricants.

Benefits of lubrication:

- **Reduction of Friction:** By providing a slippery film, lubricants reduce the resistance between moving parts, allowing them to move more freely and efficiently.
- **Wear Reduction:** Lubrication minimizes wear and tear by preventing direct contact between surfaces, thereby extending the life of components.
- **Heat Dissipation:** Lubricants can absorb and dissipate heat generated by friction, helping to maintain optimal operating temperatures.
- **Corrosion Prevention:** Many lubricants have protective properties that prevent rust

and corrosion, safeguarding the surfaces they coat.

- **Contaminant Removal:** Lubricants can help in carrying away debris and contaminants from the contact surfaces, maintaining cleanliness and performance.

Lubrication methods:

- **Manual Lubrication**

In manual lubrication**,** lubricant is applied manually using tools like grease guns, oil cans, or brushes.

Manual lubrication is Suitable for low-speed, low-load machinery, or when lubrication points are infrequent.

Example: Applying oil to a door hinge using an oil can.

- **Drip Feed Lubrication**

In drip feed lubrication, lubricant is delivered drop by drop from a reservoir to the lubrication point.

This method of lubrication is common in machinery with slow-moving parts or where precise control of lubricant quantity is needed.

Example: Drip feed lubricators in textile machines.

- **Splash Lubrication**

In splash lubrication, moving parts splash lubricant around the interior of a housing, ensuring all parts are coated.

Splash lubricant is common in gearboxes and internal combustion engines.

Example: Engine crankcase lubrication.

- **Force-Feed Lubrication**

In force feed lubrication, lubricant is forced through pipes and nozzles under pressure, usually by a pump.

This method is applied for High-speed or high-load machinery requiring continuous lubrication.

Example: Oil lubrication systems in large industrial engines.

- **Oil Bath Lubrication**

In oil Bath lubrication, Parts are partially submerged in a bath of oil, ensuring constant lubrication as they rotate or move.

This method is applied on Gearboxes, chain drives, and some bearing housings.

Example: Lubrication of gears in a gearbox.

- **Grease Lubrication**

In grease lubrication grease is applied to surfaces, often using grease guns or automatic dispensers.

This method pf lubrication is suitable for Bearings, bushings, and other components requiring a lubricant that stays in place.

Example: Greasing wheel bearings in vehicles.

- **Automatic Lubricators**

This method uses devices that automatically dispense lubricant at set intervals or based on machinery conditions.

Applications: Machinery requiring consistent lubrication without manual intervention.

✓ **Advantages of automated lubrication**

- All critical components are lubricated.
- Lubrication occurring in operating condition of machinery.
- Safe operation of machinery due to proper lubrication.
- Energy consumption is less due to less friction.
- Overall productivity is increased due to reduction in down time.
- Lubrication is carried out in proper safety.

- **Solid Lubrication**

In solid lubrication, Solid lubricants like graphite, molybdenum disulphide, or Teflon are applied to surfaces.

This method is suitable for the environments where liquid lubricants are impractical, such as high temperatures or vacuum conditions.

Example: Solid lubricant coatings in aerospace components.

- **Circulating Oil Systems**

Description: Oil is continuously circulated through the system, filtered, and cooled before being returned.

Applications: High-load and high-speed machinery requiring clean and cooled lubricant.

Example: Lubrication systems in large turbines and compressors.

- **Oil Jet Lubrication**

In this method, High-pressure jets of oil are directed at the lubrication points.

Applications: High-speed gears and bearings.

- ✓ **The Cleaning of punching machine:**

The cleaning activities of punching machine after use involves the following cleaning tools and their functions, steel wire brush to remove loosen chips and cloth rugs used to remove oil and greases

Practical Activity 1.4.2: Performing Pre-operation activities for maintaining punching equipment

Task:

1: Individually, you are requested to go in Manufacturing workshop for cleaning and lubricating the punching equipment.

2: Select and wear appropriate PPE according to the work to be performed.

3: Select lubricant and cleaning tools according to the work requirement.

4: Individually clean and lubricate punching equipment.

5: Present your work to the trainer, workshop assistant or your classmate.

6: For more information, read the key reading 1.4.1.

7: Perform the task provided in application of learning 1.4

Key readings 1.4.2: Performing Pre-operation activities for maintaining punching equipment

- **Procedure of applying lubricant on punching machine:**
  - ✓ Clean the punching equipment thoroughly before applying lubricant. Use a brush or cloth to remove any debris, dust, or residue on the surfaces.
  - ✓ Choose the appropriate lubricant for the punching equipment.
  - ✓ The lubricant should be compatible with the materials used in the equipment and provide adequate protection and lubrication.

- ✓ Apply the lubricant to the moving parts of the punching equipment. Use a brush or applicator to ensure that the lubricant is evenly distributed. Pay special attention to areas where metal parts come into contact with each other.
- ✓ Avoid over-lubricating the equipment. Excess lubricant can attract dirt and debris, which can cause wear and damage to the equipment.
- ✓ Wipe off any excess lubricant with a clean cloth or paper towel.
- ✓ Test the punching equipment to ensure that it is functioning properly after applying the lubricant.
- ✓ Regularly inspect the equipment to determine whether it requires additional lubrication or maintenance.
- ✓ Reapply lubricant as needed based on the manufacturer's recommendations.

- **Pre-operation maintenance of punching equipment:**
  - ✓ **Fault detection:** by visualizing or listening noise operation of punching equipment
  - ✓ **Fault isolation:** in this step equipment are not immediately initiated production process
  - ✓ **Fault elimination:** such as lubricating, tightening and cleaning all necessary parts punching equipment
  - ✓ **Verification of fault elimination:** This Performed after elimination of failure without interrupting the continuity of the production process.
- **Steps for cleaning punching equipment**
  - ✓ Place the components on properly space for clean.
  - ✓ Using the proper brush for cleaning.
  - ✓ Place a clean lag under the components are cleaned whether are removed
  - ✓ Inspect cleaned components for metal chips
  - ✓ Repeat steps if contamination is still present.
  - ✓ Inspect again components are correctly cleaned and Make sure that all contamination is removed**.**
- **Perform Tightening activities**
  - ✓ Use the appropriate wrench or screwdriver to tighten all bolts and screws.
  - ✓ Ensure even tightening to maintain proper alignment.
  - ✓ Check that all clamps are secure and adjust their tension as necessary.
  - ✓ Properly secured clamps prevent the workpiece and tooling from shifting during the punching process.

Points to Remember

- When lubricating punching equipment take into practice the cleaning methods
- For cleaning punching equipment and tools put into practice the cleaning techniques
- While preparing punching equipment for punching operation remember to clean and lubricate the moving parts of punching equipment wherever necessary.
- While preparing punching equipment for punching operation remember to tight all bolts and screws evenly to ensure the punch and die stay in place during operation.

Application of learning 1.4.

You are requested to Visit the nearby metal work Agakiriro and perform the following tasks related to punching operation

i. Clean the punching equipment

ii. Lubricate the punching equipment

iii. Perform tightening for punching equipment

Learning outcome 1 end assessment

Theoretical assessment

01. Complete the following sentence by using the appropriate word selected from the following:(**Drilling, punching, shearing and punch press).**

i. The forming process that uses a ……to force a tool through the workpiece to create a hole via shearing is called …….

02. Fill in the following table by the appropriated word or sentences selected from the followings: **Gloves, Helmet, Foot protection, protects against sharp and hot objects, Safety boot, Protect against intense light, Eye protection and Fight against overhead objects**

Body parts	Name of PPE	Functions
Head Protection	…….	…….
…….	Cutting glass	…….
Hand protection	…….	…….
…….	…….	provide resistance to slippery surfaces

03. Match column **A** representing advantages and disadvantages of punching operation with their explanations in column **B**. Use each letter only once and write it in the provide blank space.

Answers	Column A	Column B
…….	**1.** Versatility	**A.** Punching operations are fast and efficient allowing for high-volume production within a short time frame.
…….	**2.** Environmental Considerations	**B.** Punching can create intricate and shapes, enabling the production of various components and parts with different designs.
…….	**3.** Noise and Vibrations	**C.** Punching operations can be used on a wide variety of materials
…….	**4.** High Speed	**D.** Punching can generate substantial noise and vibrations, which may require additional measures for workplace safety and comfort
…….	**5.** Complex Shapes	**E.** The process may produce waste material in the form of punched-out sections, which may require recycling or disposal measures.

04. Read the following statement and write the letter corresponding to the correct answer.

i. Among the following types of punches which one is Suitable for creating ventilation slots

a) Custom shape punch
b) Oblong Punch
c) Square punch
d) Rectangular punch

05. The following materials are ferrous metals, Except:
   a) Wrought Iron
   b) Bronze
   c) Stainless Steel
   d) Cast Iron

06. The material property of punching tools and dies to resist fracture due to high impact loads is known as:
   a) Toughness
   b) Hardness
   c) Strength
   d) Brittleness

07. Which one is not a factor affecting the selection of punches and dies
   a) Die clearance
   b) Dies and punches materials
   c) Product shape
   d) Die and punch colour

08. The followings are steps for operating hydraulic punching machine. Rearrange them in the correct order from first to last.
   a) Use the control panel to activate the hydraulic system.
   b) Deactivate the hydraulic system and remove the punched material.
   c) Adjust the hydraulic pressure settings based on material thickness.
   d) Place the material on the die under the punch.
   e) The hydraulic ram pushes the punch through the material.

09. Read the following statement and answer by **TRUE** if the statement is right or **FALSE**, if the statement wrong:
   a) plash Lubrication is a lubrication method used in machinery with slow-moving parts,
   b) Grease lubricant presents high viscosity than oil lubricant.
   c) Mechanical punching machine is the only punching machine suitable for high-speed operation.
   d) The punch size is greater than the die opening size.

Practical assessment

XL water supply company Ltd, is specialize in pipe assembling used to supply water at long distance.

The pipes are assembled by using flanged joint, to avoid the leakage defect at the joint, round metallic gasket must be inserted into the joint, the director general of XL water company ltd has requested your school to fabricate a hundred (100) metallic gaskets made in sheet metal ,you are requested to go in the manufacturing workshop and apply work place safety precaution ,checking punching equipment safety tips, select the appropriate punches and die ,selected required material ,select punching equipment suitable to the task ,select tightening tools and right lubricant and also carry out punching equipment maintenance by cleaning and lubricating activities within one(1) hour.

END

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INTERPRETING DRAWING

Indicative contents
2.1 Interpretation of drawing
2.2 Setting up punching equipment
2.3 Punching work piece

Key Competencies for Learning Outcome 2 : Carry out Punching Operation

Knowledge	Skills	Attitudes
• Description of cutting list elements and cutting list format • Description of punching operations	• Interpreting of drawing • Setting up punching equipment • Punching the work piece	• Being attentive while setting up punching equipment • Being active while punching the work piece • Having critical thinking while interpreting a technical drawing • Being consistence while describing punching methods

Duration: 15hrs

Learning outcome 2 objectives:

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

1. Describe effectively cutting list elements for punching operation
2. Fill correctly cut list format for punching operation
3. Position correctly the die for punching in accordance with the operation to be performed.
4. Fix correctly punching tool and workpiece for punching operation
5. Perform correctly punching operations according to the punching tool geometry.

Resources

Equipment	Tools	Materials
• PPE • Punching machine • Benches • Angle grinder • Anvil • Vices • Shear machine • Cut-off machine, • Bending machine • Rolling machine • Air compressor • Firefighting equipment	• Rulers • Dies • Punches • Sand papers • Files • Cutting tools • Clamping tools • Paint brush • Measuring tools • Marking tools • Common tools (hummer, screw driver, pliers, spanners, wrench, Allen key) • Cloths rugs	• Pens • Papers • Pencils • Paints • Oil • Grease • Soap.

	• Wire brushes • Bloom • Spray gun	

Indicative content 2.1: Interpretation of Drawing

Duration: 2 hrs

Theoretical Activity 2.1.1: Description of cutting list elements

Tasks:

1: you are requested to answer the following questions:

i Discuss about cutting list element for a drawing?
ii Describe the elements of cutting list for a drawing
iii Prepare a Sample of cutting list format

2: Participate in group forming and provide answer of asked question on paper

3: Present the findings/answers in whole class

4: Follow actively the trainer's clarification and ask questions where necessary.

5: Read the key readings 2.1.1.

Key readings 2.1.1: Description of cutting list elements

- **Cutting list**

Cutting list, also known as a bill of materials (BOM) is a tabular list of the items used to make an assembly. Cutting 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

- **Elements of cutting list:**
  - ✓ **Item number**

Item numbers are based on the assembly structure, that is, the order in which parts are displayed in assembly.

  - ✓ **Serial number /Part number**

Part number or drawing number which is a reference back to the detail drawing.

  - ✓ **Description /Specifications.**

Description is usually a cut name or a complete description of purchase part or stock specification, including size and dimensions.

  - ✓ **Quantity**

The number of that particular parts used to make an assembly.

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

  - ✓ **Dimension**

Dimension refers to the measurable size or extent of an object, which is typically expressed in units of length, width, height, depth, diameter, or other specific parameters depending on the shape and nature of the item**.**

  - ✓ **Material**

Material refers to the raw materials, components, sub-assemblies, parts, and other items required to manufacture a product. These are the basic substances from which products are made, such as metals, plastics, and chemicals. For example, steel sheets used to fabricate car body parts.

- **Cutting 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 cutting list filled format:

Item number	Part number	Description	Quantity
1	ABC123-01	Fuel injection tube	2
2	ABC123-02	Deliver 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

Practical Activity 2.1.2: Filling the cutting list format

Task:

1: Individually, referring to the previous activity 2.1.1, you are requested to go in Manufacturing workshop to interpret the given drawing and fill the cutting list format.

2: Take a drawing representing the work to be performed.

3: Interpret the drawing according to the work requirement.

4: Take the cutting list format and fill it.

5: Present your work to the trainer, workshop assistant or your classmate.

6: Read the key reading 2.1.2.

7: Perform the task provided in application of learning 2.1

Key readings 2.1.2: Filling the cutting list format

- **Detailed procedures for filling out a cutting list format**
  - ✓ **Gather Necessary Information**
    - Obtain the detailed drawing or blueprint of the project.
    - Ensure you have a clear understanding of the parts and materials required.
  - ✓ **Prepare the Cutting List Template**
    - Use a standardized template for the cutting list. The template typically includes columns for part number, description, material, dimensions, quantity, and any special instructions.
  - ✓ **List Each Part/Component**
    - **Part Number:** Assign a unique part number to each component. This helps in identifying and referencing parts easily.
    - **Description:** Provide a brief description of each part.
    - **Specify Material**
      - **Material Type:** Indicate the material for each part, such as aluminum, stainless steel, or plywood.
      - **Material Grade:** Specify the grade of the material if necessary (e.g., 304 stainless steel).
  - ✓ **Detail Dimensions**
    - **Length:** Enter the length of the part.
    - **Width:** Specify the width of the part.
    - **Thickness:** Indicate the thickness or gauge of the material.
    - Other Dimensions: Include any other critical dimensions, such as diameter for round parts or angles for specific cuts.
  - ✓ **Quantity**
    - **Number of Pieces:** Write the total number of each part needed.
    - **Cutting Allowance:** Factor in any allowances for cutting, such as kerf width or material waste.
  - ✓ **Example of cutting list format**

Part number	Description	Material	Length (mm)	Width (mm)	Thickness(mm)	quantity	Special instructions
1	Side panel	Stainless steel	1000	500	2	4	Deburr edges

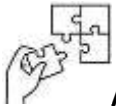
2	Top plate	Aluminium	1200	800	3	2	Anodize surface
3	Support bracket	Carbon steel	200	50	5	8	Drill 10mm dia holes

✓ **Tips for Effective Cutting List Preparation**

- **Accuracy:** Ensure all dimensions and quantities are accurate to prevent errors and material wastage.
- **Clarity:** Use clear and concise descriptions to avoid confusion during the punching process.
- **Consistency:** Maintain a consistent format for all cutting lists to streamline the punching operation.
- **Updates:** Regularly update the cutting list to reflect any changes in design or material requirements.

Points to Remember

- When interpreting technical drawing the cutting list elements mainly materials and specification
- When interpreting a drawing remember 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
- For effective cutting list preparation consider the following tips: accuracy, clarity, consistency and update.
- A cutting list format typically includes columns for part number, description, material, dimensions, quantity, and any special instructions.



Application of learning 2.1.

Visit a manufacturing factory located nearby your school and perform the following tasks:

i. Cut one blank of 20mm of diameter and one blank of 35 mm of diameter from a mild steel sheet metal by using punching machine
ii. After cutting these two blanks, fill the cutting list format.

SN	Criteria	Indicators	Yes	No
1	Cutting list format is effectively filled	1.1. Part number is filled		
		1.2. Parts descriptions are filled		
		1.3. Material types are filled		
		1.4. Parts dimensions are filled		
		1.5. Parts quantity is filled		
		1.6. Special instructions are filled.		
Marks:			/6	
Passing line:			70%	

Indicative content 2.2: Setting up Punching Equipment

Duration: 3hrs

Theoretical Activity 2.2.1: Description of procedures of setting up punching equipment.

Tasks:

1: you are requested to answer the following questions:

i Describe the steps of positioning dies on punching equipment.

ii Describe the methods of mounting punches for punching operation.

iii Describe the procedures of fixing the workpiece on the punching equipment.

3: Write the answers of asked questions on flip chat /papers.

4: Present the findings/answers in whole class

5: Pay attention to the trainer's clarification and ask questions where necessary.

. Read the key readings 2.2.1.

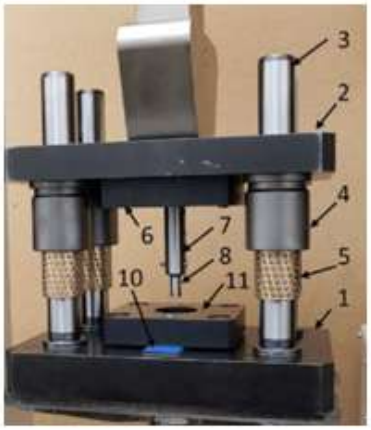
Key readings 2.2.1: Description of procedures of setting up punching equipment.

- **Procedures of positioning die:**
  - ✓ **Clean the Die**
    - Thoroughly clean the die to remove any debris or residues that may affect the installation and operation.
  - ✓ **Inspect the Die**
    - Check the die for any signs of wear, damage, or defects. Replace any components that do not meet the required standards.
  - ✓ **Select the Appropriate Die**
    - Choose the correct die set for the specific punching operation. Ensure they are compatible with the material thickness and desired hole shape.
  - ✓ **Position the Die Holder.**
    - Place the die holder in the designated area of the punching machine. Ensure it is properly aligned with the machine's guide system.
  - ✓ **Install the Die.**

- Insert the die into the die holder. Make sure it is seated properly and securely. Depending on the machine, this may involve tightening screws or bolts to hold the die in place.

✓ **Types of die holder:**

- **Fixed Die Holder:** stationary die holder that securely holds the die in place. Commonly used in simple, repetitive punching operations where the die does not need to be changed frequently.



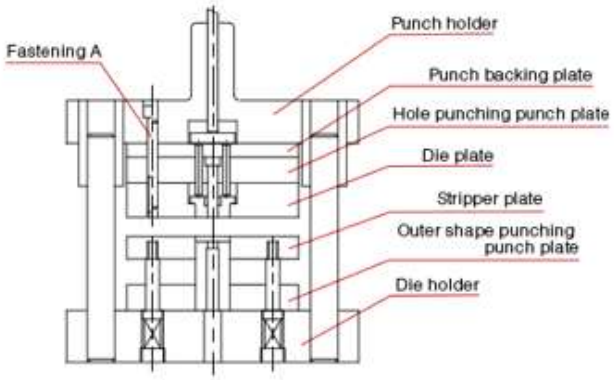


Fig35: Fixed die holder

- **Adjustable Die Holder:** Allows for fine adjustments to the position of the die. Useful in operations requiring precise alignment.
- **Quick-Change Die Holder:** Designed for rapid die changes, reducing downtime between different punching operations.
- **Rotary Die Holder:** Holds the die in a rotary turret, allowing for multiple dies to be used in sequence without manual changeover
- **Spring-Loaded Die Holder:** Equipped with springs to provide additional support and cushioning during the punching operation.
  - Used to minimize tool wear and absorb shock, especially in high-speed punching operations.
  - A spring-loaded die holder used in a high-speed mechanical press for automotive parts production.
- **Hydraulic Die Holder:** Uses hydraulic pressure to clamp and release the die securely.

- Hydraulic Die holder is Suitable for heavy-duty punching operations requiring significant force.
- Hydraulic die holder is used in a hydraulic punch press for punching thick steel plates.

- **Methods of mounting punches for punching operation.**

Types	**Mounting methods**	**Remark**
1. Flange fixing	The position and perpendicularity of the punch are maintained by the shank and the head prevents the punch from coming off	Standard type for round punches. reliable in preventing the punch from coming off
2. Flange positioning with a key flat	The position and perpendicular of the punch are maintained by the shank and the head prevents the punch from coming off	The position is determined by a key flat shank machined by WED and inserted into a hole
3. Locating with dowel pins	Positional accuracy is achieved with the dowel, pin and the head fasten the punch in place	The dowel hole is created by NC machining allowing easy positioning This type is often used for automobile dies
4. Fixing with adjustment pins	The position and perpendicularity of the punch are maintained by the shank and the head is fastened with a bolt	This type allows the punch to be replaced easily

5. Bolt fixing (tapping)	The position and perpendicularity of the punch are maintained by the punch plate and the head and the bolt prevents the punch from coming off	Highly accurate and also reliable preventing the punch from coming off. It is not suit able for thin punches or punching for heavy load.
6. Key fixing	The groove of the punch is fixed in place with a holder	This type allows the punch to be installed and replaced easily. this type is often used for precision dies when striper plate is small.
7. Holder fixing	The head of the punch is screwed in place with a holder	This type allows the punch to be replaced easily. This type is used in case when the clearance between the punch pate and stripper plate is small
8. Ball lock	A steel ball inside a special retainer locks the punch groove to fasten the punch in place	The punch can be mounted and removed easily by lifting up the steel ball with the pin. This type is often used for automobile dies
9. Taper fixing	A tapered part prevents the punch from coming off	This type is inexpensive because the head is produced by upsetting. This is often used for quill punch

10. Taper +ring	A special ring supports the tapered part	The special ring allows tapered head punches with high-strength heads to be easily installed

✓ **Steps of mounting punches on punching equipment:**

- **Ensure Safety:** Always wear protective gear such as gloves and safety glasses.
- **Select the Punch:** Choose the appropriate punch for the operation based on the material and desired hole shape.
- **Inspect the Punch:** Check for any damages or wear on the punch. Replace if necessary.
- **Clean the Punch Holder:** Ensure that the punch holder is clean and free from debris.
- **Insert the Punch:** Place the punch into the holder. Make sure it is seated correctly and securely.
- **Tighten the Punch:** Use the designated tightening mechanism (screws, bolts, or clamps) to secure the punch firmly in place.
- **Check Alignment:** Ensure that the punch is aligned correctly with the die. This can be done manually or using alignment tools.
- **Test the Setup:** Perform a test punch on a sample material to check the alignment and ensure the punch operates smoothly.

- **Procedures of fixing the workpiece on the punching equipment.**

✓ **Fixing the workpiece on the punching equipment involves the following steps:**

- **Position the Workpiece:** Place the workpiece on the machine bed, aligning it with the die. Use guides, stops, or markings to position it accurately.
- **Adjust Clamps:** Move the clamps into position over the workpiece. Ensure they are placed in a way that holds the workpiece securely without obstructing the punching area.

- **Tighten Clamps:** Tighten the clamps firmly to hold the workpiece in place. Use manual clamps, hydraulic clamps, or magnetic clamps as required by the machine setup.
- **Check Workpiece Stability:** Ensure the workpiece is stable and does not move when lightly tapped or pushed.
- **Double-Check Alignment:** Verify that the workpiece is properly aligned with the punch and die to avoid misalignment during punching.

Practical Activity 2.2.2: Setting up punching equipment.

Task:

1: Referring to the previous activity 2.2.1, you are requested to go in Manufacturing workshop and position dies, fix punching tool and fix the workpiece for punching operation.

2: Select and wear appropriate PPE according to the work to be performed.

3: Individually position the die, fix the punching tool and fix workpiece for punching operations

4: Present your work to the trainer, workshop assistant or your classmate.

5: Read the key reading 2.2.1.

6: Perform the task provided in application of learning 2.2

Key readings 2.2.2: Setting up punching equipment.

- **Steps of installing the punch and die**
  - ✓ Remove any burrs, flash, or impurities from the die and the die mounting surface.
  - ✓ Adjust the top dead center position of the ram according to the selected die height, and install the upper and lower dies.
  - ✓ After the mold is installed, adjust the pressure of the hydraulic system to 3.5Mpa through computer programming.
  - ✓ Start the press brake and press the switch (button) on the operation station to make the ram go down and control it at an appropriate position so that there is a certain gap between the punch and die then shut it down.
  - ✓ Check if the punch and die are aligned.

- ✓ Tighten the screws while pressing
- ✓ Start the machine and press the switch (button) on the operation station to make the ram go down, close and pressurize the punch and die.
- ✓ Check whether there is any gap between the ram and the top punch.
- ✓ Press the return switch on the operation station to return the ram to the top dead center.

- **Fixing the workpiece.**
  - ✓ To achieve optimal workpiece positioning and alignment, it is essential to follow a few best practices:
    - Take the time to properly position the material before starting the punching process.
    - Ensure it is flat, smooth, and securely held in place.
    - Use alignment guides or markers on the machine to assist in aligning the material accurately. These guides can help achieve consistent hole placement.
    - Double-check the alignment before initiating the punching action. Verify that the material is aligned with the punching tools to avoid any misalignment issues.
    - For manual punching machines, maintain a steady hand and pay close attention to aligning the material accurately with the punching tools.
    - Regularly inspect and clean the machine's platform or bed to ensure it is free from debris or obstructions that may affect the material's alignment.
- **workpiece holding devices for punching operation.**

  Work holding is a catchall term referring to any device or apparatus used to keep a workpiece stable and immobile. Some common examples are Toggle, Clamps, Power clamps, End stops, Soft or hard jaws, Vises, Fixtures and jigs.

Points to Remember

- When setting up punching equipment the following procedures must be taken into account, die positioning, fixing punching tool and fixing workpiece.
- When clamping the work piece for punching operation use the holding device
- While installing the punch and die remember to Remove any burrs, flash, or impurities from the die and the die mounting surface.
- While installing dies for punching operation adjust the top dead centre position of the ram according to the selected die height, and install the upper and lower dies.

- After installing punch Check whether there is any gap between the ram and the top punch.
- Before initiating the punching action., Verify that the material is aligned with the punching tools to avoid any misalignment issues.

Application of learning 2.2.

Visit the nearby metal work Agakiriro that fabricates punched product and perform the following tasks:

i. Position dies for punching operation

ii. Fix punching tools

iii. Fix the workpiece for being punched.

Indicative content 2.3: Punching Work piece

Duration: 10 hrs

Theoretical Activity 2.3.1: Description of punching operations

Tasks:

1: you are asked to describe on the following punching operations performed on punching operation:

i Stamping
ii Blanking
iii Perforating
iv Parting
v Drawing
vi Notching
vii Lancing
viii Bending

2: Write the answer of asked questions on papers.

3: Present the findings/answers in whole class

4: Follow actively trainer's clarification and ask questions where necessary.

5: Read the key readings 2.3.1

Key readings 2.3.1: Description of punching operations

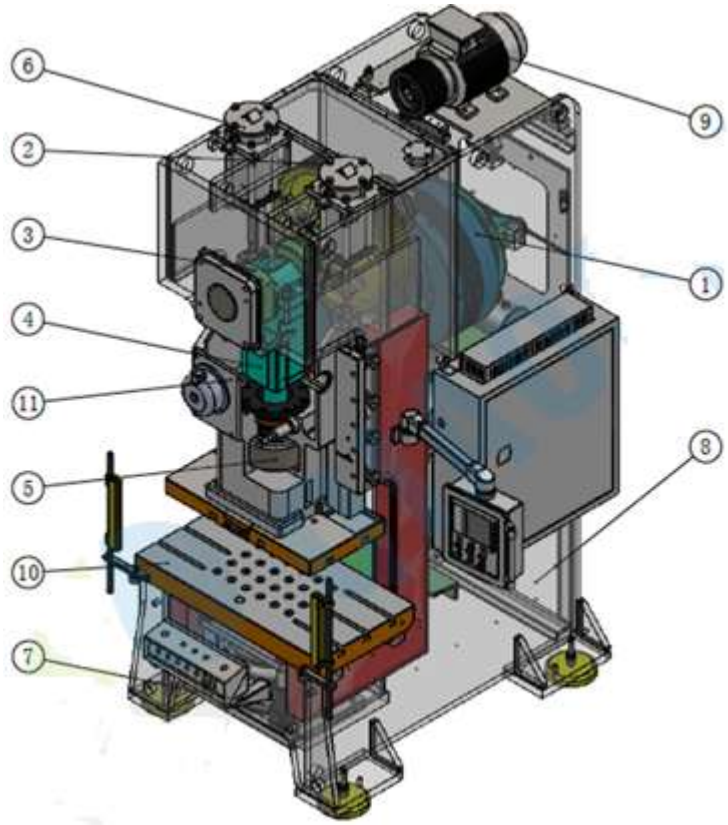
- **Stamping.**

Metal stamping is a complex manufacturing process used to transform flat metal sheets into shapes. Metal stamping utilizes dies and stamping presses to convert pieces of flat sheet metal, or blanks, into different shapes. Metal fabricators feed blanks into a sheet metal stamping press that uses pressure to shape and shear the material into the desired form.

The metal is fed into a press, where the stamping tool, also known as a die, creates the desired

shape. The die is pressed into or through the metal with tremendous force.

Metal stamping is a low-cost, high-speed manufacturing process that allows metal fabricators to produce a high volume of identical metal components.



1. Transmission system assembly with flywheel, dry clutch brake and gear shaft
2. Main gear
3. Crankshaft
4. Connecting rod
5. Hydraulic overload protection (HOLP)
6. Balancer
7. Adjusting nut
8. Frame
9. Main motor

Fig36: Precision Single Crank C-Frame Stamping Machine.

Fig37: Sheet Metal Stamping Process Aranda Tooling

- ✓ **Stamping operations.**

Metal stamping operations refer to the entire process or set of activities involved in shaping, cutting, or forming metal workpiece using stamping machines. The operations involve a series of steps, including design and tooling, material feeding, stamping, quality

control, and sometimes post-processing. The types of metal stamping operations employed in a metal fabrication plant are as follows:

- **Progressive die stamping.**

In progressive die stamping, a sheet of metal is unrolled, fed into the press and passes through different stations of tooling each of which performs one or more metalworking processes (e.g., cut, bend, and punch). The sheet stays in the conveyor system of the stamper and the part stays connected in its base strip throughout the process.

The workpiece stops at each station and is shaped by a die before it moves on. After completion of the stamping, the press moves up, and the sheet moves horizontally in the bed. The part is gradually formed as the workpiece progresses through the stations. At the last station, the finished part is ejected from the sheet.

The advantages of a progressive die stamping operation are quick production of parts with complex geometries, tight tolerances, high repeatability, and reduced labor costs. Progressive die stamping combines multiple metalworking steps in a single tooling. Due to the nature of the process of progressive die stamping and its inability to make deep punches, it is not used for parts that require deeper punches.

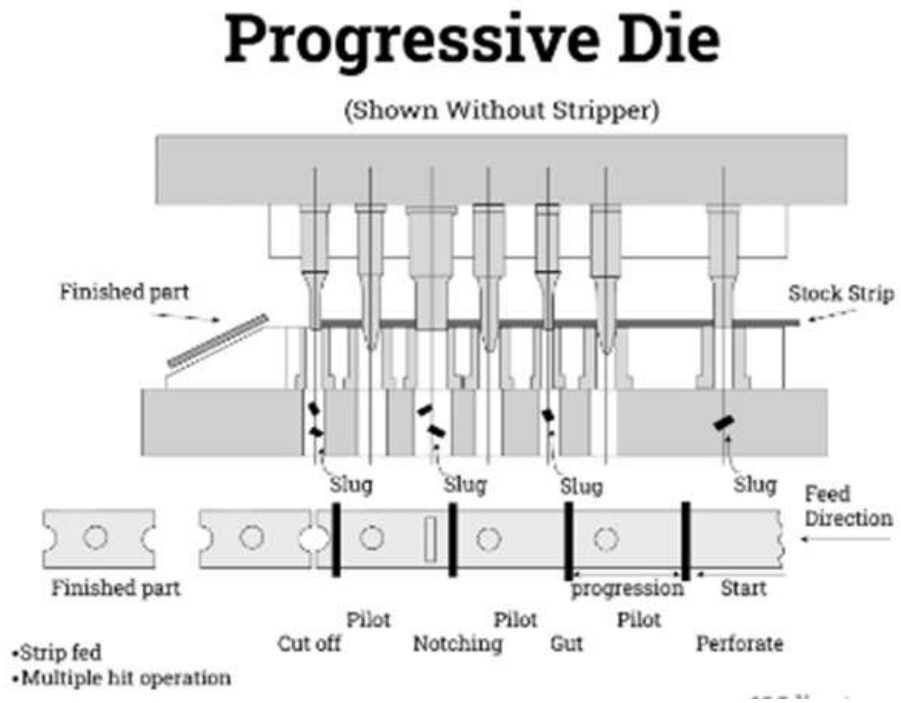


Fig38: Progressive die

- **Advantages of progressive stamping:**

- Produces large numbers of parts very quickly. It has the potential to produce seven or eight parts per minute, up to 1500 per hour.
- It operates automatically, unattended or monitored.
- One machine can produce all of the parts.
- All die stations are mounted on a single die. Parts are produced together in a single pressing.
- Progressive dies are faster and run on less expensive equipment**.**

Transfer Die Stamping.

In transfer die stamping, the workpiece is first separated from the metal sheet and transferred from one stamping station to the other. The separated materials can be transferred to different presses, which enables the fabricator to produce varieties of parts in parallel.

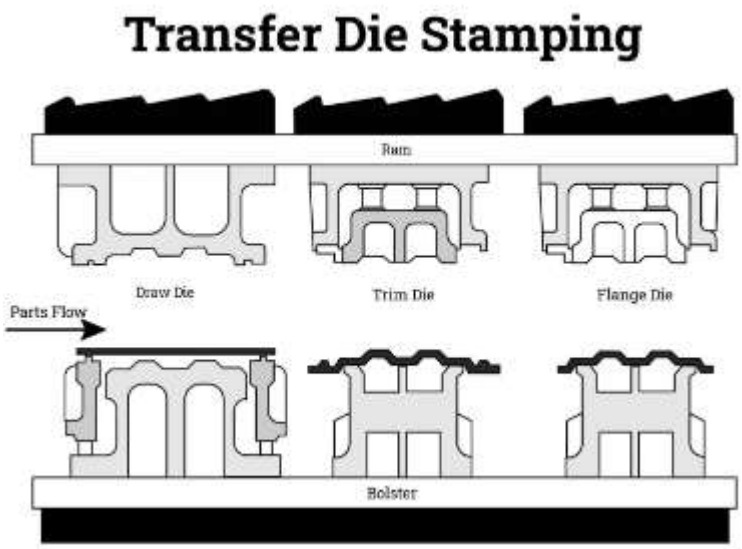


Fig39: Transfer Die

- **Advantages of transfer stamping**
  - **Multiple motions:** Two and three-axis motions can be performed during a single cycle. Three-axis motion lifts the workpiece for the next operation.
  - **Part placement:** Using gauges or locators, each part is automatically positioned perfectly for each operation.
  - Faster production: Large parts are rotated, turned, and positioned easily, and moved rapidly from station to station.
  - **Computerization:** Servo drive transfers program the types of parts, press speeds, and length of press strokes.
  - **Turnaround times:** High volumes of parts are completed with less handling, lower waste, and decreased labor costs.

- **Four slide Stamping.**

In four slide stamping or multi-slide stamping, the rams are aligned horizontally and slide toward the workpiece. It is a unique type of stamping process, different from the traditional stamping process which requires the downward stroke of a press. Each slide has one tool that can simultaneously bend, twist, cut or form in a horizontal stroke. A multi-slide stamping machine can have more than four moving slides

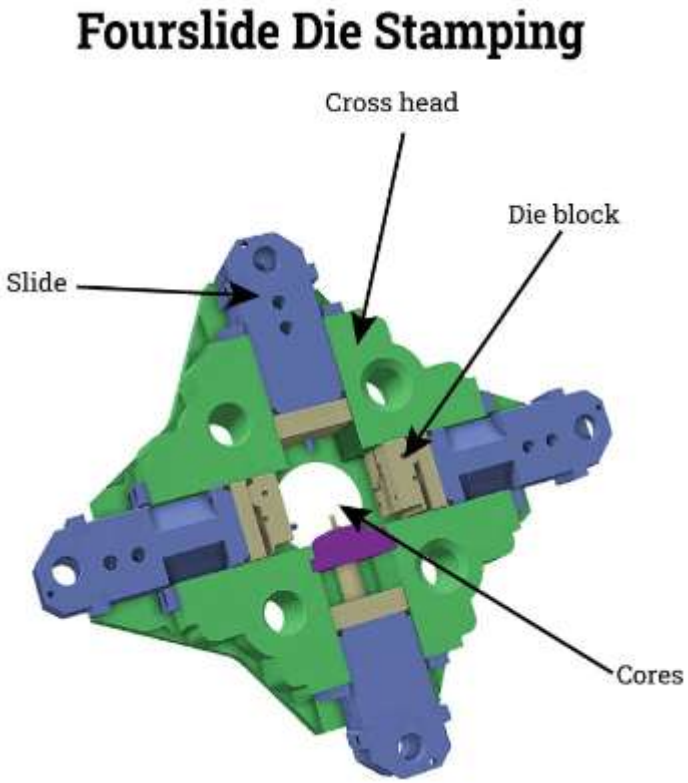


Fig40: Four slide Die Stamping

- **Compound Stamping.**

In compound stamping, the die can perform multiple operations such as cutting, bending, and punching in one downward stroke. The sheet is continuously fed in the stamper and the finished part is then ejected out from the metal strip. A stroke can create multiple cuts and holes in the workpiece without the use of multiple dies and performing multiple strokes, which reduces production time and augments cost savings.

Compound stamping has good repeatability. However, it is somewhat limited to forming flat metal pieces with simpler geometries, such as washers.

Fig41: washer

Compound stamping uses compound die.

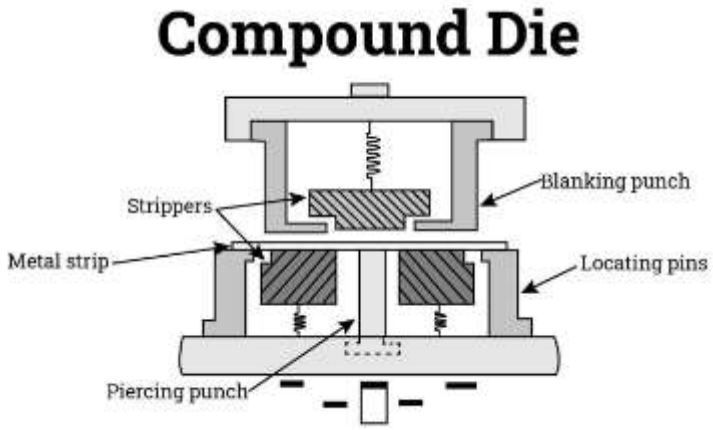


Fig42: compound die

- **Advantages of compound stamping:**
  - **Efficiency:** Compound dies cut complicated parts in a single stroke avoiding the need for multiple dies.
  - **Cost-Effectiveness:** Compound die stamping manufactures parts quickly, saving time and money.
  - **Speed:** Compound die stamping produces parts in seconds and can produce over 1000 parts in an hour.
  - **Repeatability:** Using a single die in compound die stamping ensures that every part has the same dimensions and configuration.

- **Hot Metal Stamping.**

It is a thermoforming process that involves a heat treatment during the stamping process. The process of hot metal stamping developed in the 1970s as a method for hardening steel for the manufacture of agricultural tools. It has evolved since that time as a method for hardening lightweight high strength parts for the auto industry.

The blank for hot stamping is placed in an oven or furnace to heat it to the proper hot stamping temperature. Once the blank reaches 1700°F, it is transferred by press feeding to the hot stamping press that rapidly closes over the blank and holds it firmly for several seconds until it cools. The hardened and formed part is ejected from the press for its final finishing.

The two forms of hot metal stamping are direct and indirect, which differ by how the blank is treated before being subjected to the heating process. In direct hot stamping, the blank is immediately placed in an oven or furnace for heating. With indirect hot stamping, the blank is cold formed prior to the heating process

Regardless of the production process, die stamping requires the use of lubricants for:

- Protection of tools and dies
- Providing hydrodynamic film to prevent surface abrasions
- Assisting material flow
- Preventing rips, tears, and wrinkles
- Reducing friction

- **Die Stamping Operations.**

Stamping dies serve two primary functions: cutting and forming, with some dies capable of performing a combination of these functions. Each operation is intended to either separate the material or shape it through plastic deformation

✓ **Forming Dies Are:**

- Bending
- Flanging
- Drawing
- Stretching
- Coining
- Ironing

✓ **Cutting Dies Are:**

- Shearing
- Blanking
- Trimming
- Notching
- Piercing

✓ **Blanking:**

Blanking is a metal fabrication step in which the workpiece is cut from its base metal sheet. The downward stroke of the punch shears the outline of the workpiece. The cut-out is called a blank. It is usually the first step in a metal fabrication process. It makes the workpiece more manageable to handle for the succeeding operations. The excess material is scrapped and may be recycled.

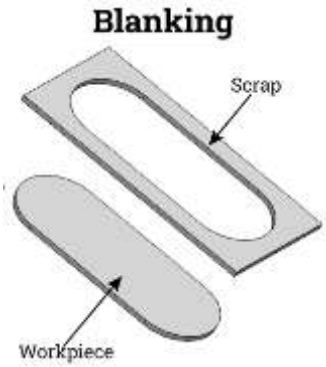


Fig43: Blanking illustration

Perforating:

- ✓ **Perforating**

Perforating is a specific type of metal stamping operation where multiple small holes are punched into a workpiece in a patterned arrangement. This process is widely used in various industries to create products with holes for functionality, aesthetics, or to reduce weight.

Perforating in metal stamping is the process of creating multiple, closely spaced holes in a material, typically a metal sheet, using a punch and die set.

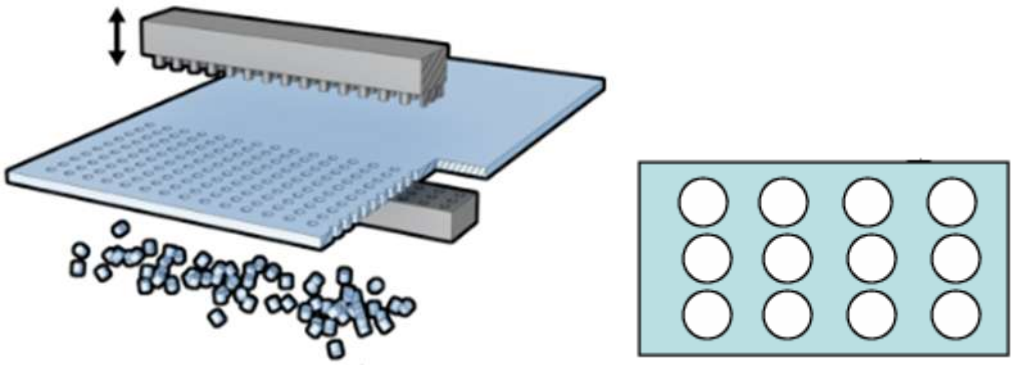


Fig44: Perforating

- ✓ **Parting:**

Parting is a punching operation in which a workpiece is divided into two or more discrete parts by cutting along a specific line. This operation is crucial in various manufacturing processes as it allows for the production of individual components from a larger sheet or strip of material. Parting is used extensively in industries like automotive, electronics, and consumer goods where precise and efficient separation of materials is required.

Parting involves cutting a sheet metal strip by a punch with two cutting edges that match the opposite sides of the blank

The parting off operation is also similar to the cut-off operation. But here scrape will separate from the blank piece. This is the reason it is the next best method for cutting blanks.

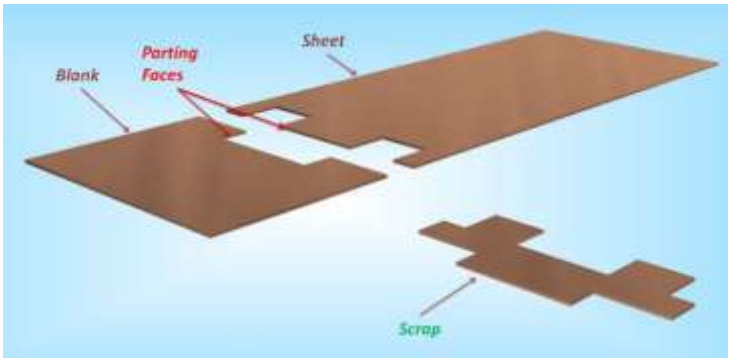


Fig45: Parting illustration

- ✓ **Drawing**

Drawing is a metalworking process of forming the blank into a hollow or concave shape with a seamless edge and parts with several diameters. It is performed by clamping the blank into a die by a blank holder and forced through it using a drawing punch. As the draw punch strokes downward towards the cavity, the workpiece experiences a complex sequence of stresses and deformation to form the finished part.

When the blank is drawn longer than its diameter, it is considered a deep drawing. Otherwise, it is referred to as shallow drawing.

Drawing is the actual stamping in the metal stamping process. A punch forces a section of metal through a die, providing the primary shape of the part. When the depth of the part is less than

the primary opening, it is considered shallow drawing; parts with a depth greater than the opening are

deep drawn.

- **Drawing operations:**

There are several different methods using in drawing, each of which requires a different approach.

- **Cold Drawing**

Cold drawing involves stretching metal at room temperature. Contrary to what some people believe, drawing typically isn't performed on heated metal. Instead, it's performed on room-temperature metal. Known as cold drawing, it's a highly effective metalworking process for manipulating the shape of metal. Compared to hot drawing, cold drawing offers greater accuracy and without jeopardizing the metal's strength or other physical properties.

- **Sheet Metal Drawing**

As you may have guessed, sheet metal drawing is used to produce sheet metal. While pressure is applied to the blank, the drawing machine stretches the metal to the desired size and shape. Using the right amount of pressure is essential to sheet metal drawing, as

it affects the metal's size. The more pressure applied, the thinner the sheet metal becomes. Failure to apply enough pressure, however, will result in the sheet metal being too thick. Sheet metal drawing is a type of cold drawing since it involves stretching metal at room temperature.

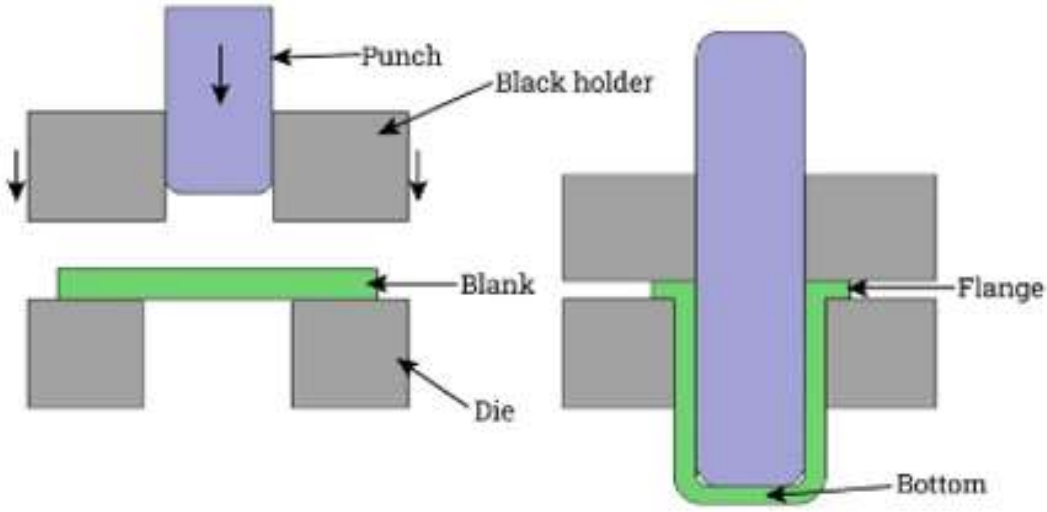
- **Bar Drawing**

Bar drawing is used to produce bar-shaped objects by stretching metal. The base metal is fed through a die; the die is typically located on a draw bench, which stretches it. Only after the metal has achieved the appropriate shape will it pass through the opposite end of the die. Bar drawing is performed on a variety of metals, some of which include steel, copper, aluminium and alloys.

- **Deep Drawing**

Deep drawing is the same as sheet metal drawing except it stretches the metal longer than its diameter. As a result, deep drawing is a more complex process that requires extra attention. It's typically performed by feeding metal into a die using a mechanical punch. The punch forces the metal to change into the shape of the die. Deep drawing, however, is characterized by the creation of a metal object that's longer than its diameter.

All metalworking processes involve the shape manipulation of metal, and drawing is no exception. It's able to pull and stretch metal to make it longer and thinner



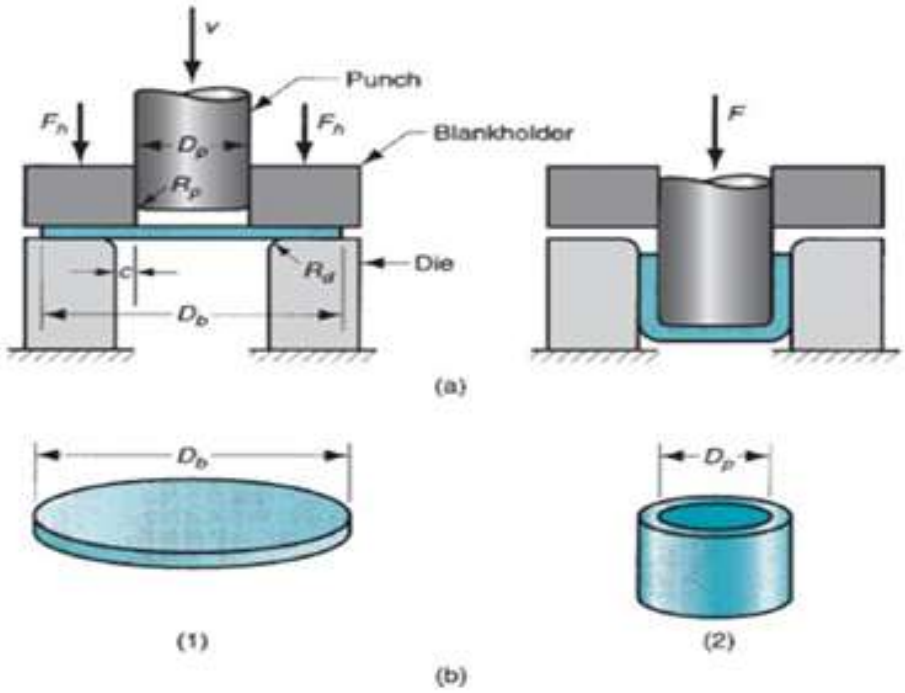


Fig46: Illustration of drawing operation

(1) start of operation before punch contacts work

(2) near end of stork

(b)corresponding work part:

(1) starting blank

(2) drawn part symbols:

C: clearance

Db: blank diameter

Rd: Die corner radius

RP: Punch corner radius

F: Drawing force

Fh: Holding force

Note: A drawing operation is feasible when the flowing conditions are fulfilled

$$\text{Drawing ratio: } DR = \frac{D_b}{D_p} \text{ feasible if } DR<2$$

$$\text{Reduction: } r = \frac{D_b - D_p}{D_b} \text{ feasible if } r<0.5$$

Thickness-to-diameter ratio =t/Db feasible if it is >1%

The drawing force required to perform a given operation can be estimated roughly by the formula

$$F = \pi D_p t(TS)\left(\frac{D_b}{D_p} - 0.7\right)$$

Where F = drawing force, N (lb); t = original blank thickness, mm (in); TS = tensile strength, MPa (lb/in2); and Db and Dp are the starting blank diameter and punch diameter, respectively, mm (in). The constant 0.7 is a correction factor to account for friction.
The holding force is an important factor in a drawing operation. As a rough approximation, the holding pressure can be set at a value = 0.015 of the yield strength of the sheet metal. This value is then multiplied by that portion of the starting area of the blank that is to be held by the blank holder. In equation form

$$F_h = 0.015Y\pi\left\{D_b^2 - \left(D_p + 2.2t + 2R_d\right)^2\right\}$$

The clearance in drawing is about 10% greater than the stock thickness: c=1.1t
Example:
For the drawing operation of Example above, determine (a) drawing force and (a) Holding force, given that the tensile strength of the sheet metal (low-carbon steel) = 300 MPa and yield strength = 175 MPa. The die corner radius = 6 mm.

- ✓ **Notching:**

Notching is a specialized punching operation where material is removed from the edge or corner of a workpiece to create a notch, a cut-out section, or a predefined shape. This operation is essential in various manufacturing processes to prepare edges for subsequent operations such as bending, joining, or welding. Notching is commonly used in industries like metal fabrication, automotive, aerospace, and electronics, where precise and clean cut-outs are required.

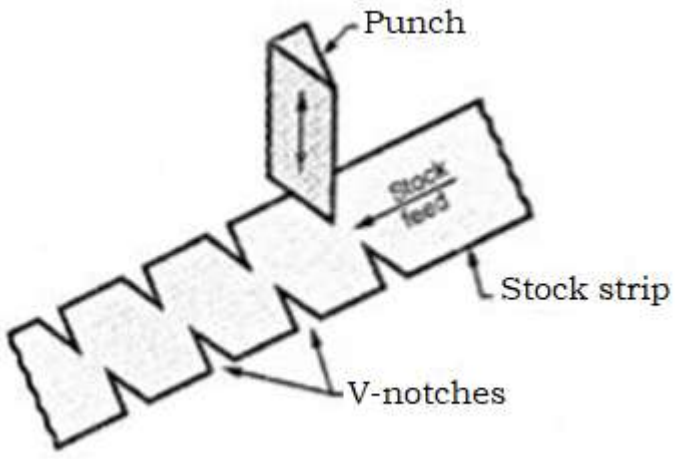


Fig47: Illustration notching operation

✓ **Lancing.**

lancing is a type of metal cutting used to make vents or tabs. A section of a part is cut along three edges and simultaneously bent. This creates the opening or hook-like feature required but eliminates a scrap collection or secondary machining step.

Lancing is the step in which a portion of the workpiece is partially cut without separating it from its base sheet.

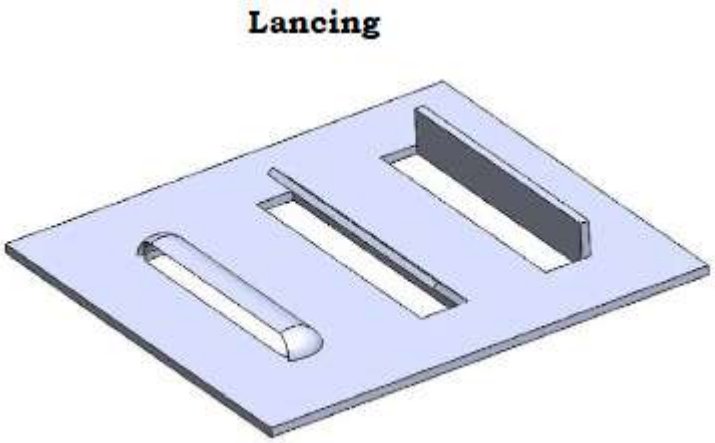


Fig48: Illustration of lancing operation

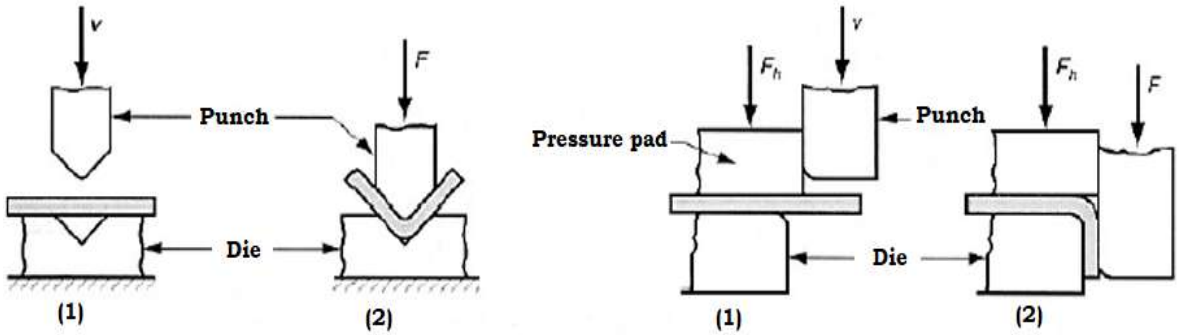
✓ **Bending.**

Bending is a metalworking process of forming an angle or a curvature in the workpiece by inducing a plastic deformation to form the bend. It is done by forcing the forming die in the workpiece which is fixed in an opposing bottom die. The downward stroke of the punch gives the bend profile to be enforced in the workpiece.

Bending is a forming operation in which a sheet metal is subjected to bending stress thereby a flat straight sheet is made into a curved sheet. The sheet gets plastically deformed without change in thickness. Die and punch are used for bending. If a v shaped die and punch are used, the bending is called v-bending.

Common bending methods and associated tooling are:

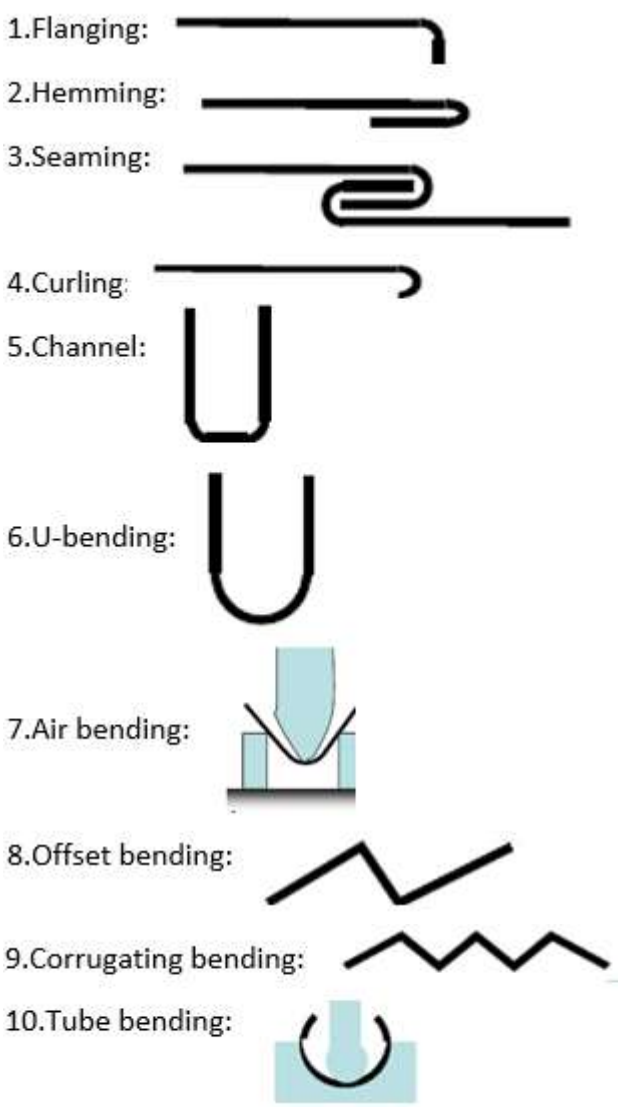
- V-bending, performed with a V-die
- Edge bending performed with a wiping die.



(Left) V-bending, and (Right) edge bending ; (1) before and (2) after bending

Fig49: Illustration bending operation methods

Other common bending operations:



Practical Activity 2.3.2: Performing punching operations

Task:

1: Individually, referring to the previous activity 2.3.1, you are requested to go in manufacturing workshop and perform the following punching operation: Stamping, blanking, perforating, parting, drawing, notching, lancing and bending with respect to trainer's instructions.

2: Select and wear appropriate PPE according to the work to be performed.

3: Individually perform Stamping, blanking, perforating, parting, drawing, notching, lancing and bending on punching equipment.

4: Present your work to the trainer, workshop assistant or your classmate

5: Read the key reading 2.3.2.

6: Perform the task provided in application of learning 2.3

Key readings 2.3.2: Performing punching operations

The punch operation separates the metal pieces by causing a precise fracture of the material. In comparison, the cutting action of a drill or holes will generate large amounts of swarf, leaving the work area covered in sharp swarf and filings.

- **There are 3 phases for a Punch & Die action:**
  - ✓ **Deformation:** The Punch being forced down causing an initial deformation of the material to be cut.
  - ✓ **Penetration:** The Punch is forced deeper into the material which starts to penetrate the Die below
  - ✓ **Fracture:** the material fractures under the force of the punch as compared to a cutting action of a drill or saw.

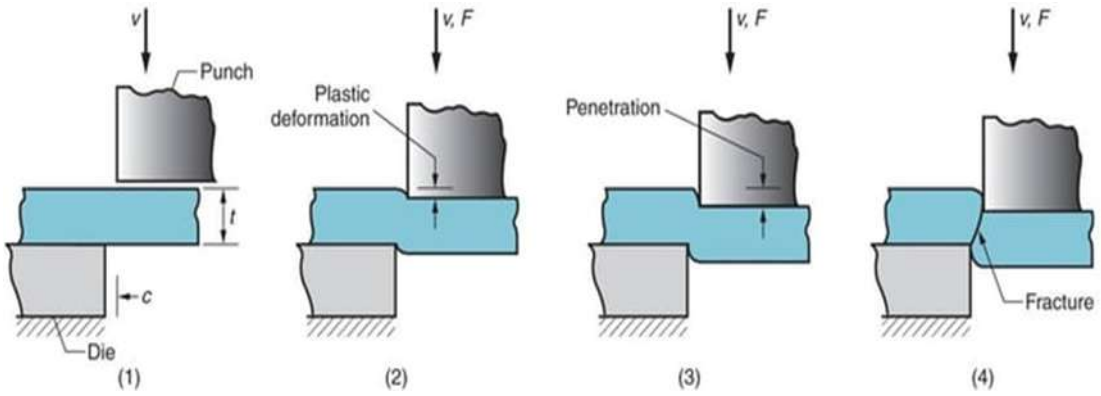


Fig50: illustration of punching phases

- **Procedures of performing metal stamping operation:**

Metal stamping is a versatile process used to produce a wide variety of metal parts. The operation typically involves pressing a sheet of metal between a punch and a die to create specific shapes or patterns. The following are the detailed procedures of metal stamping:

- ✓ **Design and Planning.**
  - **Determine the Part Design.**

Task: Create a detailed design of the part to be stamped, including dimensions, shapes, and

hole locations.

Details: you can use CAD software to create the design, ensuring all specifications are precise. This includes the overall dimensions, the size, and location of any holes, and the bending angles if applicable.

- **Material Selection.**

Task: Choose the appropriate material based on the part's requirements, such as strength, ductility, and thickness.

Example: Selecting stainless steel for its corrosion resistance and strength.

Details: Consider factors like the material's ability to withstand the stamping force without cracking, its wear resistance, and its final application. Ensure the material selected can be sourced in the required thickness and quantity.

- **Tool selection.**

Task: select the punch and die set to match the part's specifications.

Details: During tool selection, ensure that the punch matches the die exactly to produce clean cuts and bends.

- **Machine Selection.**

Task: Select an appropriate punching machine (mechanical, hydraulic, CNC) based on the material and complexity of the part.

Details: Consider the machine's force capacity, speed, and precision. For complex parts, CNC machines offer programmable control and can handle intricate designs.

- **Tool Installation**

Task: Install and align the punch and die on the punching machine securely.

Example: Mounting the punch and die set onto the punching machine and ensuring proper alignment.

Details: Ensure the punch and die are securely fastened to avoid misalignment during operation. Use alignment tools and checks to verify proper positioning.

- **Machine Calibration.**

Task: Set the machine to the appropriate force, speed, and other settings.

Details: Adjust settings based on the material's thickness and properties. Ensure the machine's parameters are correctly input to prevent damage to both the material and the tools.

- **Workpiece Preparation.**

Task: Cut the metal sheets to the required size and clean them if necessary.

Details: Use precision cutting tools to size the sheets accurately. Cleaning can involve removing oils, dirt, or oxidation to ensure a clean stamping process.

- **Positioning the Workpiece.**

Task: Place the metal sheet on the work table and use clamps or other methods to secure it in place.

Details: Properly position the material to ensure it does not move during punching. Use jigs or fixtures if necessary for repeated accuracy.

- **Performing the Stamping Operation.**
  - ✓ **Perform a Test Run.**

Task: Conduct a test run using a scrap piece of material to ensure accuracy.

Details: Check for issues such as misalignment, incorrect force application, or tooling problems. Adjust settings as necessary.

- ✓ **Make Adjustments**

Task: Adjust the machine settings or tool alignment based on the test run results.

Example: Adjusting the punch alignment if the holes or shapes are slightly off.

Details: Fine-tune the machine settings and tool alignment to ensure optimal performance and accuracy.

- ✓ **Start the Operation**

Task: Begin the stamping process by activating the machine.

Details: Monitor the initial few parts to ensure everything is running smoothly and producing parts to specification.

- ✓ **Post-Processing.**
  - **Inspect the Parts:**

Task: Inspect the stamped parts for accuracy and quality.

Example: Using calipers to measure the dimensions of the holes and bends.

Details: Conduct a thorough inspection of parts to ensure they meet the required specifications and quality standards.

- **Deburring**

Task: Remove any burrs or sharp edges from the stamped parts.

Details: Use manual or automated deburring tools to smooth out any rough edges and ensure the parts are safe to handle.

- **Cleaning and Finishing.**

Task: Clean the parts and apply any necessary surface treatments.

Example: Cleaning the stamped product and applying a protective coating to prevent corrosion.

Details: Clean the parts to remove any residues from the stamping process and apply finishes like paint, plating, or coatings as required.

- **Tool Maintenance.**

Task: Regularly inspect and maintain the punch and die to keep them sharp and in good condition.

Example: Sharpening the punch and die periodically to ensure precise cuts.

- **Machine Maintenance.**

Task: Perform routine maintenance on the punching machine to keep it running smoothly.

Details: Follow a maintenance schedule for lubrication, parts replacement, and system checks to ensure continuous operation.

- Record Keeping.

Task: Document the production details, including material batches and inspection results, for quality control and traceability.

Details: Maintain detailed records of material specifications, batch numbers, machine settings, and inspection outcomes for future reference and quality assurance.

- **Procedures of performing blanking:**
  - ✓ **Determine the Part Design**

Create a detailed design of the part to be blanked, including dimensions and shapes.

You can use CAD software to create the design, ensuring all specifications are precise. Include any necessary tolerances and surface finish requirements.

Example: Designing a circular metal washer with specific outer and inner diameters.

- ✓ **Material Selection.**

Task: Choose the appropriate material based on the part's requirements, such as strength,

ductility, and thickness.

Example: Selecting aluminum for its lightweight properties and corrosion resistance.

Details: Consider factors like the material's ability to withstand the blanking force without cracking, its wear resistance, and its final application.

- ✓ **Tool selection**

Task: select the punch and die set to match the part's specifications.

Example: Creating a punch and die set that will produce the circular metal washers with precise dimensions.

Details: during tool section, ensure that the punch matches the die exactly to produce clean cuts. The tool design should also account for the material properties to minimize wear and tear on the punch and die.

- ✓ **Machine Selection.**

Task: Select an appropriate punching machine (mechanical, hydraulic, CNC) based on the material and complexity of the part.

Example: Choosing a mechanical punch press for its speed and ability to handle high-volume production.

Details: Consider the machine's force capacity, speed, and precision. For high-volume production, mechanical punch presses are efficient and cost-effective.

- ✓ **Tool Installation.**

Task: Install and align the punch and die on the punching machine securely.

Example: Mounting the punch and die set onto the mechanical punch press and ensuring proper alignment.

Details: Ensure the punch and die are securely fastened to avoid misalignment during operation. Use alignment tools and checks to verify proper positioning.

- ✓ **Machine Calibration.**

Task: Set the machine to the appropriate force, speed, and other settings.

Example: Calibrating the mechanical punch press to apply the correct force for the aluminum material.

Details: Adjust settings based on the material's thickness and properties. Ensure the machine's parameters are correctly input to prevent damage to both the material and the tools.

- ✓ **Workpiece Preparation.**

Task: Cut the metal sheets to the required size and clean them if necessary.

Example: Cutting the aluminum sheets to the size needed for the circular washers and cleaning them to remove any contaminants.

Details: Use precision cutting tools to size the sheets accurately. Cleaning can involve removing oils, dirt, or oxidation to ensure a clean blanking process.

- ✓ **Positioning the Workpiece.**

Task: Place the metal sheet on the work table and use clamps or other methods to secure it in place.

Example: Placing the aluminium sheet on the mechanical punch press's work table and securing it with clamps.

Details: Properly position the material to ensure it does not move during blanking. Use jigs or fixtures if necessary for repeated accuracy.

- **Performing the Blanking Operation:**
  - ✓ **Perform a Test Run.**

Task: Conduct a test run using a scrap piece of material to ensure accuracy.

Example: Running a test blank on a scrap piece of aluminium to check for alignment and precision.

Details: Check for issues such as misalignment, incorrect force application, or tooling problems. Adjust settings as necessary.

- ✓ **Make Adjustments.**

Task: Adjust the machine settings or tool alignment based on the test run results.

Example: Adjusting the punch alignment if the blanked pieces are slightly off.

Details: Fine-tune the machine settings and tool alignment to ensure optimal performance and accuracy.

- ✓ **Start the Operation.**

Task: Begin the blanking process by activating the machine.

Example: Starting the mechanical punch press to begin producing the circular washers.

Details: Monitor the initial few parts to ensure everything is running smoothly and producing parts to specification.

- ✓ **Inspect the Parts**

Task: Inspect the blanked parts for accuracy and quality.

Example: Using calipers to measure the dimensions of the circular washers.

Details: Conduct a thorough inspection of parts to ensure they meet the required specifications and quality standards.

- ✓ **Deburring**

Task: Remove any burrs or sharp edges from the blanked parts.

Example: Using a deburring tool to smooth the edges of the aluminium washers.

Details: Use manual or automated deburring tools to smooth out any rough edges and ensure the parts are safe to handle.

- ✓ **Cleaning and Finishing.**

Task: Clean the parts and apply any necessary surface treatments.

Example: Cleaning the washers and applying a protective coating to prevent corrosion.

Details: Clean the parts to remove any residues from the blanking process and apply finishes like paint, plating, or coatings as required.

- ✓ **Tool Maintenance.**

Task: Regularly inspect and maintain the punch and die to keep them sharp and in good condition.

Machine Maintenance:

Task: Perform routine maintenance on the punching machine to keep it running smoothly.

Example: Lubricating the mechanical punch press and checking for wear.

Details: Follow a maintenance schedule for lubrication, parts replacement, and system checks to ensure continuous operation.

- ✓ **Record Keeping.**

Task: Document the production details, including material batches and inspection results, for quality control and traceability.

Details: Maintain detailed records of material specifications, batch numbers, machine settings, and inspection outcomes for future reference and quality assurance.

- **Procedures of performing perforating.**

Determine the Perforation Pattern: Create a detailed design of the perforation pattern,

including the size, shape, and arrangement of holes.

Example: Designing a metal screen with a hexagonal hole pattern for use in a ventilation system.

Material Selection: Choose the appropriate material based on the application's requirements, such as strength, ductility, and thickness.

Consider factors like the material's ability to withstand the punching force, its ductility, and its final application.

Tool selection: Select the punch and die set to match the perforation pattern.

Example: Creating a punch and die set that will produce the hexagonal hole pattern.

Machine Selection: Select an appropriate punching machine (mechanical, hydraulic, CNC) based on the material and complexity of the perforation pattern.

Consider the machine's force capacity, speed, and precision. CNC machines are preferred for perforating operations due to their ability to produce intricate patterns accurately.

Tool Installation: Install and align the punch and die on the punching machine securely.

Ensure the punch and die are securely fastened to avoid misalignment during operation. Use alignment tools and checks to verify proper positioning**.**

Machine Calibration: Set the machine to the appropriate force, speed, and other settings.

Adjust settings based on the material's thickness and properties. Ensure the machine's parameters are correctly input to prevent damage to both the material and the tools.

Workpiece Preparation: Cut the metal sheets to the required size and clean them if necessary.

Use precision cutting tools to size the sheets accurately. Cleaning can involve removing oils, dirt, or oxidation to ensure a clean perforating process.

Positioning the Workpiece: Place the metal sheet on the work table and use clamps or other methods to secure it in place.

Properly position the material to ensure it does not move during perforating. Use jigs or fixtures if necessary for repeated accuracy.

Perform a Test Run: Conduct a test run using a scrap piece of material to ensure accuracy.

Example: Running a test perforation on a scrap piece of aluminium to check for alignment and precision.

Check for issues such as misalignment, incorrect force application, or tooling problems.

Adjust settings as necessary.

Make Adjustments: Adjust the machine settings or tool alignment based on the test run results.

Example: Adjusting the punch alignment if the holes are slightly off.

Start the Operation: Begin the perforating process by activating the machine.

Monitor the initial few parts to ensure everything is running smoothly and producing parts to specification.

Inspect the Parts: Inspect the perforated parts for accuracy and quality.

Example: Using calipers to measure the dimensions of the holes and the overall pattern.

Deburring: Remove any burrs or sharp edges from the perforated parts.

Use manual or automated deburring tools to smooth out any rough edges and ensure the parts are safe to handle.

Cleaning and Finishing: Clean the parts and apply any necessary surface treatments.

Clean the parts to remove any residues from the perforating process and apply finishes like paint, plating, or coatings as required.

Tool Maintenance: Regularly inspect and maintain the punch and die to keep them sharp and in good condition.

Details: Schedule regular maintenance checks and sharpening to prolong tool life and maintain perforating accuracy.

Machine Maintenance: Perform routine maintenance on the punching machine to keep it running smoothly.

Details: Follow a maintenance schedule for lubrication, parts replacement, and system checks to ensure continuous operation.

Record Keeping: Document the production details, including material batches and inspection results, for quality control and traceability.

Details: Maintain detailed records of material specifications, batch numbers, machine settings, and inspection outcomes for future reference and quality assurance.

- **Procedures of performing parting operation:**

Determine the Parting Line: Create a detailed design specifying the parting line(s) along which the material will be separated.

You can use CAD software to outline the exact parting line, ensuring precise specifications.

This design should include tolerances and any specific requirements for edge finish.

Material Selection: Choose the appropriate material based on the application's requirements, such as strength, ductility, and thickness.

Consider the material's properties such as tensile strength, ductility, and thickness to ensure it is suitable for parting.

Tool selection: select punch and die set to match the parting line.

Selected tool should ensure clean and precise cuts along the parting line. Account for material properties and required tolerances in the design.

Machine Selection: Select an appropriate punching machine (mechanical, hydraulic, CNC) based on the material and complexity of the parting line.

Example: Choosing a mechanical punch press for its speed and efficiency in cutting straight lines.

Consider the machine's capacity to handle the required force and its ability to maintain precision during repetitive operations.

Tool Installation: Install and align the punch and die on the punching machine securely.

Use alignment tools to ensure the punch and die are properly positioned and securely fastened to prevent any movement during operation.

Machine Calibration: Set the machine to the appropriate force, speed, and other settings.

Input the material thickness, punch speed, and other relevant parameters to ensure optimal performance.

Workpiece Preparation: Cut the metal sheets to the required size and clean them if necessary.

Example: Cutting the mild steel sheets to the size needed for the components and cleaning them to remove any contaminants.

Ensure the workpiece are properly sized and free from any debris or contamination that might affect the parting operation.

Positioning the Workpiece: Place the metal sheet on the work table and use clamps or other methods to secure it in place.

Properly align the workpiece with the parting line and ensure it is firmly secured to prevent movement during punching.

Perform a Test Run: Conduct a test run using a scrap piece of material to ensure accuracy.

Example: Running a test parting on a scrap piece of mild steel to check for alignment and

precision.

Inspect the test piece for accuracy and make any necessary adjustments to the machine settings or tooling alignment.

Make Adjustments: Adjust the machine settings or tool alignment based on the test run results.

Example: Adjusting the punch alignment if the parting line is slightly off.

Start the Operation: Begin the parting process by activating the machine.

Example: Starting the punch press to begin cutting the metal strips along the parting line.

Monitor the initial few parts to ensure the operation is running smoothly and producing parts to specification.

Inspect the Parts: Inspect the parted components for accuracy and quality.

Deburring: Use manual or automated deburring tools to ensure the edges are safe and clean.

Cleaning and Finishing: Clean the parts to remove any residues and apply finishes such as paint, plating, or coatings as required.

Tool Maintenance: Inspect and maintain the punch and die to keep them sharp and in good condition.

Machine Maintenance: Lubricate the punch press and checking for wear.

Follow a maintenance schedule for lubrication, parts replacement, and system checks to ensure continuous operation.

Record Keeping: Maintain detailed records of material specifications, batch numbers, machine settings, and inspection outcomes for future reference and quality assurance.

- **Procedures of performing drawing operation.**

Determine the Part Design: Create a detailed design of the part to be drawn, including dimensions, shapes, and features.

Example: Designing a deep-drawn cylindrical cup with specific height, diameter, and wall thickness.

Material Selection: Choose the appropriate material based on the part's requirements, such as strength, ductility, and thickness.

Consider factors like the material's ability to undergo plastic deformation without cracking, its ductility, and its final application

Example: Selecting mild steel for its good formability and strength.

Tool selection: select the punch and die set to match the part's specifications.

Machine Selection: Consider the machine's force capacity, speed, and precision. Hydraulic presses are preferred for drawing operations due to their ability to apply controlled, uniform force.

Tool Installation: Ensure the punch and die are securely fastened to avoid misalignment during operation. Use alignment tools and checks to verify proper positioning.

Machine Calibration: Set the machine to the appropriate force, speed, and other settings.

Adjust settings based on the material's thickness and properties. Ensure the machine's parameters are correctly input to prevent damage to both the material and the tools.

Workpiece Preparation: Use precision cutting tools to size the blanks accurately. Cleaning can involve removing oils, dirt, or oxidation to ensure a clean drawing process.

Positioning the Workpiece: Place the metal blank on the work table and use clamps or other methods to secure it in place.

Properly position the material to ensure it does not move during drawing. Use jigs or fixtures if necessary for repeated accuracy.

Perform a Test Run: Conduct a test run using a scrap piece of material to ensure accuracy.

Check for issues such as misalignment, incorrect force application, or tooling problems. Adjust settings as necessary.

Make Adjustments: Adjust the machine settings or tool alignment based on the test run results.

Start the Operation: Begin the drawing process by activating the machine.

Inspect the Parts: Inspect the drawn parts for accuracy and quality.

Deburring: Use manual or automated deburring tools to smooth out any rough edges and ensure the parts are safe to handle.

Cleaning and Finishing: Clean the parts and apply any necessary surface treatments.

Clean the parts to remove any residues from the drawing process and apply finishes like paint, plating, or coatings as required.

Tool Maintenance: inspect and maintain the punch and die to keep them sharp and in good condition.

Machine Maintenance: Follow a maintenance schedule for lubrication, parts replacement,

and system checks to ensure continuous operation.

Record Keeping: Maintain detailed records of material specifications, batch numbers, machine settings, and inspection outcomes for future reference and quality assurance.

- **Procedures of performing notching operation.**

Determine the Notch Design: Create a detailed design specifying the notch shape, dimensions, and locations.

Material Selection: Choose the appropriate material based on the requirements of the notched part, such as strength, ductility, and thickness.

Tool selection: Ensure the selected tool accommodates the notch shape and material properties for clean and precise cuts.

Machine Selection: Consider the machine's capacity to handle the required force and its ability to maintain precision during repetitive operations.

Tool Installation: Use alignment tools to ensure the punch and die are properly positioned and securely fastened to prevent any movement during operation.

Machine Calibration: Input the material thickness, punch speed, and other relevant parameters to ensure optimal performance.

Workpiece Preparation: Cut the metal sheets to the required size and clean them if necessary.

Ensure the workpiece are properly sized and free from any debris or contamination that might affect the notching operation.

Positioning the Workpiece: Place the metal sheet on the work table and use clamps or other methods to secure it in place.

Properly align the workpiece with the notch locations and ensure it is firmly secured to prevent movement during punching.

Perform a Test Run: Conduct a test run using a scrap piece of material to ensure accuracy.

Inspect the test piece for accuracy and make any necessary adjustments to the machine settings or tooling alignment.

Make Adjustments: Adjust the machine settings or tool alignment based on the test run results.

Start the Operation: Begin the notching process by activating the machine.

Inspect the Parts: Inspect the notched components for accuracy and quality.

Deburring: Use manual or automated deburring tools to ensure the edges are safe and

clean.

Cleaning and Finishing: Clean the parts to remove any residues and apply finishes such as paint, plating, or coatings as required.

Tool Maintenance: inspect and maintain the punch and die to keep them sharp and in good condition.

Machine Maintenance: Follow a maintenance schedule for lubrication, parts replacement, and system checks to ensure continuous operation.

Record Keeping: Maintain detailed records of material specifications, batch numbers, machine settings, and inspection outcomes for future reference and quality assurance.

- **Procedures of performing lancing operation.**
  - ✓ Create a detailed design specifying the lance shape, dimensions, and locations.
  - ✓ Choose the appropriate material based on the requirements of the lanced part, such as strength, ductility, and thickness.
  - ✓ Select the punch and die set specifically for the lancing operation.
  - ✓ Select an appropriate punching machine (mechanical, hydraulic, CNC) based on the material and complexity of the lance.
  - ✓ Install and align the punch and die on the punching machine securely.
  - ✓ Set the machine to the appropriate force, speed, and other settings.
  - ✓ Cut the metal sheets to the required size and clean them if necessary.
  - ✓ Place the metal sheet on the work table and use clamps or other methods to secure it in place.
  - ✓ Conduct a test run using a scrap piece of material to ensure accuracy.
  - ✓ Adjust the machine settings or tool alignment based on the test run results.
  - ✓ Begin the lancing process by activating the machine.
  - ✓ Inspect the lanced components for accuracy and quality.
  - ✓ Remove any burrs or sharp edges from the lanced components.
  - ✓ Clean the parts to remove any residues and apply finishes such as paint, plating, or coatings as required.
  - ✓ Inspect and maintain the punch and die to keep them sharp and in good condition.
  - ✓ Perform routine maintenance on the punching machine to keep it running smoothly.
  - ✓ Maintain detailed records of material specifications, batch numbers, machine settings, and inspection outcomes for future reference and quality assurance.
- **Procedures of performing bending operation.**

Determine the Bend Design: Create a detailed design specifying the bend angles, radii, and positions.

Material Selection: Choose the appropriate material based on the requirements of the bent

part, such as strength, ductility, and thickness.

Tooling selection: Ensure the selected tooling accommodates the bend angle and material properties for clean and precise bends.

Machine Selection: Select an appropriate punching machine (mechanical, hydraulic, CNC) based on the material and complexity of the bend.

Tool Installation: Use alignment tools to ensure the punch and die are properly positioned and securely fastened to prevent any movement during operation.

Machine Calibration: Input the material thickness, punch speed, and other relevant parameters to ensure optimal performance.

Workpiece Preparation: Ensure the workpiece are properly sized and free from any debris or contamination that might affect the bending operation.

Positioning the Workpiece: Properly align the workpiece with the bend locations and ensure it is firmly secured to prevent movement during punching.

Perform a Test Run: Conduct a test run using a scrap piece of material to ensure accuracy.

Make Adjustments: Adjusting the punch alignment if the bends are slightly off.

Start the Operation: Begin the bending process by activating the machine.

Inspect the Parts: Inspect the bent components for accuracy and quality.

Deburring: Use manual or automated deburring tools to ensure the edges are safe and clean.

Cleaning and Finishing: Clean the parts to remove any residues and apply finishes such as paint, plating, or coatings as required.

Tool Maintenance: Inspect and maintain the punch and die to keep them sharp and in good condition.

Machine Maintenance: Follow a maintenance schedule for lubrication, parts replacement, and system checks to ensure continuous operation.

Record Keeping: Maintain detailed records of material specifications, batch numbers, machine settings, and inspection outcomes for future reference and quality assurance.

Points to Remember

- While Punching the workpiece should be take into consideration of punching operations
- While Punching the workpiece should be take into consideration clearance between punch and die
- While performing Punching operation consider the following phases, deformation, penetration and fracture.
- Enhance effective punching operations must respect the punched part Design, material and machine Calibration
- After Punching operations cleaning and Maintenance of punching equipment will be ensured before making report of work done.

Application of learning 2.3.

Visit the nearby metal workpiece namely Agakiriro that fabricates punched product and perform the following tasks:

i. Perform stamping operation
ii. Perform blanking operation
iii. Perform perforating operation
iv. Perform parting operation
v. Perform drawing operation
vi. Perform notching operation
vii. Perform lancing operation
viii. Perform bending operation

Learning outcome 2 end assessment

Theoretical assessment

01. Read the following statement and write the letter corresponding to the right answer.

i. The following are elements of cutting list except:

a) Part number
b) Item specification
c) Quantity
d) Quality

02. Read the following statement and select the correct answer, forming die includes:

a) Notching
b) Coining
c) Trimming
d) Blanking

03. Read the following statement and write the letter corresponding to the right answer.

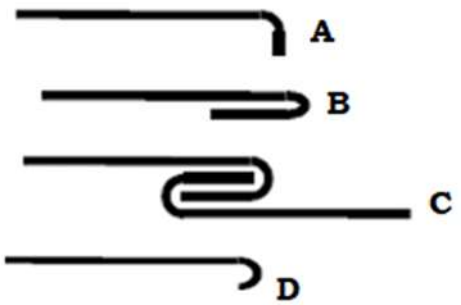
i. Which one is not a procedure of positioning a die?

a) Clean the die
b) Inspect the die
c) Design the die
d) Position the die holder

04. Read the following statement and select the correct answer, which one is a benefit of lubricating stamping die:

a) Assisting material flow
b) Increase friction
c) Increase hardness

05. Which one is a hemming operation in the following bending operations:



06. What should be the drawing force if, a drawing operation is used to form a cylindrical cup with inside diameter = 75 mm and height = 50mm. The starting blank size = 138mmand the stock thickness = 2.4mm? given that the tensile strength of the sheet metal (low-carbon steel) = 300 MPa and yield strength = 175 MPa. The die corner radius = 6 mm.

a) 194396N
b) 193 396N
c) 187 500N
d) 186500N

07. Complete the following sentence by the appropriate word in bracket (**Parting Lancing, Blanking, Perforating, Notching**).

i. ..... is a specialized punching operation where material is removed from the edge or corner of a workpiece.
ii. ..... is a punching operation in which a workpiece is divided into two or more discrete parts by cutting along a specific line.

d) Rising heat

08. Match column A representing common procedures of performing any punching operation with their explanations in column B. Use each letter only once and write it in the provide blank space.

Answers	**Column A**	**Column B**
1…….	1. Determine the part Design	**F.** Choose the appropriate material based on the requirements of the punched part, such as strength, ductility, and thickness.
2…….	2. Material Selection	**G.** Use alignment tools to ensure the punch and die are properly positioned and securely fastened to prevent any movement during operation.
3…….	3. Tool selection	**H.** Cut the metal sheets to the required size and clean them if necessary.
4…….	4. Machine Selection	**I.** Place the metal sheet on the work table and use clamps or other methods to secure it in place.
5…….	5. Tool Installation	**J.** Create a detailed design specifying the part shape, dimensions, and locations.
6…….	6. Machine Calibration	**K.** Ensure the selected tool accommodates the part shape and material properties for clean and precise cuts.
7…….	7. Workpiece Preparation	**L.** Input the material thickness, punch speed, and other relevant parameters to ensure optimal performance.
8…….	8. Positioning the Workpiece:	**M.** Consider the machine's capacity to handle the required force and its ability to maintain precision during repetitive operations.

Practical assessment

Hot and fast beverage is a new sorghum porridge shop in your home area, the hot and fast beverage needs a hundred (100) cylindrical cups having internal diameter of 70mm and 50mm of height. Regardless to the cup handles, you are requested to perform a sample of this cup in aluminium sheet metal of 1.25mm of thickness within two (2) hours.

END

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Indicative contents

3.1 Finishing punched product

3.2 Maintaining punching machine

3.3 Store materials, tools and equipment

3.4 Reporting performed work

Key Competencies for Learning Outcome 3 : Perform Post-Operation Activities

Knowledge	Skills	Attitudes
• Explanation of surface and edge finishing techniques after punching operation • Description of basic preventive maintenance of punching equipment • Description of Methods of storing materials tools and equipment after punching operation • Description of methods for reporting the work done	• Finishing punched product • Maintaining punching machine • Lubricating punching machine • Cleaning punching equipment and punching tools • Storing materials, tools and equipment • Reporting performed work	• Being attentive while finishing punched products. • Being active while cleaning punching equipment and punching tools • Have self-confidence explaining surface and edge finishing techniques. • Being organizer while storing materials, tools and equipment • Being task oriented while maintaining punching equipment

Duration: 7 hrs

Learning outcome 2 objectives:

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

1. Explain clearly both surface and edge finishing techniques according the product requirement.
2. Describe clearly the basic preventive maintenance of punching equipment
3. Describe properly the Methods of storing materials tools and equipment after punching operation
4. Explain clearly the methods for reporting the work done.
5. Apply correctly finishing techniques for edge and surface of punched product according to the product requirement.
6. Perform appropriately the basic preventive maintenance to maintain punching machine according to the manufacture 'instructions.
7. Store properly materials, tools and equipment used in punching operation.
8. Report correctly the work done according to the reporting procedures and templates.

Resources

Equipment	Tools	Materials
• PPE • punching machines • benches • angle grinder • anvil • vices • shear machine • cut-off machine • bending machine • rolling machine • air compressor	• Rulers • Dies • Punches • sand papers • files • cutting tools • clamping tools • paint brush • measuring • marking tools • common tools (hummer, screw	• Paints • oil • grease • soap

• firefighting equipment.	driver, pliers, spanners, wrench, Allen key) • cloths rugs • wire brushes	

Indicative content 3.1: Finishing Punched Product

Duration: 2 hrs

Theoretical Activity 3.1.1: Description of finishing techniques for edge and surface of punched product

Tasks:

1: You are requested to answer the following questions:

I. Identify finishing technics used on edge and surface of punched product

II. Describe finishing techniques for finishing edge and surface of punched product

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

3: Present the findings/answers to the whole class

4: Follow actively the trainer's clarification and ask question if any.

5: Read the key readings 3.1.1.

Key readings 3.1.1: Description of finishing techniques for edge and surface of punched product

- **The following finishing techniques are applied on both edge and surface of punched product:**
  - ✓ **Grinding:**
  - Grinding is an abrasive machining process that uses a grinding wheel or grinder as the cutting tool. Grinding is a subset of cutting, as grinding is a true metal-cutting process. Grinding is very common in mineral processing plants and the cement industry.
  - A mechanical process using a rotating grinding wheel or grinding disc made from abrasive material containing small particles of grit ranging from fine to coarse. The wheel revolves around a central axis, making contact with the surface of the workpiece, while the particles act as cutting tools that cut chips from the material.
  - **Grinding:** Grinding is the process of removing metal by the application of abrasives which are bonded to form a rotating wheel. When the moving abrasive particles contact the workpiece, they act as tiny cutting tools, each particle cutting a tiny chip from the workpiece.

- A grinding machine, often shortened to grinder, is a power tool (or machine tool) used for grinding.
- It is a type of machining using an abrasive wheel as the cutting tool**.**

✓ **The most common types of grinders.**

- **Fixed grinders.**
  - **Surface grinder**
    - A surface grinder consists of an abrasive wheel, a chuck (a workplace holding device) and a rotary table. The surface grinder is generally used for finishing the work-piece or the object. The main use of the surface grinder is in the finishing process.
    - Surface grinding is best if used for flat cutting. Flat surface cutting is most commonly used surface cutting. The surface grinder is one of the best grinders to be used for this purpose. Grinding is the process of finishing the work piece or the object or we can say it makes the work piece in perfect shape.

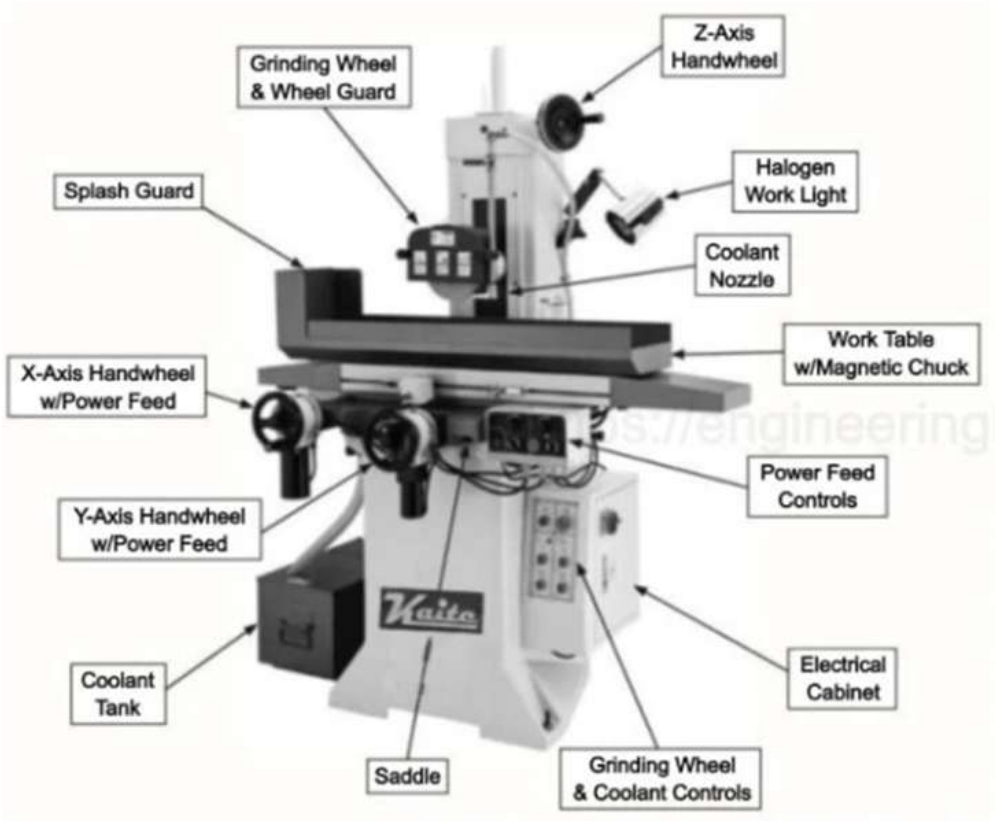

Fig51: Surface grinder

- **Types of Surface Grinding Machine:**
  - **Horizontal-Spindle Surface Grinder.**

The boundary of the wheel is in contact with the work piece producing the flat surface. The horizontal spindle surface grinder is one of the best type grinders to be used for flat cutting surfaces.

- **Vertical-Spindle Surface Grinder.**

It is a grinder to be used to allocating the finishing touch to the workplace. It has also been used for flat cutting surfaces.

- **Disc Grinders and Double-Disc Grinder**

Disc grinders are similar to surface grinding. Disc grinders are made available for both the upright position as well as the horizontal spindle categories. Double disc grinder work on both the sides of the work piece or the object. Disc grinders can achieve especially fine tolerance.

- **Grinding Wheel for Surface Grinder**

Aluminum oxide, silicon carbide, diamond, and cubic boron nitride are four commonly used abrasive materials for the surface of the grinding wheel. The material, aluminum oxide is one of the best to be used. As is the case with any grinding operation, the terms and conditions of the wheel are incredibly important.

- **Bench grinders.**

Bench grinders: The bench grinder is used for the sharpening of cutting tools and the rough grinding of metal. Because the work is usually held in the hand, this type of grinding is sometimes called “offhand grinding”

1. On/Off switch
2. Worklight switch
3. Coolant tray
4. Right work rest
5. Left work rest (grooved)
6. Left safety shield (w/ magnifier)
7. Right safety shield
8. Left wheel guard
9. Worklight
10. Grinding wheel
11. Right wheel guard
12. Spark deflector

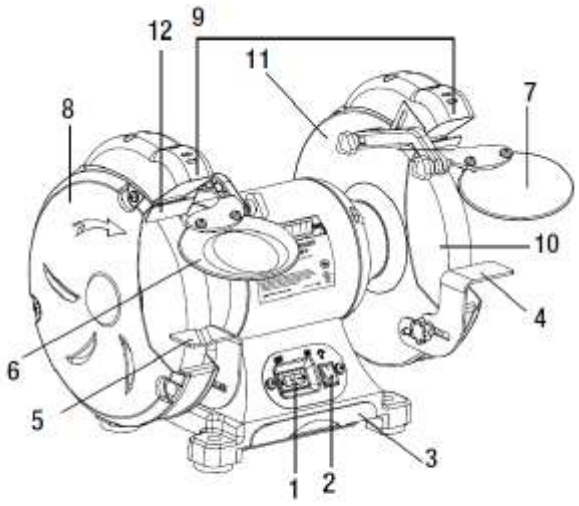

Fig52: Bench grinding machine

- ✓ **Portable or hand-held grinders.**
  - **Die grinders**

Die grinder is a simple yet powerful tool that is traditionally used to grind the metal. This tool is very versatile and can be used to grind almost any material. It is used to polish or smooth rough edges and has incredible power and unbelievable RPM speeds. It comes in both electric and pneumatic varieties. There are a number of jobs that a die grinder can help you with, but here are some of the most common uses.

Fig53: Die grinder

- **Angle grinder.**
  - An angle grinder, also known as a side grinder, is a handheld power tool used for cutting, grinding and polishing
  - Angle grinders can be powered by an electric motor, petrol engine or compressed air. The motor drives a geared head at a right-angle on which is mounted an abrasive disc that can be renewed when worn. Angle grinders typically have an adjustable guard and a side-handle for two-handed operation
  - Angle grinders may be used both for removing excess material off a piece or simply cutting into a piece. There are many different kinds of discs that are used for various materials and tasks, such as cut-off discs (diamond blade), abrasive grinding discs, grinding stones, sanding discs, wire brush wheels and polishing pads. The angle grinder has large bearings to counter side forces generated during cutting, unlike a power drill, where the force is axial. Angle grinders are widely used in metalworking and construction, as well as in emergency rescues. They are commonly found in workshops, service garages and auto body repair shops. There are a large variety of angle grinders to choose from when trying to find the right one for the job. The most important factors in choosing the right grinder are the disc size and how powerful the motor is**.**

Fig54: Angle grinder

- **Safety Precautions to Take When Using an Angle Grinder:**
  - Wear proper gear. Angle grinder safety starts by ensuring you're
  - dressed appropriately from head to toe.
  - Ensure the grinder itself is in proper condition. The grinder itself
  - must be in proper condition
  - Use the correct disc
  - Use the disc guard.
  - Slow down, speed up
  - Keep the grinder away from flammables.
- **Advantages and Disadvantages of angle grinder.**

Advantages of angle grinder	**Disadvantages of angle grinder.**
1. It is portable, means that it can be used on the side during fabricating different items such as trusses, doors, windows etc. 2. It is used to cut any shape of metals (e.g. flat bar, sheet metal, square, pipes, etc 3. When the skilled person is using it, the metal can be cut at a certain angle. 4. The cost is low	1. It cannot be used when there is no electricity 2. When used to cut big thicknesses, a lot of time is required. 3. The care should be taken when using the angle grinder, if the disc is not fixed properly, it can jump and damage the user. 4. Some materials are lost during this process.

- **Grinding Procedures:**
  - Ensure the proper wheel for the stock is being used.
  - Clean the bed before placing the workpiece onto it.
  - Place magnetic parallels around the workpiece to ensure the workpiece does not shift during
  - grinding.
  - Turn the magnetic chuck on to secure the pieces onto the bed.

✓ **Filing.**

Filing is a material removal process in manufacturing. Similar to grinding, depending on use, to both sawing and grinding in effect, it is functionally versatile, but used mostly for finishing operations, namely in deburring operations. Filing operations can be used on a wide range of materials as a finishing operation. Filing helps achieve workpiece function by removing some excess material and deburring the surface.

Techniques of using hand files:

- Cross Filing

Also called straightforward filing, this technique involves pushing the file across the edge of the material. It can be used for finishing, shaping or sharpening.

This is the most commonly used filing technique. It's easy as pie to do, but difficult to master completely.

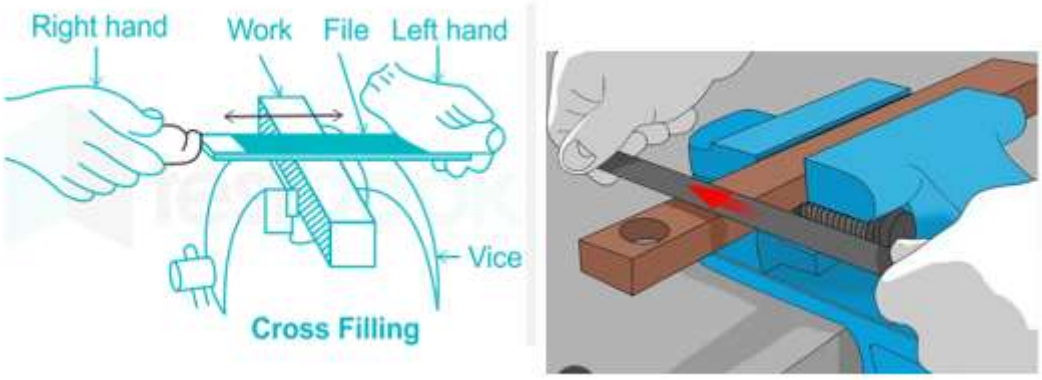

Fig56: Cross filing illustration

- **Advantages**
  - An adaptable technique, useful for smoothing, finishing, sharpening and deburring.
  - Can be used with any type of file.
  - Can be used on small components.
- **Disadvantages**
  - Difficult to master and can result in an undesirable sloped surface on thicker workpiece

- **Draw Filing**

This technique is a little more unusual and involves holding a file at each end and using it in a similar way to sandpaper. This technique is only used for finishing, and only with single-cut files.

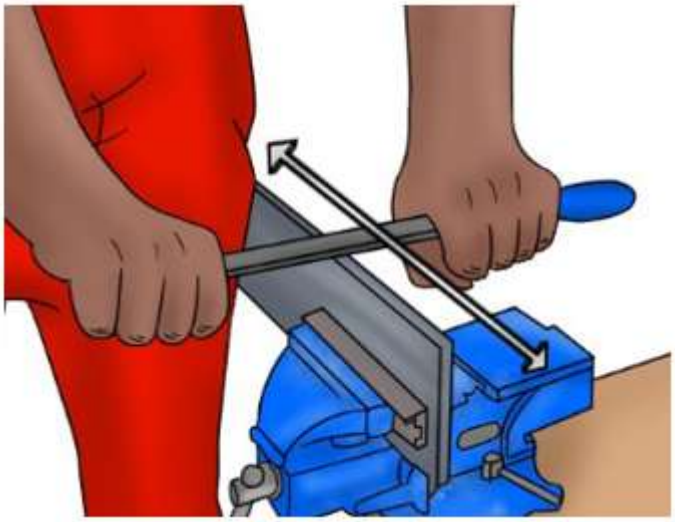

Fig57: Draw filing illustration

- **Advantages**
  - Very effective at creating a smooth surface.
- **Disadvantages**
  - Only works with single-cut files.
  - Cannot be used in tight spaces

Lathe Filing

Lathe filing is used to smooth and shape cylindrical pieces of material, such as wooden chair legs.

This is a tricky technique that involves mounting your workpiece in a lathe, which will rotate it when activated. The lathe must be spun faster than usual to ensure maximum filing consistency. The lathe filing technique is otherwise similar to cross filing.

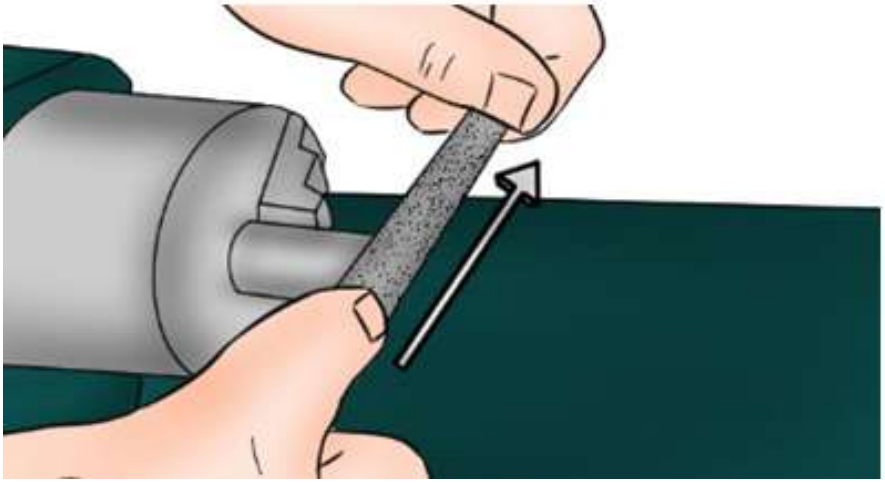

Fig58: Lathe deburring

- **Advantages**

- The only way to file a cylindrical work piece with any consistency.
- Allows for rapid shaping of material.
- Can be used for finishing, shaping and deburring.

    - **Disadvantages**

- Requires a lathe.
- Mistakes cause irregularities in an otherwise symmetrical pattern.
- Requires a file with safe edges if you are working close to edges of the workpiece to prevent damage to lathe and file.
- It's difficult to be accurate.

✓ **Deburring:**

Deburring is a finishing process that removes sharp edges, burrs, fins or inconsistencies from material, such as metals, steel and alloys, leaving the material with smooth edges and fine finished surface.

Types of deburring

- **Manual Deburring**

Mechanical deburring process where burrs are removed from a workpiece using a manual deburring tool.

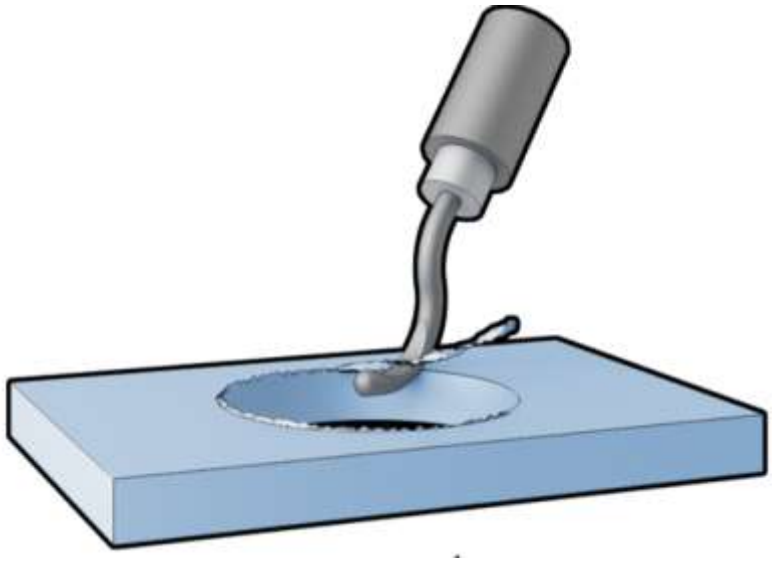

Fig59: Illustration of Manual deburring

The tool that has a sharp cutting edge on a bent tip is drawn along the edge to be deburred. The way the tool is articulated to the handle makes it easy to maintain the correct cutting angle, making deburring for instance a hole, very easy to perform in one operation.

- **File Deburring**

Mechanical deburring process where a file is used to process the workpiece surface so that its surface roughness is improved.

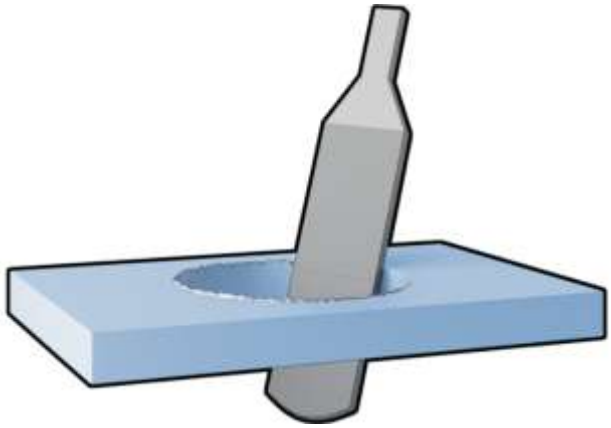

Fig60: Illustration of File deburring

In this process the tool is usually made of hard metal and is knurled such that more subsequent cuts are created. The cutting inserts are angled so that cutting occurs when the file is pressed against the workpiece and moved forward. The files are available in many versions and diameters to suit different jobs. A common file is one that is flat on one side and rounded on the others to be able to process both round holes as in this case, and straight edges.

- **Grind deburring**

Mechanical deburring process where an abrasive wheel is used to remove burrs and irregularities.

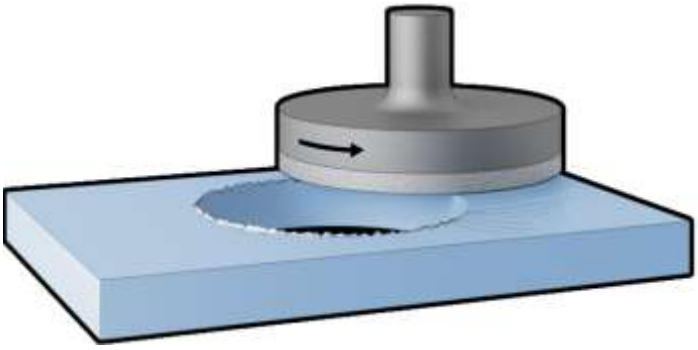

Fig61: Illustration of grind deburring

In this process the rotating grinding wheel presses down against the surface of the workpiece thus removing impurities and burrs. The choice of the grinding wheel depends on the workpiece material and the desired results.

- **Milling Deburring**

Mechanical deburring process with burrs from the previous process is removed by controlled milling.

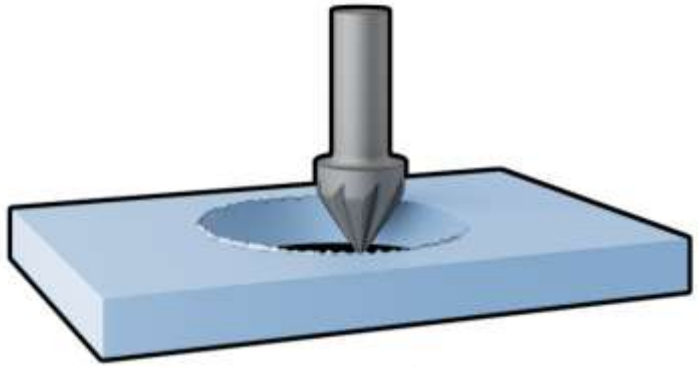

Fig62: Illustration of Milling deburring

In this process the work piece is clamped in a mill where the burrs are removed by controlled milling.

- **Plasma Deburring**

Thermal processing deburring where a plasma is used to remove burrs on the workpiece.

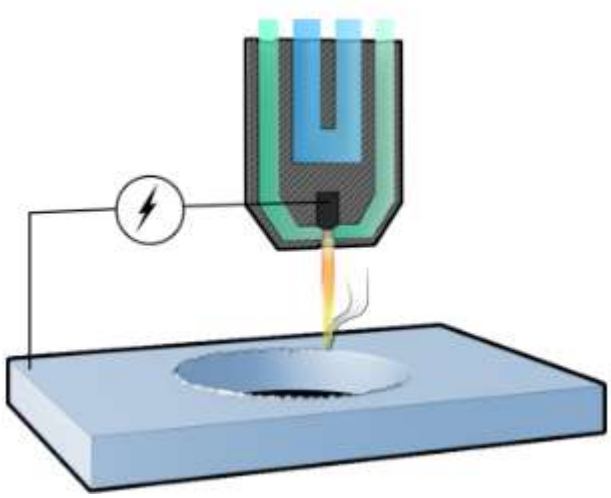

Fig63: Illustration of plasma deburring

In this process the method uses plasma that is commonly used in plasma cutting, but in this method the plasma is used for processing just the workpiece surface. The workpiece is fastened, and a plasma stream is directed on the workpiece surface. The plasma then oxidizes the burrs on the surface.

- **Deburring with sandblasting**

Mechanical deburring process in which compressed air mixed with an abrasive is ejected toward the workpiece surface to wear away burrs**.**

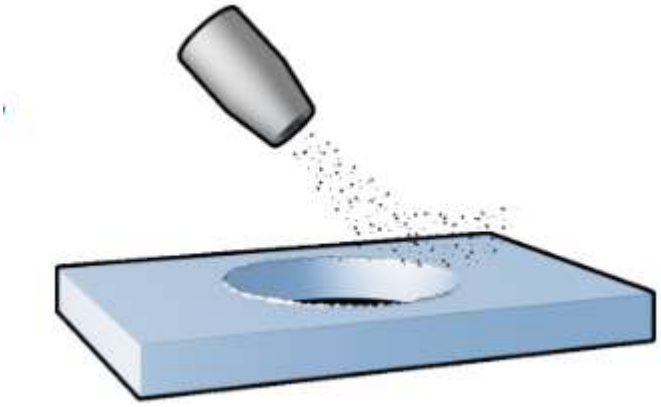

Fig64: Illustration of deburring with sandblasting

- **Electrochemical deburring**

Electrochemical process that deburrs edges by an electrolytic process.

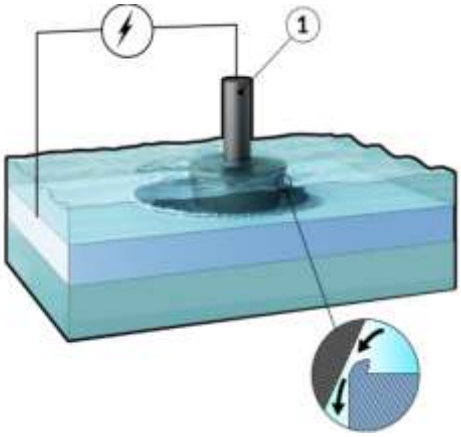

Fig 65: Illustration electrochemical deburring

The workpiece acts as anode and tool acts as cathode by connecting to the power source. The tool is positioned adjacent to the burrs and a continuous current flowing through the electrolyte corrodes the burrs. Cut particles are carried away by the flow.

The tool is designed for the needs and therefore also remote inaccessible inner burrs.
Metal sanding

- **Electro discharge deburring**

Abrasive processing method in which controlled spark discharges from an electrode deburrs the sharp edges of the machined workpiece.

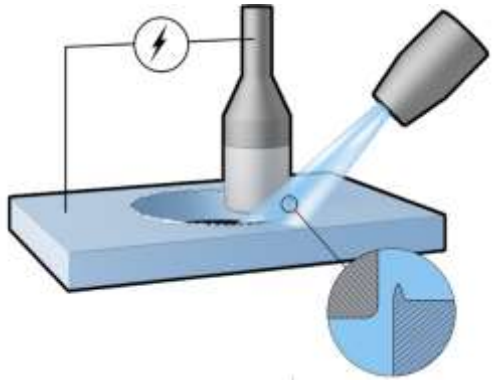

Fig66: Illustration of electro discharge deburring

In this process the tool consists of a probe which is positioned close to the burrs to be cleared. The entire workpiece is usually immersed in a dielectric, i.e. deionized water.

Connection via power supply allows the probe to act as cathode and burrs as anode. When the electrode is brought close to the burrs occasional spark discharges occur. The discharge means that the burrs are melted and vaporized. Dielectric also helps to cool the process and carry away removed material during the time the probe is moved towards the burrs.

- **Laser Deburring**

Thermal deburring process where a laser beams of lower intensity than in conventional laser cutting and is directed towards the workpiece burrs.

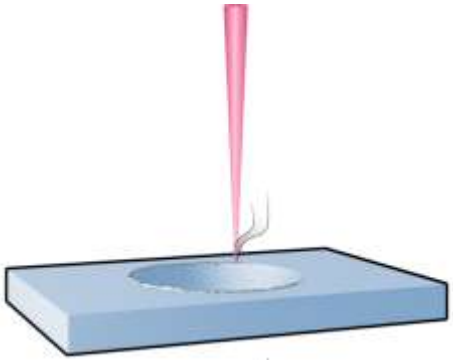

Fig67: Illustration of laser deburring

The method uses a laser created by a laser generator and thus similar to the processes used for laser machining. The difference is mainly that the laser beam intensity in this method is slightly lower to reduce the risk of new burrs forming due to heat generation. The focus point is also a bit above the surface to give a wider beam at the point of impact. The laser beam is directed towards the burrs of the workpiece so that they are burned due the intensity of the laser.

- ✓ **Metal sanding.**

Metal sanding or reeling is a metals finish done manually or through the appropriate machinery, which means passages on abrasive belts, coarse and then gradually finer grains, until the desired level of smoothness is achieved

- **Selecting the Right Sanding Tools and Abrasives.**

Sandpaper: Available in various grit sizes, sandpaper is the most versatile option. Coarse grit sandpaper (40-80) is suitable for heavy material removal, while medium grit sandpaper (120-220) is used for intermediate sanding. Fine grit sandpaper (320-400) provides a smooth finish, and extra-fine grit sandpaper (600-1200) is ideal for final polishing.

Fig 68: Sand paper

Sanding Sponges: These flexible blocks with abrasive surfaces are handy for intricate or curved surfaces. They come in different grits and can be easily shaped or trimmed for better access to tight areas

Fig69: Sand sponges

Sanding Discs or Sanding Belts: These are typically used with power sanders, such as orbital sanders or belt sanders. They offer faster material removal and are available in various grits and sizes.

Fig70: Sanding disc

- **Safety Precautions during metal sanding**

- **Wear Protective Gear:** Always wear safety goggles, a dust mask, and gloves to protect your eyes, respiratory system, and hands from metal dust, debris, and potential hazards.
- **Work in a Well-Ventilated Area:** Sanding metal produces fine particles and dust, which can be harmful if inhaled. Ensure you work in a well-ventilated space or wear a respirator to minimize exposure.
- **Secure the Workpiece:** If you are using power sanders, ensure the workpiece is securely clamped or held in place to prevent accidents or injuries.
- **Minimize Fire Hazards:** Some metals, like aluminum, produce fine particles that are highly flammable. Keep a fire extinguisher nearby and avoid working near open flames or sparks.

✓ **Polishing:**

Polishing refers to an abrading operation that follows grinding and precedes buffing. The two main reasons for polishing are to remove considerable amounts of metal or non-metallic and smooth a particular surface. This operation is usually followed by buffing to refine a metallic or non-metallic surface.

- **Polishing procedures**
  - **Check the product surface**: before polishing a metal surface you have to check the smoothness or roughness of it.

  Methods for testing surface profile and/or surface roughness:
    - Surface Comparators.
    - Replica Tape.
    - Surface Profile Gauges.
    - Surface Roughness Gauges
  - **Selection of polishing pad:** polishing pad used for paint cleaning, remove swirl marks, light scratches, fine sanding scratches, and other defects in the workpiece.
  - They're most commonly made of foam, wool, or microfiber. Some pads are meant for manual use while other need to be fixed on power tools.

Fig 71: Polishing pad

- **Advantages of polishing**
  - Polishing can improve the fatigue and corrosion resistance of the work piece.

- Polishing can also be used as an intermediate process to provide a surface with strong paint film and coating adhesion for subsequent processes such as painting and electroplating.
- Polishing is a widely used abrasive processing method. Metal and non-metallic materials, precision electromechanical products, and daily necessities can all be polished to improve surface quality.
- Polishing generally does not require special equipment, and the tool box processing method is relatively simple and low in cost.

✓ **Metal coating**

Metal coating is a process of applying a layer or layers of material onto a metal surface to enhance its properties and protect it from various environmental and mechanical factors. The primary purposes of metal coating include corrosion resistance, improved aesthetic appearance, increased hardness, enhanced electrical conductivity, and reduced friction.

Paint Coating: A painted coating is essentially the application of liquid paint. It is the most accessible and cost-effective type of coating. Different paint formulations can be used depending on the type of metal, the operating environment and the performance requirements

Selecting the correct type of paint: When it comes to a metallic surface, there are only two types of paints that can practically be used, anti-corrosion paint and oil paint

Fig72: Anti corrosion paint

- **Materials and tools used for Metal Painting:**
  - Wire brush
  - A Sandpaper
  - Drop cloth
  - Clean cotton cloths
  - Spray primer
  - Spray paint
  - Protective gear (safety glasses and dust mask

Practical Activity 3.1.2: Applying finishing techniques for edge and surface of punched product

Task:

1: Individually, referring to the previous activity 3.1.1, you are requested to go in Manufacturing workshop and apply the following finishing techniques, grinding, filing, deburring, sanding and metal coating on the surface and edges of punched product respecting the trainer's instructions.

2: Pay attention on trainer's instructions.

3: Individually perform grinding, filing, deburring, sanding and metal coating.

4: Present your work to the trainer, workshop assistant or your classmate.

5: Read the key reading 3.1.2.

6: Perform the task provided in application of learning 3.1

Key readings 3.1.2

Applying finishing techniques for edge and surface of punched product

- ✓ **Performing grinding operation.**
  - **Safety precautions during grinding operation:**
- Ensure the guard is in the proper place, positioned between the operator and the wheel
- Wear proper gear. Grinders safety start by ensuring you're dressed appropriately from head to toe.
- Ensure the grinder itself is in proper condition. The grinder itself must be in proper condition
- Use the correct disc
- Use the disc guard
- Slow down, speed up
- Keep the grinder away from flammables.
- Liquid coolants should not be used with grinders as they can cause the metal to shatter.
- Stand to the side of the wheels when starting up.
- Let the wheels gain maximum speed before starting to grind.
- Work piece must never be held with gloves, cloth, apron or pliers.
- Do not grind on the side of the wheel.
- Small objects must not be held by hand.

- Never leave the machine running unattended

Procedure of performing grinding operation:

- **Inspect the Punched Product:** Check for any visible burrs, rough edges, or deformities.
- Ensure the product meets the initial dimensional requirements.
- **Clean the surface:** Remove any dirt, oil, or debris from the surface by using a suitable cleaning agent like a degreaser.
- **Secure the Workpiece:** Use a vise, clamps, or a magnetic chuck to hold the workpiece securely.
- **Prepare the Work Area:** Ensure the area is well-ventilated and clear the workspace of any flammable materials.
- **Select Appropriate Grinding Disc:** Choose the right disc based on the material (e.g., metal, stainless steel) and the desired finish. Common discs include flap discs for smooth finishing, grinding discs for heavy material removal, and cutting discs for trimming.
- **Check Wheel Condition:** Ensure the grinding wheel is free of cracks, chips, or excessive wear.
- Wear Protective Gear:
  - Safety glasses or a face shield to protect your eyes.
  - Ear protection to guard against noise.
  - Heavy-duty gloves to protect your hands.
  - Appropriate work attire to protect your body from sparks and debris.
- **Set Grinding Parameters:** if surface grinder is Adjust the speed, feed rate, and depth of cut on the grinding machine.
- **Start the Grinding Machine:** Turn on the grinding machine and allow it to reach operating speed.
- **Perform Rough Grinding:** Begin with rough grinding to remove large burrs and achieve basic shape and dimension. Move the workpiece back and forth across the grinding wheel.
- **Perform Intermediate Grinding:** Use a finer grinding wheel or adjust the grinding parameters for intermediate grinding.
- **Perform Finish Grinding:** Use the finest wheel or abrasive belt to achieve the desired surface finish.

Procedures for using hand held angle grinder:

- Hold the grinder so that any sparks fly away from you and anyone nearby, and away from all flammable materials.
- Allow the grinder to reach operating speed, then apply load gradually.
- Maintain a constant space to avoid uneven surfaces.

- Do not apply excessive force and avoid prolonged use.

Fig73: Illustration of using angle grinder

- ✓ **Filing operation:**
  - **Hand file handling.**
- Clamp the work piece as close as possible to the jaws of the vice.
- Use protective jaws (Aluminium) to protect the work piece.
- Start with a rough file for removing more material then
- Take a smooth file to reach a good surface.
- Forward stroke with pressure; Return stroke without pressure.
- Move with the file crosswise to control the area of filing.
- Clean the file from time to time (especially smooth files) with a wire brush to prevent messy finishes.
- Never work with a file without a file grip.

- ✓ **Procedures of using hand files:**
  - **Choose the Appropriate File Type:**
- Flat Files: For flat surfaces.
- Half-Round Files: For both flat and curved surfaces.
- Round Files: For enlarging holes.
- Triangular Files: For internal angles and corners.
- Needle Files: For fine detail work.
  - **Select the Correct Cut Type:**
- Single-Cut Files: For finishing and deburring.
- Double-Cut Files: For faster material removal.
- Rasp-Cut Files: For coarse shaping.

- Secure the Workpiece: Clamp the workpiece securely in a vise or on a workbench and ensure it is stable and won't move during filing.
  - **Filing Techniques:**
- **Hold the File Properly:**
  - Grasp the file handle with your dominant hand.
  - Use your other hand to guide and apply pressure near the tip.
  - Example: Holding a flat file with your right hand on the handle and your left hand guiding the tip.
- **Set filing angle and Pressure**
  - Position the file at the appropriate angle for the desired cut. Apply even, moderate pressure; do not press too hard.
- **Control Strokes and Motion.**
  - Use long, even strokes along the length of the file.
  - Push the file forward, applying pressure, and then lift slightly on the return stroke to avoid dulling the file.

✓ **Filing Procedures.**

- **Rough Shaping:** Start with a coarser file for initial shaping and material removal.
- Example: Using a double-cut file to quickly remove excess metal.
- **Finishing:** Switch to a finer file for smoothing and finishing and use a single-cut file for a smooth surface.

✓ **Deburring operation:**

Deburring tools are essential for removing sharp edges, burrs, and imperfections from metal, plastic, or other materials after machining or cutting processes.

- **Procedure for using deburring tools effectively:**

- Selecting the Right Deburring Tool: Choose the Appropriate Tool Type.
  - **Hand Deburring Tools:** For small or intricate workpiece.
  - **Rotary Deburring Tools:** For larger areas or higher efficiency.
  - **File or Scraper:** For general-purpose deburring.
  - **Specialized Deburring Blades:** For specific materials or shapes.
  - **Secure the Workpiece:** Clamp the workpiece securely in a vise or on a workbench.
  - **Clean the Workpiece:** Remove any debris, oil, or dirt from the surface.
- Hold the Tool Properly: Grasp the deburring tool handle with your dominant hand.
- Use your other hand to steady the workpiece if necessary.
- Position the tool at the appropriate angle for the edge or burr.
  - **Deburring Motion:**

- Use smooth, consistent strokes along the edge or burr.
- Move the tool in one direction to ensure a clean cut.

Deburring area.

- **Edge Deburring:** Run the tool along the edges to remove burrs and sharp edges.
- **Hole Deburring:** Use a countersink or a rotary deburring tool to deburr holes.
- **Surface Deburring:** For surfaces with burrs, use a flat file or a rotary tool with an abrasive pad.
- **Example:** Using a rotary deburring tool with an abrasive pad to smooth a flat metal surface.

Finishing Touches:

- **Inspect the Workpiece:** Check the workpiece for any remaining burrs or sharp edges.
- Example: Running your fingers along the edges of the aluminium part to feel for any remaining burrs.
- **Preform Final Pass:** Make a final pass with the deburring tool if necessary to ensure smoothness.
- Example: Making a final light pass with the deburring tool to ensure all edges are smooth.

✓ **Metal sanding operation:**

Using sandpaper is a common method for smoothing surfaces, removing imperfections, and preparing materials for further finishing.

Fig74: Sanding illustration

Selecting the Right Sandpaper according to grift.

- Coarse Grit (40-60): For removing material quickly and smoothing rough surfaces.
- Medium Grit (80-120): For general sanding and removing small imperfections.
- Fine Grit (150-180): For final sanding before finishing.
- Very Fine Grit (220-400): For sanding between coats of paint or varnish.
- Example: Choose 120 grit sandpaper for smoothing rough wood before painting.

Select the Type

- Aluminium Oxide: Good for wood, metal, and plastic.

- Silicon Carbide: Best for metal and hard surfaces.
- Garnet: Ideal for fine woodworking.
- Example: Use aluminium oxide sandpaper for general wood sanding.

Sanding Technique

- **Wrap the Sandpaper:**
  - Wrap the sandpaper around a sanding block for flat surfaces.
  - Fold the sandpaper for small areas or intricate details.
  - Example: Wrap 120 grit sandpaper around a sanding block for sanding a flat wooden surface.
- **Use a Circular Motion:**
  - For curved surfaces or when blending areas, use a circular sanding motion.
  - Example: Use circular motions to sand the curved edges of a metal chair.

Progress Through Grits

- **Start with Coarse Grit:**
  - Begin with a coarse grit to remove material quickly and smooth rough areas.
  - Example: Start with 80 grit sandpaper to smooth rough spots on a wooden board.
- **Move to Medium Grit**
  - Progress to a medium grit to remove coarse scratches and further smooth the surface.
  - Example: Switch to 120 grit sandpaper after initial sanding with 80 grit.
- **Finish with Fine Grit.**
  - Finish with fine grit for a smooth, ready-to-finish surface.
  - Example: Use 220 grit sandpaper for the final sanding pass before applying paint or varnish.
- **Clean the Surface**
  - Remove Dust: Wipe the surface with a tack cloth or damp cloth to remove sanding dust.
  - Inspect the Surface: Check for any remaining imperfections and repeat sanding if necessary.
- **Perform Final Touches**
  - Fold the sandpaper to sand edges and corners.
  - Example: Fold 120 grit sandpaper to sand the edges of a metal picture frame.
  - Detail Sanding: Use a fine grit for detailed areas and intricate shapes.

- Example: Use 220 grit sandpaper to sand the intricate details of a metal carving.

✓ **Polishing operation:**

- **Polishing procedures:**

- **Selection of polishing pad:** Select the Polishing pad for paint cleaning, remove swirl marks, light scratches, fine sanding scratches, and other defects in the work piece
  - Type of polishing pad: types of polishing pad are, Foam microfiber and wool
  - Microfiber and wool are aggressive and used chiefly for heavy cutting and spot defect removal, while foam pads are available as different types to tackle everything from cutting to refining and finishing
- **Inserting polishing pad into angle grinder:**

Fig 75: Polishing pad fitted into angle grinder

- **Polish the product:** Polishing is the process of creating a smooth and shiny surface on the product by using a polishing pad

Fig 76: Illustration polishing procedure

✓ **Preparation for painting.**

- **Red oxide and solvent mixing.**

Before beginning your paint job, you have to get some items in order. First, pick the right type of paint and paint thinner. Mixing your paint with the right thinner will allow more paint to spray out of the sprayer and ultimately help your paint job look better in the end.

Fig 77: Paint materials.

- **Painting techniques:**

Spray techniques: spray painting is a painting technic where a device sprays a coating(paint) through the air onto the surface.

- Using an air compressor and a paint sprayer can help you cover more space at one time and can help you make sure that you get an even coat of paint on your surface. After you've selected the right paint sprayer for your job, you are ready to start painting. You can attach the spray gun to the air hose and activate the trigger-lock button by pushing it. Make sure that all of the hoses are connected to their appropriate sockets and plug any power cords into an outlet.
- After your equipment is ready to start, you can turn on the gun. Adjust the right air pressure, then test your paint flow on a piece of paper before starting on your walls. You can continue to adjust any of the settings on your gun until you get the right flow and pressure for your paint job
- Always wear a mask, safety glasses, and gloves to protect yourself from harmful fumes and particles.

Fig78: Painting by air compressor

- **Brushing:** after mixing red oxide with solvent, therefore it is time to paint by using brush, hence the term brushing comes from.

Fig79: illustration of wire brush painting.

Points to Remember

- While finishing edges and surface of the punched product, you should consider the finishing techniques
- While preparing for grinding and using hand files select the appropriate grinders and hand files
- To enhance the smoothness of the sanded metal, use sanding materials.
- While grinding respect the steps of performing grinding operation.
- While Filing consider the filing techniques.

Application of learning 3.1.

Visit any manufacturing workshop that produces punched products and perform both edge and surface finishing of the punched product by respecting the following instructions:

i. Deburr the edges of the punched product
ii. File the edges of the punched product
iii. Grind the surface of the punched product
iv. Sand the surface of the punched product
v. Polish the surface of the punched product
vi. Paint the surface of the punched product

Indicative content 3.2: Maintaining Punching Machine

Duration: 2 hrs

Theoretical Activity 3.2.1: Description of preventive maintenance for punching equipment.

Tasks:

1: you are requested to respond the following questions:

i. What do you understand by preventive maintenance?
ii. Describe lubrication and cleaning as preventive maintenance technics of punching equipment.

2: Provide the answer of asked questions and write them on papers/flip chat.

4: Pay attention to the trainer's clarification and ask questions where necessary.

5: Read the key readings 3.2.1

Key readings 3.2.1

Description of routine preventive maintenance of punching equipment.

- **Preventive maintenance**

Preventive maintenance is the practice of regularly inspecting, cleaning, lubricating and maintaining equipment to prevent breakdowns, malfunctions, or other problems. The goals of preventive maintenance are to increase productivity, reduce costs, and improve safety by addressing potential issues before they occur. Routine preventive maintenance activities performed for punching machine maintenance:

- ✓ Cleaning
- ✓ Lubrication

✓ **Cleaning:**

Cleaning a punching machine requires different methods depending on the type and extent of contamination. The followings are various cleaning methods used to clean a punching machine:

Dry Cleaning Methods

- **Vacuum Cleaning:** Use a vacuum cleaner with appropriate attachments to remove loose debris, dust, and metal shavings from the machine's surface, work table, and surrounding area. This method is effective for large and easily accessible areas.

- **Compressed Air:** Use compressed air to blow away dust and small particles from hard-to-reach areas, crevices, and vents. This method is useful for areas where vacuuming is not feasible. Ensure that the use of compressed air does not blow debris into sensitive components.

Manual Cleaning Methods

- **Wiping:** Use clean, lint-free cloths or rags to wipe down surfaces, removing dust, dirt, and grease. This method is suitable for general cleaning of flat and accessible surfaces.
- **Brushing:** Use brushes with soft or stiff bristles to clean areas with stubborn dirt or grime. Soft-bristled brushes are used for delicate surfaces, while stiff-bristled brushes are effective for removing tough contaminants.

Wet Cleaning Methods

- **Solvent Cleaning:** Use cleaning solvents or degreasers to dissolve and remove grease, oil, and other stubborn contaminants. Apply the solvent to a cloth or brush and clean the affected areas. Ensure that the solvent is compatible with the machine's materials and components.
- **Washing:** For parts that can be removed from the machine, such as the punch and die, wash them with a suitable cleaning solution. Rinse thoroughly and dry before reinstallation.

Specialized Cleaning Methods

- **Ultrasonic Cleaning:** Use ultrasonic waves to clean small parts and components. This method is effective for removing contaminants from intricate and hard-to-reach areas. Parts are submerged in a cleaning solution and subjected to ultrasonic waves that create microscopic bubbles to remove dirt.
- **Steam Cleaning:** Use steam to clean and sanitize surfaces. Steam cleaning is effective for removing grease and oil without the need for harsh chemicals. Ensure that components can withstand high temperatures and moisture.

Preventive Cleaning Methods

- **Routine Wiping and Dusting:** Regularly wipe and dust the machine to prevent the build-up of dirt and debris. This helps maintain the machine's cleanliness and reduces the need for intensive cleaning.
- **Protective Covers:** Use protective covers to shield the machine from dust and contaminants when not in use. Covers help minimize the accumulation of dirt and reduce the frequency of cleaning.

✓ **Lubrication:**

Lubricating a punching machine is crucial for ensuring its smooth operation, reducing wear and tear, and extending its lifespan. Different methods can be used for lubricating various parts of the machine, each suited to specific needs and types of machinery. The followings are methods that can be used to lubricate punching machine:

Manual Lubrication

- **Grease Guns:** Use a grease gun to manually apply grease to specific lubrication points, such as bearings and joints. This method allows precise control over the amount and location of the lubricant.
- Example: Lubricating the main bearings of the punching machine.
- **Oil Cans:** Use an oil can to apply oil to smaller, accessible parts. This method is simple and effective for regular maintenance.
- Example: Oiling the moving parts of the punch mechanism.

Automatic Lubrication Systems

- **Centralized Lubrication Systems:** These systems distribute lubricant from a central reservoir to multiple points on the machine through a network of tubing and metering devices. They ensure consistent and controlled lubrication.
- Example: A centralized system lubricating all critical points on a CNC punching machine.
- **Single-Point Lubricators:** Automatic lubricators installed at individual lubrication points, providing a steady supply of lubricant over time.
- Example: An automatic lubricator mounted on the main spindle of the punching machine.

Drip Feed Lubrication

- Drip Feed Oilers: These devices slowly release oil drop by drop to specific parts, ensuring continuous lubrication. They are often adjustable to control the flow rate.
- Example: Drip feed oilers lubricating the linear guides of a punching machine.

Spray Lubrication

- **Spray Nozzles:** Use nozzles to spray lubricant onto moving parts or surfaces. This method is effective for lubricating larger areas and surfaces exposed to high friction.
- Example: Spraying lubricant onto the sliding surfaces of the punching machine's work table.

Bath Lubrication

- **Oil Bath:** Parts of the machine, such as gears or bearings, are partially submerged in an oil bath, providing continuous lubrication as they rotate through the oil.
- Example: Gears and bearings in the main drive mechanism of the punching machine.

Mist Lubrication

- **Oil Mist Systems:** Create a fine mist of oil that is carried by compressed air to lubricate parts. This method ensures even distribution and is often used in high-speed applications.
- Example: Mist lubrication for high-speed spindles in CNC punching machines.

Grease Pack Lubrication

- **Pre-Packed Grease:** Some components are pre-packed with grease during assembly and only require periodic replenishment.
- Example: Pre-packed bearings in the punch head assembly.

Splash lubrication.

- This lubrication method is commonly used in engines and gearboxes where a rotating shaft dips into a pool of oil, which is then splashed onto other parts of the machinery through the spinning motion.

Practical Activity 3.2.2: Performing preventive maintenance of punching equipment.

Task:

1: Individually, referring to the previous activity 3.2.1, you are requested to go in Manufacturing workshop for lubricating and cleaning punching machine as preventive maintenance activities with respect trainer's instructions.

2: Select and wear appropriate PPE according to the work to be performed.

3: Individually lubricate and clean punching machine.

4: Present your work to the trainer, workshop assistant or your classmate.

5: Read the key reading 3.2.2

6: Perform the task provided in application of learning 3.2

Key readings 3.2.2: Performing preventive maintenance of punching equipment.

- **Procedures of cleaning punching machine**
  - ✓ **Maintain safety and security and Safety First:**
    - Turn off the machine and disconnect it from the power source.
    - Wear appropriate personal protective equipment (PPE), such as gloves, safety glasses, and a dust mask.
  - ✓ **Gather Cleaning tools and materials:**
    - Clean, lint-free cloths or rags
    - Brushes (soft and stiff-bristled)
    - Compressed air canister or air compressor
    - Cleaning solvents or degreasers (compatible with machine components)
    - Vacuum cleaner (with appropriate attachments)
    - Disposal containers for waste materials
  - ✓ **Perform Initial Cleaning**
    - **Remove Large Debris:** Use a vacuum cleaner to remove large debris, dust, and metal shavings from the machine's surface, work area, and floor.
    - **Compressed Air:** Use compressed air to blow away dust and smaller particles from crevices, vents, and hard-to-reach areas. Be cautious not to blow debris into sensitive components.

✓ **Perform Detailed Cleaning**

- **Clean the Work Table:**
  - Wipe the work table with a clean cloth to remove any remaining debris, oil, or grease.
  - If necessary, use a mild cleaning solvent to dissolve stubborn grease or oil.
- **Clean the Punch and Die:**
  - Remove the punch and die if possible and clean them separately using a stiff-bristled brush to remove stuck-on materials.
  - Wipe with a cloth and apply a small amount of cleaning solvent if needed.
  - Inspect for wear or damage and replace, if necessary, before reinstallation.
- **Clean the Machine Body**
  - Wipe down the exterior surfaces of the machine with a clean cloth.
  - Use a soft-bristled brush for areas with stubborn dirt or grime.
  - Clean any control panels or screens carefully to avoid damaging electronics.

✓ **Procedures of lubricating punching machine:**

- **Maintain security and Safety First:**
  - Turn Off and Disconnect: Ensure the machine is turned off and disconnected from the power source to prevent accidental start up.
  - Personal Protective Equipment (PPE): Wear appropriate PPE such as gloves, safety glasses, and protective clothing.
- **Gather Materials:**
  - Appropriate lubricants (oil or grease) as recommended by the machine manufacturer.
  - Cleaning materials (cloths, brushes, and solvent if needed).
  - Lubrication tools (grease gun, oil can, etc.).
- **Clean the Machine:**
  - Surface Cleaning: Wipe down the machine surfaces to remove dust, dirt, and debris.
  - Component Cleaning: Clean around the lubrication points to prevent contaminants from entering the lubrication system.
- **Inspect Lubrication Points:**
  - Check all lubrication points for signs of wear, damage, or contamination.
  - Identify any areas that require special attention or have been missed in previous maintenance routines.
- **Apply lubricant**
  - By using Grease Guns: Use a grease gun to manually apply grease to specific lubrication points, such as bearings and joints. This method allows precise control over the amount and location of the lubricant.
  - Example: Lubricating the main bearings of the punching machine.
  - By using Oil Cans: Use an oil can to apply oil to smaller, accessible parts. This

method is simple and effective for regular maintenance.
  - Example: Oiling the moving parts of the punch mechanism.
- **Lubricate Bearings.**
  - Locate Bearings: Find all bearing points on the machine.
  - Apply Lubricant: Use a grease gun to apply grease to grease fittings or an oil can for oil fittings, ensuring not to over-lubricate.
- **Lubricate Moving Parts:**
  - Sliding Surfaces: Apply lubricant to sliding surfaces and guides.
  - Joints and Hinges: Lubricate all joints, hinges, and pivot points.
- **Lubricate Gear Systems:**
  - Gearboxes: Check the oil level in gearboxes and add oil if necessary.
  - Open Gears: Apply grease to open gears using a brush or grease gun.
- **Lubricate Hydraulic Components:**
  - Hydraulic Oil: Check the hydraulic oil level and top up if needed. Follow the manufacturer's recommendations for the type of hydraulic oil.
- **Inspect the Machine:**
  - Check for any signs of wear, damage, or loose parts. Tighten any loose bolts or screws.
  - Ensure that all safety guards and covers are securely in place.
- **Test Run:**
  - Reconnect the machine to the power source and perform a test run to ensure everything is functioning correctly.
  - Listen for unusual noises or vibrations and address any issues immediately.
- **Record Maintenance**
  - Record the cleaning and maintenance activities in the machine's maintenance log. Include the date, actions performed, and any observations or issues noted.

Points to Remember

- While cleaning the punching machine you should consider the cleaning methods.
- When lubricating punching machine consider the lubrication methods
- While cleaning punching equipment mainly gather cleaning materials and tools.
- When lubricating punching equipment use Grease Guns to manually apply grease to specific lubrication points.

Application of learning 3.2.

Visit any manufacturing workshop that produces punched products and perform the following tasks:

i. Clean the punching machine
ii. Lubricate the punching machine

Indicative content 3.3: Store Materials, Tools and Equipment

Duration: 2 hrs

Theoretical Activity 3.3.1: Description of Care and storage procedures of materials tools and equipment

Tasks:

1: you are requested to answer the following question:

i. Describe the procedures of caring materials, tools and equipment.
ii. Describe the procedures of storing materials, tools and equipment.

2: Write the provided answers of asked question on flip chat/papers.

3: Present the findings/answers in whole class

4: Pay attention to the trainer's clarification and ask questions where necessary.

5: Read the key readings 3.3.1.

Key readings 3.3.1

Description of Care and storage procedures of materials tools and equipment

- **Procedures of caring materials, tools and equipment.**
  - ✓ Equipment has to be cleaned and maintained in accordance with manufacturers specifications and/or local instructions to ensure correct functionality of equipment.
  - ✓ Any unserviceable tools are repaired, replaced or reported to relevant personnel to ensure correct functionality.
  - ✓ Tools are transported in a safe, secure, efficient manner to minimize risk of injury to personnel and damage to equipment.
  - ✓ Tools are stored and secured according to manufacturers or workplace procedures to prevent damage to, and losses of, equipment
- **Procedures of storing tools and equipment.**
  - ✓ **Clean the tools and equipment:**
    - **Wipe Down Tools:** Remove dirt, dust, and debris from tools before storing them. Use a clean, dry cloth for general cleaning and a damp cloth for stubborn grime.

- **Oil and Lubricate:** Apply a light coat of oil to metal surfaces to prevent rust. Lubricate moving parts to keep them in good working condition.
- Inspect for Damage: Check tools for any signs of damage or wear and perform necessary repairs before storage.

✓ **Assess the Tools and Equipment.**

- **Inventory:** Take stock of all tools and equipment to determine storage needs.
- **Categorize:** Group similar items together (e.g., hand tools, power tools, gardening tools).

✓ **Select Storage Solutions.**

- **Toolbox for Hand Tools:** Choose a portable toolbox with compartments for screwdrivers, pliers, and wrenches.
- **Portable Toolboxes:** Ideal for small hand tools and frequently used items. Portable toolboxes are easy to carry and often come with compartments for organization
- Shelving Unit for Larger Items: Install a heavy-duty shelving unit for power tools, paint cans, and other bulky items.
- **Storage Cabinets:** Suitable for storing larger tools and equipment. Cabinets often have adjustable shelves to accommodate different sizes.
- **Lockers:** Provide secure storage for personal protective equipment (PPE) and valuable tools, preventing unauthorized access.
- **Wall-Mounted Shelves:** Utilize vertical space and keep tools off the floor. Ideal for lighter tools and equipment.
- **Freestanding Shelves:** Provide versatile storage for heavy and bulky items. Can be placed anywhere in the workspace.
- **Pegboards:** Perforated boards mounted on walls, allowing tools to be hung on hooks. Easy to customize and rearrange.
- **Hook Systems:** Use hooks and brackets to hang tools directly on walls or pegboards, providing quick access.
- **Wall-Mounted Tool Racks:** Hold long-handled tools like shovels, rakes, and brooms vertically against the wall.
- **Freestanding Tool Stands:** Provide stable storage for heavy tools and equipment that need to be easily accessible
- **Stackable Bins:** Use stackable plastic bins to organize small parts, fasteners, and hardware. Label each bin for easy identification.

✓ **Implementing Organizational Systems.**

- **Labelling:** Clearly label storage locations, bins, and containers to make it easy to find and return tools.
- **Shadow Boards:** Use shadow boards with outlines of tools to ensure each tool has a designated place.

- **Inventory Management:** Keep an inventory of tools and equipment, noting their storage locations and any maintenance needs.

✓ **Maximizing Space Utilization.**

- **Vertical Storage:** Use vertical space by installing shelves, racks, and pegboards on walls.
- **Stackable Bins:** Utilize stackable bins to make the most of available space.
- **Mobile Storage:** Use mobile tool carts or cabinets for tools that need to be moved frequently.

✓ **Ensuring Accessibility and Safety.**

- **Easy Access:** Store frequently used tools at eye level or within easy reach. Place rarely used items on higher shelves or in less accessible areas.
- **Safety Precautions:** Store sharp or heavy tools securely to prevent accidents. Use blade guards and safety covers as needed.
- **Secure Storage:** Lock toolboxes, cabinets, and storage rooms to prevent unauthorized access and theft.

- **Tips for storing tools and equipment:**

✓ **According to the sizes:**

- The tools and equipment should be stored according to the sizes, where the tools of the same sizes can be kept in a convenient area depending on their sizes.

✓ **According to their types**

- The tools or equipment of the same types should be kept or stored together, if possible, this will help it to be easily available when needed and provide a safe storage of them.

✓ **According to their use**

- All tools and equipment of the same use should be stored in the same place with respect to their physical, chemical and/or mechanical properties, sometimes it is better to store in a dry place.
- Overall, be sure to take care of your tools to ensure their longevity and efficiency.
- Inspect your tools as possible and take the proper steps, some of which are mentioned above, to keep them in good condition.

- **Benefits of organizing the tools in your workshop/garage.**

✓ Proper Maintenance. By storing your tools, you'll increase their durability.

✓ Improved Accessibility. By properly storing your tools, you'll be able to: find the tools that you need promptly.

✓ Maximize Your Space.

✓ Contact Mudline Cabinets

✓ Prolonged Lifespan

- ✓ Safe Handling: Proper storage ensures that tools and equipment are easily accessible and safe to handle.

Practical Activity 3.3.2: Applying techniques of caring and storing tools, materials and equipment after punching operation.

Task:

1: Individually, referring to the previous activity 3.3.1, you are requested to go in manufacturing workshop and apply techniques of caring and storing tools, materials and equipment after their use, with respect trainer's instructions.
2: Select and wear appropriate PPE according to the work to be performed.

3: Individually care and store tools materials and equipment used in punching operation in prepared space.

4: Present your work to the trainer, workshop assistant or your classmate.

5: Read the key reading 3.3.1.

6. Perform the task provided in application of learning 3.3

Key readings 3.3.2: Applying techniques of caring and storing tools, materials and equipment after punching operation.

- **Techniques of storing materials tools and equipment**
  - ✓ **Re-arranging:** The first step to organizing tools is to do a thorough inventory. Once you have a general idea of the tools on hand, sort them into like categories. Group all of the power tools, the small hand tools, and so on. Next, create zones and use cabinetry to keep the like items together.

Fig80: Illustration of tools rearrangement.

- ✓ **Shelving:** shelf is a flat, horizontal plane used for items that are displayed or stored in a home, business, store, or elsewhere. It is raised off the floor and often anchored to a wall, supported on its shorter length sides by brackets, or otherwise anchored to cabinetry by brackets, dowels, screws, or nails.

Fig81: Shelving illustration

- ✓ **Hanging:** an execution by strangling or breaking the neck by a suspended noose. something hung: such as. Curtain, a covering (such as a tapestry) for a wall.
- ✓ Hanging refers to the method of storing items by suspending them from a surface, typically a wall, ceiling, or any vertical surface. This method utilizes various tools and equipment like hooks, pegs, racks, or specialized holders to keep items off the ground and within easy reach.

Fig 82: Hanging illustration

Points to Remember

- While storing materials, tools and equipment respect procedures.
- Tools, materials and equipment can be stored by either their sizes, their types or their uses
- Organizing tools in your workshop is more beneficial for proper maintenance.
- Re-arranging, Shelving, hanging are the most preferable methods of storing Materials tools and equipment

Application of learning 3.3.

Visit the manufacturing workshop of that produces punching product and perform the following tasks:

i. Store materials used for punching operation
ii. Store tools used in punching operation
iii. Store equipment used in punching operation

Indicative content 3.4: Reporting Performed Work

Duration: 1 hr

Theoretical Activity 3.4.1: Introduction to the performed work report.

Tasks:

1: you are requested to answer the following questions:

i. What do you understand by a technical work report?
ii. What is the purpose of reporting the performed work?
iii. Identify the types of report for reporting a performed work.
iv. Identify the advantages of reporting the performed work

2: write the provided answers of asked question on papers/flip chat.

3: Present the findings/answers in whole class.

4: Read the key readings 3.4.1.

Key readings 3.4.1: Introduction to the work report.

- **Work Report**
  - ✓ **Definition of Work Report**
    - A work report is a simple and cohesive document that outlines the fundamental activities and tasks conducted by an employee throughout the day, week, month, quarter, year, or any time period mandated by the management of the company or organization.
    - A report can be a written document or electromagnetic record.
  - ✓ **The purpose of a work report**
    - The purpose of a work report is to explain a certain topic based on a specific aspect of one's job. It also illustrates the growth and work accomplishments of an employee through indicating certain tasks, activities, and other project completions in a given time period, as well as measuring the overall work performance in the business firm or organization.
  - ✓ **Types of report**
    - **Informational Reports**
      - The first in our list of reporting types are informational reports. As their name suggests, this report type aims to give factual data about a specific topic. This can include performance reports, expenses reports, justification reports, among others. A differentiating characteristic from these reports

is their objectivity, they are only meant to inform but not propose solutions or hypotheses.

- **Analytical Reports**
  - This report type contains a mix of useful information to facilitate the decision-making process through a mix of qualitative and quantitative data as well as real-time and historical data. Unlike informational reports that purely inform users about a topic, this report type also aims to provide recommendations about the next steps and help with problem-solving. With this information in hand, businesses can build strategies based on analytical evidence and not simple intuition
- **Operational Reports**
  - These reports track every pertinent detail of the company's operational tasks, such as its production processes. They are typically short-term reports as they aim to paint a picture of the present.
- **Product Reports**
  - As its name suggests, this report type is used to monitor several aspects related to product performance and development. Businesses often use them to track which of their products or subscriptions are selling the most within a given time period, calculate inventories, or see what kind of product the client values the most. Another common use case of these reports is to research the implementation of new products or develop the existing ones.
- **Department Reports**
  - These reports are specific to each department or business function. They serve as a communication tool between managers and team members that need to stay connected and work together for common goals.
- **Progress Reports**
  - From the brunch of informational reports, progress reports provide critical information about the status of a project. These reports can be produced on a daily, weekly, or monthly basis by employees or managers to track performance and fine-tune tasks for the better development of the project.
- **Vertical & Lateral Reports**
  - Last but not least in our rundown of the top 10 types of reports we have vertical and lateral reports. This reporting type refers to the direction in which a report travel. A vertical report is meant to go upward or downward the hierarchy.

✓ **Advantages of reporting:**

- Ensure enhanced control and visibility.
- Ensures that teams and departments remain self-driven
- Defines clearly who each person should report to or refer certain projects to

- Defines levels of responsibility and authority clearly
- Measure and Evaluate Work Performance
- Determine Strengths, and Weaknesses Build Up Work Reputation

Practical Activity 3.4.2: Reporting the work done

Task:

1: Individually, referring to the previous activity 3.4.1, you are requested to prepare a report of the punched work with respect trainer's instructions

2: Prepare a technical report of the punched product.

3: Present your work to the trainer, workshop assistant or your classmate.

4: Read the key reading 3.4.2.

5: Perform the task provided in application of learning 3.4

Key readings 3.4.2: Reporting the work done

- **Procedures of preparing a punched work report.**
  - ✓ Find the Appropriate Template and Follow Instructions
  - ✓ Plan the Structure of the Report
  - ✓ Construct a Summary of the Accomplished Tasks and Activities
  - ✓ Write with Conciseness and Accuracy
  - ✓ Proofread and Revise the Overall Report
  - ✓ Prepare the Final Work Report
- **Report template information for a punched work.**
  - ✓ **Title and Introduction**
    - **Title:** Clearly state the title of the report, such as "Report on Punched Work for [Project Name]".
    - **Introduction:** Provide an overview of the report, including the purpose, scope, and summary of the punched work performed.
  - ✓ **Objective**
    - **State the Objective:** Clearly define the objective of the punched work. For example, "The objective of this project was to produce metal brackets with specified dimensions and hole placements for use in construction.
  - ✓ **Materials Used**
    - **List of Materials:** Provide a detailed list of materials used in the punching

operation, including specifications.

- Example: "Material: Stainless Steel, Grade 304, Thickness: 3mm"

✓ **Tooling and Equipment**

- Tools and Equipment: Describe the tools and equipment used, including the punch press machine, dies, and any special fixtures.
- Example: "Punch Press: CNC Punching Machine, Model XYZ, Dies: Custom-made for bracket production"

✓ **Process Description**

- **Design and Planning:** Describe the design phase, including CAD designs and material selection.
- **Tool and Machine Preparation:** Outline the preparation of tools and the machine, including installation and alignment.
- **Setup and Calibration:** Detail the machine calibration, workpiece preparation, and positioning.
- **Performing the Punching Operation:** Explain the actual punching process, including any test runs and adjustments.
- **Post-Processing:** Describe the steps taken after punching, such as deburring, cleaning, and finishing.

✓ **Quality Control**

- **Inspection Methods:** Explain the methods used to inspect the punched parts.
- Example: Visual inspection for defects, dimensional inspection using calipers, and surface finish checks.
- **Quality Standards:** State the quality standards and tolerances that were adhered to during the punching operation.
- Example: Tolerances: +/- 0.1mm for hole placement, Surface Finish: No burrs exceeding 0.2mm

✓ **Results**

- **Production Data:** Provide data on the number of parts produced, the number of acceptable parts, and any defects observed.
- Example: "Total Parts Produced: 1000, Acceptable Parts: 980, Defects: 20 (burrs, misalignment)"

✓ **Challenges and Solutions**

- **Challenges:** Describe any challenges encountered during the punching process.
- **Example:** "Challenge: Misalignment of punch and die causing off-centre holes."
- **Solutions:** Explain the solutions implemented to overcome these challenges.
- **Example:** "Solution: Re-calibrated the punch press and realigned the die to correct the issue."

✓ **Recommendations**

- **Process Improvements:** Suggest any improvements or changes to the process to enhance efficiency or quality.
- **Example:** "Recommendation: Implement routine maintenance checks for the punch press to prevent misalignment issues."

✓ **Conclusion**

- **Summary:** Summarize the key points of the report, including the success of the punched work and any notable findings.
- **Future Work:** Mention any future work or follow-up actions that are planned based on the findings of this report.

✓ **Appendices**

- **Supporting Documents:** Include any supporting documents, such as CAD drawings, inspection reports, and material certificates.
- **Photographs:** Add photographs of the punched parts, tools, and equipment used in the process.

Points to Remember

- While preparing a report of the performed work take into consideration the types of report.
- While preparing a work done report, you have to find an appropriate Template.
- While making Report of a work done should consider Report template information**.**

Application of learning 3.4.

You are requested to visit the school's manufacturing workshop and fabricate a water filter using a 1.25mm thick stainless-steel sheet. You are required to punch one thousand (1000) holes of 2mm diameter using a die punching machine and then prepare a report detailing the work completed.

Learning outcome 3 end assessment

Theoretical assessment

01. Match column **A** representing edges and surface finishing techniques with their explanations in column **B**. Use each letter only once and write it in the provide blank space.

Answers	Column A	Column B
……	**1.**Filing	**A.** Finishing process that removes sharp edges, burrs, fins and leaving the material with smooth edges and fine finished surface
……	**2.**Grinding	**B.** Metals finish done manually or through the appropriate machinery, which means passages on abrasive belts, coarse and then gradually finer grains.
……	**3.**Polishing	**C.** Process of applying a layer or layers of material onto a metal surface to enhance its properties and protect it from various environmental and mechanical factors.
……	**4.**Deburring	**D.** Material removal process in manufacturing by using file
……	**5.**Metal coating	**E.** Refers to an abrading operation that follows grinding and precedes buffing.
……	**6.**Metal sanding	**F.** The process of removing metal by the application of abrasives which are bonded to form a rotating wheel.

02. These are the steps of using hand held angle grinder. Rearrange them appropriately by writing the first up to the last step.

1. Allow the grinder to reach operating speed, then apply load gradually.
2. Do not apply excessive force and avoid prolonged use.
3. Hold the grinder so that any sparks fly away from you and anyone nearby, and away from all flammable materials.
4. Maintain a constant space to avoid uneven surfaces**.**

03. Read the following statement and answer true if the statement is correct and false if the statement is not corrected.

a) Hand Deburring tools is used for larger areas or higher efficiency.
b) Rotary Deburring Tool is used for specific materials or shapes.
c) File or Scraper is used for general-purpose deburring.
d) Specialized Deburring Blade is used for small or intricate workpiece.

04. Choose the letter corresponds to the right answer:

I. The following maintenance activities, which one is note a preventive maintenance activity?

a. Cleaning
b. Lubricating
c. Collecting
d. Repairing

II. The followings are manual cleaning methods except:

a. Wiping
b. Steam cleaning
c. Brunching
d. Dusting

III. Lubrication tools used to lubricate linear guides of the punching machine is:

a. Oil cans
b. Grease guns
c. Spray nozzle
d. Drip feed oilers

IV. Which one in the following statements is a tip for storing tools? Write the letter corresponding to the correct answer

a. Tools are stored according to their colour.
b. Tools are stored according to their hardness.
c. Tools are stored according to their weight.
d. Tools are stored according to their use.

V. Template report for the work done should represent the following information except:

a. Part list
b. Title
c. Introduction
d. Appendices

VI. Among the following types of report which one is used to monitor aspects related to product performance and development?

a. Progressive report
b. Product report
c. Analytical report
d. Operation report

Practical assessment

The bus of the school under which you study involved in a collision with another vehicle, resulting in significant damage to the front fender panel, which is now irreparable. A manufacturing technician at your school has completed punching a new front fender panel from a 1.5mm thick aluminium sheet. You are requested to perform the post punching activities to finish this punched front fender panel with respect to the following instructions:

1. The punched edges of the front fender panels must be finished using manual deburring tools
2. The surface of the front fender must be finished by using grind deburring tool
3. The smoothness of the front fender panel is enhanced by sanding using a sanding disc and polished using polishing pad
4. The front fender panel is painted by sprayed aluminium paint.
5. Maintain the clean lines and arrangement of the workshop for proper future use.
6. Report the work done.

END

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