

COMPETENCE BASED CURRICULUM

SENIOR SCHOOL GRADE 10



METAL TECHNOLOGY NOTES



1.0 Fundamentals of Metal Technology

1.1 Introduction to Metal Technology

1.1.1 Definition of Terms in Metal Technology

Understanding the terms is the foundation of learning Metal Technology. Below are the key terms explained simply:

- **Metal** - A solid material, usually hard, shiny, and malleable, that can conduct heat and electricity.
 - ❖ **Examples:** Iron, Steel, Aluminium, Copper, Brass, Bronze.
- **Metal Technology** - The study and practice of working with metals to produce useful products and structures.
 - ❖ **Example:** Making doors, chairs, gates, and kitchen utensils.
- **Material** - Any substance used to make objects. Metals, wood, plastics, and ceramics are examples.
 - ❖ **Example:** Steel sheet used for roofing.
- **Tools** - Instruments used to perform specific tasks in metal work.
 - ❖ **Examples:** Hammer, Screwdriver, Pliers, Hacksaw, Files.
- **Machines** - Mechanized devices that make metalworking faster and more precise.
 - ❖ **Examples:** Lathe machine, Welding machine, Drilling machine, Grinding machine.
- **Personal Protective Equipment (PPE)** - Equipment worn to protect oneself from injury while working in a workshop.
 - ❖ **Examples:** Safety goggles, Gloves, Apron, Ear muffs, Safety boots.
- **Workshop** - A place equipped with tools and machines for metalworking.
 - ❖ **Examples:** School metal workshop, Fabrication workshop, Engineering workshop.

1.1.2 Importance of Studying Metal Technology

Studying Metal Technology opens career opportunities, develops practical skills, and contributes to community development.

- **Career Opportunities:**
 - ❖ Fitter and machinist

- ❖ Welder
- ❖ Sheet metal worker
- ❖ Fabricator
- ❖ Blacksmith
- ❖ Mechanical engineer
- **Practical Benefits:**
 - ❖ Skills in repairing machines and metal structures.
 - ❖ Ability to manufacture household and industrial items.
 - ❖ Creativity in designing metal products.
- **Economic Benefits:**
 - ❖ Starting metalwork businesses like welding shops, fabrication units.
 - ❖ Reduces dependency on imported products.
- **Example Activities:**
 - ❖ Making metal gates, windows, and chairs for the community.
 - ❖ Repairing bicycles, scooters, and machinery parts.

1.1.3 Metal Technology Related Businesses in the Community

Metal technology is applied in many local businesses. Observing these helps students understand practical applications.

- **Welding and Fabrication Shops**
 - ❖ Services: Making gates, grills, metal doors, metal furniture.
 - ❖ Tools used: Welding machines, angle grinders, hammers.
- **Automobile Workshops**
 - ❖ Services: Repairing car parts, manufacturing engine components.
 - ❖ Tools used: Hydraulic lifts, wrenches, drills.
- **Construction Companies**
 - ❖ Services: Metal roofing, reinforcement bars, structural beams.

- ❖ Tools used: Cutting machines, bending machines.
- **Blacksmith Workshops**
 - ❖ Services: Traditional iron tools like hoes, machetes, knives.
 - ❖ Tools used: Anvil, hammer, forge.
- **Metal Recycling Centers**
 - ❖ Services: Collect scrap metals, melt, and reshape them into new products.
 - ❖ Examples: Aluminum cans turned into new utensils.

Activity for Students:

- Visit local workshops to observe the tools, machines, and metals used.
- Identify the types of metal products made.

1.1.4 Importance of Metal Technology in Daily Life

Metal technology affects almost every part of our daily lives. Understanding its applications helps appreciate its value.

- **Household Items:**
 - ❖ Cooking utensils (pots, pans)
 - ❖ Furniture (metal chairs, tables, beds)
 - ❖ Doors and windows
- **Transport:**
 - ❖ Cars, bicycles, buses, motorcycles
 - ❖ Railway tracks
- **Infrastructure:**
 - ❖ Bridges, water tanks, electric poles
 - ❖ Fencing and gates
- **Healthcare:**
 - ❖ Surgical instruments
 - ❖ Hospital beds and trolleys

- **Industrial Applications:**
 - ❖ Manufacturing machines
 - ❖ Storage tanks and containers
 - ❖ Tools for workshops

Example:

- A blacksmith uses metal technology to make a door gate, improving security in homes.

1.1.5 Brainstorming and Research Activity

Objective: Build understanding by exploring concepts actively.

- **Step 1: Brainstorm**
 - ❖ Discuss in class: What metals are you familiar with?
 - ❖ Identify tools and machines in your school workshop.
- **Step 2: Research**
 - ❖ Use books, digital media, or print media to search for:
 - Types of metals and their properties.
 - Local businesses using metal technology.
 - Careers in metalwork.
- **Step 3: Presentation**
 - ❖ Students present findings with examples, sketches, or photos.

1.1.6 Summary Table of Key Points

Term	Definition	Examples
Metal	Hard, shiny, malleable material	Iron, Copper, Aluminium
Metal Technology	Working with metals to make products	Welding, Fabrication
Material	Substance used to make objects	Steel, Wood, Plastic
Tool	Hand instruments for tasks	Hammer, File, Hacksaw
Machine	Mechanized devices for metalwork	Lathe, Drill, Grinder

PPE	Safety equipment in workshop	Gloves, Goggles, Apron
Workshop	Place for metalwork	School workshop, Welding shop

1.1.7 Illustrative Examples

Example 1 - Making a Metal Chair

- Materials: Steel rods, steel sheet
- Tools: Hacksaw, hammer, welding machine
- PPE: Gloves, goggles, apron
- Process: Cut rods → Weld frame → Attach seat → Finish with paint

Example 2 - Repairing a Bicycle Chain

- Materials: Metal chain, lubricants
- Tools: Wrench, pliers
- Process: Remove broken chain → Clean parts → Fit new chain → Test

Example 3 - Fabricating a Metal Gate

- Materials: Iron rods, sheet metal
- Tools: Welding machine, grinder, hammer
- Process: Measure → Cut rods → Weld → Grind → Paint

Key Takeaways:

- Metal Technology is essential for career development, community services, and daily life.
- Practical knowledge includes metals, tools, machines, PPE, and workshops.
- Observing local businesses enhances understanding of real-life applications.
- Safety is crucial when working with metals.

2.0 Safety at the Workshop

Safety is the foundation of metal technology. A workshop is full of sharp tools, heavy machines, and hot metals, so knowing safety rules can prevent accidents and save lives.

2.1 Importance of Safety in a Metal Workshop

- Ensures **personal safety** from injuries (cuts, burns, eye injuries).
- Protects **equipment and tools** from damage.
- Reduces **risk of fire and electric accidents**.
- Promotes a **safe working environment**, increasing productivity.
- Encourages **responsibility and discipline** in the workshop.

Example: Wearing goggles while grinding metal prevents eye injuries from sparks.

2.2 Workshop Safety Rules and Regulations (OSHA Guidelines)

The **Occupational Safety and Health Act (OSHA)** provides rules to prevent accidents. Key rules include:

2.2.1 Personal Safety Rules

- Always wear **Personal Protective Equipment (PPE)**.
 - ❖ Safety goggles - protect eyes from flying particles.
 - ❖ Gloves - protect hands from sharp edges and heat.
 - ❖ Aprons - protect clothes and skin from sparks.
 - ❖ Ear muffs - protect ears from loud noise.
 - ❖ Safety boots - protect feet from falling objects.
- Do **not wear loose clothing** or jewelry; they can get caught in machines.
- Tie back long hair to prevent entanglement in tools.

2.2.2 Equipment Safety Rules

- Inspect tools and machines before use.
- Do not use damaged tools; report broken machines immediately.
- Switch off machines when not in use.

- Keep machines **clean and well-lubricated**.
- Only trained personnel should operate machines like welding machines or lathes.

2.2.3 Environmental Safety Rules

- Keep the workshop **clean and organized**; remove scrap metal and oil spills.
- Ensure **good ventilation** to avoid inhaling fumes.
- Store flammable liquids safely away from heat.
- Mark emergency exits and keep them **unobstructed**.

Example: A tidy workshop reduces trips and falls.

2.3 Possible Causes of Accidents in a Metal Workshop

Accidents in workshops often happen due to negligence or lack of knowledge.

- **Human error:** Carelessness, rushing tasks, lack of training.
- **Faulty equipment:** Broken machines, damaged tools, frayed electrical cords.
- **Environmental hazards:** Wet floors, poor lighting, cluttered workspace.
- **Ignoring PPE:** Not wearing gloves, goggles, or helmets.
- **Fire hazards:** Sparks, flammable materials, or overheating equipment.

Example: A student cutting metal without gloves may suffer a deep hand cut.

2.4 First Aid Procedures for Workshop Accidents

Accidents can occur despite precautions. Knowing first aid is essential.

2.4.1 Minor Cuts and Abrasions

- Clean the wound with **clean water or antiseptic**.
- Apply **antibiotic cream**.
- Cover with a **sterile bandage**.

2.4.2 Burns

- Cool the affected area under **running cold water** for 10-20 minutes.
- Do not apply ice directly.
- Cover with a **clean, dry cloth**.

- Seek medical attention for severe burns.

2.4.3 Eye Injuries

- Do not rub eyes.
- Rinse immediately with **clean water**.
- Remove any visible metal particles carefully with tweezers if possible.
- Seek medical attention immediately.

2.4.4 Electric Shock

- **Switch off power source** immediately.
- Do not touch the victim with bare hands if still in contact with electricity.
- Call for medical assistance.
- Keep the victim **lying down** and check for breathing.

2.4.5 Fractures

- Immobilize the injured part using a **splint or firm support**.
- Avoid moving the person unnecessarily.
- Seek medical attention immediately.

Example: A spark from welding burns a hand; immediately rinse with cold water, cover, and report.

2.5 Components of a Metal Workshop Layout

A well-organized workshop reduces accidents and improves workflow. Key components include:

- **Entrance and exit** - clearly marked for emergency access.
- **Workbenches** - for handwork, cutting, filing, and assembly.
- **Machine area** - lathes, drilling, grinding machines with safety zones.
- **Storage area** - organized storage for raw materials, tools, and PPE.
- **Chemical/flammable storage** - away from sparks and heat.
- **First aid station** - easily accessible with first aid kits.
- **Fire safety equipment** - extinguishers, fire blankets, sand buckets.
- **Waste disposal area** - for scrap metals and used consumables.

Illustration Example:

- Welding machines in one corner with a safety barrier.
- Workbenches arranged in rows with clear walking paths.
- Storage racks for metals and tools along walls.

2.6 Brainstorming and Practical Activities

Objective: Students actively explore workshop safety.

- **Step 1: Brainstorm**
 - ❖ List all possible hazards in the workshop.
 - ❖ Discuss examples of past accidents in local workshops.
- **Step 2: Research**
 - ❖ Search online for OSHA guidelines.
 - ❖ Watch videos on safe metalworking practices.
- **Step 3: Practical Demonstration**
 - ❖ Demonstrate correct PPE use.
 - ❖ Simulate a minor injury and perform first aid procedures.
- **Step 4: Workshop Visit**
 - ❖ Observe safety measures in real workshops.
 - ❖ Note the placement of fire extinguishers, first aid kits, and PPE stations.

2.7 Summary Table of Workshop Safety

Aspect	Explanation	Examples
Personal Safety	Use of PPE	Goggles, Gloves, Apron, Boots
Equipment Safety	Check tools and machines	Lathe, Welding machine, Hacksaw
Environmental Safety	Clean, ventilated, organized	Remove scrap metal, Proper lighting
Causes of Accidents	Human error, faulty equipment, unsafe environment	Cuts, burns, electric shocks

First Aid	Immediate care for injuries	Clean cuts, Cool burns, Rinse eyes
Workshop Layout	Organized areas to reduce accidents	Workbenches, Storage racks, Machine zones

2.8 Illustrative Examples

Example 1 - Proper PPE Use

- Student grinding metal wears goggles, gloves, and apron.
- Sparks hit apron instead of skin → injury avoided.

Example 2 - Accident Scenario

- Wet floor causes slipping → Student falls → Minor cuts → First aid applied → Learning point: keep floors dry.

Example 3 - Workshop Layout

- Welding corner is separated by a **metal screen** → prevents sparks from reaching other students.
- Fire extinguisher mounted nearby → quick response to small fires.

Key Takeaways:

- Safety prevents accidents, injuries, and fatalities.
- PPE, proper layout, and environmental cleanliness are crucial.
- Understanding OSHA rules is essential for legal and safe practice.
- First aid knowledge saves lives in case of accidents.
- Visiting real workshops helps students see safety measures in action.

2.0 Tools and Materials in Metal Technology

2.1 Hand Tools and Bench Tools

Hand tools and bench tools are essential in metal workshops for performing precise work, shaping, joining, and measuring metals. They are the foundation of practical metalworking skills.

2.1.1 Selection of Hand and Bench Tools

Selecting the right tool ensures efficiency, safety, and accuracy in tasks.

- **Types of Tools:**

A) Cutting Tools

Used to cut, shape, or trim metals.

- **Hacksaw** - for cutting metal rods, bars, and sheets.
- **Tin snips** - for cutting thin metal sheets.
- **Files** - for smoothing rough edges and finishing metal surfaces.
- **Chisels** - for cutting or carving metal.
- **Example Task:** Cutting a steel rod to make a metal frame.

B) Driving Tools

Used to hit or drive objects.

- **Hammer (ball peen, cross peen, claw)** - shaping, striking chisels, driving nails/pins.
- **Mallet** - used when striking surfaces that should not be damaged.
- **Screwdrivers** - driving screws into metal or machinery.
- **Example Task:** Hammering a metal pin into a joint.

C) Holding Tools

Used to hold metal pieces firmly in place during work.

- **Bench vice** - securing metal for filing, cutting, or drilling.
- **Clamps** - temporary holding of small pieces.
- **Pliers** - gripping and bending small metal parts.
- **Example Task:** Holding a metal plate in a vice to drill a hole.

D) Measuring Tools

Used to ensure accuracy in dimensions.

- **Steel rule** - measuring lengths.
- **Vernier caliper** - precise internal and external measurements.
- **Tape measure** - measuring long sections.
- **Try square** - checking right angles.
- **Example Task:** Measuring a metal bar to cut it to 30 cm.

E) Marking Out Tools

Used to mark metal before cutting or shaping.

- **Scriber** - marks lines on metal surfaces.
- **Centre punch** - marks drilling points.
- **Surface gauge** - transferring measurements accurately.
- **Example Task:** Marking a drilling point on a steel plate.

2.1.2 Performing Tasks Using Hand and Bench Tools

Proper use of tools is crucial to achieve quality work and avoid accidents.

- **Cutting Metal with Hacksaw**
 1. Secure the workpiece in a bench vice.
 2. Select the correct blade (fine for thin metal, coarse for thick).
 3. Use long, steady strokes, applying pressure only on the forward stroke.
 4. Smooth edges with a file.
- **Filing Metal**
 1. Secure the piece in a vice.
 2. Hold the file handle with one hand and push with the other.
 3. Use even strokes, keeping the file flat.
- **Drilling Metal**
 1. Mark the hole with a centre punch.

2. Secure the metal in a vice.
3. Use appropriate drill bit and lubricate for smooth drilling.

- **Hammering and Bending**

1. Place metal on an anvil or flat surface.
2. Use correct hammer type.
3. Bend or shape metal gradually to avoid cracking.

Tip: Always use the correct tool for the task to prevent accidents and damage.

2.1.3 Maintenance of Hand and Bench Tools

Maintaining tools extends their life and ensures safety.

- **Cleaning**

- ❖ Wipe tools after use to remove dirt, oil, and metal dust.
- ❖ Remove rust using sandpaper or rust remover.

- **Sharpening**

- ❖ Files, chisels, and hacksaw blades must be kept sharp for efficient work.

- **Lubrication**

- ❖ Hinges, moving parts of pliers, screwdrivers, and vices should be oiled.

- **Storage**

- ❖ Keep tools in toolboxes, racks, or drawers.
- ❖ Avoid leaving tools on the floor or benches to prevent accidents.

Example: Sharpening a chisel regularly ensures clean cuts on metal.

2.1.4 Importance of Hand and Bench Tools in a Workshop

- **Efficiency:** Speeds up metalwork tasks.
- **Precision:** Accurate cutting, measuring, and marking.
- **Safety:** Proper tools reduce chances of accidents.
- **Skill Development:** Mastering hand tools is foundational for advanced metalwork.
- **Cost-saving:** Maintaining and using the right tools reduces material wastage.

Examples of Use in Daily Life:

- Making a metal gate (cutting, bending, welding with hand tools first).
- Repairing a bicycle chain (using pliers, wrenches).
- Fabricating a metal shelf (using hacksaw, files, clamps, and hammer).

2.1.5 Illustrative Examples of Common Hand and Bench Tools

Tool Type	Tool Name	Use/Task Example
Cutting	Hacksaw	Cutting steel rods
Cutting	File	Smoothing edges of metal sheet
Driving	Hammer	Driving pins into metal
Driving	Screwdriver	Fixing screws on metal brackets
Holding	Bench vice	Securing metal for drilling
Holding	Pliers	Bending metal wire
Measuring	Steel rule	Measuring length of metal rod
Measuring	Vernier caliper	Measuring diameter of pipe
Marking	Centre punch	Marking drilling points
Marking	Scriber	Drawing cutting lines

2.1.6 Safe Use and Demonstration Tips

- Always **check tools for defects** before use.
- Hold tools **firmly** but comfortably.
- Cut or hammer **away from the body**.
- Keep hands **clear of sharp edges** and moving parts.
- Use **bench tools with clamps or vices** for stability.
- Wear **PPE** at all times (goggles, gloves, apron, boots).

Activity for Students:

- Pick a metal task (cutting, drilling, filing) and perform it using appropriate hand and bench tools.
- Demonstrate maintenance by cleaning and storing the tools properly.
- Discuss which tool was most effective for the task and why.

2.1.7 Summary Table of Key Points

Aspect	Points to Remember	Examples
Cutting Tools	Hack saw, files, chisels - for shaping metal	Cutting rods, smoothing sheets
Driving Tools	Hammer, mallet, screwdrivers - for striking/driving	Hammering pins, driving screws
Holding Tools	Vice, clamps, pliers - for securing work	Holding sheet for drilling
Measuring Tools	Rulers, calipers, try square - for accuracy	Measuring rods, marking angles
Marking Tools	Scriber, punch - for layout work	Marking drilling points
Maintenance	Cleaning, sharpening, oiling, storing tools	Sharpen files, oil pliers, store safely
Importance	Efficiency, precision, safety, skill development	Making gates, repairing machines

2.1.8 Illustrative Practical Examples

Example 1 - Making a Metal Bracket

- Tools: Hacksaw (cutting), file (finishing edges), hammer (bending), bench vice (holding).
- Steps: Measure → Mark → Cut → File → Bend → Assemble.

Example 2 - Repairing a Bicycle

- Tools: Pliers (remove chain), screwdriver (tighten bolts), hammer (adjust parts).
- Outcome: Smooth operation of bike.

Example 3 - Fabricating a Small Shelf

- Tools: Hacksaw, hammer, file, bench vice, steel ruler, centre punch.
- Steps: Measure metal → Mark → Cut → Drill holes → Assemble → Finish.

Key Takeaways:

- Correct selection and use of hand and bench tools ensure safety and quality work.
- Maintenance and storage prolong tool life.
- Mastery of these tools forms the basis for all metalworking tasks.
- Observing examples in workshops improves understanding and skills.

2.2 Measuring and Marking Out Tools

Measuring and marking tools are critical in metalwork because **accuracy determines the quality of finished products**. A small mistake in measurement can ruin the entire workpiece.

2.2.1 Identification of Measuring and Marking Out Tools

A) Measuring Tools

Used to determine the **length, thickness, angle, and diameter** of metal workpieces.

- **Steel Rule:** Measures length and distance.
 - ❖ **Example:** Measure a 50 cm steel rod before cutting.
- **Vernier Caliper (outside and inside):** Measures internal and external diameters accurately.
 - ❖ **Example:** Measuring diameter of a metal pipe.
- **Micrometer:** Measures very small thicknesses or diameters precisely.
 - ❖ **Example:** Measuring sheet metal thickness (0.5 mm).
- **Tape Measure:** For measuring long lengths of metal sheets, rods, or beams.
 - ❖ **Example:** Measure a 3 m metal sheet for roofing.
- **Try Square:** Checks and marks **right angles (90°)**.
 - ❖ **Example:** Ensuring a metal frame corner is perfectly square.
- **Angle Block / Protractor:** Measures or marks specific angles.
 - ❖ **Example:** Marking a 45° bevel cut on a metal sheet.
- **Surface Plate / Surface Table:** Flat reference surface for accurate measurement or marking.
 - ❖ **Example:** Checking flatness of a metal plate before drilling.

- **Odd Leg Caliper:** Used for marking lines parallel to the edge of a metal sheet.
 - ❖ **Example:** Drawing parallel lines for bending a sheet.
- **Vee-block:** Holds cylindrical metal objects for marking or drilling.
 - ❖ **Example:** Holding a round metal rod for drilling a hole.
- **Scribing Block:** A holder to hold scribes for marking straight, parallel lines.
 - ❖ **Example:** Drawing parallel lines on a metal plate for cutting.
- **Trammel:** Measures and marks large circles or arcs.
 - ❖ **Example:** Marking a 50 cm diameter circle on a steel plate.

B) Marking Tools

Used to **transfer measurements onto metal surfaces** accurately.

- **Scriber:** Marks lines on metal surfaces using scratches.
 - ❖ **Example:** Marking cutting lines on sheet metal.
- **Dot Punch / Centre Punch:** Creates small indentations to guide drilling points.
 - ❖ **Example:** Making a dent before drilling to prevent drill slip.
- **Divider:** Used to mark **equal distances or arcs**.
 - ❖ **Example:** Dividing a metal rod into 5 equal segments.
- **Example List of Common Tools:**

Tool	Use / Application
Steel rule	Measuring length of rods, sheets
Vernier caliper	Measuring external/internal diameters
Micrometer	Measuring thickness of sheets
Tape measure	Measuring long distances
Try square	Marking right angles
Angle block	Marking angles like 30°, 45°, 60°
Surface table	Reference flat surface

Odd leg caliper	Parallel line marking
Vee-block	Holding round rods for drilling
Scribing block	Marking straight, parallel lines
Trammel	Marking large circles/arcs
Scriber	Drawing cutting lines
Dot punch	Making drill guides
Divider	Equal spacing marking

2.2.2 Performing Tasks Using Measuring and Marking Tools

Proper use ensures **accuracy, precision, and quality work.**

- **Example Tasks:**

1. **Measuring and Cutting a Steel Rod**

- ❖ Measure 50 cm using steel rule or tape.
- ❖ Mark cutting line with scriber.
- ❖ Dot punch the line for drill point if needed.
- ❖ Cut along marked line using hacksaw.

2. **Marking a Metal Sheet for Drilling Holes**

- ❖ Use try square to mark straight lines.
- ❖ Dot punch at drilling points.
- ❖ Drill safely along punched marks.

3. **Drawing Circles or Arcs on Metal Plates**

- ❖ Use trammel or divider.
- ❖ Mark with scriber.
- ❖ Check measurements with steel rule.

4. **Checking Dimensions of Cylindrical Rods**

- ❖ Use vee-block to hold rod.

- ❖ Use outside calliper or vernier caliper to check diameter.

5. Parallel Line Marking on Metal Sheets

- ❖ Use odd leg caliper or scribing block.
- ❖ Draw lines parallel to the edge.
- ❖ Ensures proper bending or cutting.

6. Angle Marking

- ❖ Use protractor or angle block.
- ❖ Mark desired angle (e.g., 30°, 45°, 60°).
- ❖ Check with try square.

2.2.3 Maintenance of Measuring and Marking Tools

Maintaining tools ensures **accuracy, longevity, and safety**.

- **Cleaning:** Wipe tools after use to remove metal dust and oil.
- **Rust Prevention:** Apply light oil on steel tools.
- **Storage:** Keep tools in designated boxes or racks.
- **Calibration:** Periodically check vernier calipers, micrometers, and squares for accuracy.
- **Handling:** Avoid dropping tools; precision tools are fragile.

Example: Vernier caliper stored in a padded case remains accurate for years.

2.2.4 Importance of Measuring and Marking Tools in Metal Workshop

- **Accuracy:** Ensures correct dimensions in metal parts.
- **Quality Work:** Properly marked metals fit and assemble correctly.
- **Efficiency:** Reduces mistakes and wastage of materials.
- **Safety:** Correct measurements prevent misaligned cuts or unsafe assemblies.
- **Skill Development:** Teaches precision and attention to detail.

Examples of Importance:

- Measuring correctly before cutting steel sheets for a gate ensures pieces fit perfectly.
- Using a centre punch prevents drills from slipping and causing accidents.

- Parallel lines drawn with odd leg calipers help in bending metal sheets accurately.
- Checking angles ensures structures like frames and supports are strong and safe.

2.2.5 Illustrative Examples

Example 1 - Cutting a Metal Plate Accurately

- Measure length and width with steel rule.
- Mark using scribe.
- Punch holes using dot punch.
- Cut along lines → Perfect rectangle.

Example 2 - Drilling Holes on Round Rods

- Hold rod in vee-block.
- Mark centre with dot punch.
- Measure diameter with callipers.
- Drill safely → Hole in correct position.

Example 3 - Bending Metal Sheet Along Parallel Lines

- Mark lines with odd leg caliper.
- Check with scribing block.
- Bend along lines → Accurate bends.

Example 4 - Fabricating a Triangular Frame

- Use angle block to mark 45° angles.
- Check angles with try square.
- Mark cutting lines with scribe.
- Cut and assemble → Perfect triangular frame.

2.2.6 Summary Table of Key Points

Aspect	Details / Points	Examples
Measuring Tools	Steel rule, tape, calipers, micrometer, try	Measure rods, pipes, sheets,

	square, angle block	angles
Marking Tools	Scriber, dot punch, divider, scribing block, trammel	Mark cutting lines, drilling points, circles
Task Performance	Measure → Mark → Punch → Cut / Drill	Cutting rods, marking holes, bending sheets
Maintenance	Clean, oil, store, calibrate	Oil calipers, keep scriber in rack
Importance	Accuracy, quality, efficiency, safety, skill	Correct fitting of metal parts, safe drilling

2.2.7 Practical Tips for Students

- Always **measure twice, mark once**.
- Keep a **clean, flat surface** for measuring and marking.
- Use **dot punch before drilling** to prevent drill slippage.
- Verify angles with **try square or angle block**.
- Use **appropriate tools** for the task (don't improvise).
- Wear **PPE** when marking, measuring, and cutting metals.

Key Takeaways:

- Measuring and marking tools are the **foundation of accurate metalwork**.
- Using tools correctly ensures **precision, safety, and quality**.
- Maintenance and proper storage keep tools accurate and durable.
- Real-life examples include: gates, frames, brackets, shelves, furniture, piping systems, and mechanical parts.

2.3 Ferrous and Non-Ferrous Metals

Metals form the backbone of all metalwork. They are classified into **ferrous** (contain iron) and **non-ferrous** (do not contain iron) metals. Understanding their **types, properties, sources, and applications** is essential for metalworking.

2.3.1 Distinguishing Ferrous and Non-Ferrous Metals

A) Ferrous Metals

- Contain **iron** as the main component.
- Usually **magnetic**.
- Prone to **rust** when exposed to moisture.
- Used where **strength and hardness** are required.

Examples:

- **Mild steel / Low carbon steel** - used in rods, sheets, gates, nails.
- **High carbon steel** - used for cutting tools, springs, chisels.
- **Cast iron** - used for engine blocks, machinery bases, manhole covers.
- **Alloy steels** - steel mixed with other metals for special properties.

Properties:

- Strong and durable
- Tough and hard
- Magnetic
- Conducts electricity moderately
- Rusts easily

B) Non-Ferrous Metals

- Do not contain iron.
- **Non-magnetic**.
- Resistant to **rust and corrosion**.
- Usually **lighter and more malleable** than ferrous metals.

Examples:

- **Copper** - electrical wires, plumbing, roofing.
- **Aluminium** - aircraft, windows, drink cans.
- **Lead** - batteries, radiation shields.
- **Tin** - coating steel, making cans.
- **Zinc** - galvanizing steel, roofing sheets.
- **Brass (Copper + Zinc)** - musical instruments, valves.
- **Bronze (Copper + Tin)** - statues, bearings.

Properties:

- Lightweight and malleable
- Non-magnetic
- Corrosion-resistant
- Conducts heat and electricity (especially copper and aluminium)
- Softer than most ferrous metals

2.3.2 Properties of Metals Found in a Metal Workshop

Understanding properties helps **choose the right metal for a job.**

A) Physical Properties

- **Color and lustre:** Copper (reddish), Aluminium (silver), Steel (greyish).
- **Density / Weight:** Aluminium is light; steel is heavy.
- **Melting point:** Iron melts at 1538°C, Aluminium at 660°C.
- **Conductivity:** Copper is an excellent conductor.

B) Mechanical Properties

- **Toughness:** Ability to withstand shock (steel).
- **Hardness:** Resistance to scratching and indentation (high carbon steel).
- **Ductility:** Ability to be stretched into wires (copper, aluminium).
- **Malleability:** Ability to be hammered into sheets (aluminium, copper).

- **Strength:** Ability to withstand force without breaking (steel, cast iron).

Practical Examples:

- Aluminium sheets in roofing → lightweight, corrosion-resistant.
- Copper wires in electrical circuits → excellent conductivity.
- High carbon steel blades → hard and durable for cutting tools.

2.3.3 Production of Iron from its Ore

Iron is produced from **iron ore** through several processes in a **blast furnace**.

Steps:

1. **Mining of iron ore** - extraction from rocks containing iron.
2. **Crushing and washing** - ore is crushed and impurities removed.
3. **Smelting in blast furnace** - ore is heated with **coke** and **limestone**.
4. **Chemical reaction:** Iron oxide + carbon → molten iron + carbon dioxide.
5. **Casting / Solidifying:** Molten iron is poured into molds to form **ingots** or **pig iron**.
6. **Refining:** Further processed into steel by removing impurities (basic oxygen process).

Key Raw Materials:

- Iron ore
- Coke (carbon source)
- Limestone (removes impurities)

Example Applications of Produced Iron:

- Mild steel rods for construction.
- Cast iron for machinery bases.
- Alloy steel for tools and automotive parts.

2.3.4 Forms of Material Supply in a Metal Workshop

Metals come in **various shapes and sizes** depending on the project.

A) Sheets and Plates

- **Metal sheets:** Thin, flexible; used for roofing, cabinets.

- **Plates:** Thick, heavy; used for machine bases, beams.

B) Bars and Rods

- **Round rods:** Axles, shafts.
- **Square / Flat bars:** Frames, supports, brackets.
- **Angle bars / Channels:** Construction frames, supports.

C) Tubes and Pipes

- Circular or square hollow sections; used in plumbing, railings, structures.
- **Example:** Aluminium tubes for window frames.

D) Wires

- Copper, aluminium wires for electrical work.
- Mild steel wires for fencing.

E) Ingots

- Raw cast metal blocks; used in forging or rolling into sheets.

F) Other Forms

- **Foils:** Thin aluminium foil for packaging.
- **Coils / Rolls:** Sheet metals supplied in rolls for continuous use.

Practical Examples:

- Aluminium sheet → roofing sheets, car body panels.
- Steel bar → gate frame, furniture frame.
- Copper wire → electrical connections.
- Cast iron plate → machinery mounting plate.

2.3.5 Applications of Ferrous and Non-Ferrous Metals in Daily Life

Metals are everywhere in our lives; their **selection depends on properties.**

Ferrous Metals Applications

- Mild steel rods → construction bars.
- High carbon steel → tools, knives, chisels.

- Cast iron → stoves, machinery bases, pipes.
- Alloy steel → car parts, machinery components.

Non-Ferrous Metals Applications

- Aluminium → aircraft, windows, soda cans.
- Copper → wiring, plumbing, coins.
- Lead → batteries, radiation shielding.
- Zinc → galvanizing steel, roofing.
- Brass → valves, musical instruments.
- Bronze → statues, bearings, medals.

Everyday Examples:

- Door gates → mild steel (ferrous).
- Cooking pots → aluminium (non-ferrous).
- Electrical wires → copper (non-ferrous).
- Car engine → cast iron and steel (ferrous).
- Coins → copper, nickel alloys (non-ferrous).

2.3.6 Summary Table

Metal Type	Examples	Properties	Applications
Ferrous	Mild steel, High carbon steel, Cast iron	Strong, hard, magnetic, rusts	Tools, gates, construction, machines
Non-Ferrous	Copper, Aluminium, Lead, Tin, Zinc, Brass, Bronze	Light, corrosion-resistant, non-magnetic, ductile	Wires, roofing, plumbing, cans, statues

2.3.7 Illustrative Examples for Practice

1. Fabricating a Steel Gate

- ❖ Use mild steel bars → strong, durable.
- ❖ Sheet steel panels → decorative inserts.

2. Electrical Wiring

❖ Copper wire → excellent conductivity, corrosion-resistant.

3. Aluminium Roofing

❖ Lightweight → easy to install.

❖ Corrosion-resistant → lasts long.

4. Tool Making

❖ High carbon steel → hammerheads, chisels, saw blades.

5. Industrial Machines

❖ Cast iron base → vibration-resistant, strong.

6. Household Items

❖ Aluminium pots, pans, trays → lightweight, corrosion-resistant.

❖ Brass taps → corrosion-resistant, decorative.

7. Art and Decoration

❖ Bronze statues, medals, ornamental handles.

2.3.8 Practical Tips for Students

- Identify metals by **magnet test** (ferrous → magnetic, non-ferrous → non-magnetic).
- Consider **strength, weight, corrosion resistance** before choosing metal.
- Always **measure and mark accurately** before cutting or shaping.
- Understand **forms of metal supply** to select the right material for the task.
- Use **ferrous metals for strength-heavy jobs**; non-ferrous for corrosion-resistant or electrical applications.

Key Takeaways:

- Metals are classified as **ferrous and non-ferrous**.
- Knowing **properties and applications** is crucial for metalwork.
- Metals come in **sheets, plates, rods, bars, wires, pipes, ingots**.
- Proper selection ensures **quality, safety, and efficiency**.

- Everyday life depends on metals for **construction, transport, electrical work, utensils, and decoration.**

2.4 Project Work in Metal Technology

Project work in metal technology allows learners to **apply theory into practice.** It emphasizes **problem-solving skills,** creativity, and practical use of **tools, materials, and machines** to address real-life needs in the community.

2.4.1 Identifying Problems in the Community

The first step in any project is **observing the community to identify problems that can be solved using metal technology skills.**

- **Examples of Community Problems:**

1. Broken or unsafe gates in homes or schools.
2. Lack of proper waste bins in neighborhoods.
3. Weak or broken furniture in schools, offices, or homes.
4. Need for water tanks or storage containers.
5. Poorly secured windows or doors in houses.
6. Broken bicycle frames or machinery parts.
7. Lack of animal feeding troughs in farms.
8. Unsafe playground equipment.
9. Missing or damaged fence posts.
10. Lack of tool storage racks in schools or workshops.

- **Activity for Learners:**

- ❖ Walk around your community or school to **observe problems.**
- ❖ List at least **5 problems** that can be solved using metal fabrication skills.

2.4.2 Suggesting Items to Solve the Problem

After identifying problems, **think of metal items that can solve them using locally available materials.**

- **Examples of Items to Make:**

1. **Steel gate** → for broken or insecure gates.
2. **Metal waste bins** → for litter collection.
3. **Metal chairs, tables, or shelves** → for weak or broken furniture.
4. **Water tanks or metal drums** → for water storage.
5. **Metal window frames with grills** → for home security.
6. **Bicycle frames or metal repair kits** → for broken bicycles.
7. **Animal feeding troughs or cages** → for farms.
8. **Metal playground swings and slides** → for schools or public areas.
9. **Fence posts and boundary rails** → for secure farms or properties.
10. **Tool racks and holders** → for workshops and storage solutions.

- **Criteria for Selection:**

- Locally available materials.
- Simple fabrication process suitable for learners.
- Solves a real community problem effectively.

2.4.3 Fabrication of the Selected Item

Fabrication involves **applying knowledge of tools, materials, measurement, marking, cutting, joining, and finishing metals** to make the item.

- **Steps in Fabrication:**

1. **Planning**

- ❖ Identify materials needed: steel rods, sheets, wires, nuts, bolts, etc.
- ❖ Draw simple **sketch of the item** with measurements.
- ❖ List **tools and machines** required: hacksaw, hammer, files, welding machine, vice, pliers.

2. **Measuring and Marking**

- ❖ Measure metal using steel rule, tape, or vernier calipers.
- ❖ Mark cutting points using scribe, dot punch, or dividers.

- ❖ Check angles using try square or angle blocks.

3. Cutting / Shaping

- ❖ Cut rods, sheets, or bars to the correct size.
- ❖ Bend sheets using hammer, mallet, or bending brake.
- ❖ Shape rods using pliers or hammers.

4. Joining Metals

- ❖ **Welding:** Join metal pieces permanently.
- ❖ **Bolting / Screwing:** Join pieces where future disassembly is needed.
- ❖ **Riveting:** Join thin sheets where welding is not possible.

5. Finishing

- ❖ Smooth rough edges with files or grinders.
- ❖ Clean surfaces from dust or grease.
- ❖ Paint or coat to prevent corrosion.

6. Inspection

- ❖ Check dimensions and angles.
- ❖ Test stability and functionality.

2.4.4 Appreciation of Tools and Equipment in Fabrication

- Tools and machines **make fabrication easier, faster, and safer.**
- Proper use ensures **quality work** and prevents injuries.

Examples:

- Hacksaw → cutting rods and sheets accurately.
- File → smoothing edges to prevent injuries.
- Welding machine → permanent joining of metal structures.
- Bench vice → holds metal securely during cutting or filing.
- Pliers → bending small metal pieces accurately.

2.4.5 Examples of Community Projects

1. Security Solutions

- **Problem:** Broken school gate.
- **Solution / Item:** Welded steel gate with hinge.
- **Materials:** Mild steel rods, angle bars, welding rods.
- **Tools:** Hacksaw, welding machine, hammer, bench vice.

2. Waste Management

- **Problem:** Litter in neighborhood.
- **Solution / Item:** Metal waste bins.
- **Materials:** Mild steel sheets, hinges, metal rods.
- **Tools:** Scriber, hammer, welding machine, pliers.

3. Furniture Fabrication

- **Problem:** Weak school chairs.
- **Solution / Item:** Metal-framed chairs with wooden or metal seats.
- **Materials:** Mild steel rods, wooden planks.
- **Tools:** Hacksaw, drill, file, welding machine.

4. Animal Farming

- **Problem:** Cattle feed scattered on the ground.
- **Solution / Item:** Metal feeding trough.
- **Materials:** Steel sheets, angle bars.
- **Tools:** Scriber, hacksaw, hammer, welding machine.

5. Water Storage

- **Problem:** Shortage of clean water storage.
- **Solution / Item:** Metal water tank or drum.
- **Materials:** Steel sheets, welding rods.
- **Tools:** Sheet bending tools, welding machine, hammer.

6. Bicycle / Motorcycle Repairs

- **Problem:** Broken bicycle frame.
- **Solution / Item:** Fabricate replacement frame or brackets.
- **Materials:** Mild steel rods, small steel sheets.
- **Tools:** Hacksaw, welding machine, pliers, files.

7. Household Improvement

- **Problem:** Weak window grills.
- **Solution / Item:** Metal grills for windows.
- **Materials:** Mild steel rods.
- **Tools:** Hacksaw, welding machine, hammer, vice.

8. Tool Organization

- **Problem:** Messy workshop tools.
- **Solution / Item:** Metal tool rack with compartments.
- **Materials:** Mild steel rods, sheets.
- **Tools:** Hacksaw, welding machine, drill.

9. Playground Equipment

- **Problem:** Broken swings at school.
- **Solution / Item:** Metal swing frame.
- **Materials:** Mild steel tubes, rods.
- **Tools:** Hacksaw, welding machine, files, paint.

10. Fencing / Boundary Solutions

- **Problem:** Unsecured farm boundary.
- **Solution / Item:** Metal fence posts and rails.
- **Materials:** Mild steel rods, wires.
- **Tools:** Hacksaw, pliers, hammer, welding machine.

2.4.6 Practical Steps in Presenting a Fabricated Project

1. **Demonstrate functionality:** Show how it works (e.g., gate opens, chair holds weight).
2. **Explain materials used:** Mention ferrous/non-ferrous metals applied.
3. **Discuss tools and machines:** Explain why each was chosen.
4. **Highlight safety measures:** PPE used, careful handling of machines.
5. **Document process:** Sketches, step-by-step photos, or video recordings.

2.4.7 Summary Table for Project Work

Step	Description	Examples
Identify problem	Observe community, list issues	Broken gates, litter, weak chairs
Suggest item	Design item to solve problem	Gate, waste bin, feeding trough
Fabricate item	Measure, cut, shape, join, finish	Welding steel rods, bending sheets, drilling holes
Use of tools	Select proper tools for each task	Hacksaw, hammer, welding machine, files, pliers
Presentation	Demonstrate item, explain process	Show water tank, swing frame, or metal rack

2.4.8 Key Takeaways

- Project work bridges **theory and practical skills** in metal technology.
- Choosing the **right materials and tools** ensures durability and efficiency.
- Projects solve **real community problems**, improving lives.
- Safety, measurement accuracy, and finishing are **critical in fabrication**.
- Examples of projects: gates, bins, furniture, water tanks, grills, troughs, racks, playground equipment, fences.

3.0 Related Drawing in Metal Technology

3.1 Scales and Conventions

Technical drawings are essential in metal technology because they provide **precise instructions** for fabrication. Understanding **symbols, abbreviations, conventions, and scales** ensures correct interpretation and communication.

3.1.1 Symbols, Abbreviations, and Conventions Used in Metal Drawings

A) Identification of Symbols

Symbols represent **materials, processes, and features** in drawings.

Common Symbols in Metal Technology:

1. Welding Symbols

- ❖ **Fillet weld** → triangle symbol.
- ❖ **Groove weld** → U, V, or bevel shapes.
- ❖ **Spot weld** → small circle.
- ❖ **Plug weld** → filled circle.

2. Cutting and Bending Symbols

- ❖ **Bend line** → dashed line with arrow.
- ❖ **Cut line** → thick solid line with scissors symbol.

3. Surface Finish Symbols

- ❖ **Machining** → check mark (√) on surface.
- ❖ **Grinding** → horizontal line with roughness number.

4. Sectional View Symbols

- ❖ **Hatching** → diagonal lines to indicate cut surfaces.

5. Fastening Symbols

- ❖ **Bolt** → circle with cross inside.
- ❖ **Nut** → hexagon symbol.
- ❖ **Rivet** → filled circle on joined parts.

Common Symbols in Metal Technology

1. Welding Symbols

1. **Fillet Weld** → represented by a **triangle**



2. **Groove Weld** → represented by **U, V, or bevel shapes**

U-shaped groove: U

V-shaped groove: V

Bevel groove: 

3. **Spot Weld** → represented by a **small circle**

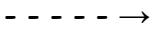


4. **Plug Weld** → represented by a **filled circle**

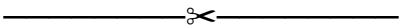


2. Cutting and Bending Symbols

1. **Bend Line** → represented by a **dashed line with an arrow**



2. **Cut Line** → represented by a **thick solid line with scissors symbol**



3. Surface Finish Symbols

1. **Machining** → represented by a **check mark (√) on the surface**



2. **Grinding** → represented by a **horizontal line with roughness number**

—Ra 3.2

(Ra = roughness average)

4. Sectional View Symbols

1. **Hatching** → represented by **diagonal lines** to indicate cut surfaces

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5. Fastening Symbols

1. **Bolt** → represented by a **circle with a cross inside**



2. **Nut** → represented by a **hexagon**



3. **Rivet** → represented by a **filled circle on joined parts**



Examples of Use:

- Triangle for **fillet weld** on a steel angle in a gate.
- V-shape groove weld on a **machine base plate**.
- Machined surface symbol on **shaft ends**.

B) Abbreviations in Metal Drawings

Abbreviations save space and clearly communicate instructions.

Common Abbreviations:

Abbreviation	Meaning	Example
Ø	Diameter	Ø25 mm rod
R	Radius	R50 mm for bend
THK	Thickness	THK 6 mm steel plate
LG	Length	LG 1 m bar
DIA	Diameter	DIA 12 mm bolt
BEND	Bend	90° BEND sheet

FL	Fillet	FL weld on plate edge
FIN	Finish	FIN all surfaces
CL	Center line	CL hole position
REF	Reference	REF dimension for info

Examples of Use:

- $\varnothing 25$ → mark diameter of a round rod.
- THK 6 → indicate thickness of sheet metal for tray.
- 90° BEND → mark fold line for metal bracket.

C) Conventions in Metal Drawings

Conventions are **agreed methods** for representing parts and features.

Common Conventions:

- **Line Types:**
 - ❖ Continuous thick → visible edges.
 - ❖ Dashed → hidden edges.
 - ❖ Chain → centerlines.
- **Views:**
 - ❖ **Front view, top view, side view** → standard orthographic projection.
- **Sectioning:**
 - ❖ Cut surfaces shown with hatching.
- **Dimensioning:**
 - ❖ Units in mm, arrows at ends, clear numbers.

Examples:

- Hidden edges of a welded angle → dashed line.
- Bolt hole at center → chain line (centerline) with \varnothing symbol.
- Machined surface → check mark with finish number.

3.1.2 Interpreting Symbols, Abbreviations, and Conventions

- Symbols indicate **type of weld, cut, or finish**.
- Abbreviations indicate **dimensions, materials, and operations**.
- Conventions provide **clarity and standardization**.

Examples:

1. Triangle symbol + FL → **fillet weld** at indicated edge.
2. $\varnothing 12$ CL → **hole with 12 mm diameter at centerline**.
3. THK 5 BEND 90° → **bend 5 mm sheet at 90°** .
4. Machined surface symbol + Ra 3.2 → **grind surface to 3.2 μm roughness**.

Activity:

- Interpret drawing of a metal bracket:
 - ❖ Identify weld type.
 - ❖ Identify sheet thickness.
 - ❖ Identify hole diameter and position.

3.1.3 Construction of Scales in Technical Drawing

Scales allow **reducing or enlarging dimensions** to fit drawings on paper.

A) Types of Scales

1. **Full Scale (1:1)** → Actual size.
2. **Reduction Scale (1:2, 1:5, 1:10)** → Draw smaller than real size.
3. **Enlargement Scale (2:1, 5:1)** → Draw larger than real size.

Examples:

- Gate frame actual size 2 m × 1 m → 1:10 scale → draw 20 cm × 10 cm.
- Bolt $\varnothing 12$ mm → 2:1 scale → draw 24 mm diameter.

B) Plane Scale Construction (Simple Ruler Method)

Steps:

1. Draw a line representing unit length (e.g., 10 cm = 1 m).

2. Mark divisions along the line according to scale ratio.
3. Draw vertical lines from divisions to construct scale grid.
4. Use scale to measure and draw components accurately.

Examples:

- 1:5 scale → 1 m = 20 cm on paper.
- 1:2 scale → 50 cm rod → 25 cm on drawing.

C) Diagonal Scale Construction (For Fractional Measurement)

Steps:

1. Draw main horizontal line.
2. Divide into equal parts for **primary units**.
3. Draw **vertical lines** at each division.
4. Draw **diagonal lines** for subdivision (secondary units).
5. Project points from diagonal to main line → precise measurement.

Examples:

- Measuring 2.35 m on 1:5 scale using diagonal scale → 47 cm + 7 mm.
- Accurate placement of holes or bends on sheet metal.

3.1.4 Applications and Importance of Symbols, Abbreviations, Conventions, and Scales

- **Accuracy:** Provides exact dimensions and locations for fabrication.
- **Communication:** Engineers, welders, and technicians understand the design.
- **Efficiency:** Saves time, reduces mistakes in cutting, welding, or machining.
- **Standardization:** Everyone follows the same method worldwide.

Examples of Application:

1. Gate fabrication → weld type and dimensions from drawing.
2. Metal shelf → thickness, hole positions, and bends from drawing.
3. Machine part → scale used to fit drawing on A4 paper.
4. Bolt hole positions → interpreted using centerline conventions.

3.1.5 Common Symbols and Abbreviations Summary Table

Symbol / Abbreviation	Meaning / Use	Example
△	Fillet weld	Triangle at joint
V	V-groove weld	Edge weld on plates
•	Spot weld	Circle on sheet
∅	Diameter	∅12 mm hole
R	Radius	R50 mm bend
THK	Thickness	THK 6 mm sheet
BEND	Bend line	90° BEND
√	Machining finish	Surface Ra 3.2
CL	Center line	Hole at CL
Dashed line	Hidden edges	Hidden hole or feature
Chain line	Center of circle or symmetry	Bolt circle

3.1.6 Examples of Drawing Interpretation

1. Gate Bracket Drawing:

- ❖ Triangle → fillet weld at 45° angle.
- ❖ THK 5 → 5 mm steel sheet.
- ❖ ∅12 CL → hole for bolt at centerline.

2. Shelf Drawing:

- ❖ 1:5 scale → measure dimensions for cutting.
- ❖ 90° BEND → fold sheet accurately.
- ❖ Machining symbol → smooth edges for safety.

3. Machine Part Drawing:

- ❖ V-groove weld → joint assembly.
- ❖ DIA 25 mm → hole for shaft.

- ❖ Chain line → centerline for hole alignment.

3.1.7 Practical Tips for Students

- Always **refer to scale** before cutting or assembling.
- Recognize **symbols and abbreviations** before starting fabrication.
- Use **plane and diagonal scales** for accurate dimensioning.
- Draw **orthographic views** for clarity (front, top, side).
- Verify dimensions using **measuring tools** from the workshop.
- Always **apply conventions** for line types, hatching, and sectioning.

3.1.8 Key Takeaways

- **Symbols** indicate weld types, cuts, fasteners, and surface finishes.
- **Abbreviations** save space and provide material, thickness, and size info.
- **Conventions** standardize line types, views, and sectional drawings.
- **Scales** allow drawing real items on paper accurately, either reduced or enlarged.
- Proper use of **drawing knowledge ensures accuracy, efficiency, and safety** in metalwork.

3.2 Pictorial Drawing

Pictorial drawings are **three-dimensional (3D) representations of objects** that show **height, width, and depth** on a two-dimensional (2D) surface. They are essential in metal technology to **visualize metal components, machines, and fabricated products** before making them.

3.2.1 Types of Pictorial Drawings

1. Isometric Drawing

- ❖ Shows **all three dimensions (height, width, depth)** equally.
- ❖ Uses **30° angles from horizontal** for width and depth.
- ❖ Objects appear more **realistic and proportional**.

2. Oblique Drawing

- ❖ Front face shown **true size**.

- ❖ Depth is **projected at an angle**, usually 30° or 45°.
- ❖ Simpler to draw than isometric but less realistic.

3. Perspective Drawing

- ❖ Mimics how the **human eye sees objects**.
- ❖ Objects appear **smaller as they recede**.
- ❖ Commonly used in **design presentation and artistic work**.

4. Axonometric Drawing (variant of isometric)

- ❖ Includes **dimetric** and **trimetric projections**.
- ❖ Shows objects in proportion but with **distorted angles for clarity**.

5. Exploded Pictorial Drawing

- ❖ Shows parts **separated but aligned** to illustrate **assembly**.
- ❖ Used for **machines, tools, and welded components**.

Examples in Metal Technology:

- Isometric drawing → steel gate with rods and welds.
- Oblique drawing → metal toolbox showing depth.
- Perspective drawing → workshop machine layout.
- Exploded drawing → bolt and nut assembly.

3.2.2 Drawing Three-Dimensional Figures

- **Common 3D shapes in metal technology:**
 1. **Prisms** → rectangular, square, triangular (metal blocks, beams).
 2. **Cylinders** → pipes, rods, shafts.
 3. **Cones / Pyramids** → funnels, hopper chutes.
 4. **Spheres / Hemispheres** → domed lids, balls in machines.
- **Steps to draw 3D figures:**
 1. Draw **front face or base** in true shape.
 2. Project **depth lines** using angles (30° for isometric).

3. Complete **height and depth**.
4. Draw **hidden lines** as dashed (if needed).

Examples:

- Rectangular prism → metal box or bracket.
- Cylinder → water pipe or piston rod.
- Triangular prism → metal wedge or bracket support.
- Cone → funnel for workshop or machine hopper.

3.2.3 Isometric Projection

- **Definition:** Representation where **all three axes are equally inclined** to the plane of projection.
- **Angles:** Width and depth lines at **30°** to horizontal. Vertical lines remain **true vertical**.

Steps for Drawing Isometric Figures:

1. Draw **vertical edges** first.
2. Draw **edges at 30°** for width and depth.
3. Connect edges to form 3D shape.
4. Add **hidden lines and details**.
5. Dimension → mark height, width, and depth.

Examples in Metal Technology:

- Isometric drawing of **steel gate** → shows rods, panels, and hinge positions.
- Isometric view of **metal toolbox** → shows lid, handles, and joints.
- Isometric drawing of **machine base** → shows slots and holes.

Tips:

- Always use **30° angles** for width and depth.
- Use **scale for proper proportion**.
- Vertical edges stay vertical for clarity.

3.2.4 Oblique Projection

- **Definition:** Front face shown in **true size**, other edges projected at an **angle** (usually 30° or 45°).
- **Types:**
 1. **Cavalier** → full depth drawn (distorted).
 2. **Cabinet** → half depth drawn (more realistic).

Steps for Drawing Oblique Figures:

1. Draw **front face** in true size.
2. Draw **depth lines** at angle (30° recommended).
3. Complete the drawing by connecting corners.
4. Add **dimensioning**.

Examples:

- Oblique drawing of **metal shelf** → shows front and depth for fabrication.
- Oblique drawing of **steel box** → for storage in workshop.
- Oblique view of **metal bracket** → shows bend and thickness.

Tips:

- Use **cavalier for simplicity**; cabinet for realistic view.
- Keep front face **accurate in measurements**.

3.2.5 Dimensioning Pictorial Drawings

- **Purpose:** Provides **exact measurements** for fabrication.
- **Dimension lines:** Thin lines with **arrows at ends**.
- **Text:** Clear, legible numbers in **mm**.
- **Projection lines:** Extend from object to avoid confusion.

Examples:

- Cylinder → Ø50 mm × 100 mm length.
- Rectangular prism → 200 mm × 100 mm × 50 mm.
- Triangular prism → base 80 mm, height 100 mm, length 150 mm.

- Gate → 2 m × 1 m × 50 mm steel rods.

Tips:

- Always include **height, width, and depth**.
- Use **same scale** for all dimensions.
- Dimension **critical features** like holes, bends, and weld positions.

3.2.6 Applications of Pictorial Drawings in Metal Technology

- **Visualizing the final product** before fabrication.
- **Communicating ideas** between designer and fabricator.
- **Checking accuracy** of dimensions, angles, and materials.
- **Planning assembly** of components.

Examples in Metal Technology:

1. Steel gate → isometric drawing shows rods, panels, welds.
2. Workshop tool rack → oblique drawing shows shelving.
3. Bolt and nut assembly → exploded pictorial drawing.
4. Machine part → isometric drawing shows holes, slots, and welds.
5. Furniture frame → oblique drawing shows seat, backrest, and support rods.

3.2.7 Practical Examples of Pictorial Drawings

Item	Type of Drawing	Materials	Purpose
Steel gate	Isometric	Mild steel rods, sheet	Visualization before fabrication
Toolbox	Oblique	Sheet metal, hinges	Easy for workshop fabrication
Workshop shelf	Oblique	Angle bars, sheets	Shows depth and height
Bolt assembly	Exploded	Bolt, nut, washer	Assembly instruction
Cylinder pipe	Isometric	Mild steel pipe	Cutting, fitting, welding plan
Bracket	Isometric	Mild steel plate	Shows bend and weld positions
Hopper / Funnel	Isometric	Sheet metal	Shows cone and cylinder connection

Machine base	Isometric	Steel plate	Shows slot positions, hole locations
Metal bin	Oblique	Steel sheet, rod	Fabrication plan for community project
Play equipment	Isometric	Steel tubes, rods	Visual plan for safety and assembly

3.2.8 Steps for Students to Practice

1. Identify an **item to draw** (e.g., gate, toolbox, shelf).
2. Choose **projection type**: isometric or oblique.
3. Draw **base or front face** in true size.
4. Project **depth and height** lines at proper angles.
5. Include **hidden lines if necessary**.
6. Add **dimension lines** for width, height, depth, diameter, bend angles.
7. Label **materials, welds, or finishes**.
8. Check drawing for **accuracy and clarity**.
9. Present in class for **discussion and critique**.

3.2.9 Summary Table of Pictorial Drawing Techniques

Technique	Characteristics	Examples in Metal Technology
Isometric	All axes at 30°; height vertical	Steel gate, cylinder pipe, bracket
Oblique	Front face true size; depth at angle	Toolbox, shelf, bin
Perspective	Realistic, depth receding	Workshop layout, machine overview
Exploded	Parts separated but aligned	Bolt-nut assembly, valve components
Axonometric	Dimetric/trimetric	Complex machine parts

3.2.10 Key Takeaways

- Pictorial drawings **visualize 3D objects** for fabrication.
- **Isometric and oblique** are common in metal technology.
- Proper **dimensioning** ensures accurate fabrication.
- Helps in **planning, communication, and assembly**.
- Always follow **scale, projection angles, and conventions**.

4.0 Metal Joining and Finishing Processes

4.1 Methods of Joining Sheet Metal

Joining sheet metal is a **fundamental skill in metal technology** used to assemble metal sheets into **functional products**. It is widely used in **fabrication of boxes, furniture, bins, roofs, gates, and machinery parts**.

4.1.1 Types of Sheet Metal Joints

Sheet metal joints are classified according to **how two sheets meet and overlap**.

1. Butt Joint

- **Definition:** Edges of two sheets meet **without overlapping**.
- **Uses:** Simple boxes, enclosures, panels.
- **Examples:**
 - ❖ Metal box fabrication.
 - ❖ Sheet metal cabinet.
 - ❖ Electrical panel covers.

2. Lap Joint

- **Definition:** One sheet **overlaps** the other.
- **Uses:** Roofing sheets, gutter assembly, metal bins.
- **Examples:**
 - ❖ Overlapping roof sheets.
 - ❖ Metal tray assembly.
 - ❖ Joining panels of water tanks.

3. Seam Joint

- **Definition:** Sheets joined by **folding, bending, or interlocking** edges.
- **Types:**
 - ❖ **Single seam** → edges folded once.
 - ❖ **Double seam** → edges folded twice for strength.

- **Uses:** Roofing, cylindrical drums, gutters.
- **Examples:**
 - ❖ Rolled cylindrical tanks.
 - ❖ Roof sheet interlocks.
 - ❖ Metal chimneys.

4. Corner Joint (optional)

- **Definition:** Sheets meet at **right angles**.
- **Uses:** Boxes, cabinets, small enclosures.
- **Examples:**
 - ❖ Drawer boxes.
 - ❖ Electrical enclosures.
 - ❖ Metal toolboxes.

Illustration Tips:

- Draw sheets overlapping for lap joint.
- Draw edges touching for butt joint.
- Show folded edges for seam joint.

4.1.2 Methods Used in Joining Sheet Metals

Sheet metal can be joined **mechanically or chemically**, depending on the application.

1. Riveting

- **Definition:** Permanent mechanical joining using **metal pins (rivets)**.
- **Process:**
 1. Drill holes in sheets.
 2. Insert rivet.
 3. Hammer or press the rivet head to secure sheets.
- **Types of Rivets:** Solid rivets, tubular rivets, pop rivets.
- **Uses:** Aircraft, metal boxes, water tanks.

- **Examples:**

- ❖ Joining metal roofing sheets.
- ❖ Fabricating small metal boxes.
- ❖ Repairing gutters.

2. Fasteners (Bolts, Nuts, Screws)

- **Definition:** Temporary or semi-permanent joining using **bolts, nuts, and screws**.

- **Process:**

1. Drill hole in sheets.
2. Insert bolt or screw.
3. Tighten with spanner or screwdriver.

- **Uses:** Workshop equipment, machines, cabinets.

- **Examples:**

- ❖ Metal drawer assembly.
- ❖ Workshop tool racks.
- ❖ Sheet metal panels for machinery.

3. Screw Threading

- **Definition:** Forming threads in sheet metal to allow **screws to fasten without nuts**.

- **Process:**

1. Drill pilot hole.
2. Tap threads using a tap.
3. Screw fastener into threaded hole.

- **Uses:** Light enclosures, electrical panels, sheet metal lids.

- **Examples:**

- ❖ Electrical junction box lid.
- ❖ Sheet metal cupboard doors.
- ❖ Small toolbox assembly.

4. Welding (Spot / Seam)

- **Definition:** Permanent joining using **heat to melt sheets together.**
- **Spot Welding:**
 - ❖ Two sheets pressed together at points.
 - ❖ Electric current melts metal locally.
 - ❖ Examples: Metal bins, car panels, roofing sheets.
- **Seam Welding:**
 - ❖ Continuous weld along sheet edges.
 - ❖ Examples: Cylindrical tanks, drums, gutters.

5. Folding / Crimping

- **Definition:** Edges of sheets bent over to **interlock without additional fasteners.**
- **Uses:** Seam joint creation, simple enclosures.
- **Examples:**
 - ❖ Metal trays.
 - ❖ Small storage bins.
 - ❖ Roof edges.

Illustrations:

- Show rivet head, bolt and nut assembly, and tapped screw hole.
- Folded edge diagrams for seam joints.

4.1.3 Performing Sheet Metal Joining in the Workshop

Steps for a Simple Project:

1. **Select Material:** Mild steel sheet (1-2 mm thickness).
2. **Choose Joint Type:** Butt, lap, seam, or corner.
3. **Mark and Measure:** Use **steel rule, scribe, dot punch.**
4. **Cut Sheet:** Using **hacksaw or shears.**
5. **Prepare Edges:** File edges for smooth joining.

6. Join Sheets:

- ❖ Riveting → drill holes, insert rivets, hammer heads.
- ❖ Screws → tap hole, insert screw.
- ❖ Welding → use spot or seam welding carefully.

7. **Check Alignment:** Ensure sheets are **even and square**.

8. **Finish:** File edges, sand, and paint to prevent corrosion.

9. **Safety:** Always wear **gloves, apron, goggles, and avoid loose clothing**.

Examples of Workshop Tasks:

- Fabricate **metal toolbox** using lap and butt joints.
- Join **roof sheets** using seam welding.
- Assemble **metal drawer** with screws.
- Make **small cylindrical drum** using seam joint and welding.
- Repair **gutter corner** using rivets.

4.1.4 Importance of Sheet Metal Joining in Daily Life

- Enables **production of functional objects:** boxes, bins, trays, roofing, tanks.
- Provides **durability and strength** to metal products.
- Allows **easy repair and maintenance** of metal objects.
- Widely used in **construction, manufacturing, automotive, and home applications**.

Examples in Daily Life:

1. Metal trash bins → lap joint + rivets.
2. Roofing sheets → seam joint + welding.
3. Toolboxes → butt and corner joints + screws.
4. Cylindrical water tanks → seam joint + welding.
5. Sheet metal furniture → lap joints + screws or rivets.
6. Car panels → spot welding.
7. Air conditioning ducting → seam and fold joints.

- 8. Metal gates → butt joints + welding.
- 9. Exhaust pipes → spot welding.
- 10. Industrial drums → seam welding.

4.1.5 Safety Measures When Joining Sheet Metal

- Always wear **personal protective equipment (PPE)**:
 - ❖ *Gloves* → prevent cuts.
 - ❖ *Goggles* → protect eyes from sparks and debris.
 - ❖ *Apron* → protect body from sparks or sharp edges.
- Keep work area **clean and free of obstacles**.
- Handle sheets carefully → **avoid sharp edges**.
- Use **proper clamps or vices** to hold sheets.
- Avoid touching **hot metal** after welding or riveting.

Examples:

- Wear gloves when hammering rivets.
- Goggles during welding or drilling.
- Clamp sheets before drilling holes for screws.

4.1.6 Summary Table of Sheet Metal Joints and Methods

Joint Type	Joining Method	Example	Daily Use
Butt	Screws, Welding	Metal box	Toolbox, cabinets
Lap	Rivets, Welding	Roofing sheet	Water tanks, gutters
Seam	Welding, Folding	Cylindrical drum	Industrial drums, chimneys
Corner	Screws, Rivets	Drawer	Metal drawers, cabinets
Folded	Folding / Crimping	Tray, small bin	Storage bins, trays

4.1.7 Key Takeaways

- **Sheet metal joints:** Butt, lap, seam, corner, folded.
- **Joining methods:** Riveting, screws, bolts, spot/seam welding, folding.
- **Applications:** Bins, trays, roofing, tanks, boxes, drawers, gates.
- **Safety** is critical: PPE, proper clamping, clean workspace.
- **Daily life use:** Construction, household items, industrial equipment.
- **Accurate measurement, edge preparation, and finishing** ensure strong, safe joints.

4.2 Sheet Metal Processes

Sheet metal processes involve **shaping, forming, or modifying flat metal sheets** into useful objects. They are fundamental in **fabricating trays, bins, ducts, roofs, and decorative items**.

4.2.1 Types of Sheet Metal Processes

Sheet metal can be processed using several methods. The main processes include:

A) Edge Treatment

- **Definition:** Process of **finishing edges of sheet metal** to remove sharpness, burrs, or to prepare edges for joining.
- **Methods:**
 1. **Filing edges** → smoothens cut edges.
 2. **Bevelling edges** → preparing for welding or joining.
 3. **Trimming edges** → remove excess material.
- **Tools:** File, bench grinder, shears, bevelling tools.
- **Examples:**
 - ❖ Metal tray edges filed smooth for safety.
 - ❖ Bevelled edges of sheet for butt joint welding.
 - ❖ Trimming roof sheet edges before overlap.
- ❖ **Importance:**

- ❖ Prevents **cuts and injuries**.
- ❖ Ensures **better joining** of sheets.
- ❖ Improves **aesthetic appearance**.

B) Hollowing (Dishing)

- **Definition:** Shaping a flat sheet into a **concave form** (like a bowl).
- **Methods:**
 1. Hammering over **dolly or stake**.
 2. Using **press or hydraulic machine** for large sheets.
- **Tools:** Mallet, cross-peen hammer, stake, sandbag, press.
- **Examples:**
 - ❖ Making **metal bowls or basins**.
 - ❖ Dishing **sink trays**.
 - ❖ Creating concave parts for decorative panels.
- **Steps:**
 1. Mark the outline on sheet.
 2. Place sheet over **stake or sandbag**.
 3. Hammer gradually from edges to center.
 4. Smooth using mallet or sandpaper.
- **Importance:**
 - ❖ Allows making **bowls, trays, pans**.
 - ❖ Helps in **decorative metalwork**.

C) Sinking

- **Definition:** Forming **shallow concave shapes** in sheet metal.
- **Difference from hollowing:** Sinking is **shallower** and covers **larger areas**.
- **Methods:**
 - ❖ Using **sinking blocks** or **hollowing blocks**.

- ❖ Gradually hammering sheet metal into **desired concave shape**.
- **Tools:** Mallet, sinking block, stake, hammer, dolly.
- **Examples:**
 - ❖ Making **tray, shallow pan, funnel, lid**.
 - ❖ Sinking decorative shapes in **metal wall panels**.
 - ❖ Forming **roof sheet ends for water drainage**.
- **Importance:**
 - ❖ Produces functional **trays, covers, funnels**.
 - ❖ Provides **aesthetic design**.

D) Raising

- **Definition:** Transforming **flat sheet metal into convex shapes** (opposite of sinking).
- **Methods:**
 - ❖ Gradual hammering from **edges to center** over **stake or hollow form**.
 - ❖ Used for **cups, domes, and rounded parts**.
- **Tools:** Mallet, raising stake, cross-peen hammer, sandbag.
- **Examples:**
 - ❖ Metal cups, bowls, and domed lids.
 - ❖ Roof domes and vents.
 - ❖ Decorative lampshades or metal ornaments.
- **Steps:**
 1. Mark the area to be raised.
 2. Place sheet on stake.
 3. Hammer gradually from edge to center.
 4. Anneal sheet occasionally if metal hardens.
- **Importance:**
 - ❖ Enables production of **convex, rounded shapes**.

- ❖ Increases **metal forming versatility**.

E) Cutting and Shearing

- **Definition:** Reducing sheet metal to **required size and shape**.
- **Methods:**
 - ❖ Shearing → straight cuts.
 - ❖ Snipping → curved or irregular cuts.
- **Tools:** Tin snips, bench shears, guillotine, hacksaw.
- **Examples:**
 - ❖ Cutting **roof sheets to size**.
 - ❖ Cutting **metal strips for trays**.
 - ❖ Shaping **metal sheet panels for machines**.

F) Bending / Folding

- **Definition:** Changing sheet metal into **angles or curves**.
- **Methods:**
 - ❖ Hand bending over **edge of table or bench**.
 - ❖ Using **brake press for precise bends**.
- **Tools:** Mallet, hammer, wooden or metal former, brake press.
- **Examples:**
 - ❖ Metal tray sides.
 - ❖ Angle edges for boxes.
 - ❖ Curved panels for ducts or roofs.

G) Forming / Pressing

- **Definition:** Producing **complex shapes** using **mechanical or hydraulic press**.
- **Methods:**
 - ❖ Pressing with **dies and molds**.
 - ❖ Stretch forming for curved panels.

- **Examples:**
 - ❖ Car body panels.
 - ❖ Cylindrical cans or drums.
 - ❖ Decorative metal wall panels.

H) Joining Processes in Sheet Metal

- **Riveting** → sheets joined permanently.
- **Screws / bolts** → temporary or semi-permanent.
- **Seam Welding** → continuous welded seam for cylindrical sheets.
- **Folding / Crimping** → interlocked edges.
- **Examples:**
 - ❖ Cylindrical tanks → seam welded.
 - ❖ Toolboxes → riveted or screwed.
 - ❖ Roof sheets → overlapped and riveted.

4.2.2 Tools and Equipment for Sheet Metal Processes

Common Tools:

Process	Tools/Equipment	Examples
Edge Treatment	File, grinder, bevelling tool	Tray edges, sheet corners
Hollowing	Mallet, stake, dolly	Metal bowl, sink tray
Sinking	Sinking block, hammer, mallet	Shallow pan, funnel
Raising	Raising stake, hammer, mallet	Domed lid, metal cup
Cutting	Tin snips, shears, hacksaw	Roof sheet, panel, strip
Bending	Brake press, hammer	Tray sides, sheet angles
Forming	Hydraulic press, die	Car panel, drum, decorative wall
Joining	Rivet gun, welding machine, screws	Toolbox, roof sheet, cylindrical tank

4.2.3 Performing Sheet Metal Processes in the Workshop

Example Project: Fabricating a small metal tray

Steps:

1. **Select Sheet Metal:** Mild steel, 1-2 mm thickness.
2. **Mark Dimensions:** Use steel rule, scribe, dot punch.
3. **Cut Sheet:** Using tin snips or shears.
4. **Edge Treatment:** File edges to remove burrs.
5. **Bend Sides:** Use brake press or hammer over former.
6. **Hollow / Sink Tray Base:** Shape base using mallet and sinking block.
7. **Raise Edges:** Form slight convex for strength.
8. **Join if Needed:** Rivet or fold overlapping edges.
9. **Finish:** Smooth surfaces, polish, paint, or apply anti-rust coating.
10. **Safety:** Wear gloves, goggles, apron. Keep work area clean.

Other Workshop Examples:

- Making a **small metal box** → edge treatment + bending + riveting.
- Fabricating **funnel** → cutting + sinking + raising.
- Roof sheet assembly → cutting + bending + seam joining.
- Decorative wall panel → forming + raising + edge finishing.
- Cylindrical drum → cutting + rolling + seam welding.

4.2.4 Importance of Sheet Metal Processes in Daily Life

- Provides **functional objects:** trays, bins, boxes, tanks.
- Enables **industrial and domestic fabrication.**
- Enhances **safety and aesthetics.**
- Reduces **waste** by accurate shaping and joining.

Examples in Daily Life:

1. Kitchen trays → hollowed and raised.
2. Metal bins → edge treatment + joining.
3. Funnels → sinking and raising.
4. Water tanks → seam welding + forming.
5. Roof sheets → cutting + bending + lap joining.
6. Electrical panels → bending + riveting.
7. Toolboxes → edge treatment + folding + joining.
8. Cylindrical drums → rolling + seam welding.
9. Decorative lamps → forming + raising.
10. Workshop shelves → cutting + bending + joining.

4.2.5 Safety Measures in Sheet Metal Processes

- Wear **PPE**: gloves, goggles, apron, closed shoes.
- Keep work area **clean and free from obstacles**.
- Handle sheets **carefully to avoid cuts**.
- Use clamps or vices to **secure sheets before hammering**.
- Avoid touching **hot surfaces** after welding or pressing.

Examples:

- Gloves when filing edges.
- Goggles during cutting or hammering.
- Clamps when bending sheets over brake press.

4.2.6 Summary Table of Sheet Metal Processes

Process	Definition	Tools	Examples / Objects
Edge Treatment	Smooth / bevel edges	File, grinder	Tray, toolbox, roof sheet
Hollowing	Make concave shapes	Mallet, stake	Bowl, basin, sink tray
Sinking	Shallow concave	Hammer, sinking block	Tray, funnel, lid
Raising	Make convex shapes	Mallet, raising stake	Bowl, domed lid, metal cup
Cutting	Reduce sheet to size	Snips, shears, hacksaw	Roof sheet, panel, strip
Bending	Make angles / curves	Brake press, hammer	Tray sides, sheet angles
Forming	Complex shapes	Hydraulic press, die	Drum, car panel, decorative wall
Joining	Riveting, screwing, welding	Rivet gun, screws, welding machine	Toolbox, roof sheet, cylinder tank

4.3 Project: Solving Community Problems Using Sheet Metal Processes

Sheet metal processes are not only **academic skills**, they can also **solve real-life problems in the community**. Projects allow learners to **apply knowledge and skills practically**, producing functional and useful items.

4.3.1 Identifying Community Problems

Step 1: Observe the Community

- Look for **needs, challenges, or gaps** in the local environment.
- Focus on problems that can be **solved using metal objects**.

Common Problems:

1. Lack of proper **waste disposal bins**.
2. Unsafe **storage for water or food**.
3. **Weak or damaged gates and fences**.
4. Absence of **metal shelves** for storage in shops or homes.

5. Unsafe **cooking or charcoal stoves**.
6. Poor **ventilation covers** for schools or workshops.
7. Missing or broken **drainage funnels**.
8. Lack of **metal benches for schools or churches**.
9. Insufficient **toolboxes or containers** in local workshops.
10. Broken or missing **metal roofs or shed covers**.

Activity:

- Brainstorm in class **5–10 problems** that could be solved using sheet metal.

4.3.2 Suggesting Items to Solve Identified Problems

Step 2: Brainstorm Possible Solutions

Problem → Possible Sheet Metal Item:

Problem	Suggested Item	Process Required
Lack of dustbins	Metal waste bin	Cutting, bending, folding, edge treatment
Unsafe water storage	Cylindrical water tank	Cutting, rolling, seam welding
Weak gates	Small metal gate	Cutting, bending, welding
No shelves	Metal storage rack	Cutting, bending, riveting
Unsafe stove	Metal charcoal stove	Cutting, bending, edge treatment
Poor drainage	Funnel or gutter	Sinking, bending, joining
Broken toolbox	Sheet metal toolbox	Cutting, bending, riveting
Missing school benches	Sheet metal bench	Cutting, bending, joining
Missing ventilation cover	Sheet metal vent cover	Cutting, bending, riveting
Decorative items	Metal lamp shade	Sinking, raising, edge treatment

Tips:

- Always select items that can use **locally available materials**.
- Consider **cost, durability, and practicality**.

- Discuss **classroom or community feasibility**.

4.3.3 Selecting Materials and Tools

Step 3: Identify Materials and Tools

Materials:

- Mild steel sheets (1-2 mm thick)
- Aluminum sheets (for lightweight projects)
- Steel rods (for structural support)
- Rivets, screws, nuts, and bolts

Tools and Equipment:

Process	Tools/Equipment	Examples of Use
Cutting	Tin snips, shears, hacksaw	Cut sheets for bins, trays
Bending	Brake press, mallet, hammer	Form sides of bins, gates
Folding	Hammer, folding former	Fold tray edges or toolbox edges
Hollowing / Sinking	Mallet, dolly, stake	Bowl, funnel, lamp shade
Raising	Raising stake, mallet	Dome lid, cup or container
Joining	Rivet gun, screws, welding machine	Toolbox, gate, vent cover
Edge treatment	File, grinder, bevelling tool	Smooth tray edges, bins

Example: For a metal waste bin:

- Tools: Tin snips, mallet, hammer, file, rivet gun.
- Materials: Mild steel sheet, rivets.
- Processes: Cutting → Edge treatment → Folding → Bending → Joining → Finishing.

4.3.4 Fabricating the Item in the Workshop

Step 4: Plan and Execute Project

Example Project: Metal Waste Bin

Steps:

1. **Design:** Sketch the bin, mark dimensions on sheet.
2. **Mark & Measure:** Use steel rule, scribe, dot punch.
3. **Cut:** Using shears or tin snips.
4. **Edge Treatment:** Smooth edges with file or grinder.
5. **Bend / Fold Sides:** Use mallet and former.
6. **Join Sides:** Rivet or screw edges.
7. **Base Attachment:** Rivet or fold base into bin.
8. **Finish:** Polish, paint, or coat to prevent rust.
9. **Check:** Ensure bin is sturdy and edges are safe.

Other Workshop Examples:

- **Water Funnel:** Cutting → Sinking → Edge treatment → Joining.
- **Toolbox:** Cutting → Folding → Riveting → Finishing.
- **Roof Vent Cover:** Cutting → Bending → Riveting → Edge treatment.
- **Charcoal Stove:** Cutting → Bending → Edge finishing → Joining.
- **Storage Rack:** Cutting → Bending → Welding → Finishing.

Tips:

- Work in **small teams** for large projects.
- Always follow **safety protocols:** gloves, goggles, apron.
- Reuse **scrap metal** for small parts.

4.3.5 Importance of Sheet Metal Projects in Community

- **Problem-solving:** Provides practical solutions to local needs.
- **Skill application:** Learners apply **knowledge of sheet metal processes.**
- **Creativity and innovation:** Encourages designing unique solutions.
- **Economic value:** Items can be sold or used, promoting **entrepreneurship.**
- **Safety improvement:** Properly fabricated items reduce **injury or damage.**
- **Examples in Community:**

1. Waste bins in schools or streets.
2. Metal water tanks in households.
3. Ventilation covers in schools or workshops.
4. Charcoal stoves for households.
5. Toolboxes for mechanics.
6. Gates and fences for security.
7. Trays, funnels, and small containers.
8. Decorative items like metal lamp shades.
9. Shelves for shops or classrooms.
10. Metal benches for public areas.

4.3.6 Examples of Possible Projects

Community Problem	Sheet Metal Solution	Processes Involved
Lack of dustbins	Waste bin	Cutting, bending, folding, riveting
Unsafe water storage	Cylindrical water tank	Cutting, rolling, seam welding
Broken school benches	Metal bench	Cutting, bending, joining
No kitchen stoves	Charcoal stove	Cutting, bending, folding
Weak home gates	Metal gate	Cutting, bending, welding
Overflowing water	Metal funnel	Cutting, sinking, edge treatment
Disorganized tools	Toolbox	Cutting, folding, riveting
Missing ventilators	Vent cover	Cutting, bending, riveting
Need for storage	Shelf rack	Cutting, bending, welding
Decorative needs	Lamp shade	Hollowing, raising, edge finishing

Extra Creative Examples:

- Metal bird feeder → cutting + folding + joining.
- Metal letterbox → edge treatment + bending + riveting.

- Small drum or container → rolling + seam welding.
- Mini water trough → sinking + raising + edge finishing.
- Metal planter → bending + folding + joining.

4.3.7 Presentation of Fabricated Item

- **Step 1:** Clean and polish finished item.
- **Step 2:** Prepare **demonstration board or poster** showing:
 - ❖ Problem identified.
 - ❖ Processes used.
 - ❖ Tools and materials.
 - ❖ Final product.
- **Step 3:** Display in class for **peer review**.
- **Step 4:** Discuss **improvements, alternative designs, and practical use**.

4.3.8 Safety Considerations During Project Fabrication

- Wear **PPE at all times:** gloves, goggles, apron, closed shoes.
- Clamp or secure sheets before cutting, hammering, or folding.
- Keep workshop area **clean and organized**.
- Avoid touching **hot sheets after welding or pressing**.
- Handle sharp edges carefully.
- Dispose of scrap metal safely.

Examples:

- Gloves when filing edges of toolbox.
- Goggles while shearing metal sheets.
- Apron when hammering tray or bin edges.
- Clamp sheets before drilling holes.

Key Takeaways:

- Sheet metal projects **solve real-life community problems.**
- Projects apply **skills in cutting, bending, folding, joining, and finishing.**
- Learners learn **planning, measuring, tool selection, and safety practices.**
- Products have **practical, economic, and aesthetic value.**
- Examples include **bins, funnels, toolboxes, gates, stoves, shelves, benches, tanks, and decorative items.**