

SECTION

3

**TIMBER, SAFETY,
PROFESSIONALS,
ILLEGAL
CONNECTION
OF ELECTRICITY,
AND TOOLS &
EQUIPMENT**



UNIT 1

WOODWORK TECHNOLOGY

Material and Artefacts Production Woodwork Industry in Ghana

INTRODUCTION

Timber goes through important steps in the woodwork industry to become the products we use daily. These phases are crucial for ensuring good quality and long-lasting wood. Understanding these steps helps us appreciate the work behind wooden items and ensures we use wood sustainably. Let us explore these phases to see how wood becomes useful in our lives.

At the end of this unit, you will be able to:

Outline the processing phases of timber in the woodwork industry

Key Ideas

- In the woodwork industry, timber goes through key phases: harvesting, sawing, seasoning, planing, treating, grading, and distribution.
- Trees are cut down and turned into boards at sawmills. The boards are dried to remove moisture, planed for a smooth surface, treated for protection, graded by quality, and then distributed to woodwork shops and construction sites. This process transforms trees into useful wood products.

PROCESSING PHASES OF TIMBER

Timber processing includes several critical phases that transform trees into usable lumber for various applications like furniture and construction. These phases encompass activities from initial tree identification in the forest to the final product in the market.

Here is an outline of the primary processing phases of timber:

Primary Processing Phase

1. Identification of Tree and Physical Inspection

This initial step involves identifying suitable trees for harvesting based on species, size, and quality criteria. Physical inspection ensures that the trees meet industry standards for timber production.

2. Harvesting: Felling of the Trees

Once identified and inspected, trees are carefully felled and prepared for transportation to the processing facility.

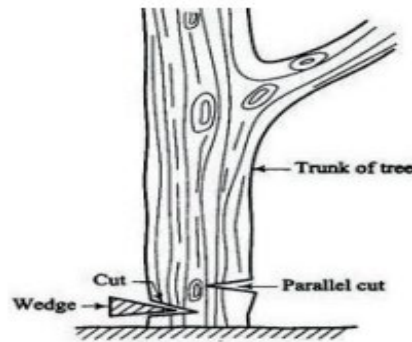


Fig. 3.1.1: Felling of a tree

3. Freight: Transportation to the Industry

After harvesting, the bulk logs are transported from the forest to the processing industry. This can be done via surface transport (trucks, railways) or sea/ocean transport, depending on the location and logistics.



Fig. 3.1.2: Truck loaded with processed timber for transport

4. Log Sorting

Upon arrival at the log yard, the logs undergo sorting. This critical process involves categorising logs based on various parameters:

- a. *Size:* Including top and bottom diameter, length, tapering, bend, ovality, and volume.

- b. *Quality*: Determined by visual inspection or automated systems to segregate logs suitable for different grades of lumber.



Fig.3.1.3: Log yard

5. Debarking

Debarking is the process of removing bark from log.



Fig.3.1.4: Process of debarking

Activity 3.1.1

Scenario:

You are part of a team of environmental engineers working for a sustainable woodwork company. Your company has been tasked with developing an educational video presentation for a community outreach programme. The video needs to explain the three phases of timber processing in a way that is engaging and easy to understand for high school learners.

Materials Needed:

- Digital devices (computers, tablets, or smartphones)
- Internet access for research
- Video editing software
- Access to a local woodwork shop or virtual tour resources
- Collaboration tools (Google Docs, Zoom, etc.)

Activity guidelines:

1. You will be in a group of 5 classmates. Each group will take on the role of the environmental engineer.
2. Your group will:
 - a. Use digital devices to research the three phases of timber processing.
 - b. Gather information on sustainable practices within each phase and note key points for presentation.
 - c. Utilise online resources, e-books, and videos to collect accurate and comprehensive information.
3. Within the group:
 - a. Discuss the importance and challenges of each timber processing phase.
 - b. Evaluate how sustainable practices can be integrated into each phase and what impact this has on the environment and the industry.
 - c. Prepare a list of pros and cons for each phase of the timber processing in terms of sustainability and efficiency.
4. Your group will visit a nearby local woodwork shop. You are to obey safety ground rules and regulations from the authorities present and carry out the following or have a virtual tour of a timber processing plant and:
 - a. Observe and take notes on the real-world application of the three phases of timber processing.
 - b. Document your observations through photos, videos, or written notes to include in your final presentation.
5. Your group will:
 - a. Collaboratively create a storyboard for the educational video presentation.
 - b. Assign roles within the group such as researchers, scriptwriters, video editors, and presenters.
 - c. Use digital tools like video editing software, presentation software, and online collaboration platforms to create your video.
6. Your group will:
 - a. Present their educational video to the class.
 - b. Engage in a group discussion to provide constructive feedback, focusing on content accuracy, creativity, and presentation skills.
7. Reflect individually and as a group on the learning process by:

- a. Discuss what each member learned about timber processing, the importance of sustainable practices, and how working collaboratively enhanced their understanding.
- b. Sharing reflections through a digital platform (e.g., a class blog or discussion forum).

Secondary Processing Phase

1. Sawmill/Lumber mill

Logs sorted and deemed suitable for saw milling are processed further. This phase involves cutting the logs into rough lumber of various dimensions.



Fig.3.1.5: Wood miser operation

2. **Conversion of timber:** Is the cutting up of logs into standard marketable sizes for commercial utilisation. This involves three methods:
 - a. *Live sawing (Slab or Through and Through Sawing):* The log is sawn into planks about halfway through on the opening face and then turned once to the opposite face for sawing until the log is finished.

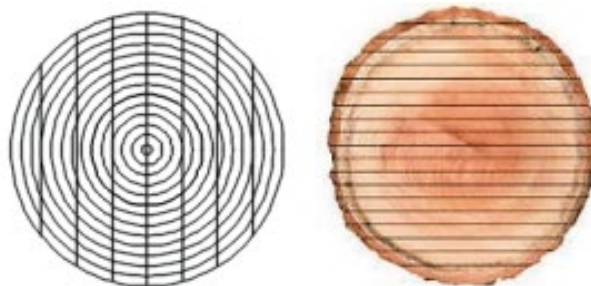


Fig.3.1.6: Live sawing method Source: Live sawing method - Search Images (bing.com)

- b. *Back sawing (Tangential Sawing)*: The log is sawn so that the width of the board is tangential to the growth rings and produce pleasant figure making suitable for cabinet work.

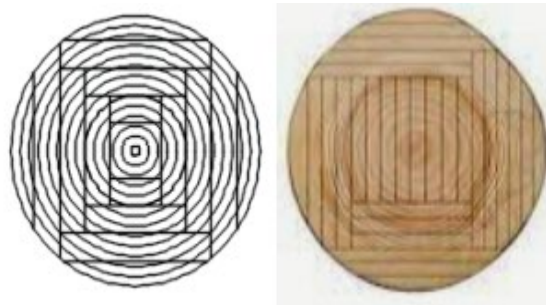


Fig 3.1.7: Tangential sawing Source: Tangential Sawing-Search Images (bing.com)

- c. *Quarter sawing (Rift/Radial)*: This method is used to convert logs into boards which have their width in the general direction of the rays. Boards which are quarter sawn show decorative medullary ray figure called silver grain.

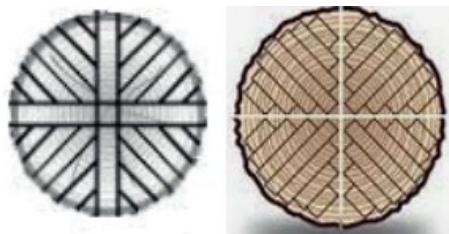


Fig.3.1.8: Quarter sawing Source: Quarter sawing - Search Images (bing.com).

Table 3.1.1: Showing advantages and disadvantages of the three conversion methods.

| Method of conversion | Advantages | Disadvantages |
|--|---|--|
| Live sawing (Slab or Through and Through Sawing) | <ul style="list-style-type: none"> • High Yield: Maximizes the amount of usable timber from each log. • Cost-Effective: Lower processing costs due to its simplicity. • Speed: Faster cutting process compared to other methods. | <ul style="list-style-type: none"> • Wood Movement: More prone to warping and cupping as it dries. • Inconsistent Grain: Produces varied grain patterns, which may be less aesthetically pleasing. |
| Back sawing (Tangential Sawing) | <ul style="list-style-type: none"> • Stable Grain: Produces boards with consistent, straight grain patterns. • Aesthetics: Attractive, uniform grain pattern desirable for many applications. | <ul style="list-style-type: none"> • Lower Yield: Less efficient use of the log, resulting in more waste. • Higher Cost: More expensive due to lower yield and increased processing time. |

| | | |
|------------------------------|---|--|
| Quarter sawing (Rift/Radial) | <ul style="list-style-type: none"> • Dimensional Stability: Less prone to warping, shrinking, and swelling. • Aesthetic Appeal: Produces attractive grain patterns, such as ray flecks in species like oak. • Durability: More structurally sound due to the uniform grain. | <ul style="list-style-type: none"> • Complex Process: More labour-intensive and time-consuming. • Lower Yield: Results in more waste, reducing the amount of usable timber. • Higher Cost: Increased production costs due to labour and reduced yield. |
|------------------------------|---|--|

Standard Marketable Sizes of Timber

The following terms are used to describe and identify the various marketable sizes of timber: baulk, half-timber, flitch, plank, deal, and batten. board, scantling strips (laths or fillets), square (quartering) and waney-edge. These marketable sizes of timber are briefly explained below:

1. **Baulk** is a large, roughly squared timber usually used for heavy construction (beams, columns).
2. **Half-timber** is a timber cut lengthwise, often half a log. It is used for timber-framed buildings.
3. **Flitch** is a thick slab of timber, often with bark used for veneers, and structural applications.
4. **Plank** is a Long, flat piece of timber, thicker than a board used for flooring, decking, and general construction.
5. **Deal** is a Softwood plank (pine or fir) with specific dimensions used for framing, flooring, and general carpentry.
6. **Batten** is a narrow strip of timber used for roofing, cladding, and framework.
7. **Board** is a thin piece of timber, usually less than 1-inch-thick normally used for furniture, shelving, and panelling.
8. **Scantling** is a small timber piece with set dimensions used for framing, studding, and structural applications.
9. **Strips (Laths or Fillets)** a thin, narrow timber pieces usually used for plaster base, roofing support, and trim.
10. **Square (Quartering)** is a timber with a square cross-section used for frames and structural supports.
11. **Waney-Edge** is a Timber with natural, untrimmed edges usually used for rustic furniture and decorative panelling.

Seasoning of Timber

Seasoning of timber is the drying-out of the excess moisture from wood so that the timber is ready for work.

There are two methods of seasoning timber. These are the Natural method and the Artificial (Accelerated) method - (kiln seasoning).

1. **Natural method - (air season):** The timber is stacked in the open air, where it is dried by the prevailing weather conditions.

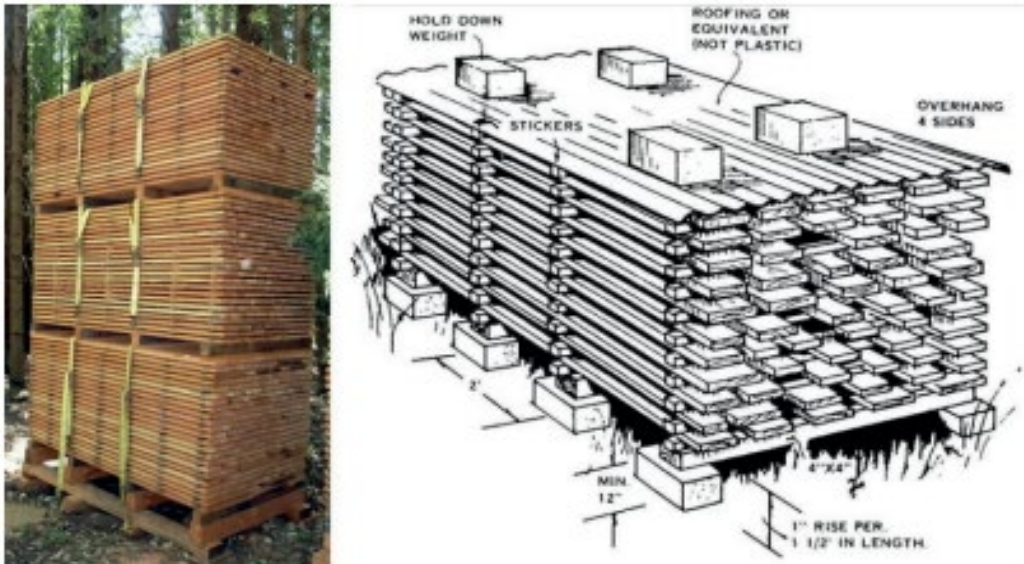


Fig.3.1.9: Timber air drying method.

2. **Artificial (accelerated) method – kiln seasoning:** The timber is stacked for air drying, and placed in an oven called a kiln, where the temperature, humidity and air circulation are accurately controlled.

Types of seasoning Kiln

- a. **Compartment kilns:** The conditions at any time are the same throughout the kiln.

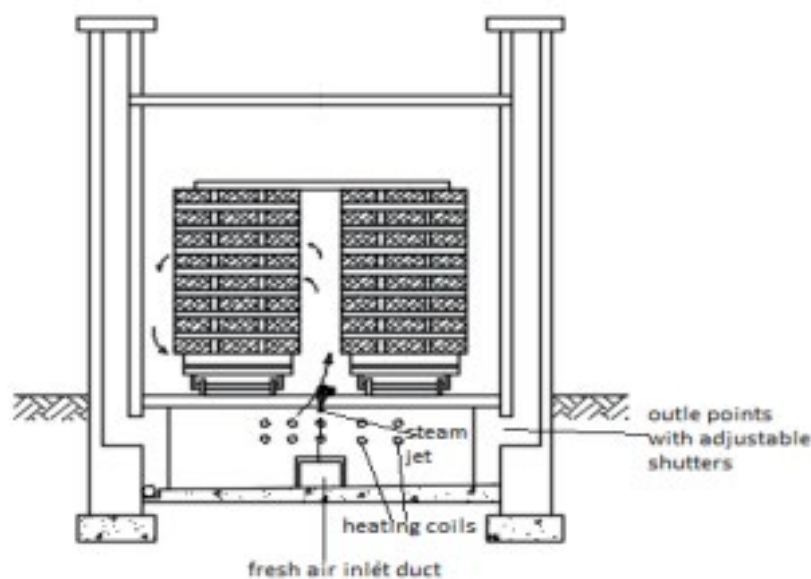


Fig.3.1.10: Compartment/Natural draught kiln

- b. **Progressive kiln:** In this type of kiln, the conditions at one end of the kiln differ from those at the other end.

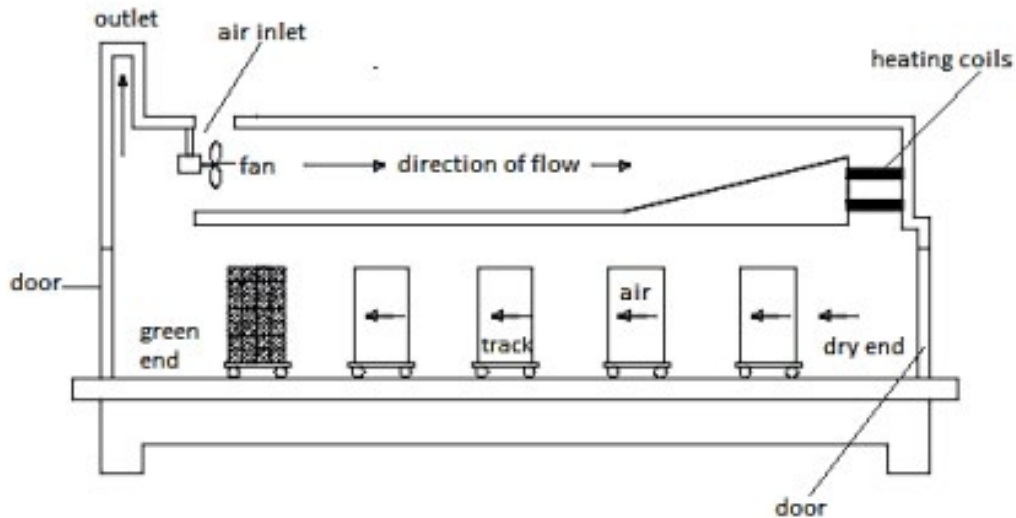


Fig.3.1.11: Progressive kiln. Source: Progressive kiln

Methods of Calculating Percentage Moisture Content (% Mc)

Calculating the percentage of moisture content is crucial in the wood industry. Two common methods used for this purpose are the oven-dry method and the moisture meter method.

1. Oven Dry Method

The oven-dry method is a standard laboratory procedure known for its accuracy. Here is how it works:

Procedure:

- Sample Collection:** Collect a representative sample of the material whose moisture content you want to measure.
- Initial Weighing:** Weigh the sample using a precise balance to obtain the initial weight (W1).
- Drying:** Place the sample in an oven set at a specific temperature (usually around 105°C for most materials) and dry it for a predetermined period (24 hours is common for many materials, but this can vary).
- Cooling:** After drying, remove the sample from the oven and place it in a desiccator to cool to room temperature. This prevents the sample from absorbing moisture from the air.
- Final Weighing:** Weigh the cooled, dried sample to get the final weight (W2). The percentage of moisture content (MC) is calculated using the following formula:

$$MC = \left(\frac{W1 - W2}{W1} \right) \times 100$$

Where: W1 = Initial weight of the sample before drying.

W2 = Final weight of the sample after drying.

Sample Question:

You have a sample of wood that initially weighed 500 grams. After drying the sample in an oven at 105°C for 24 hours, the final weight of the wood is 350 grams. Using the Formula:

$MC = \left(\frac{W1 - W2}{W1} \right) \times 100$, calculate the percentage of moisture content in the wood:

Substitute the given values into the formula to find the moisture content:

- Initial weight (W1): 500 grams
- Final weight (W2): 350 grams

$$MC = \left(\frac{W1 - W2}{W1} \right) \times 100$$

$$MC = \left(\frac{500 - 350}{500} \right) \times 100$$

$$MC = \left(\frac{150}{500} \right) \times 100$$

$$MC = (0.3) \times 100$$

MC = 30%. Thus, the moisture content of the wood sample is 30%.

2. Moisture Meter Method

The moisture meter method is quicker and more convenient, particularly for in-field measurements. There are various types of moisture meters, including pin-type and pinless meters. Here's a general overview of how they work

Procedure:

- Sample Preparation:** Ensure the sample surface is clean and free of any material that might affect the reading.
- Meter Calibration:** Calibrate the moisture meter according to the manufacturer's instructions, ensuring it is set for the specific material type.
- Measurement:** Pin-type meter: Insert the meter's pins into the material. The meter measures the electrical resistance between the pins, which varies with moisture content.
- Pinless meter:** Place the meter on the material's surface. It uses electromagnetic waves to measure moisture content.
- Reading:** The meter directly provides the moisture content reading as a percentage.

Table 3.1.2: Showing Methods of Seasoning; Advantages and Disadvantages

| Method of Seasoning | Advantages | Disadvantages |
|---------------------|--|--|
| Oven Dry Method | <ul style="list-style-type: none"> High accuracy Standardised method used in scientific research and industrial applications | <ul style="list-style-type: none"> Time-consuming Requires access to an oven and precise balance Not suitable for in-field measurements |

| | | |
|-----------------------|--|---|
| Moisture Meter Method | <ul style="list-style-type: none"> • Quick and easy to use • Portable and convenient for field measurements • Immediate results | <ul style="list-style-type: none"> • Less accurate compared to the oven dry method • Requires regular calibration and maintenance • Readings can be affected by material density, temperature, and other factors |
|-----------------------|--|---|

Properties of Timber

1. **Surface quality of timber:** The surface quality of timber depends on the visible nature and arrangement of the wood elements such as fibres and vessels, which are characteristic of each species of timber (e.g. straight grains, diagonal grains).
2. **Working qualities:** This refers to the ease or difficulty of sawing chiselling, curving, shaping, bending, turning, gluing and nailing.
3. **Mechanical properties:** These include; tensile strength, compressive strength, shearing strength, bending strength, stiffness, toughness, elasticity, hardness, and durability.

Defects in Timber

A defect in timber is any irregularity appearing in or on the wood which may cause it to be less strong and durable when used for construction work.

1. **Natural and artificial defects:** These include knots, shakes, surface splits, checks, warp (bow, cup, spring, twist), casehardening, honeycombing, collapse, wet rot and dry rot.
2. **Insect attack:** When insects attack and destroy the usefulness of timber, the insects are declared pests, and the damage is described as a defect. The two insect groups which cause the most damage to timber are termites and beetles.

Wood preservation

In general, existing wood preservatives may be divided into three, *Tar-oil*, *Water-Borne* and *Organic solvent*.

Methods of application: These include the pressure method/treatment and the non-pressure method/ treatment

Activity 3.1.2

Using the sample question example above on page xxx, solve the following problems:

- a. A wood sample initially weighs 750 grams. After drying in an oven, the final weight is 525 grams. What is the moisture content of the wood?
- b. A sample of wood weighs 1200 grams before drying and 900 grams after drying. Calculate the moisture content.

- c. The initial weight of a wood sample is 1000 grams. After drying, the weight reduces to 800 grams. What is the moisture content?
- d. A piece of wood has an initial weight of 600 grams. After oven drying, its weight is 480 grams. What is the moisture content?
- e. Before drying, a wood sample weighs 900 grams. After drying, it weighs 675 grams. Determine the moisture content.

Activity 3.1.3

Scenario:

Your team works for an architectural firm specialising in sustainable design. The firm is preparing a new project that highlights the aesthetic and functional properties of timber. You need to present a proposal that demonstrates which method of timber conversion best enhances the timber's figure, using sketches and digital tools for a professional presentation.

Materials Needed:

- Digital devices (computers, tablets, or smartphones)
- Internet access for research
- Digital drawing tools or sketching materials
- Access to a sawmill or woodworking workshop or virtual tour resources
- Presentation tools (PowerPoint, Google Slides, etc.)
- Collaboration tools (Google Docs, Zoom, etc.)

Activity guidelines:

You will be part of a group of 5 classmates acting as a team of architects.

1. Your group will:

- a. Research the different methods of timber conversion: plain sawing, quarter sawing, and rift sawing.
- b. Use digital resources such as online articles, e-books, and instructional videos to understand the techniques and outcomes of each method.
- c. Gather information on how each method affects the timber's figure and structural properties.

2. Within the group:

- a. Discuss the advantages and disadvantages of each conversion method in terms of aesthetics and functionality.
- b. Evaluate which method brings out the best figure in the timber and why.
- c. Consider factors such as grain patterns, wood stability, and potential uses in architectural design.

3. **Your group will** visit a nearby sawmill or woodworking workshop. You are to obey safety ground rules and regulations from the authorities present and carry out the following:
 - a. Observe timber conversion methods in action.
 - b. Engage with professionals to gain insights into the practical aspects of each conversion method.
 - c. Document the experience through sketches, photos, or videos.
4. **Your group will:**
 - a. Collaboratively create detailed sketches of timber sections resulting from each conversion method.
 - b. Use digital drawing tools or traditional sketching methods to illustrate the grain patterns and figures of the timber.
 - c. Prepare a digital presentation that includes your sketches, research findings, and insights from your experiential learning.
5. Your group will present their findings and sketches to cover the following:
 - a. Explanation of each timber conversion method
 - b. Comparison of the figures produced by each method
 - c. Group's recommendation on which method brings out the best figure and why.
 - d. Engage in a class discussion to provide constructive feedback and share additional insights.
6. Reflect individually and as a group on the learning process by:
 - a. Discussing what each member learned about timber conversion methods, the importance of the timber figure, and how collaborative work contributed to their understanding.
 - b. Sharing reflections through a digital platform (e.g., a class blog or discussion forum).

Tertiary Processing Phase

Normally, these technological properties - surface quality, working qualities, mechanical properties, defects and preservation methods, staining or finishing - come in the tertiary processing phase because they are considerations which need to be considered when, for example, selecting timber to make artefacts.

These tertiary processes phase include:

1. Artefact production: such as furniture, joinery, cabinet making, mould builders.
2. Finishes and finishing

3. Quality control
4. Packaging and shipping

Activity 3.1.4

Scenario:

You are part of a team of construction consultants working for a company specialising in sustainable building practices. The company is preparing a workshop for new employees to explain the importance of seasoning timber before use in construction projects. Your team needs to develop an interactive presentation that demonstrates why seasoning is necessary and how it impacts the quality and durability of timber.

Materials Needed:

- Digital devices (computers, tablets, or smartphones)
- Internet access for research
- Presentation tools (PowerPoint, Google Slides, Prezi, etc.)
- Access to a timber yard or construction site or virtual tour resources
- Collaboration tools (Google Docs, Zoom, etc.)

Activity guidelines:

1. You will be part of a group of 5 classmates. Each group will act as a team of construction consultants.
2. Your group will research the following:
 - a. The process of timber seasoning, including methods such as air seasoning and kiln seasoning.
 - b. Use digital resources such as online articles, e-books, and instructional videos to gather information on the benefits and challenges of seasoning timber.
 - c. Identify key points about the necessity of seasoning, including moisture content reduction, prevention of warping and splitting, and improvement of structural integrity.
3. Your group will discuss the reasons why seasoning timber is crucial for construction projects by:
 - a. Evaluating the differences between seasoned and unseasoned timber in terms of durability, stability, and suitability for various applications.
 - b. Developing a list of scenarios where unseasoned timber might cause problems and how seasoning can prevent these issues.
4. a. Your group will visit a nearby timber yard or construction site to observe seasoned and unseasoned timber in use. Obey safety ground rules and regulations from authorities as they take you around.

- b. Engage with professionals to gain insights into the practical benefits of seasoning timber.
 - c. Document the experience through photos, videos, or written notes to include in your final presentation.
5. Your group will:
 - a. Collaboratively create an interactive presentation that explains why seasoning timber is necessary.
 - b. Use digital tools like PowerPoint or Google Slides, to design your presentation.
 - c. Include visual aids such as diagrams, photos, and videos from your research and site visits.
 - d. Develop interactive elements like quizzes or discussion prompts to engage the workshop audience.
6. Your group will present their findings and interactive presentation to cover the following:
 - a. Explanation of the seasoning process
 - b. Importance of reducing moisture content in timber
 - c. Benefits of seasoned timber for construction projects
 - d. Real-life examples and scenarios observed.
 - e. After each presentation, engage in a class discussion to provide constructive feedback and share additional insights.
7. Reflect individually and as a group on the learning process by:
 - a. Discussing what each member learned about the necessity of seasoning timber, the impact on construction quality, and how collaborative work contributed to their understanding.
 - b. Sharing reflections through a digital platform (e.g., a class blog or discussion forum).

Conclusion

The processing phases of timber, from harvesting to finished product, involve several critical steps. Initially, trees are felled and transported to sawmills where they are debarked and sawn into various sizes. Next, the timber undergoes seasoning, either by air-drying or kiln-drying, to reduce moisture content and enhance stability. Following this, the wood is graded and sorted based on quality and intended use. Finally, the timber is treated to protect against pests and decay, and then it may be planed, cut, and finished to meet specific requirements for construction, furniture-making, and other applications. These phases ensure the timber is durable, functional, and suitable for a wide range of uses.

Review Questions

1. Imagine you are overseeing a woodworking project and need to ensure efficiency. You have just received a fresh batch of timber. How would you strategically navigate through the three essential processing phases of timber in the woodwork industry to maximize quality and output?
2. How would you explain the concept of 'conversion' in timber to a new team member who's unfamiliar with woodworking terminology?
3. Imagine you need to explain the natural method of seasoning timber to a new apprentice. How would you describe the process, and what sketches would you use to illustrate each step?
4. You are leading a training session for new employees at a woodworking shop. How would you differentiate between the three phases of timber processing in the woodwork industry to ensure they understand the distinct tasks and goals of each phase?
5. What are the key activities involved in the preparation phase of timber processing, and how do these activities ensure the timber is ready for subsequent phases?
6. During the machining phase, what types of machinery and techniques are typically used to shape and size the timber, and why is precision important in this phase?
7. In the finishing phase of timber processing, what methods are employed to enhance the timber's appearance and durability, and how do these methods contribute to the overall quality of the final product?

Answers to Review Questions

1. To effectively manage the timber processing phases in woodworking, I would approach it systematically:
 - *Preparation Phase:* First, I would inspect the incoming timber for quality and dimensions, ensuring it meets project specifications. Then, I would organise the timber based on type and size, readying it for the next steps.
 - *Machining Phase:* Here, I'd use appropriate machinery to cut, plane, and shape the timber into required components. Precision is key to achieving accurate dimensions and smooth finishes, so I'd monitor the machines closely to maintain quality.
 - Once machined, I'd focus on enhancing the timber's appearance and durability. This involves sanding to smooth surfaces, applying stains or finishes as per design requirements, and inspecting each piece to ensure it meets quality standards before final assembly or delivery.
2. When we talk about 'conversion' in the context of timber, we're referring to the process of transforming raw logs into usable wood products. This includes steps like sawing the logs into boards or planks of different sizes and shapes that can be further processed or used directly in construction or woodworking projects. It's essentially the initial stage where timber is cut and shaped to begin its journey from raw material to finished product.
3. To explain the natural method of seasoning timber to a new apprentice, I would describe the process as follows:
 - *Staging the Timber:* Start by stacking the timber logs in a well-ventilated area. Ensure the logs are elevated off the ground using wooden or metal supports to allow air circulation underneath. Sketch: A side view of timber logs stacked on supports with arrows indicating airflow underneath.
 - *Stacking Technique:* Arrange the timber in a crisscross pattern, with spacers or stickers between each layer to maintain consistent airflow throughout the stack. This helps in even drying and reduces the risk of warping. Sketch: A front view of the stacked timber showing the crisscross pattern and spacers between layers.
 - *Protection from Elements:* Cover the top of the stack with a waterproof material to protect it from rain while leaving the sides open to ensure good ventilation. This prevents the timber from getting wet while still allowing it to dry naturally. Sketch: An illustration showing the stack covered with a tarp or similar material on top, with open sides for airflow.
 - *Monitoring the Seasoning:* Over time, regularly check the timber for moisture content and signs of drying. Natural seasoning can take several months to a few years, depending on the type of wood and environmental conditions. Sketch: A

timeline or series of images showing the timber stack over different stages of the seasoning process, indicating changes in moisture content.

4. To help new employees understand the distinct tasks and goals of the three phases of timber processing in the woodworking industry, I would explain as follows:

Preparation Phase:

- Tasks: Inspect and sort the incoming timber for quality and dimensions. Remove any debris and mark the timber for cutting.
- Goals: Ensure that only high-quality timber moves forward in the process and that the timber is organised and ready for machining.
- Example: “In this phase, you will check each piece of timber for defects like knots or cracks and sort them by size. It is like preparing ingredients before cooking a meal.”

Machining Phase:

- Tasks: Cut, plane, and shape the timber using various woodworking machines such as saws, planers, and routers.
- Goals: Achieve precise dimensions and smooth surfaces, preparing the timber for assembly or finishing.
- Example: “Here, you’ll transform rough timber into usable components. It is like cutting and shaping dough into cookies using different cutters and tools.”

Finishing Phase:

- Tasks: Sand, stain, and apply finishes to the timber to enhance its appearance and protect it from environmental damage.
 - Goals: Provide a final product that is aesthetically pleasing and durable.
 - Example: “In the finishing phase, you’ll make the wood look beautiful and last longer. It is like icing and decorating a cake after it’s been baked.”
5. The key activities in the preparation phase include inspecting the incoming timber for defects, sorting it by size and quality, and marking it for cutting. Additionally, the timber is cleaned to remove any dirt or debris. These steps are crucial because they ensure that only high-quality timber moves forward in the process, minimising waste and defects in the final product.
 6. In the machining phase, various types of machinery are used, including saws, planers, and routers. Techniques such as cutting, planing, and shaping are employed to transform the raw timber into specific dimensions and forms required for the final product. Precision is vital in this phase to ensure that the components fit together correctly during assembly and that the final product meets the desired specifications and quality standards.
 7. The finishing phase involves methods such as sanding, staining, and applying protective finishes like varnish or paint. Sanding smooths the timber surfaces; while staining and finishes enhance the wood’s natural beauty and provide protection against moisture, insects, and wear. These methods contribute to the overall quality

of the final product by ensuring it is aesthetically pleasing, durable, and suitable for its intended use.

ANNEX 3.1.1: POSSIBLE RESPONSES TO SOME ACTIVITIES

ACTIVITY 3.1.2

- a. 30%
- b. 25%
- c. 20%
- d. 20%
- e. 25%

ACTIVITY 3.1.4

Research:

- Investigate timber seasoning processes, including air seasoning and kiln seasoning.
- Use digital resources like online articles, e-books, and videos to gather information on the benefits and challenges of seasoning timber.
- Identify key points such as moisture content reduction, prevention of warping and splitting, and improvement of structural integrity.

Discussion:

- Evaluate the differences between seasoned and unseasoned timber in terms of durability, stability, and suitability.
- Develop a list of scenarios where unseasoned timber might cause problems and how seasoning can prevent these issues.

Site Visit:

- Visit a nearby timber yard or construction site to observe seasoned and unseasoned timber.
- Engage with professionals to gain insights into the practical benefits of seasoning timber.
- Document the experience with photos, videos, or written notes for the presentation.

Presentation Creation:

- Collaboratively create an interactive presentation explaining the necessity of seasoning timber.
- Use digital tools like PowerPoint or Google Slides.
- Include visual aids such as diagrams, photos, and videos from your research and site visits.
- Develop interactive elements like quizzes or discussion prompts to engage the audience.

Presentation Delivery:

Present your findings, covering:

- Explanation of the seasoning process
- Importance of reducing moisture content in timber
- Benefits of seasoned timber for construction projects
- Real-life examples and scenarios observed

Engage in a class discussion to provide constructive feedback and share additional insights.

Extended reading

- [Walton, J., \(1970\). Woodwork in Theory in and Practice \(metric edition\). Pages 201-203, 219-229.](#)
- [www.booktopia.com.au](#)
- [www.engineeringenotes.com](#)
- [www.wagnermeters.com](#)

References

1. [Rundmo, T., & Hale, A. R. \(2003\). Managers' attitudes towards safety and accident prevention. Safety science, 41\(7\), 557-574. https://doi.org/10.1016/S0925-7535\(01\)00091-1](#)
2. [Walton, J., \(1970\). Woodwork in Theory in and Practice \(metric edition\).](#)
3. [www.booktopia.com.au](#)

Glossary

Distribution: Storing and transporting processed timber to woodwork shops, construction sites, etc.

Grading: Inspecting and categorising the wood based on quality, strength, and appearance.

Harvesting: Cutting down trees from forests or plantations.

Planing: Smoothing the surface of the wood and making it a standard thickness.

Sawing: Cutting logs into boards or planks at sawmills.

Seasoning: Removing moisture from the boards to prevent warping or cracking.

Treating: Applying chemicals or coatings to protect the wood from insects, decay, and weather.

UNIT 2**AUTOMOTIVE TECHNOLOGY****Introduction to Engine Technology****INTRODUCTION**

Welcome to our study on auto workshop safety practices. Safety in the work environment must be considered a top priority if we want to protect ourselves, and the people who visit our workshop from accidents. It is therefore the responsibility of all people who visit the work area to observe specific safety rules and regulations. Having a clearer understanding of workshop safety practices can help us develop a positive attitude towards the observance and promotion of safety measures at the school workshop, service station, or any other place, like the roadside, where it becomes necessary for vehicle servicing to be carried out. It is also our responsibility to ensure the safety of our customers as we guide them to comply with all the safety rules at the workshop.

At the end of this unit, you will be able to:

Demonstrate safety measures applied to servicing, repair and maintenance of engine systems.



Fig. 3.2.1: An auto mechanic servicing an engine (Source: www.freepik.com)

Key Ideas

- Safety is an overarching theme in every industrial setting. The actions or inactions of everyone in the industry can have serious consequences on both lives and property.
- A positive attitude can have a sustainable impact on work and reduce operational costs whilst negligence and a careless attitude can reduce work output. Extreme disregard for safety measures will inevitably lead to accidents in the workplace. The work is important, but the lives involved are more important. It is therefore very important for all persons who come into direct contact with the workshop to properly secure themselves and their property by adhering to workshop safety measures and practices.

SAFETY MEASURES

Safety may refer to the state of being free from danger or an ideal condition in which work can be carried out without danger. The instructions, rules and regulations put in place to reduce the risk of accidents and injuries in the work area are referred to as *safety measures*.



Fig. 3.2.2: A safety tag

Importance of Safety in the Workshop

An accident is an undesirable or unfortunate happening that occurs unintentionally and usually results in harm, injury, damage, or loss, including possible loss of life. An injury so caused may not necessarily be confined to the person or persons directly involved; others may be affected, too. Some accidents can lead to permanent injury, disability or even death. For these reasons, rules and regulations must be strictly followed to prevent the occurrence of accidents in the workshop.

The main reason for accident prevention is to reduce the risk of accidents, to save lives, and to mitigate the risks of injury or to lessen its severity. It is also important to note that car servicing can sometimes take place outside of the workshop or garage, so it is important to apply the same safety rules anywhere any maintenance work is carried out.

Types of Safety in the Workshop

Various measures are needed in the workshop to ensure the safety of all persons, tools, machines and vehicles being serviced. These types of safety are personal safety, customer safety and general workshop safety.

Personal Safety

Personal safety in the workshop involves taking precautions to protect yourself from injuries and accidents. You need to have a full knowledge of the work area, its organization, the type and the enforcement of safety rules to reduce the occurrence of danger and the risk of an accident or accidents occurring. It is therefore very important for you to observe the following safety rules and regulations in the workshop:

1. Wear appropriate personal protective equipment such as safety glasses (or goggles), gloves, overall/overcoat, safety boots, ear plugs/earmuffs, nose mask, etc.
2. Wear good clothes with tight sleeves and trouser legs when working. Loose clothes may get caught in moving machinery and lead to accident.
3. Do not wear a ring, tie, necklace or bangle while working on a machine. These articles can get caught in machinery or be entangled
4. Do not keep sharp or angular tools in your pocket. Sharp objects can cause injuries, damage clothing, restrict movement, and pose fall hazards. Tool belts can be used to hold small tools while working.
5. Do not run in the workshop. Running in the workshop can lead to accidents, such as slips, trips, and collisions with equipment or other workers.
6. Do not have fun with others in workshop. It is important to remain focused on the work and so any act that can distract you from the work you are doing must be avoided.
7. Ensure there is adequate lighting and good ventilation to prevent build-up of exhaust fumes, dust, and strong odour from chemical substances.
8. Ensure that guards are provided, in place and correctly maintained around rotating parts of machines to prevent accidental contact.
9. Keep tools and equipment in their storage boxes or well organised in the work area for easy access and to prevent trips and falls.



Fig. 3.2.3: A tools box (Source: indiamart.com)

10. Always use the correct tool for the job: use tools and equipment for their intended purpose and by following the manufacturer's instructions. Always ensure you have obtained proper training on the safe use of tools and machines.

11. Regularly inspect your tools for damage before use. A faulty tool or machine can cause serious injury or damage to the vehicle part being serviced.
12. Use rigid support for raised vehicles. Never support a raised vehicle only on a jack or sandcrete or concrete block while working under it. The hydraulic release valve can be accidentally triggered and cause the vehicle to collapse and crush the worker under it. The blocks could be faulty, shatter or collapse, trapping you under the vehicle. It is advisable and safer to provide additional support like jack stands or axle stands to ensure personal safety



Fig. 3.2.4: Raised car supported on axle stands (Source: vehiclescene.com)

13. Pay attention to moving vehicles at the workshop. Keep vehicle access routes unobstructed. It is better to stop working and make way for passing vehicles than to be overly concentrated on the task. Remember that the workshop is a restricted area and drivers may need your assistance while moving on the premises.
14. Know the location of emergency exit points and firefighting equipment like fire extinguishers and sand bucket. You must know how to use the fire extinguisher and other equipment in fighting minor fire outbreaks.

Visit: (<https://www.ifsecglobal.com/fire-extinguishers/choose-right-type-fire-extinguisher/>) to explore more information on fire extinguishers.



Fig. 3.2.5: A fire extinguisher (Source: universalautospare.com.au)

NOTE: There are several types of fire extinguishers designed to fight different classes of fire. In the absence of a fire extinguisher, a fire bucket may be used to control minor fires. Fire buckets are inexpensive, easy to use, and require no special training or maintenance. A fire bucket may contain sand, water or a specially designed fire extinguishing agent.



Fig. 3.2.6: A fire bucket (Source: indiamart.com)

15. Practice safe lifting techniques. The right procedure for lifting heavy objects from the floor is to stand close to the object with one foot slightly ahead of the other. Squat down by bending your knees and hips while keeping your back straight. Assess the weight of the object before attempting to lift it. Step forward whilst lifting the weight and keep it close to your body when moving. Use the same approach as before when squatting down to pick up the item. Keep your back and neck straight and keep looking ahead. Slowly lower your knees until the item touches down.

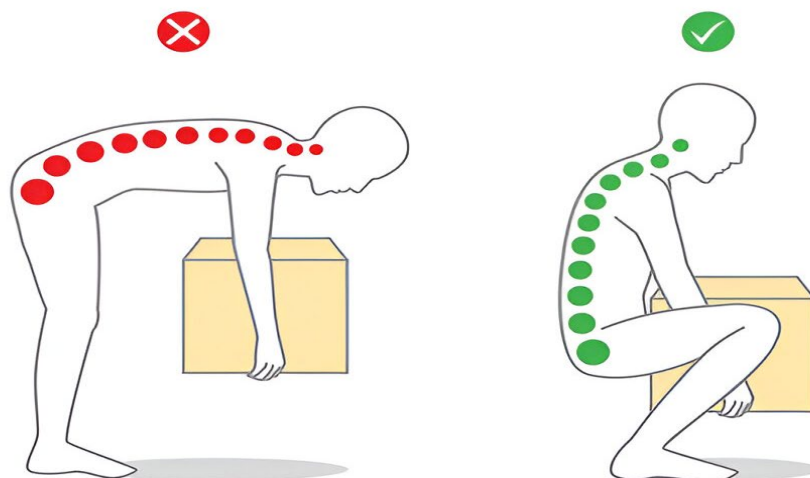


Fig. 3.2.7: Safe load-lifting technique

16. Do not use your mouth to siphon fuel (petrol, diesel, etc.). the fuel contains several harmful chemicals that can cause chemical burns and respiratory diseases when accidentally ingested. Always use a siphoning pump to transfer fuel from the fuel tank into another container.

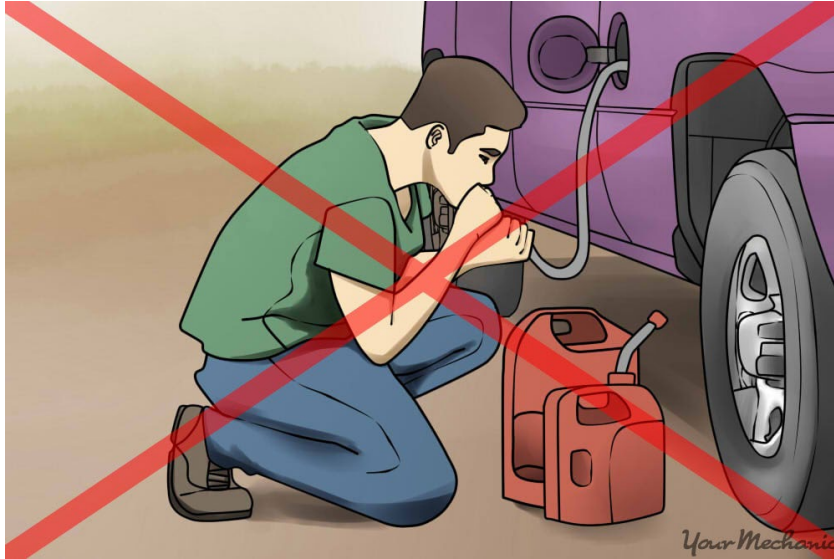


Fig. 3.2.8: Inappropriate siphoning of fuel using the mouth (Source: safetynews.co.nz)

17. Never direct air compressor guns at the body when discharging air from it. High-pressure air can penetrate the skin and enter the bloodstream, causing an air embolism, which can be fatal. Also, avoid using the air compressor to blow away dust from surfaces as the dust particles can pollute the air and cause inhalation problems.

Customer Safety

The customer must be seen as the most important person in your workshop. All activities must be done in a way that will not pose any danger or discomfort to them. Their safety is as important as yours. It is your responsibility to help them identify and observe all the safety measures that will ensure their maximum safety in your workshop. Below are some safety measures for your customers.

1. Keep customers away from restricted areas including the work area. To safeguard customers from danger and possible accidents, ask them to sit in the reception area or provide a temporary waiting area for them.



Fig. 3.2.9: Customer safety signage

2. Advise customers about the safety rules of the workshop. You are the main contact of your workshop and not everybody may be familiar with the operations of your workplace. Help visitors to know places that they can and cannot visit. Safety protocols must be displayed at one or more visible locations in the workshop to inform customers about the dos and don'ts. Take them round the shop if they ask to take a tour the workplace.
3. Keep the workshop floor clean and free of hazards. The floor must be clean but not slippery. Oil and liquid spills must be cleaned immediately. Keep walkways clear of tools, machine components and any other items such as oil containers or buckets.
4. Provide appropriate warning signs for customers. Show customers places like walkways, emergency exits and emergency assembly points so they can easily evacuate in case there is danger. Signs and markings must be such that any person entering the workshop can read and interpret or understand.



Fig. 3.2.10: Emergency Assembly Point Sign

5. Provide customers with relevant safety gear if they need to come near your work area. Trips, slips and falls can lead to serious accidents. Oil spills, flying iron filings and dust can pose health threats to the customer just the same way they can be dangerous to you. Make adequate provision for appropriate personal protective equipment for your customers to keep them safe from hazards.
6. Ensure there is adequate ventilation in waiting areas provided for your customers. The waiting area must be free from hazardous chemicals like fuels, flammable materials and sources of heat that can release offensive odours or possibly cause a fire outbreak.

Workshop Safety

Workshop safety refers to the general rules that must be observed in the workshop to ensure the safety of workers, customers, tools and equipment and to make the entire work environment safe for everyone. Some basic workshop safety rules are:

1. Keep the workplace clean and tidy. Clean the workshop every morning and after the daily work is finished. There should not be any types of oil, fluids, grease and iron waste on the floor of the workshop. Oil Spills on the floor should be cleaned immediately using either a duster, sand or sawdust and placed in the appropriate waste container.
2. Provide adequate lighting and ventilation at the workshop.
3. Keep the workshop environment well organised. Tools, equipment and work benches must be arranged and positioned at their proper locations in the workshop. Cables and wires must not entangle or cross walkways. Workers and visitors must not be obstructed

while moving about in the workshop. Highly volatile and flammable substances must be separated from sources of sparks and heat.

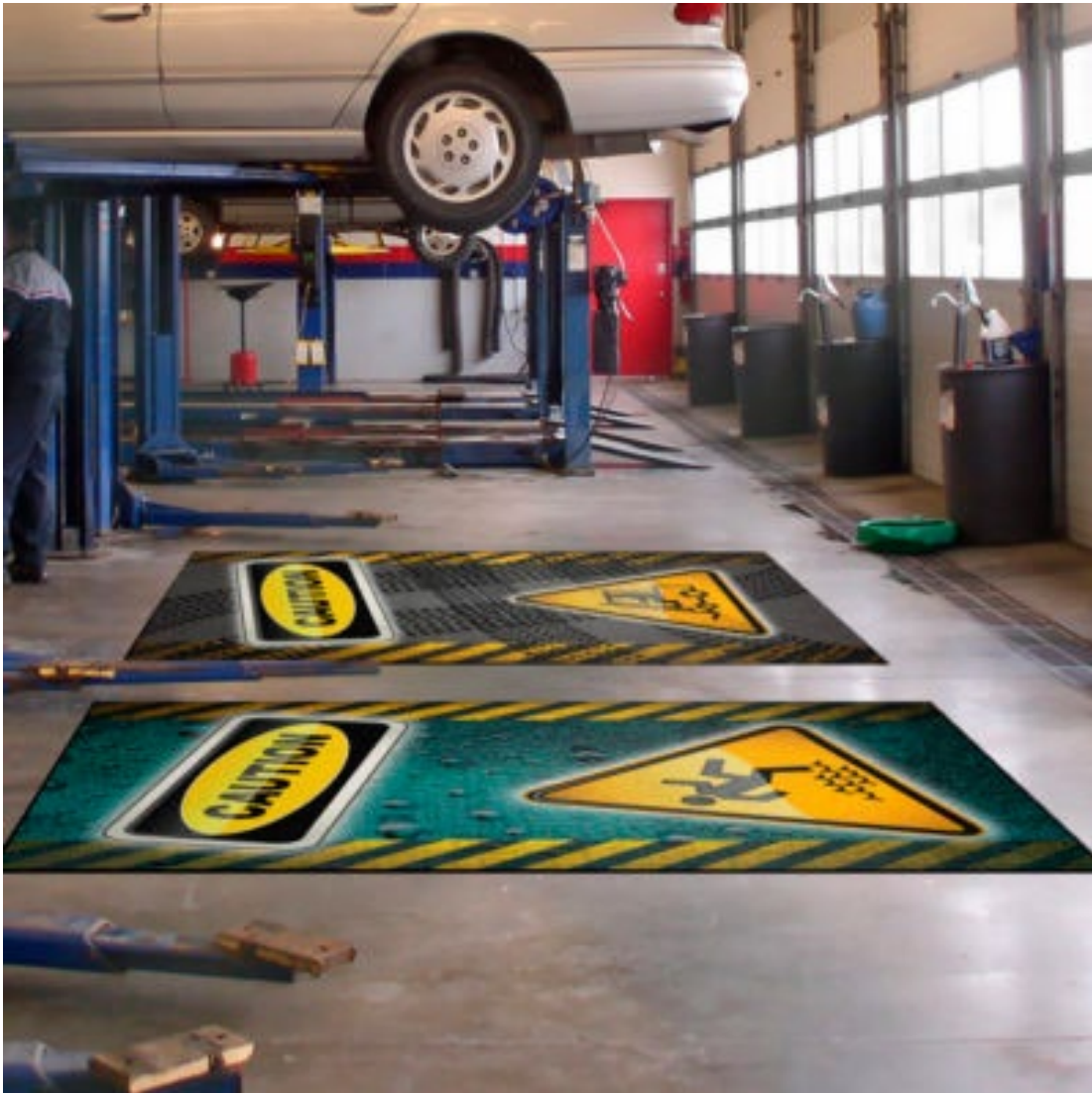


Fig. 3.2.11: A well-organised service shop with floor markings

(Source: prudentialuniforms.com)

4. Provide first aid kits for handling emergencies and accidents.
5. Display safety signs or symbols in visible places in the workshop. The symbols must be internationally accepted and easy to be understood by all persons.
6. Any high voltage electrical connection areas should be labelled as such as off limits to unauthorised personnel.
7. Fix guards around the machine rotating parts before starting the machine.
8. Do not try to repair any machine whilst it is running.
9. switch off machinery or equipment when it is not in use. Pull out power plugs from mains when any machine will not be used over a longer period. Cover the plugs to keep the contacts clean and to minimise any damage to them.
10. Avoid using frayed cords or wires of machines or damaged power supply points.

11. Assign tag-outs and lock-outs to faulty machines and power outlets to inform people about their working conditions in case you are not present.



Fig. 3.2.12: A lockout being applied to a device

12. Keep fire extinguishers in places where they can be easily accessed.
13. Maintain correct waste disposal. Keep all collected waste in clearly marked containers or refuse boxes/bins for safe and legal collection and disposal.

Safety Signs

Safety signs can be put into five categories. They are as follows:

1. **Prohibition Signs:** Red circle with a diagonal line. They are a danger sign, telling you that it is not safe to proceed or do something.



Fig. 3.2.13: Examples of prohibition signs

2. **Warning Signs:** Yellow or amber triangle with a black border. Warning signs are there to warn you of dangers but not to stop doing something.



Fig. 3.2.14: Examples of warning signs

3. **Mandatory Signs:** Blue circle with a white pictogram. Mandatory signs are there to tell you to do something.



Fig. 3.2.15: Examples of mandatory signs

4. **Emergency Information Signs:** Green rectangle or square with a white pictogram.



Fig. 3.2.16: Examples of emergency information signs

5. **Fire Safety Signs:** Red rectangle or square with a white pictogram. Fire equipment/ fighting signs show you where fire equipment is and what type.



Fig. 3.2.17: Examples of fire safety signs

Note: insure yourself, your customers and the workshop against accidents, however, remember that the best form of insurance is safety precaution.

Activity 3.2.1

1. Make a sketch of an auto repairer fully dressed in his or her personal protective equipment.
2. Label the personal protective equipment worn.
3. Apart from what you have read in this material, outline other personal safety measures that you can follow to protect yourself when servicing an engine.

Activity 3.2.2

1. Watch the video: Automotive Workshop Design Fit-out Solutions at https://youtu.be/bWbY-xu23co?si=4bbdN2-i_w_kR5e_
OR
Explore the internet for pictures of modern auto service shops.
2. compare the layout and organisation of the service shop in the video or in the pictures you found on the internet with an auto service shop you have visited in your community.
 - a. Upon your visit to a local auto service shop, what are some of the measures local auto service shops need to put in place to ensure the safety of
 - i. workers,
 - ii. customers, and

- iii. vehicles at the workshop?
- b. What, in your opinion, is likely to contribute to the poor state of local auto service shops in Ghana?
- c. Suggest, at least, five ways mechanics in Ghana can improve the safety standards at their workshops.

Activity 3.2.3

1. Visit a standard auto service shop near you or in a school nearby and observe the compliance level of safety measures using the checklist below.

Automotive Workshop Inspection Checklist

The checklist provided is to aid identification of key issues in most automotive workshops. *Modify it as required for your premises.* It targets many of the injury causes prevalent in an auto workshop.

Company name:

Date of Inspection:

| |
|----------------|
| DD / MM / YYYY |
|----------------|

| ITEM | YES | NO | COMMENTS |
|---|--------------------------|--------------------------|----------|
| Policies and Procedures | | | |
| OH&S Policy displayed | <input type="checkbox"/> | <input type="checkbox"/> | |
| OH&S Committee in place | <input type="checkbox"/> | <input type="checkbox"/> | |
| DWG's formed and HSR's elected | <input type="checkbox"/> | <input type="checkbox"/> | |
| Issue resolution procedures in place | <input type="checkbox"/> | <input type="checkbox"/> | |
| New employees and contractors' induction program in place | <input type="checkbox"/> | <input type="checkbox"/> | |
| Approved first-aid kit and eye-wash equipment available | <input type="checkbox"/> | <input type="checkbox"/> | |
| Injury register provided and maintained | <input type="checkbox"/> | <input type="checkbox"/> | |
| Emergency contact numbers prominently displayed | <input type="checkbox"/> | <input type="checkbox"/> | |
| Unauthorised persons prohibited from entering workshop areas | <input type="checkbox"/> | <input type="checkbox"/> | |
| Standard Operating Procedures (SOP's) for workshop activities | <input type="checkbox"/> | <input type="checkbox"/> | |
| 'If you are injured' poster displayed in workplace | <input type="checkbox"/> | <input type="checkbox"/> | |
| Manual Handling | | | |
| Manual-handling risks such as heavy and awkward items identified, assessed and controls implemented | <input type="checkbox"/> | <input type="checkbox"/> | |
| Awkward and sustained postures such as working under bunnets identified, and controls implemented | <input type="checkbox"/> | <input type="checkbox"/> | |
| Mechanical aids used to lift heavy or awkward items | <input type="checkbox"/> | <input type="checkbox"/> | |
| Toolboxes mobile for ease of moving around workshop area | <input type="checkbox"/> | <input type="checkbox"/> | |

| | | | |
|---|--------------------------|--------------------------|--|
| Workshop areas | | | |
| All exits clear and accessible | <input type="checkbox"/> | <input type="checkbox"/> | |
| Toilets and showers provided and clean | <input type="checkbox"/> | <input type="checkbox"/> | |
| Kitchen facilities provided and adequate | <input type="checkbox"/> | <input type="checkbox"/> | |
| Adequate lighting provided | <input type="checkbox"/> | <input type="checkbox"/> | |
| Fire extinguishers provided, maintained and accessible | <input type="checkbox"/> | <input type="checkbox"/> | |
| Hearing protection and audiometric testing provided and records kept as per Noise Regulations | <input type="checkbox"/> | <input type="checkbox"/> | |
| All electrical equipment maintained as per Energy Commission Act, 1997 (Act 541) and BS 7671 and records kept | <input type="checkbox"/> | <input type="checkbox"/> | |
| All hoists, trolley jacks serviced and maintained as per GS 150 & ISO and records kept | <input type="checkbox"/> | <input type="checkbox"/> | |
| Minimum 600mm clearance provided between hoists and other equipment | <input type="checkbox"/> | <input type="checkbox"/> | |
| Compressors inspected and serviced regularly | <input type="checkbox"/> | <input type="checkbox"/> | |
| Power tools inspected and serviced regularly | <input type="checkbox"/> | <input type="checkbox"/> | |
| Parts stored in appropriate areas with racking, shelves, etc. | <input type="checkbox"/> | <input type="checkbox"/> | |
| No goods stored on top of internal offices/buildings unless designed for load bearing purposes | <input type="checkbox"/> | <input type="checkbox"/> | |
| Eye protection provided where needed | <input type="checkbox"/> | <input type="checkbox"/> | |
| Guards fitted to equipment where required, i.e. bench grinders, compressor pulleys, etc. | <input type="checkbox"/> | <input type="checkbox"/> | |
| All Asbestos Containing Materials (ACM's) handled appropriately as per Environmental Protection Agency Act (Act 490), e.g. brakes, clutches, gaskets. | <input type="checkbox"/> | <input type="checkbox"/> | |
| No electrical equipment used in 'wet' areas of workshop | <input type="checkbox"/> | <input type="checkbox"/> | |
| Welding screens available and used | <input type="checkbox"/> | <input type="checkbox"/> | |
| Tyre inflation cages available and used | <input type="checkbox"/> | <input type="checkbox"/> | |
| All lifting equipment inspected regularly, e.g. chains, slings | <input type="checkbox"/> | <input type="checkbox"/> | |
| Chemicals | | | |
| All dangerous goods/hazardous substances stored and labelled appropriately | <input type="checkbox"/> | <input type="checkbox"/> | |
| Material Safety Data Sheets available for all chemicals | <input type="checkbox"/> | <input type="checkbox"/> | |
| Dangerous goods/Hazardous substances register kept and maintained | <input type="checkbox"/> | <input type="checkbox"/> | |
| Appropriate personal protection equipment/training provided for employees when using dangerous goods/hazardous substances | <input type="checkbox"/> | <input type="checkbox"/> | |
| Waste oils and other products disposed of appropriately | <input type="checkbox"/> | <input type="checkbox"/> | |
| Falls from Heights | | | |
| Mezzanine levels provided with guard rails and kickboards if required | <input type="checkbox"/> | <input type="checkbox"/> | |
| Stairs have handrails and anti-slip tread | <input type="checkbox"/> | <input type="checkbox"/> | |
| Work platforms used to gain access to work at height | <input type="checkbox"/> | <input type="checkbox"/> | |
| Pit areas provided with fall protection | <input type="checkbox"/> | <input type="checkbox"/> | |

| Housekeeping | | | |
|--|--------------------------|--------------------------|--|
| Workshop floor free of slips and trips hazards | <input type="checkbox"/> | <input type="checkbox"/> | |
| Fluid spills cleaned up immediately | <input type="checkbox"/> | <input type="checkbox"/> | |
| Rubbish not stored near flammable substances | <input type="checkbox"/> | <input type="checkbox"/> | |
| Spill-containment equipment available | <input type="checkbox"/> | <input type="checkbox"/> | |
| All tools and equipment stored appropriately | <input type="checkbox"/> | <input type="checkbox"/> | |
| Air lines, hoses, and tools clear of floor surfaces | <input type="checkbox"/> | <input type="checkbox"/> | |
| Gas cylinders stored and secured appropriately | <input type="checkbox"/> | <input type="checkbox"/> | |
| Metal rubbish bins provided and emptied on a regular basis | <input type="checkbox"/> | <input type="checkbox"/> | |
| Clothing laundered in an appropriate manner | <input type="checkbox"/> | <input type="checkbox"/> | |

*OH&S: Occupational Health and Safety

*DWG's: Designated Work Groups

*HSR: Health and Safety Representative

*ISO: International Organisation for Standardisation

*GSA: Ghana Standards Authority

2. Follow the report writing guide below and compile a report on what you observed during the visit.

Report Writing Guide

- Title page: The title page often includes a descriptive title (not just "Report"), author's name, class and section numbers, and date of submission. Check with the teacher for the format or information required.
- Table of Contents
- List of Illustrations – any pictures you took
- Executive Summary – initial paragraph to summarise what you did
- Introduction – clear opening to say why you're doing the report, what you're going to cover, and what the outcome will be.
- Body – This will include where you visited, who you met, what you observed, methods of questioning, findings, and results
- Conclusions – what you found, what you can advise, what needs to change
- References: This list includes only the sources you used for the visit. If you want to include others, add them as a reference list
- Appendices – to include anything that didn't go into the main body but is still important. This could be an example of a safety checklist used by the workshop

3. Discuss your findings in class.

Extended Reading

[Guide to Mandatory Safety Signs](#)

<https://agsci.oregonstate.edu/mycas/section-2-%E2%80%93-general-safety-rules/chapter-15-motor-vehicle-maintenance-safety-rules>

<https://safetyculture.com/topics/lockout-tagout/>

<https://safetyculture.com/topics/safety-symbols/>

<https://www.acesecurity.co.uk/blog/what-are-the-different-types-of-fire-extinguishers-and-their-uses>

www.seton.co.uk/mandatory-symbol

Review Questions

1. As an Auto Technology student, prepare posters or labels of workshop safety protocols that can be displayed at your school workshop, highlighting the following groups:
 - a. students and workshop technicians
 - b. customers/visitors
 - c. workshop and vehicles.
2. Some of your friends in class refuse to wear their PPE when visiting the workshop for practical lessons. Outline five ways to help them develop a positive attitude to appropriate PPE use at the workshop.
3. We read in the introduction that apart from the school and auto service shops, servicing of cars can also be done at the roadside when a car suddenly develops a fault. As an auto mechanic professional, your customer calls you on the phone and reports that their car has developed a fault on their way to work. What safety guidelines would you follow when servicing the car at the location where it broke down?
4. Visit (<https://youtu.be/58naKHqpCWo>) to watch a step-by-step procedure for using a fire extinguisher.
 - a. Briefly describe the procedure for using a fire extinguisher to control fire.
 - b. Search the internet for the six (6) different types of fire extinguishers and the classes of fire each one can be used on.

(Present your answer by following the table format shown below. An example has been provided for you.)

| Type of fire extinguisher | Class of fire used on | Colour code | Containing agent | Examples of fires |
|---------------------------|-----------------------|-------------|--------------------------------------|--|
| Water fire extinguisher | A | Red | Pure water with or without additives | Fires involving solid and organic materials such as wood, paper, straw, textiles, etc. |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

Answers to Review Questions

1. *(Answer to Question 1 will be purely subjective and reflect each learner's innovation.)*
2. Five ways to assist colleague students develop a positive attitude toward the wearing of personal protective equipment when visiting the workshop for practical lessons:
 - Invite them to take part in regular safety workshops and training sessions to learn about the potential hazards in the auto workshop and the importance of wearing PPE.
 - Support the establishment and enforcement of clear, written safety policies that require PPE in the work environment.
 - Observe and reward or commend friends who consistently wear PPE correctly.
 - Prepare and display posters around the workshop to remind colleagues of the importance of PPE and show the correct way to wear them.
 - Serve as a role model by always wearing the PPE when visiting the workshop.
3. Safety guidelines to follow when carrying out car servicing on the road:
 - Move the vehicle to the side of the road or to a safe location where it would not impede the flow of traffic. You also need to move the driver and passengers (if carried) to a safe spot at the side of the road away from the traffic to prevent any possible injury or accident to them.
 - Turn on your hazard lights to alert other drivers that your vehicle is stationary and may pose a hazard.
 - Place a warning triangle at an appropriate distance behind your vehicle to alert approaching traffic. The triangle should be placed at least 30 meters behind the vehicle on highways and about 15 meters behind the vehicle in an urban area.
 - Wear reflective vests or other high-visibility clothing to make yourself more visible to other road users, especially when you are in an area where visibility is relatively poor.
 - Avoid working on the side of the vehicle that is closest to traffic.
 - If working on an incline or if the vehicle is at risk of rolling, use wheel chocks to prevent movement.
 - Ensure the vehicle is in a park (or in gear for manual transmissions) and engage the parking brake before starting any work.

Use proper tools and techniques for any roadside repairs to avoid injuries.

4. a. Briefly describe the procedure for using a fire extinguisher to control fire.

Using a fire extinguisher must follow these simple steps. But the most important and foremost directive is to select the appropriate type of fire extinguisher for the type of fire being handled.

- Pull the safety pin.
 - Aim the nozzle at the base of the fire.
 - Squeeze the handle to discharge the chemical.
 - Sweep across the fire from left to right till it is put under control.
- b. Types of fire extinguishers, their class labels, colour coding containing agents and types of fires they are used on.

| Type of fire extinguisher | Class of fire used on | Colour code | Containing agent | Examples of fires |
|-----------------------------------|-----------------------|-------------|----------------------------------|--|
| Water fire extinguisher | A | Red | Water | Fires involving solid and organic materials such as wood, paper, straw, textiles, etc. |
| Carbon Dioxide (CO ₂) | B, E | Black | Carbon dioxide | Fires involving flammable liquids and electrical equipment |
| Foam | A, B | Cream | Aqueous Film Forming Foam | Fires involving solid materials and flammable liquids (e.g., petrol, oil) |
| Dry Powder | A, B, C | Blue | Ammonium phosphate | Fires involving solid materials, flammable liquids, and gases (e.g., methane and butane) |
| Dry Powder (Specialist) | D | Blue | Special powders (e.g., graphite) | Fires involving flammable metals (e.g., magnesium, potassium, lithium and aluminium) |
| Wet Chemical | F | Yellow | Potassium acetate | Fires involving cooking oils and fats (e.g., deep-fat fryers) |

References

1. [Denton, T. \(2012\). Advanced Automotive Fault Diagnosis. Routledge: Abingdon, England.](#)
2. [Denton, Tom \(2011\). Automobile mechanical and electrical systems. Butterworth-Heinemann: Kidlington, Oxford.](#)
3. [SafeWork SA \(2017\). Automotive workshops Work health and safety guidelines.](#)
4. [WorkSafe Victoria \(2004\). Automotive Workshop Safety.](#)

UNIT 3

BUILDING CONSTRUCTION TECHNOLOGY

Pre-construction Activities

INTRODUCTION

The Professionals involved in building construction projects are critical for the effective and efficient undertaking of the desired outcome of every building construction project. The knowledge of the Professionals will enhance your understanding of their identities and then help you to know how they become professionals and what guides them in their work. As learners, your ability to explain the stakeholders involved in building construction will enrich your understanding of the professionals involved in building construction. You will also learn how these professionals use codes of conduct to enhance their professional image.

At the end of this unit, you will be able to:

Identify the Professionals involved in building construction projects.

Key Ideas

- Professionals are personnel, who are experts in specified skills.
- Within building construction projects, there are various professionals who are employed to undertake projects.
- These personnel are experts in the specified skills within building construction projects. This personnel are very skillful, effective, efficient and proficient in undertaking every operation in their specified skill areas.
- The employment of professionals on construction projects is to ensure quality and successful project outcomes.

PROFESSIONALS IN THE BUILDING CONSTRUCTION INDUSTRY

The personnel involved in building construction projects who have specialised skills are known as professionals. The contents of Table 3.3.1 identify the key professionals usually involved in building construction projects, with their specific descriptions.

Table 3.3.1: Professionals involved in building construction projects.

| Professionals | Descriptions |
|---|--|
| Construction Manager | A Construction Manager oversees and coordinates construction projects, ensuring their successful execution from start to finish. |
| Architect | An architect is a professional who designs and plans buildings and structures, ensuring they are functional, safe and aesthetically pleasing. |
| Structural Engineer | A structure engineer is one who designs and analyses the structural integrity and strength of buildings. |
| Civil Engineer | A civil engineer designs, constructs and maintains infrastructure projects like roads, bridges, dams and water supply systems for public use. |
| Quantity Surveyor | Is the one who manages all costs related to building and civil engineering projects ensuring projects are completed within budget and required standard. |
| Artisans in the building construction industry | Artisans are skilled workers who are specialised in trades like carpentry, masonry, plumbing, electricals, painting, plastering and tiling. As professionals, they are referred to as carpenters, masons, plumbers, electricians, painters and tilers. |

How the Professionals Involved in Building Construction Become Members of Professional Associations

1. **Identify Relevant Associations:** Research and identify the associations that align with their specific field or career goals. Some prominent associations include the Ghana Institute of Construction (GIOC), the Association of Building and Civil Engineering Contractors of Ghana (ABCECG), and the Ghana Institution of Engineers (GhIE).
2. **Meet Eligibility Criteria:** Ensure they meet the eligibility requirements for membership. For example, the Ghana Institution of Engineers requires attending a pre-examination workshop and meeting certain educational and professional experience criteria.
3. **Submit an application:** Complete and submit the application form provided by the association. This often requires details about professional background, education, and work experience.
4. **Pay Membership Fees:** Pay the required membership fees. These fees can vary depending on the association and the type of membership (e.g., student, associate, or professional memberships).
5. **Provide Supporting Documents:** Submit any required supporting documents, such as resumes, letters of recommendation, proof of education, and certifications.

6. **Attend Required Workshops or Examinations:** Some associations may require new members to attend workshops or pass examinations. For instance, the Ghana Institution of Engineers requires attending a pre-examination workshop.
7. **Engage in Association Activities:** Actively participate in association activities such as meetings, conferences, and networking events to maximise the benefits of membership and contribute to the professional community.
8. **Engage in Continuing Professional Development (CPD)** - many associations require members to carry out CPD through reading books and magazine articles, attending conferences or trade shows and the training mentioned above.

Steps to Take to Become a Professional in The Building Construction Industry

1. **Obtain Relevant Education:** Start with a high school diploma. Pursue higher education in fields like construction management, civil engineering, or architecture. Degrees from accredited institutions are highly valued.
2. **Acquire Necessary Certifications:** Obtain professional certifications relevant to your area of specialization. This could include certifications from recognized bodies such as the Ghana Institution of Engineers (GhIE) or the Ghana Institute of Construction.
3. **Gain Practical Experience:** Work as an intern or apprentice under experienced professionals. Practical experience is crucial for understanding the on-site realities of construction projects.
4. **Join Professional Associations:** Becoming a member of professional bodies such as the Association of Building and Civil Engineering Contractors of Ghana (ABCECG) can enhance your professional status and provide networking opportunities.
5. **Stay Updated with Industry Regulations:** Familiarize yourself with local construction laws and regulations. Regularly update your knowledge to stay compliant with any changes.
6. **Build a Professional Network:** Networking with other professionals can provide mentorship and opportunities for collaboration. Attend industry conferences, workshops, and seminars.
7. **Develop a Business Plan:** If you aim to start your own construction business, create a comprehensive business plan. This should cover your business model, financial projections, and marketing strategy.
8. **Register Your Business:** Register your construction business with the relevant authorities. This includes obtaining the necessary licenses and permits to operate legally in Ghana.
9. **Hire Qualified Staff:** As your business grows, hire skilled and certified professionals to join your team. Ensure continuous training and development for your staff to keep up with industry standards.
10. **Maintain Professional Integrity:** Uphold ethical standards in all your dealings. Transparency, quality workmanship, and adherence to timelines will help build your reputation in the industry.

The Regulations Guiding the Professional Bodies in The Building Construction Industry

1. **Legal Framework for Construction:** Although there is no statutory requirement for licensing contractors, various laws and regulations govern the industry. This includes compliance with building codes, safety standards, and environmental regulations.
2. **Regulatory Bodies and Professional Associations:** Several professional bodies and regulatory authorities oversee the standards and practices within the construction industry. These include the Ghana Institution of Engineers (GhIE), the Ghana Institute of Architects (GIA), and the Ghana Institute of Surveyors (GhIS). These bodies set professional standards, conduct examinations, and offer certifications for practitioners.
3. **Construction and Engineering Laws:** Ghana has specific construction and engineering laws that cover the making of construction projects, supervision of construction contracts, and adherence to international standards. These laws ensure that projects meet the required safety, quality, and sustainability standards.
4. **Quality Control and Standards:** The industry is regulated to ensure contractors meet quality standards and deliver value for money. This involves adherence to best practices, use of certified materials, and compliance with project specifications.
5. **Professional Licensing and Certification:** Industry professionals must obtain licenses and certifications from relevant professional bodies. These certifications are essential for ensuring that professionals have the necessary skills and knowledge to perform their roles effectively.

The Restrictions on Professional Bodies in Building Construction Industry

1. **Compliance with Building Codes and Standards:** Professional bodies must ensure that their members adhere to national building codes and standards. These codes regulate the design, construction, and maintenance of buildings to ensure safety and quality.
2. **Health and Safety Regulations:** Construction projects must comply with health and safety regulations that protect workers and the public. This includes adhering to specific safety protocols and guidelines to prevent accidents and injuries on construction sites.
3. **Permits and Approvals:** Before commencing any construction project, professional bodies must ensure that all necessary permits and approvals have been obtained from relevant authorities. This includes land use permits, environmental impact assessments, and building permits.
4. **Ethical Standards:** Members of professional bodies are required to follow ethical guidelines that promote integrity, transparency, and accountability in their work. This helps prevent corruption and ensures that construction projects are executed fairly and responsibly.
5. **Regulatory Oversight:** Although there is no single dedicated regulatory body for the construction sector, various governmental agencies oversee compliance with

construction regulations. Professional bodies must coordinate with these agencies to ensure that projects meet all legal requirements.

6. **Quality Control and Assurance:** Professional bodies must implement quality control and assurance measures to ensure that construction projects meet specified standards. This involves regular inspections, audits, and compliance checks throughout the construction process.

The Codes of Conduct for Professional Bodies in Building Construction Projects

Table 3.3.2: Codes of Conduct of Professional Bodies in Building Construction Projects

| CODES | CONDUCTS |
|------------------------|---|
| Competence | Professional Development, Adherence to Standards, Demonstrating Competency, Ethical Practice and Accountability |
| Recommended Scale fees | Transparency in Fees, Standardization, Fair Compensation, Ethical Considerations |
| Standard | Integrity and Honesty, Conflict of Interest, Competence and Continuous Improvement, Accountability and Responsibility, Ethical Conduct and Professional Behavior |
| Performance | Integrity and Ethical Behavior, Competence and Continuous Improvement, Accountability and Responsibility, Compliance with Standards and Regulations and Professionalism |
| Ethics | Integrity and Honesty, Professional Competence, Conflict of Interest, Fairness and Transparency and Respect for Stakeholders |

The Building Construction Professional Associations in Ghana

1. **Association of Building and Civil Engineering Contractors of Ghana (ABCECG)**
This association represents contractors involved in building and civil engineering works across Ghana. It aims to promote the interests of its members and uphold professional standards in the construction industry.
2. **Construction Industry Development Authority (CIDA)**
The Construction Industry Development Authority (CIDA) in Ghana is an initiative aimed at regulating, standardising, and promoting excellence in the construction industry. Although the bill for establishing CIDA is still under discussion, it is seen as a critical step towards creating a globally competitive.
3. **Ghana Chamber of Construction Industry (GhCCI)**

This chamber serves as a platform for various stakeholders in the construction sector, including contractors, consultants, and suppliers. It focuses on advocacy, capacity building, and fostering collaboration among its members.

Activity 3.3.1

Study the major professions practising in the Ghanaian building construction industry individually and write short notes about the professions for group discussion in the classroom.

Activity 3.3.2

Join the organised excursion for the class to visit the sites and offices of the professionals in building construction and interview them about how they become members of the professional associations.

Activity 3.3.3

1. Study the steps to take to become a professional in the building construction industry. Search the internet using Google or other search engine for further information on the steps to be taken to become a professional in the industry.
2. In your group discuss the steps necessary to become a professional.

Activity 3.3.4

Google search for the regulations guiding the professional bodies in the building construction industry and make short notes. Read about the regulations guiding the professional bodies in building construction in the learning manual and compare and confirm with the short notes from the Google search.

Activity 3.3.5

Participate in a group class discussion on how professionals in the building construction industry can influence good pricing, good quality and good time for building construction projects.

Review Questions

1. List the major steps to take for an individual to become a professional in the building construction industry.
2. Explain how professional bodies control their members by subjecting them to codes of professional conduct.
3. Describe the effects of using codes of professional conduct in the building construction industry.

Answers to Review Questions

1. An individual needs to take the following steps to become a professional in the building construction industry:
 - **Obtain Relevant Education** with a high school diploma or degree in fields like construction management, civil engineering, or architecture.
 - **Acquire Necessary Certifications** by obtaining professional certifications relevant to the area of specialisation bodies such as the Ghana Institution of Engineers (GhIE) or the Ghana Institute of Construction.
 - **Gain Practical Experience** as an intern or apprentice under experienced professionals.
 - **Join Professional Associations** for example: the Association of Building and Civil Engineering Contractors of Ghana (ABCECG).
 - **Stay Updated with Industry Regulations** and construction laws and regulations.
 - **Build a Professional Network** with other professionals for mentorship and opportunities for collaboration.
 - **Develop a Business Plan** to start your own construction business.
 - **Register Your** construction business with the relevant authorities. Obtain the necessary licenses and permits to operate legally in Ghana.
 - **Hire Qualified** skilled and certified professionals to join your team.
 - **Maintain Professional Integrity** in all your dealings. Transparency, quality workmanship, and adherence to timelines.
2. Explaining how professional bodies control members by subjecting them to codes of professional conduct by adhering to the following:
 - **Compliance with Building Codes and Standards** to ensure that their members adhere to national building codes, standards, safety and quality.
 - **Health and Safety Regulations** on construction projects must be complied with.
 - **Permits and Approvals** for all building construction projects must be obtained from relevant authorities.
 - **Ethical Standards must be adhered** to by all members of the professional associations, to promote integrity, transparency, and accountability in their work.
 - **Regulatory Oversight** bodies must ensure that construction sector governmental agencies oversee the compliance of construction regulations.

- **Quality Control and Assurance:** Professional bodies must implement quality control and assurance measures to ensure that construction projects meet specified standards.
3. The effects of using codes of professional conduct in the building industry will result in the following:

Competency developed through a code of professional conduct will enhance the following:

- **Professional Development** includes continuous learning and development to keep the skills and knowledge up to date.
- **Adherence to Standards** by members will enhance compliance with established industry standards, building codes, regulations, best practices and the latest technologies in construction.
- **Demonstrating Competency** through qualifications, certifications, and practical experience.
- **Ethical Practice** implies that Professionals should act with integrity, ensuring their decisions and actions are in the best interest of their clients, the public, and the environment.
- **Accountability** implies that Professionals must take responsibility for the outcomes of their projects.

Recommended Scale fees will be ensured by the code of professional conduct through:

- **Transparency in Fees** will result in Professional bodies presenting clear and transparent fee structures understandable to clients.
- **Standardisation must** reflect on fee scales standardised and published as a percentage of the construction costs.
- **Fair Compensation** guidelines must ensure professionals are fairly compensated for their work, taking into account the complexity, scale, and nature of the project.
- **Ethical Consideration** by Professional bodies must emphasise ethical conduct in fee determination. Professionals must insist that services are provided with commensurate fees charged.

Standards to be developed through the code of professional conduct will be:

- **Integrity and Honesty** mean Professionals must uphold the highest standards of integrity and honesty in all their relationships and dealings.
- **Conflict of Interest:** Professionals must avoid situations of personal interest that may conflict with their professional duties.
- **Competence and Continuous Improvement:** Professionals must maintain and improve their competence through continuous learning and professional development.

- **Accountability and Responsibility:** Professionals must take responsibility for their work and decisions. They should be accountable to their clients, employers, and the public.
- **Ethical Conduct** means that Professionals must act ethically in all aspects to ensure fairness, and respect and avoid any form of corruption.
- **Professional Behavior** must uphold all dignity and reputation of the profession.

Performance to be enhanced by code of professional conduct through:

- **Integrity and Ethical Behaviour:** Professionals must conduct themselves with integrity, avoiding any form of unethical behaviour such as bribery or corruption.
- **Competence and Continuous Improvement:** Professionals are expected to maintain and enhance their skills and knowledge through continuous learning and development. This ensures they remain competent in delivering high-quality work.
- **Accountability and Responsibility:** Professionals should take full responsibility for their actions and decisions, ensuring accountability in all their professional activities.
- **Compliance with Standards and Regulations:** Adherence to relevant industry standards, codes, and regulations is mandatory to ensure that projects meet legal and safety requirements.
- **Professionalism** must be maintained in all interactions and activities, towards clients, colleagues, and other stakeholders.

Ethics to be effected by the code of professional conduct through:

- **Integrity and Honesty** must be demonstrated by Professionals in all practices and provide accurate information.
- **Professional Competence must be** maintained through professional knowledge and skills in the delivery of construction projects.
- **Conflict of Interest** means that Professionals must avoid conflicts of interest and make decisions in the best interest of the project.
- **Fairness and Transparency** must be ensured in all building construction dealings.
- **Respect for Stakeholders** must be accorded to all involved in construction projects.

Extended Reading

Click on the links below for more information on the topics discussed in this unit.

- [“Professional Quantity Surveyor”. www.ciqs.org.](http://www.ciqs.org)
- [“Structural Engineer \(SE\) Licensure Explained”. *Engineering.com*. Retrieved September 21, 2020.](#)
- [“What is Civil Engineering?”. *Department of Civil Engineering and Engineering Mechanics: Columbia University*. Archived from the original on 24 December 2015.](#)
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3. <https://ghie.org.gh/membership/>
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UNIT 4

ELECTRICAL AND ELECTRONIC TECHNOLOGY

Electrical Systems Design

INTRODUCTION

Transmission and distribution networks are designed to carry a certain amount of electrical power safely and efficiently. The networks get overloaded when the amount of power flowing through the lines exceeds their designed capacity. The electricity usage of each device or appliance when in use adds to the total **LOAD** on the circuit. In this unit, the complications that develop when the power flowing through a transmission or distribution network exceeds its capacity due to illegal connections will be examined.

At the end of this unit, you will be able to:

Apply the concept of power transmission and distribution in electricity supply.

Key Ideas

- Unauthorised connection of electricity is one of the causes of overburdening the distribution network by overloading and outbalancing the distribution network
- Illegal connections lead to overloading of the distribution network on electricity service providers and consumers.

APPLICATION OF THE CONCEPT OF POWER TRANSMISSION AND DISTRIBUTION IN ELECTRICITY SUPPLY

The Effects Of Overloading A Distribution Network Caused By Illegal Connection

Overloading the distribution network, which refers to supplying more electrical load than the electrical network is designed to handle, can have several adverse effects.

Illegal Connection of Electricity

Illegal connection of electricity is an unlawful and unapproved means of **altering the electrical installation** by imposing *additional loads* that have not been planned for, to an existing electric power source without the knowledge of authorities that provide electricity such as Volta River Authority (VRA) or Electricity Company of Ghana (ECG).

Unauthorised connection of electricity is one of the causes of overburdening the distribution network by overloading and outbalancing the distribution network. Illegal connections are considered energy fraud and a danger to public safety.

Effects of Illegal Electrical Connection

1. Extra power burden is placed on power supplied to legal or approved consumers.
2. It leads to a drop in the voltage of the main supply since it has a specific number of loads to carry.
3. It leads to frequent power outages and cuts.
4. It may cause damage to electrical appliances
5. It can cause electrocution
6. It leads to a loss of revenue to government authorities that provide power.
7. It strains the infrastructure beyond its limits
8. It can cause overheating of the line,
9. It can lead to voltage instability and line failure
10. Power disruptions can lead to the burn-out of electrical installations and electric shock.
11. It can cause equipment damage,
12. It can cause fire hazards,
13. It can result in shorter lifespans for electrical equipment.
14. It can result in the tripping of circuit breakers or blowing of fuses and cutting power supply to the affected area.

The Ripple Effects of Illegal Connection

The ripple effects of electricity theft are numerous as it affects the;

- a. utility provider,
- b. electricity customers,
- c. fraudsters who engage in such theft.

On the utility provider's side: electricity theft takes several forms, including;

- i. meter bypass,
- ii. illegal connection,
- iii. meter tampering,
- iv. the introduction of foreign objects to slow down the meter reading accuracy, etc.
- v. Service providers become unable to account for the amount of electricity disbursed.

- vi. The revenue the service providers receive from customers cannot cover the cost of the electricity provided.
- vii. Electricity theft destroys electrical infrastructure, creating a burden for utility providers to fix which could lead to higher bills for the customer.
- viii. Power disruptions can lead to the burn-out of electrical installations, electrical shocks and unbalanced voltage.

On both the legal and illegal customers' side

The illegal connections;

- i. draw vital electricity from other households when connected to an overhead pole or substation.
- ii. significantly increase the chances of overloading and outbalancing the stability of the system.
- iii. overload the system to a dangerous and unsafe level.
- iv. make protective devices trip off.
- v. cause power disruptions to neighbourhoods and customers within the vicinity of the activity.
- vi. force customers to experience power outages for a long time when the activity is conducted.
- vii. create voltage drops in the vicinity causing appliances such as fridges, air conditioners, fans, or electronic systems such as TVs, and PCs seem to lack sufficient power to operate.
- viii. benefits an illegal, underground economy by supplying electricity illegally.

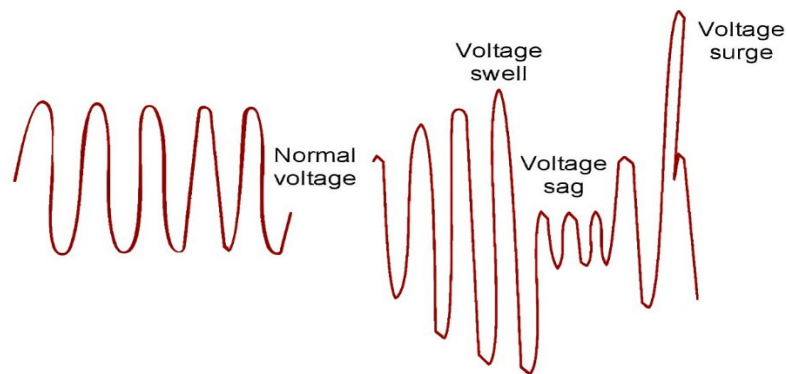


Fig.3.4.1: Pictures of voltage fluctuation in a distribution network (bing.com)

Other Signs of Overloaded Circuits

Other signs of overloading that are less noticeable include:

- 1. Dimming of light, especially if light dims when appliances or lamps are switched ON
- 2. Buzzing outlets or switches
- 3. Outlets or switch covers that are warm to touch
- 4. Burning smells from outlets or switches
- 5. Burned plugs or outlets

6. Power tools appliances, or electronic devices that seem to lack sufficient power.
7. Power surge.



Fig.3.4.2: Picture of a damaged transformer (bing.com.)



Fig.re 3.4.3: Picture of illegal wiretapping of electricity

Activity 3.4.1

1. Use VPLab to simulate the overload condition of a short-circuited 240V/30V double wound transformer. or any other transformer of lower rating by gradually increasing the load in the circuit.
 - a. Observe the effects of the overload on the transformer.
 - b. How does overloading the circuit affect the current flowing through the transformer?
 - c. What are the potential consequences of overloading the transformer in terms of overheating and fire hazards?
 - d. How can overloading affect the reliability and stability of the distribution system?
2. What are the safety implications for both the utility provider and the consumers due to overloading? Consider the following prompts and questions to perform this activity.

Safety Implications for Utility Providers

- a. List at least three items of equipment that are exposed to damage or failure or replacement because of overloading.
- b. State the ways in which overloading inconveniences customers.
- c. State the safety hazards the personnel of the service provider are exposed to during maintenance or repair activities.
- d. State several actions that can be taken against the utility provider for non-compliance of safe operating conditions of the distribution network.

Safety Implications for Customers

- a. List a number of ways in which overheating due to overloading can affect the consumers of electricity.
- b. State the safety hazards consumers are exposed to in an overloaded network when interacting with the electrical network.
- c. State the inconveniences that consumers of electricity are plunged into by power disruptions due to overloading.

Review Questions

1. List the potential safety hazards and risks associated with illegal connections.
2. What are the primary factors that contribute to overloading in a distribution network?
3. What measures can be implemented to raise public awareness of the negative consequences of illegal connections?
4. What measures can be taken to prevent or mitigate the effects of overloading in a distribution network?
5. How does overloading affect power quality for end-users connected to the distribution network?
6. How does overloading affect the lifetime and operational efficiency of distribution equipment?
7. Analyse the consequences of illegal connections on the distribution network.
8. How do weather conditions and seasonal variations affect the likelihood of overloading in distribution networks?
9. Find out if there are specific industries or regions that are more susceptible to distribution network overloading, and if so, why?

Answers to Review Questions

1. **Safety Hazards and Risks:**
Electrocution, fire hazards, Property damage, health risks, service interruptions.
Legal and financial consequences.
2. Increased electricity demand, the concentration of loads, aging infrastructure
Inadequate maintenance, Unauthorised or illegal connections, voltage instabilities.
Educational campaigns, using TV, radio, social media posters, and community events.
3. Collaboration with community leaders, and neighbourhood associations to disseminate information about the risks of illegal connections, distribution of flyers or leaflets and brochures, that explain the consequences of electricity theft and illegal connections, School programmes
Interactive workshops and seminars, engagement with utility customers.
4. **Load forecasting to plan for infrastructure upgrades.**
 - Asset management using predictive analytics to assess the condition of existing transformers, poles and cables.
 - network planning by simulating various scenarios for network expansion.
 - fault detection and management using predictive analytics to identify potential faults in the distribution network.
 - customer engagement to analyse changes in energy usage patterns and consumer preference,
 - policy and regulatory compliance to analyse the impact of policy changes and regulatory requirements on network operations and investments.

Long-term planning to provide insights into trends that may impact the electricity distribution network, such as population growth, urbanisation, technological advancements, and climate change.
5.
 - *Voltage Sag or Dip:* When distribution lines are overloaded, the voltage supplied to end-users can drop below normal levels during peak demand periods.
 - *Voltage Unbalance:* In three-phase systems, unequal loading can lead to uneven voltage levels, affecting equipment performance and potentially causing overheating.
 - *Frequency Variations:* In extreme cases of overloading, frequency variations do occur. Unstable frequencies can lead to operational disruptions and potential damage.
 - *Voltage Flicker:* Overloading can cause voltage flicker, which is rapid, repetitive changes in voltage levels.

- *Equipment Damage and Efficiency*: Overloading can lead to overheating transformers and conductors and reduce overall system efficiency and increase maintenance costs.
6.
 - Transformer overheating and aging, Cable overheating and degradation
 - Switchgear and circuit breakers can stress the switchgear,
 - Losses and Efficiency: Overloaded equipment experiences higher electrical losses due to increased resistance and heating. These losses reduce the overall efficiency of the distribution system, leading to wasted energy and higher operational costs.
 - Inefficient operation can also strain generating capacity, affecting the reliability of the entire electrical grid.
 - Maintenance Costs: Overloaded equipment requires more frequent inspections, maintenance, and possibly replacement, causing increasing operational costs for utility providers.
 7. Overloading and Overheating:
 - a. Power Quality Issues such as voltage fluctuation, harmonic distortion
 - b. Revenue losses for utility providers such as unaccounted consumption, revenue collection challenges, safety hazards such as fire and electrocution
 8. Blown debris against the lines, falling trees, and toppling of utility poles or transmission towers in extreme winds are the primary causes of damage to overhead transmission and distribution lines, inevitably leading to end-user power interruptions.
 9. Grid congestion can occur in any region when there is limited capacity to transfer power between different regions in the transmission system. This can lead to overloading of specific transmission lines that are critical for transferring power between regions. When a transmission line becomes overloaded, it can lead to voltage instability, increased line losses, and even line tripping or failure.

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- <https://www.thespruce.com/what-is-electrical-circuit-overload-1152861>
- [International Energy Agency](#)
- [Kato Electrical](#)

UNIT 5

METAL TECHNOLOGY

Engineering materials, tools and Machines.

INTRODUCTION

This unit will introduce you to the variety of basic gas welding tools and equipment which are valuable and widely used for gas welding operations. It will further offer you the opportunity to describe the gas welding tools and equipment and discuss their uses and safety precautions to be observed when using these tools. When metals are welded, the pieces to be joined are raised to a high temperature and fused together. The gas welding process is one of the methods of joining metals pieces together. Gas welding is used due to its versatility, portability, cost-effectiveness, safety and ease of operation. It is used in locations or areas where electricity may not be readily available. The oxy-acetylene welding process uses burning gases to produce the heat needed for joining the pieces of metals. A mixture of acetylene and oxygen in equal quantities produces a temperature of around 3150 degrees Celsius. A welding rod is used to provide the extra metal needed to produce a good joint. Gas welding is the process used to join a wide range of metals, including mild steel, stainless steel, aluminium, copper, and brass in the automotive, construction, and manufacturing industries. The gas welding tools and equipment are relatively lightweight and portable, allowing them to be carried easily and used in remote areas. They are relatively simple to set up and operate, making them accessible to beginners in metalwork technology. As a beginner, you should make sure to observe the safety precautions related to gas welding operations.

At the end of this unit, you will be able to:

Identify and explain the use of various tools and equipment for gas welding.

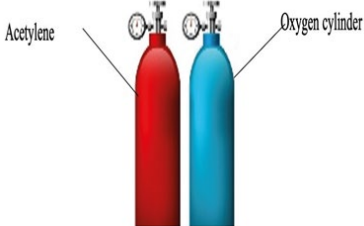
Key Idea

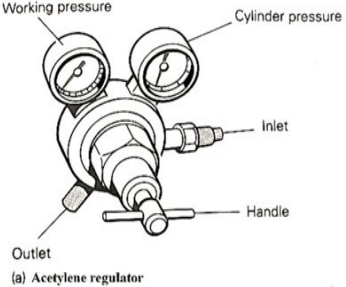
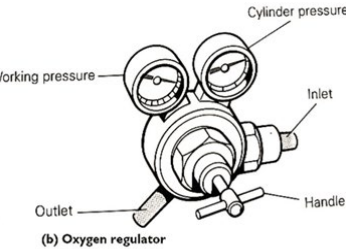
The knowledge and understanding of gas welding tools and equipment will facilitate the demonstration of basic gas welding operations for the acquisition of skills and competencies required for job creation, further education and training.


TOOLS AND EQUIPMENT FOR GAS WELDING

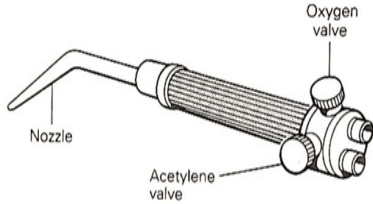
Gas welding is a hot flame joining process for metals using fuel gases and oxygen. Metal joining can take place both with or without the use of filler material. Gas welding is very suitable for welding pipes and tubes. It is effective and economic for applications like construction and repair of heating, ventilation and air conditioning systems.

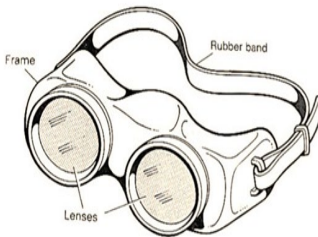
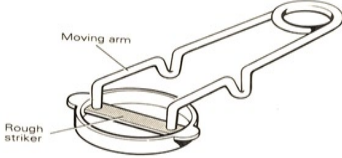

Table 3.5.1: Tools and Equipment for Gas Welding

| S/N | TOOL/ EQUIP- MENT | DESCRIPTION OF TOOL/ EQUIPMENT | USES OF TOOL/ EQUIP- MENT | SAFETY TO BE OB- SERVED | PICTURE OF TOOL/EQUIPMENT |
|-----|---------------------|--|--|---|--|
| 1 | Oxygen cylinder | The oxygen cylinder is made of steel and is fitted with right-hand screw thread. It is identified by being painted blue or green or black . | The oxygen cylinder is used for storing liquified oxygen gas under pressure. | The acetylene cylinder must never be trans-filled (made full). The oxygen and acetylene gases mixed at the correct proportions and ignited produce one of the hottest flames. Be extremely careful when removing regulators from cylinders. Do not allow to remain on a benchtop for a length of time. Never use oil or grease. |  <p>Acetylene (maroon or red colour) and oxygen (blue colour) cylinders.</p> <p>(Source: Oxygen and acetylene cylinders - Search Images (bing.com))</p> |
| 2 | Acetylene cylinders | Acetylene cylinders are made of steel. They have a concave bottom and are fitted at the top and bottom with fusible plugs to relieve any excess pressure when subjected to greater heat or undue pressure. They are fitted with left-hand screw threads and are painted red or maroon . | It is used for storing liquified acetylene gas under pressure. | | |

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| <p>3</p> | <p>Pressure regulators</p> | <p>Pressure regulators reduce the high storage pressure to a suitable working pressure and maintain a constant pressure at the blowpipe. The pressure regulators commonly used are acetylene pressure regulator and oxygen pressure regulator. The pressure regulators have two gauges: Supply pressure gauge and working pressure gauge. Regulators for fuel acetylene gas and oxygen gas are designed to be non-interchangeable. All oxygen fittings have plain nuts and right-hand threads while all acetylene fittings have grooved nuts and left-hand threads.</p> | <p>The pressure regulators are used to control the pressure of gases, reducing the high pressure in the cylinders to a lower, usable pressure for welding or cutting of materials.</p> | <p>When opening the cylinder, do not stand directly in front of the regulator. Keep regulators away from sparks or flames at the worksite. Check for leaks in the diaphragm.</p> |   |
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| <p>4</p> | <p>Hoses</p> | <p>The hoses are of two types; the acetylene hose and the oxygen hose. In oxy- acetylene gas welding, the oxygen gas and the acetylene gas are carried from the oxygen and acetylene cylinders to the welding torch through hoses. Colour coding is used in identifying the hose carrying the gas. The hose having blue colour carries oxygen and red colour is used for acetylene hose.</p> | <p>Hoses are used to transfer various types of fuel gases for welding and cutting.</p> | <p>Inspect equipment for leaks at connections using approved leak-test solution. Inspect hoses for leaks and worn places. Replace bad hoses and cylinders from sparks, flame and hot metal.</p> |  <p>Hoses https://www.google.com</p> |
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| <p>5</p> | <p>Welding torch/ blowpipe</p> | <p>A welding torch is the main component of the oxy- acetylene equipment where the oxygen and acetylene gases are mixed in the mixing chamber. It has a mixing chamber and the nozzle(tip). Regulated outflow of the mixed gases when struck with a spark lighter produces flame. A high temperature flame is produced by adjusting the oxygen and acetylene valves, according to the welding material. There are two types of welding torch namely:</p> <ul style="list-style-type: none"> i. Low pressure or injector torch and ii. Medium pressure or equal pressure torch. | <p>The flame produced is used to weld or cut the materials.</p> | <p>During the cutting process, it is important to protect yourself from flying sparks, slag, and bright light. Make sure to wear PPE designed for welding and cutting operations. These include goggles, with tempered lenses, gloves, aprons, and safety shoes.</p> | <div style="text-align: right;">  </div> <p>Welding torch/blow pipe</p> <p>Source: Welding torch - Search Images (bing.com)</p> |
|----------|--------------------------------|--|---|--|--|

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|---|-----------------|--|--|--|--|
| 6 | Welding Goggles | Welding goggles are a type of personal protective equipment used in performing certain types of welding to protect the eyes and face. Gas flames produce high intensity light and heat rays, which are harmful to the naked eye. | To protect the eyes from these rays, goggles are used. Goggles also protect the eyes from flying sparks. | Most welding glasses are not suitable for looking at the sun. Only welding goggles with shade level 14 can protect your eyes properly. |  <p>Welding goggles</p> <p>Source: Welding goggles - Search Images (bing.com)</p> |
| 7 | Spark Lighter | A gas spark lighter, sometimes just called a spark lighter, striker or flint lighter, is a type of lighter used in many applications to safely light a gaseous fuel to start a flame. | It is commonly used for butane burners and oxyacetylene welding torches | Use the well-constructed lighter for all your burner ignition needs |  <p>Spark lighter</p> <p>Source: Spark lighter - Search Images (bing.com).</p> |
| 8 | Welding rods | The welding rods are designed to melt at a lower temperature than the metal being welded, allowing them to fuse the weld, ensuring that it is uniform and consistent. There are various types of welding rod, and the most common ones are mild steel, cast iron, alloy steel, stainless steel, brass and aluminium. | Welding rods are used to provide the filler material in the welding process | You should wear face/eye protection and other body protection (especially gloves on the hands). |  <p>Welding rods</p> <p>https://primeweld.com/blogs/news/weldings-rods-and-electrodes-guide</p> |

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| 9 | Oxy-acetylene equipment set-ups. | Two bottles, both colour coded, and so are the regulators for each gas, attach each regulator to the appropriate bottle. The oxygen is normally right-hand thread to be tightened with appropriate spanner. Attach hoses, torch and turn on gases. | First, it's used to produce a controlled flame when welding. It can also be used for mixing acetylene and oxygen properly before release. Finally, it can prevent flashbacks and help welders obtain a specific flame. | Wear welding gloves, helmet, leather apron, welding chaps, leather boots, welding goggles, and other personal protective equipment to help prevent weld burns and injury. Make sure the welding goggles or face shields have at least a No. 4 filter lens. |  <p>Oxy-acetylene equipment set-ups</p> <p>Source: Oxyacetylene equipment set-up - Search Images (bing.com).</p> |
|---|----------------------------------|---|--|--|---|

General Gas Welding Safety Tips

1. Protect hoses and cylinders from sparks, flames and hot metal.
2. Use a flint lighter to ignite the flame.
3. Stand to the side (away from the regulators) when opening cylinder valves.
4. Open cylinder valves very slowly to keep sudden high pressures from exploding the regulators.
5. When welding, special goggles or masks (having 'coloured' glass) must be worn to protect the eyes from the glare from the flame of the arc.
6. A leather apron and glove should also be worn to protect against molten metal and flying sparks.

Oxy-Acetylene Gas Welding Cylinder Colour Codes

According to British standards (BS EN 1089-3)

- a. **Oxygen:** Black body with a white shoulder (the top part of the cylinder).
- b. **Acetylene:** Maroon body shoulder

According to International Organisation for Standardisation. (ISO 32 and ISO 225)

- a. **Oxygen:** Black or dark green body with a white shoulder.
- b. **Acetylene:** Maroon

In the United States of America

- a. **Oxygen:** Green or black.
- b. **Acetylene:** Maroon, red, or sometimes black.

The unit has covered the various tools and equipment used for gas welding. These tools are essential for beginners in metalwork technology. The unit has further equipped you with the knowledge and understanding relating to the tools and equipment, their uses and how to recognise and identify specified items for gas welding. You have undertaken workshop projects to appreciate and practice the use of the various gas welding tools and equipment to improve your skills and competences.

Resources such as pictures of the tools and equipment used for gas welding, videos and websites showing how the tools and equipment for gas welding are being used, real objects (oxyacetylene cylinder, oxygen cylinder, pressure regulators, welding torch or blowpipe, hoses, goggles, spark lighter, welding rods), charts and sketches/drawings of the tools and equipment for gas welding.

For the unit to be accomplished, you should be able to identify and demonstrate the uses of the various tools and equipment for gas welding.

The following activities will help you gain a better understanding of the unit discussed. It will further foster collaboration among you as a group of learners.

Activity 3.5.1

Your Applied Technology facilitator has given you pieces of mild steel plates to design and produce a book holder to be used in his/her office to reduce congestion. Using the gas welding operation:

1. Identify four tools you will need for making the book holder.
2. State six procedures/steps you will follow to make the book holder.
3. Identify four items of PPE you will need for making the artefact.
4. Outline the safety precautions to be observed when making the artefact.
5. Evaluate the made artefacts, stating the strengths and weaknesses of the made artefact and suggest modifications.

Activity 3.5.2.

Gas welding tools and equipment are relatively simple to set up and operate, making them accessible to beginners in metalwork technology.

Using your ICT tools by browsing the internet, find out the following:

1. Importance of welding pieces of metal using gas welding.
2. Colours used for painting the acetylene and oxygen cylinders.
3. Reasons why the acetylene and oxygen cylinders are painted in different colours.
4. Reasons why safety must be observed when using the gas welding tools/equipment.

Activity 3.5.3

One suitable way of demonstrating the understanding of tools and equipment used for gas welding is through sketches. Constant practising of sketches will further enhance your skills and competencies in the subject area.

1. Make freehand pictorial sketches of any five of the gas welding tools/equipment in a sketchbook.
2. Label any two parts of each of the tools/equipment sketched in (3ai) above.
3. Briefly describe the use of each of the tools/equipment sketched.
4. Show your work to your facilitator for feedback.
5. Use the feedback from your facilitator to make corrections.

Activity 3.5.4

For you to demonstrate your understanding of gas welding, there is a need for your Applied Technology teacher to organise industrial visits for your class at nearby welding and fabrication shops. The visit will help you to identify some of the tools, equipment and products that could not be found in your school workshop/environment.

Note: For this activity, make sure you follow all health and safety guidelines and instructions at all times to maximise your own and others' safety.

1. Briefly discuss in groups, the following stages involved in embarking on the industrial visits:
 - a. preparations before the visit
 - b. what to do during the visit
 - c. what to do after the visit
2.
 - a. Identify any six (6) gas welding tools/equipment in the welding and fabrication shops you have visited.
 - b. Observe how to demonstrate the uses of the gas welding tools/equipment in the shops and practice them.
 - c. Observe how to demonstrate safety precautions when using the gas welding tools and equipment.
3.
 - a. Prepare a visit report in groups and discuss in class for feedback.
 - b. Take pictures or make sketches of some tools/equipment and products you found in the welding and fabrication workshop you visited.
 - c. Prepare a photo or sketch album and display it in the classroom/workshop for appraisal.
 - d. Use the feedback from the appraisal conducted to make modifications to the album.

Review Questions

The following questions will help you learn more about the areas we have covered in this indicator:

1. The gas welding tools and equipment are relatively lightweight and portable, allowing them to be carried easily and used in remote areas.
 - a. Explain the uses of the following tools/equipment in gas welding:
 - i. Acetylene cylinder
 - ii. Oxygen cylinders
 - iii. Pressure regulators
 - iv. Hose
 - v. Welding goggles
 - b. The shapes of acetylene cylinders and oxygen cylinders seem similar but there are differences between them. Knowing their differences will assist you select the suitable flame for carrying out the gas welding operations.
 - i. Distinguish between the acetylene cylinder and the oxygen cylinder used for gas welding.
 - ii. Briefly describe how the acetylene cylinder and oxygen cylinder can be identified.
2. Regulators for fuel acetylene gas and oxygen gas are designed to be non-interchangeable.
 - a.
 - i. Briefly describe the function of the regulator used in gas welding.
 - ii. Distinguish between the acetylene regulator and the oxygen regulator.
 - b. Colour coding is used in identifying the type of hose used for carrying the gases
 - i. Briefly describe the function of the hoses used in gas welding.
 - ii. Briefly describe how the hoses are connected to the gas cylinders taking into consideration their colours.
 - iii. Briefly describe the safety precautions to be observed when fixing the gas welding hoses to the pressure regulators and the welding torch.
 - c.
 - i. Briefly explain the function of the gas welding blowpipe/torch.
 - ii. Briefly describe how the blowpipe operates.
3. Freehand sketching of tools and equipment promotes understanding, creativity and acquisition of skills and competencies. It is necessary for you to practice freehand sketching of tools and equipment on a regular basis.

Sketch the following tools/equipment used in gas welding:

- a. Oxygen cylinder

- b. Acetylene cylinder
- c. Oxygen regulator
- d. Acetylene regulator
- e. Spark lighter
- f. Welding torch or blowpipe
- g. Welding goggles

Answers to Review Questions

1.
 - a.
 - i. **Acetylene cylinders** - It is used for storing liquified oxygen gas under pressure.
 - ii. **Oxygen cylinders** - It is used for storing liquified acetylene gas under pressure.
 - iii. **Pressure regulators** - The pressure regulators are used to control the pressure of gases, reducing the high pressure in the cylinders to a lower, usable pressure for welding or cutting.
 - iv. **Hose** - Hoses are used to transfer various types of fuel gases for welding and cutting of materials.
 - v. **Welding goggles** - To protect the eyes from these rays, goggles are used. Goggles also protect the eyes from flying sparks.
 - b.
 - i. **The oxygen cylinders** are made of steel painted black and are fitted with right-hand screw threads while the **acetylene cylinders** are made of steel, painted red or blue. They are fitted with left-hand screw threads and have concave bottoms fitted at the top and bottom with fusible plugs to relieve any excess pressure when subjected to greater heat or undue pressure.
 - ii. They can be identified by their colours: **Oxygen cylinders** are mostly painted **black** and **Acetylene cylinders** are mostly painted **red** or **blue**).
2.
 - a.
 - i. Pressure regulators help reduce the high storage pressure to a suitable working pressure and maintain a constant pressure at the blowpipe.
 - ii. **Regulators** for fuel acetylene gas and oxygen gas are designed to be non-interchangeable. All oxygen fittings have plain nuts and right-hand threads while all acetylene fittings have grooved nuts and left-hand threads.
 - b.
 - i. The **hoses** are of two types; the **acetylene hose** and the **oxygen hose**. In oxy-acetylene gas welding the oxygen gas and the acetylene gas are carried from the oxygen and acetylene cylinders to the welding torch through the hoses.
 - ii. Colour coding is used in identifying the hoses carrying the gases. The hose having **blue colour** carries oxygen and the **red colour** is used for the acetylene hose.
 - iii. Inspect equipment for leaks at connections using approved leak-test solutions.

Inspect hoses for leaks and worn places. Replace bad hoses and cylinders from sparks, flames and hot metals.

c.

- i. A welding blowpipe or torch is the main component of the oxy-acetylene equipment where the oxygen and acetylene gases are mixed in the mixing chamber. There are two types of torches, the low pressure or injector torch and medium pressure or equal pressure torch.
- ii. Regulated outflow of the mixed gases when struck with a spark lighter produces a flame. A high-temperature flame is produced by adjusting the oxygen and acetylene valves, according to the welding material and used for welding or cutting the materials.

3. Sketch the following tools/equipment used in gas welding:



a. Acetylene cylinder (red)



b. Oxygen cylinder(blue)



c. Oxygen regulator (blue)



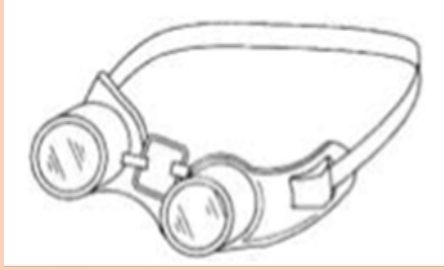
d. Acetylene regulator (red)



e. Spark lighter



f. Welding torch/blowpipe



g. Welding goggles

Extended Reading

Click on the links below to get more information on the topic discussed in this unit.

- <https://www.elft.nhs.uk/sites/default/files/2022-02/Oxygen%20Cylinder%20Guide%20and%20Uses.pdf>
- <https://www.fluidcontrols.co.uk/how-pressure-regulators-work/>
- https://www.google.com/search?q=EXAMPLES+OF+WELDING+HOSES&dq=EXAMPLES+OF+WELDING+HOSES&gs_lcrp=EgZjaHJvbWUyBggAEEUYOdIBCTE1NzU5ajBqNKgCALACAA&sourceid=chrome&ie=UTF-8

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4. [Love, G. \(1980\). The Theory & Practice of Metalwork: London & Edinburgh, Longman.](#)
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8. <https://rdso.indianrailways.gov.in/works/uploads/File/Draft%20Handbook%20on%20Welding%20Techniques.pdf>

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