MODERN WOODWORK TECHNOLOGY: DESIGN AND CONSTRUCTION

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DEDICATION

This work is dedicated to the Almighty God

ACKNOWLEDGEMENTS

We owe thanks and deep gratitude to many individuals for their immense contributions to the successful completion of this project. First, we wish to record professional colleagues' enormous support and encouragement.

In writing this work, the authors consulted many related works in the area, including published and unpublished works. We are grateful to the authors for the wealth of knowledge gained from their works.

Our deep and sincere appreciation and gratitude go to our families for their unflinching support and encouragement, especially their love, patience and understanding. At the same time, we persevered to publish this work. The success of this work also owes much to circles of friends for their forbearance and enthusiasm during a long spell of this work. May God bless these and many more that, in one way or another, contributed to the success of this work.

We also wish to extend our gratitude to Ibrahim Aliyu, who spared enough time to read, make suggestions, provide guidance, and give advice, which helped to make this work a huge success.

Finally, we give all praise, glory, and honour to the Almighty God for his indispensable inspiration and magnificent gift of knowledge, which guided us in putting this work together.

FOREWORD

The book 'Modern Woodwork Technology: Design and Construction' will be warmly received by Vocational and Technical Education (VTE) scholars who have long felt the need for a suitably compiled textbook on woodwork. The various chapters cover the history of wood, workshop safety rules, common basic hand tools, methods and techniques of woodworking power tools, planning and squaring to dimensions, forestry, timber, cross-sectional views of a tree, veneer and veneering, wood fasteners, ironmongery, design concepts, timber finishes, a glossary of technical terms, and essay questions. The main features of the principal styles of period furniture are discussed in some detail.

There are many excellent illustrations specially drawn to elucidate the text. The book will be a useful guide to students preparing for woodwork examinations and will assist everyone who is interested in the creative skills of woodworking. I strongly recommend it for students and teachers in technical education.

I congratulate the authors on the arrangement and general treatment of the subject matter, and I wish this book every success.

PREFACE

In keeping with its predecessor, this second edition of modern woodwork technology has been revised and updated to satisfy the requirements of all users and extend its appeal to an even wider readership.

Any person interested in the subject matter, whether to prepare for NABTEB, WAEC Technical, NECO, or simply as a hobby, will find something of value and interest in these pages. If used correctly, the book will provide a foundation for access to higher levels of craft competence.

I gratefully acknowledge the assistance of Aminu Jibril of the National Examinations Council (NECO) in its preparation.

Hassan, A. M. *(PhD)*

TABLE OF CONTENTS

CHAPTER ONE
INTRODUCTION

Objectives

At the end of this chapter, you should be able to;

i. Explain the occupations in woodworking
ii. Differentiate between:
    a. Carpentry and Joinery
    b. Cabinetry and upholstery
    c. Rough and finish carpentry

Woodworking is one of the occupational disciplines studied in technical institutions in Nigeria. The National Board for Technical Education (NBTE) states that the aim of woodworking technology at technical institutes is to produce trained craftsmen for self-employment or paid employment. Machine operation, furniture construction, upholstery design and construction, carpentry, and joinery are among the skill sets needed for jobs in the woodworking industry. Due to the fast change occurring in each of these fields of woodworking technology, practitioners need to possess adaptable abilities and skills.



Figure 1 a) formwork for plinth **b) decking for upper floor** **c) formwork for lintel**

The names carpentry and joinery are often used as compound words. However, carpenters have different roles from joiners. Carpenters create structural skeletons while adhering to building codes and specifications on site and construct building elements such as formwork (figure 1a-c), walls, roofs, floors, ceilings, billboards, and shoring. There are two categories and several subcategories of carpentry works.

The categories are:

Commercial: Professionals who work in office buildings, malls, retail stores, restaurants, and other commercial buildings (Figure 2).

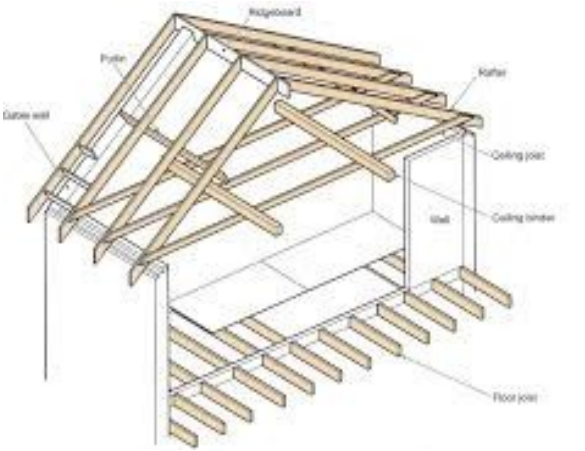

Figure 2: Building frame (Wall, floor, and roof)

Industrial: A highly specialised field. Professionals work on roads, dams, tunnel bracing, and sewer projects.

The subcategories of carpentry work include:

Trim: Install, repair, and fix trim on doors, windows, baseboards, mantels, etc. Any trim that surrounds a door or window is termed casing. It connects the door or window to the wall while serving as

a design element. In some parts of the world, these jobs are tagged finish carpentry.

Cabinet Making: Cabinetry is another type of finish carpentry, intricate work in great demand for high-end builds and remodels (Figure 3a & b).

Figure 3: a) Wardrobe b) Small side cabinet

Green Carpentry: Carpenters specialise in using environmentally friendly materials and practices.

Residential: These carpenters typically focus on new home builds and remodels (Figure 4).

Joinery: is the art of joining woods and other products to construct doors, windows, staircases, mouldings, trims, wardrobes, etc. Unlike framing, this work will be visible outside, so it must be neat, clean, and finely detailed.

Figure 4: Small bungalow

Furniture Construction: deals with designing and constructing office and home furniture for various uses. This may comprise cabinetry (Figure 3b), upholstery (Figure 5), or a combination of both (Figure 6). Fine details and skilled workmanship are required, as are sound materials, sound construction, fitness for use, and aesthetics.

Fig 5a: Full-cover upholstery

Fig 6: Show wood upholstery

Machine woodworking: Wood machinists use machine tools to prepare and process various wood and wood products to produce wood-based articles. The use of both manual and automated machines is involved. Details are discussed under woodworking power tools and methods.

Workplace fundamentals: The need to provide technical college students with workplace fundamentals, thinking skills and abilities that will enable them to be flexible and adaptive to the present and anticipated future changes has arisen as a result of the fast advances in technology. Globally evolving technology has made work environments more adaptable, process-based, and multitasking. This is done to satisfy the requirements of the dominant information society, the extensive use of discoveries and inventions in workplaces, and changes in how labour is organised. In light of this, educational institutions must adapt their curricula to reflect changes in workplaces to generate graduates with the fundamental workplace skills based on the framework of the 4C's, that is, communication, collaboration, critical thinking and creative thinking, necessary for success in the knowledge-based economy and society of the twenty-first century. To reflect changes in the industry, the woodworking technology curriculum also has to be made robust.

Employers in the woodworking industry hire workers with workplace skills who can adapt, apply, and transmit their knowledge to various situations and technology environments. Getting technical college students ready for the 21st century is a challenge. A change in the method of education used to teach woodworking technology in technical institutions is thus necessary to prepare students for the woodworking workplace environment of the twenty-first century. The traditional instructional methods, especially lecture and demonstration teaching methods, though used for so many years in the teaching of woodworking technology, seem today inadequate for equipping students with skills such as creative skills, higher-order thinking skills, and problem-solving skills needed by the students

to thrive as craftsmen in the 21st-century woodwork workplace. Today's workplace environment is multi-tasking and requires the knowledge and use of soft skills and hybrid materials. The consequence of using these methods in teaching vocational subjects such as woodwork technology in technical colleges is that students cannot acquire workplace skills, retain their learning, and apply it in new situations. Moreover, it was maintained that lecture and demonstration methods are inappropriate for teaching and encouraging students to think for themselves in practical-related subjects, including woodwork technology. This could, therefore, be partly responsible for the low achievement of technical college students in woodwork technology examinations and at the workplace when eventually employed after graduation. As researchers continue the quest for finding the most appropriate teaching/learning methods for technical, Vocational Education and Training (TVET), of which woodworking is one, advances in the area of tools, equipment, materials, and processes continue to emerge, making both the education processes and workplace more complex to handle.

Evaluation

1. Explain the occupations in woodworking
2. Differentiate between:
    a. Joinery and carpentry
    b. Cabinetry and upholstery
    c. Rough and finish carpentry

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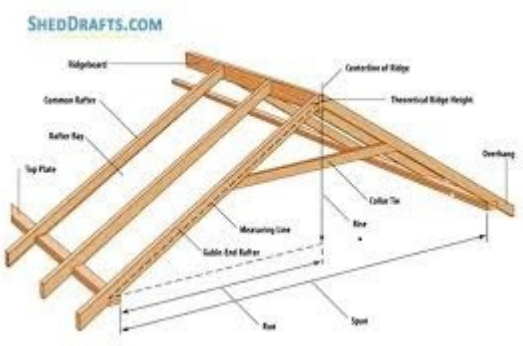
CHAPTER TWO
THE HISTORY OF WOOD

Objectives

At the end of this chapter, you should be able to;

i. Give the history of wood
ii. Explain the kinds of wood

Wood has had a significant impact on human history. It gave the ape-man a place to live, tools, and transportation. His rudimentary shelter, made of young trees wrapped in branches and skins, evolved into a variety of houses, including a log cabin, castle, cottage with timber framing (figure 1), townhouse with half-timbering, chalet, bungalow, and even a trailer. For furniture within the home over the course of many thousands of years, wood was utilised to create a variety of chairs, tables, and beds.



Wood was used to make **Figure 7:** Roof framing

many of man's weapons, including spears, shields, arrows, catapults, battering rams, battleships, and even aircraft. These weapons helped to alter history.

Prior to the invention of the wheel and the use of wood for transportation, primitive man used logs as rollers to carry large loads. Logs were used for a variety of vehicles, including carts, buses, bicycles, galleons, barques, steamships, sleighs, skis, airplanes, and gliders; the list is practically limitless.

Wood has been used as a raw material, accompanied by the development of hand tools for woodworking. It is surprising to learn that many tools' fundamental shapes haven't altered much throughout time. Today's tools and those used by our ancestors share many similarities.

Carpenters, joiners, cabinet makers, coopers, boatbuilders, wheelwrights, patternmakers, sculptors, carvers, and toy makers have all existed throughout history. Every generation gains access to the information and expertise that came before it.

Wood Today

Despite developing many new, 'man-made' synthetic materials, wood remains a very important raw material. Traditional uses in building and the home remain largely unchanged, but technical advances and the demands of modern mass production have led to new methods of working with wood.

The development of machines capable of producing large quantities of manufactured boards, such as plywood, blockboard, chipboard, and hardboard, has enabled designers and engineers to generate new ideas and techniques. Plywood can be used to construct canoes and sailing dinghies that are lightweight yet strong. It can also be moulded to create shells for chairs and

television cabinets. Chipboard and blockboard, veneered with wood or plastic laminates, are employed to mass-produce good quality, affordable furniture and kitchen units. Modern adhesives that provide quick and powerful bonds have facilitated the technique of lamination. Like plywood, laminating involves glueing layers of wood together to form shapes and sizes that are unattainable by any other means.

Figure 8: A half-upholstered seat and bed, handcrafted from Nigerian softwood and finished in gold (Bala Enterprises Nigeria, 2022).

Massive building portal frames can be constructed with exciting sweeps and curves and tremendous strength. Shapes for chair frames and table legs can also be laminated.

In furniture factories and elsewhere, designers have developed a wide range of specialised woodworking machines, including saws of all kinds, planers, sanders, spindle cutters, moulding machines, dowelling and dovetailing machines, hydraulic and pneumatic clamping devices, and specialised heating equipment to expedite the setting of glues.

The home craftsman who performs 'do-it-yourself' jobs around the house now has labour-saving power drills, saws, and sanding machines.

Period Furniture

Because these titles imply the sort of furniture being made, it is useful to divide the years from 1500 to 1800 into the ages of the carpenter, cabinet maker, and designer. Early furniture was created by the carpenter, who saw it as an add-on to his regular duties. As a result, it had the traits of a craftsman experienced in intricate joinery work. The cabinet builder period began shortly after 1660 when certain woodworkers started specialising in creating furniture. Last but not least, in the middle of the eighteenth century, furniture became identified with specific designers and artisans, giving rise to Age of the Designer.

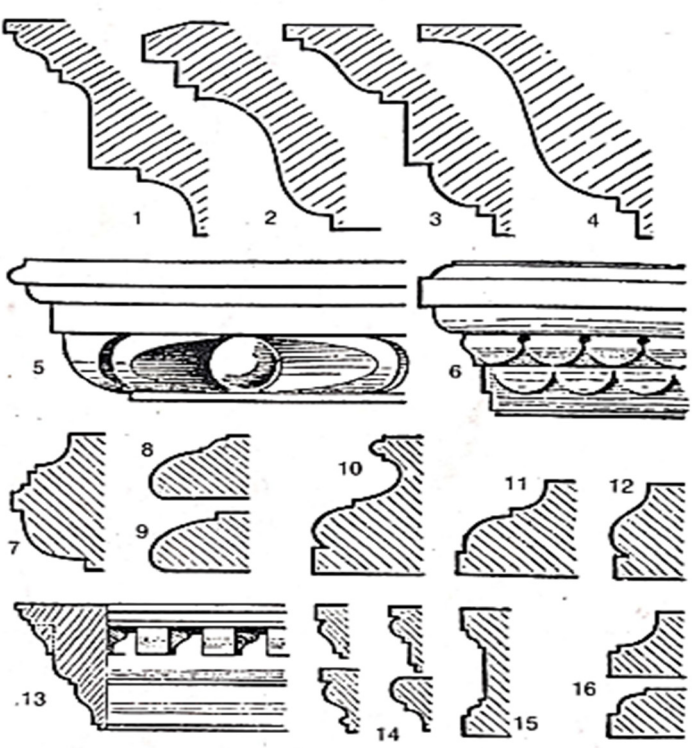


Figure 9: Jacobean period 1603-1660

Jacobean mouldings as applied to furniture were a free and somewhat coarse rendering of the classical.

Nos. 1 to 4 and 13 are cornice mouldings.

Nos. 5 to 7 are surbase mouldings.

Nos. 8 and 9 are table or chest top sections.

Nos. 10 to 12,16 and 17 are suitable for bases.

No. 14 shows panel mouldings, and No. 15 a channeling.

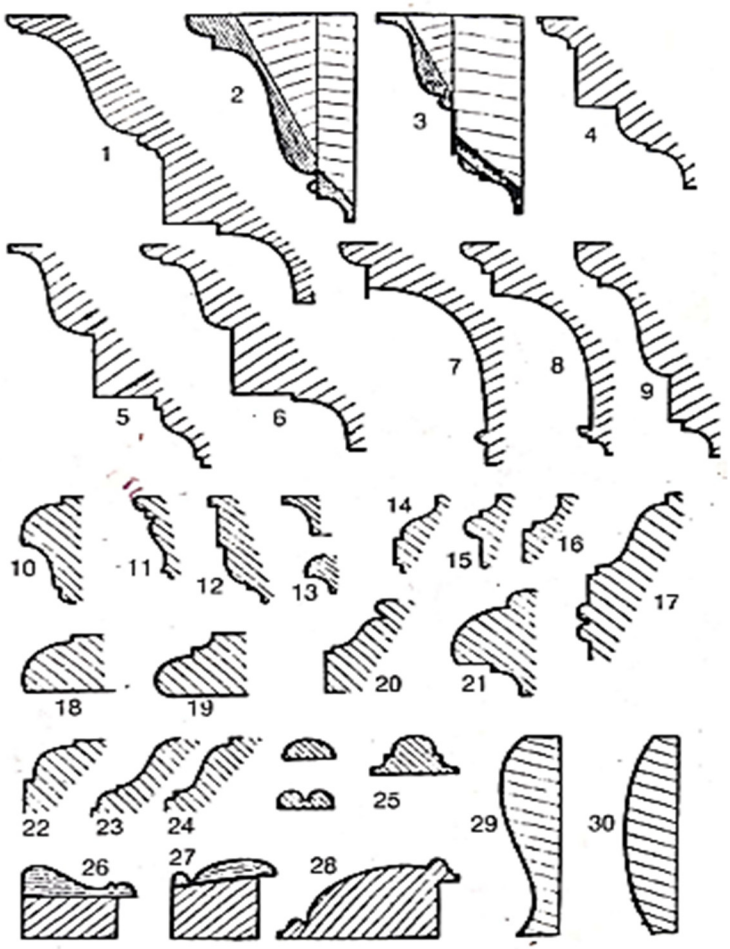


Figure 10: Walnut period 1660-1720

Cross-grained walnut-era mouldings, deeply rooted in tradition, were the standard. They consisted of a wooden core with a thin layer of cross-grained walnut. Veneered components were frequently utilised.

The cornice mouldings are listed from 1 to 9. Tabletop and surbase parts can be found in numbers 10 to 21. Base mouldings are Nos.

22 to 24. No. 25 depicts tiny beads used on drawer edges, barred doors, and similar surfaces. Sections 26 through 28 are numbers for mirror frames. Frieze contours are Nos. 29 and 30.

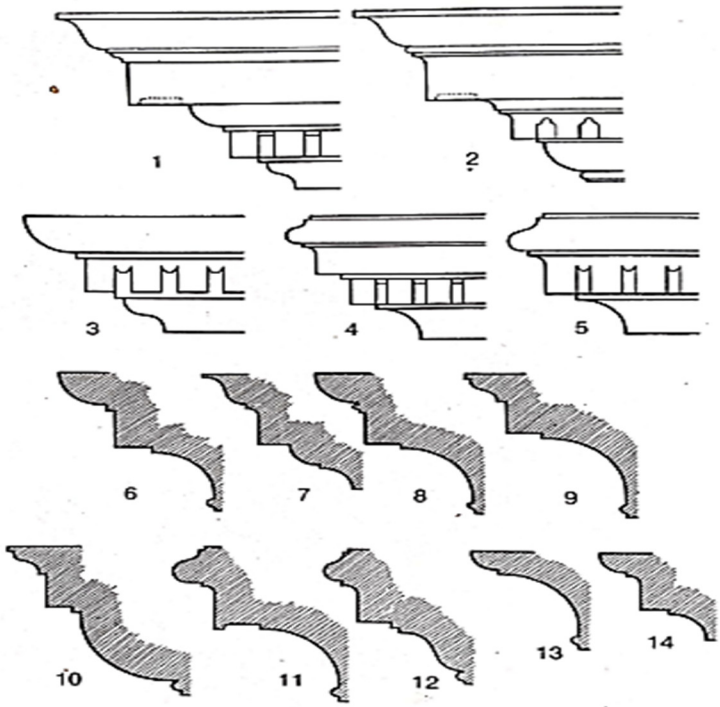


Figure 11: Chippendale period 1745-1780

The majority of the mouldings from this era were based on classical models. Frequently, portions were sliced from the best student work.

The cornice mouldings are listed from 1 to 14, with Nos. 4, 5, 11, and 12 being appropriate for modest height levels.

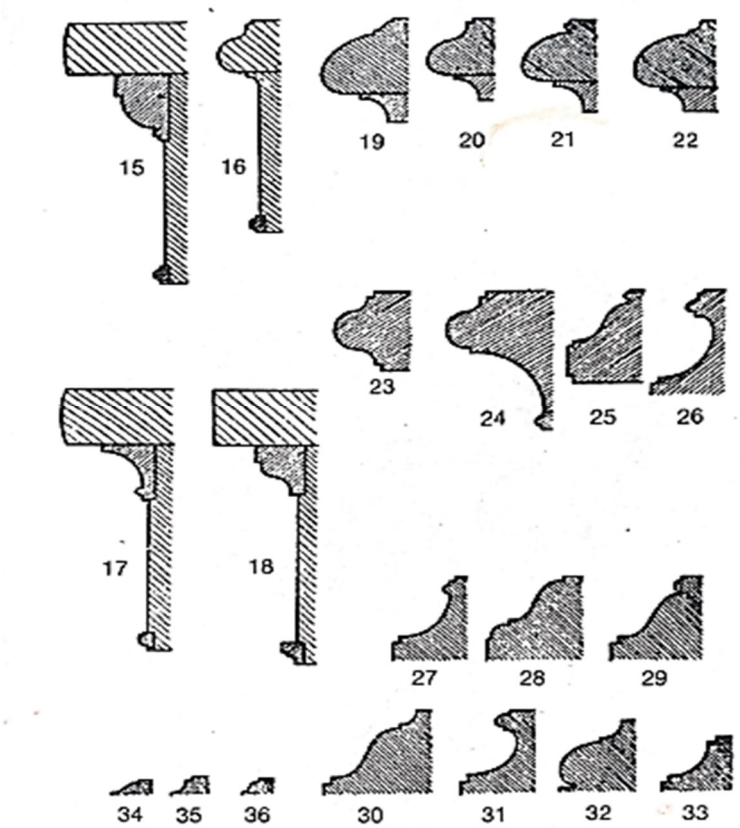


Figure 12: Table sections with frieze rails are given in Nos. 15 to 18.

Nos. 19 to 22 are for tables or low cabinet tops.

Surbase mouldings are shown in Nos. 23 to 26.

Nos. 27 to 33 are base mouldings.

Nos. 34 to 36 are suitable for panels.

The mouldings are taken partly from old furniture and partly from the "Gentleman and Cabinet Maker's Director."

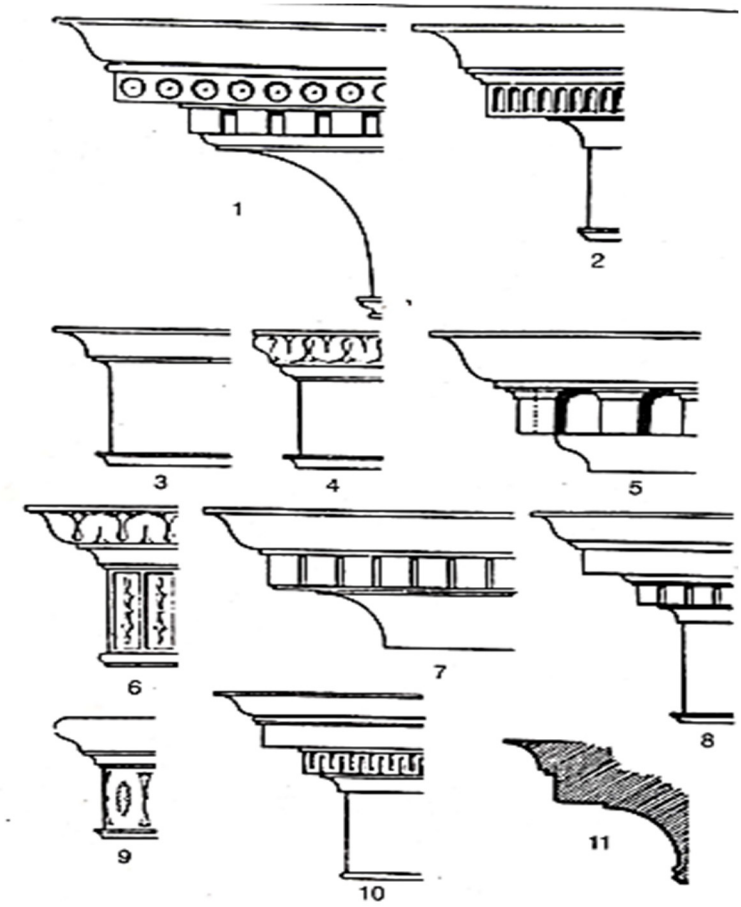


Figure 13a: Hepplewhite period 1760-1790

This type of moulding was based on the classical, but the portions were reduced to fit the relatively small size needed for furniture. Carving in a controlled manner was commonly used.

The cornice mouldings are listed from 1 to 13.

Surbase portions are numbers 14 through 2o.

Nos. 21 to 26 are mouldings for plinths.

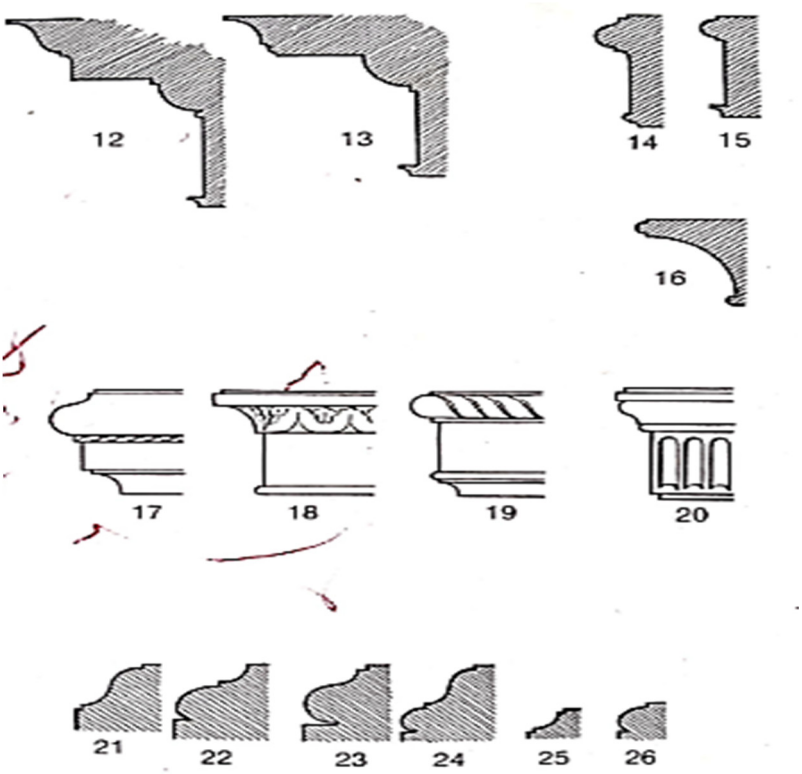


Figure: 13b: Hepplewhite period 1760-1790

Some Hepplewhite mouldings were decorated with inlay rather than carving. This usually took the form of ebony or satinwood lines or cross-banding. Occasionally, the fluted effect shown in 2 was inlaid rather than carved. A recessed appearance was obtained by using a veneer immersed in hot sand to give a shaded effect.

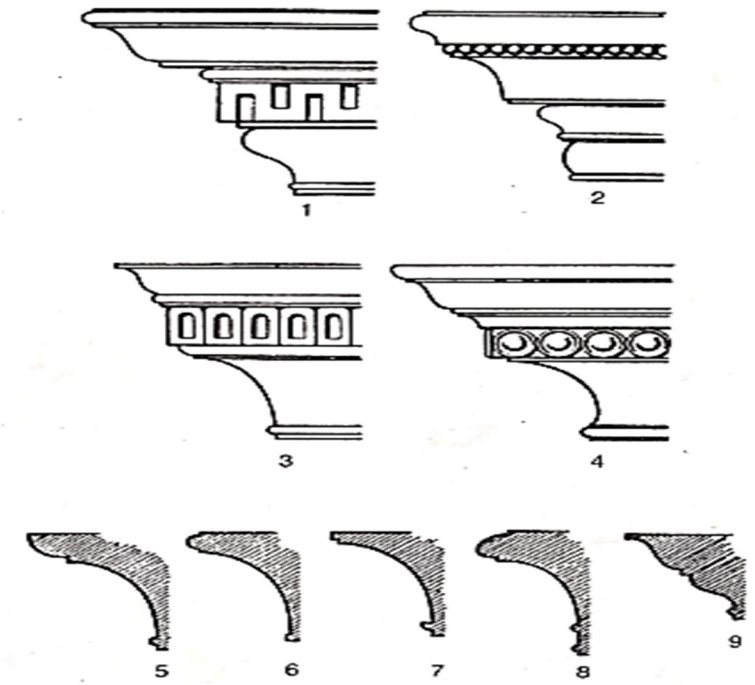


Figure 14a: Sheraton period 1790-1806

Mouldings from the Sheraton era were often finer than those from the Chippendale era. They often took the shape of simple square fillets, frequently with inlaid lines or bandings. To save money, larger cornice mouldings were always backed with wood.

The cornice mouldings listed from 1 to 13 are. Nos. 6, 8, and 12 are particularly well suited for a low cornice that is at eye level or slightly below.

The numbers 14 through 17 provide surbase mouldings.

Table toppers are those between the ages of 18 and 21. Sections 22 through 25 are for bases.

Door mouldings with bars are numbers 26 to 28. It is a shelf mould, No. 29.

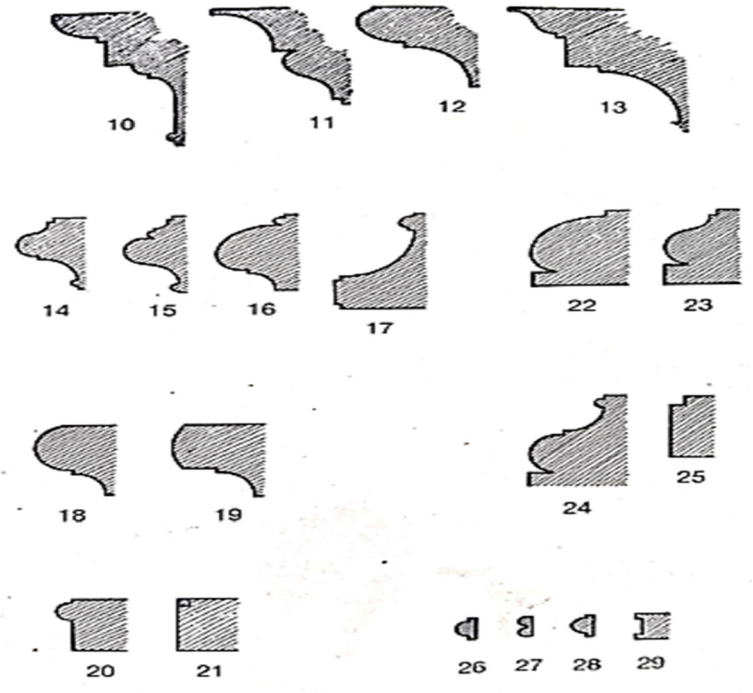


Figure 14b: Sheraton period 1790-1806

In the case of mouldings decorated with carving, the detail was sometimes applied as a strip glued on to a flat surface. Thus, the dentil pattern in 1 and the repeating device in 3 were frequently carved separately and added later, though, in good-quality work, they might be carved in the solid.

Evaluation

1. What do you understand by Period Furniture
2. What do you understand by the age of a designer?

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CHAPTER THREE

SAFETY RULES FOR YOUR WORKSHOP

Objectives

At the end of this chapter, you should be able to;

i. Know general woodworking and workshop safety rules
ii. Know what one should do before using woodworking machines
iii. Select and use various safety gear

The woodworking business is intriguing and may provide a very rewarding career or hobby. However, some regulations must be observed to ensure everyone's fun and safety, just like in most enterprises and pastimes. Safety must always come first to prevent mishaps when using tools or equipment. One must also understand that all hand tools, portable power equipment, and woodworking machines have a specialised application in a woodworking environment to achieve optimal safety. Additionally, if misused, each piece of equipment has its unique risks. To ensure personal safety, maximise enjoyment, and create projects that one can be proud of, one must become knowledgeable about their usage and upkeep.

Although the guidelines listed below are extensive, they are not meant to be all-inclusive. When working, one must constantly utilise common sense. It is better to wait until you have more knowledge before moving forward with a certain "set-up" or if you are highly concerned about your safety when using a piece of equipment. Accidents sometimes happen, even to the most informed and safety-conscious individuals. Still, the likelihood of an accident will be considerably reduced if you read, comprehend,

and abide by the safety precautions described and, where necessary, use safety gadgets. These remarks are not intended to incite fear but to promote a healthy respect for all tools used and prevent mishaps.

General Woodworking and Workshop Safety Rules:

1. only utilise equipment and tools for woodworking that you are familiar with or have been taught how to use.
2. Before using an item or equipment, ensure you have read and comprehended the owner's manual.
3. Always utilise safety gear (Figure 8: Safety gear) suitable for the tool or equipment, such as dust masks, face shields, goggles, and hearing protection.

Figure 15a: Safety gear for woodworking

4. Wear the proper attire. Avoid donning gloves, ties, scarves, loose-fitting clothes, or jewellery when near moving machinery. An apron over a T-shirt or Short-sleeve shirt (Figure 15b) is unique. Additionally, avoid going barefoot

Figure 15b: Apron

or wearing sandals with exposed toes within the store. Gloves should only be worn momentarily when handling or stacking raw timber for storage.

5. Keep all distractions to a minimum. Don't tune on to the radio. If you must speak to somebody, turn off any devices you are using.
6. debris, oil spills, and pieces of wood. To remove sawdust or wood shavings from a machine or work area, always use a brush and don't touch the cutting blade if the machine is in motion.
7. Always ensure the safety guards are set up and functioning correctly for all utilised equipment.
8. Avoid standing in water or using any electrical equipment while it is raining or unpleasant.
9. Ensure that all equipment is correctly grounded and earthed before usage.
10. employ the right tools and supplies for the job whenever possible. Never use a tool or accessory not made for a specific machine.
11. Before working on a machine, always examine the stock and remove any nails, screws, staples, loose knots, or other flaws.
12. Make sure the switch is off before plugging in a device. Additionally, ensure that the ON/OFF switch is easily accessible.

13. When using the equipment, keep the power wires out of the way. Electrical lines should not be laid across the floor to avoid tripping. If possible, install wiring or power cords above or below the floor. If an extension cable must be used, be sure it has a ground socket and the right wire size.
14. Pay constant attention to the task at hand. Avoid daydreaming while working, and keep your hands and fingers safe from whirling components and blades.
15. Push the stock onto the cutting area using a push stick whenever feasible.
16. Always grip the material firmly When drilling, sanding, or cutting.
17. Never modify something while the power is on. If you can, disconnect the device before changing the blades, bits, drive belt, etc.
18. Before using any drills, bits, blades, or other tools, ensure that they are in good operating order and sharp.
19. Lighting is crucial. It's essential to be able to see scales and measuring tools clearly, as well as see drills, bits, and cut lines on wood stock.
20. Wait for a machine to reach maximum speed before using it.
21. You should never leave a running machine unattended. Once it has completely stopped, turn off the power.
22. If a machine does not sound properly or emits an odd scent or smoke, switch it off immediately and investigate the issue before reuse.
23. Avoid risky activities where a slip might send your hand slamming into a blade or cutting equipment.
24. Ensure that no spills or debris on the floor might result in an accident.

25. Aim to avoid standing behind any stock that is being cut, planned, or joined. There is a chance of significant harm in the case of a kickback.
26. Keep all machinery, tools, and equipment greased, sharpened, and in good working order.
27. Store used greasy and discoloured rags in a metal container with a lid. This will reduce spontaneous combustion.
28. Always keep an ABC class fire extinguisher handy. All types of flames will be put out using the ABC class.
29. Toss out or hone worn-out cutters, chisels, blades, drill bits, lathe tools, etc. Dull tools may not produce the desired level of work and may cause mishaps.
30. Store wood safely and dryly. Timber should never be kept close to tools or workspaces.
31. Keep scrap materials or little stock that could be used for future projects in a wooden box.
32. If feasible, use an exhaust ventilation system to clear the machinery of chips and sawdust.
33. Never use substances that would impair eyesight or judgment in a workshop setting, including alcohol and drugs.

What should you do before using woodworking machines?

If not utilised correctly, woodworking machine tools may be harmful.

- Only operate woodworking equipment you have been taught to safely and correctly.
- Carefully read the owner's handbook.

- Before using any tool or equipment, understand the directions.
- If you have concerns about safely performing the task, ask questions.

What safety procedures should you follow when using woodworking machines?

- Always use a face shield while wearing safety glasses, goggles, or both.
- Wear hearing protection appropriate for the volume and frequency of noise you are exposed to in the workshop. If you can't hear someone speaking from three feet away, the machine's noise level is excessively loud, and you might have hearing loss.
- When handling wood, wear gloves to protect your hands from splinters, but keep them away from whirling blades and other equipment components where they may catch.
- When necessary, put on protective footwear.
- Before using any machinery or equipment, ensure the protection is in place, functional, and effectively protects the machine. Examine and adjust all other safety equipment.
- Before using the device, confirm that it is correctly earthed.
- Before turning on the power, remove all keys and adjustment wrenches from the machine.
- Before cutting, routing, or performing similar operations, check the stock for nails or other objects.
- Ensure that START and STOP buttons are quickly and conveniently accessible to operators on all equipment. START buttons need to be secured so that the machine won't start by accident. It is advised to place a collar around the button 1/8 to 1/4 inches (or 3 to 6 mm) above it.

- Ensure that all blades and cutting implements are clean, sharp, and in good functioning condition so that they may cut naturally rather than with effort.
- Before checking, replacing, cleaning, adjusting, or repairing a blade or a machine, turn off the power and remove the power cable (or lock out the power source). Also, when discussing the project, switch off the electricity.
- To move material into the cutting area, use a "push stick." Jigs help ensure the safety of hands when cutting. Keep your hands away from the cutting blade's path.
- When drilling or milling, clamp all work parts down and secure them.
- Use sufficient illumination to make the workpiece, cutting edges, and machine controls visible. Lighting sources should be placed or covered to prevent glare and reflections from hitting the operator's eyes.
- Check that there is enough room on the floor around the equipment so that you may safely machine the size of the work item being processed without running into other people or machinery.
- For big work items, use extension tables or roller supports. Supports are needed on both the infeed and outfeed sides.
- To remove created sawdust or chips, woodworking equipment should be equipped with effective and well-maintained local exhaust ventilation systems.
- Electrical wires should not be tripping hazards, be above head height, or be buried in the floor.
- Maintain a clutter-free, spotless, thoroughly swept, and well-lit workspace. Spills need to be cleaned up immediately. Floor surfaces must be flat and non-slip. Good housekeeping

procedures and workplace design will reduce the number of slips, trips, and fall-related injuries and accidents.

What should you avoid when working with woodworking machines?

- Keep loose clothes, work gloves, neckties, bracelets, rings, and other jewellery that might get tangled in moving body parts.
- Steer clear of clumsy movements and hand postures where a slip might slam your hand into a cutting instrument or blade.
- Never hand clean up sawdust or debris from the cutting head when a machine operates. When the machine has stopped, use a stick or brush.
- Never use compressed air to clean sawdust, turnings, or other debris off equipment or clothes.
- Never leave machinery running unless specifically built and intended to be operated while unattended. Never leave a machine until the power has been turned off and it has completely stopped.
- Do not shock or distract an operator when operating woodworking equipment.
- Do not attempt to remove a stopped blade before turning the power OFF
- Horseplay ought to be outlawed. Injury may result from it.
- The employee in charge of the workshop will make sure that all necessary safety precautions are taken. He will assist in supplying recommendations and guidelines as required and conduct routine workshops audits to check for adherence to set norms. Any powered equipment must only be used by those who have been appropriately trained and approved.

For workshops that are intended to be used by students:

1. The selected staff member is responsible for conducting and documenting training. The training process should include both classroom education (which should include reading the operator's Manual for each piece of equipment) and practical competence training.
2. Training shall be recorded, and the department will be in charge of keeping records.
3. Workshops must be kept tidy and in good condition.
4. Workplace safety regulations must be posted.
5. Horseplay is not allowed.
6. Machines must be checked before usage:
    a. Machines should NEVER be used if no guards are in place.
    b. Machines should be placed out of service if:
        1. Guards are missing or damaged.
        2. The machine is damaged or not operating correctly.
        3. Power cords are damaged, or the plug is not properly earthed.
7. Use the proper equipment for the task. Avoid attempting to use a tool or accessory for a task it was not intended for.
8. Wear the right clothing. It is not recommended to wear anything that may get caught in a moving object, such as loose-fitting clothing, gloves, jewellery, watches, ties, ID badges, or anything else dangling. A protective head covering, such as a hair net, should be used with long hair.

a. Never wear open-toe shoes - Use closed-toe shoes in the shop.

9. In a workshop, no student should operate a powered piece of machinery alone. Use the buddy system when shopping.

10. The operation hours of workshops should be specified and advertised.

11. Never operate a powered device when intoxicated. This includes times when you are ill, overly exhausted, upset, rushed, or taking medicine that might make you sleepy.

12. Never be afraid to ask for assistance. When in doubt about a tool's safe use or any other part of a work, always ask. Ask workshop staff to examine any tools or projects you are unsure of. Make sure to be clear and use common sense before beginning work.

13. All injuries should be evaluated, and first aid or proper medical care should be given immediately.

Evaluation

1. Explain why safety in a workshop is so important
2. What main safety rules would you recommend for a workshop?
3. Describe the steps that should be taken when someone receives a cut in the workshop

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CHAPTER FOUR
COMMON BASIC HAND TOOLS

Objectives

At the end of this chapter, you should be able to;

i. Give classification of hand tools

ii. Uses and care of hand tools

iii. Explain the uses of workbenches and their appliances

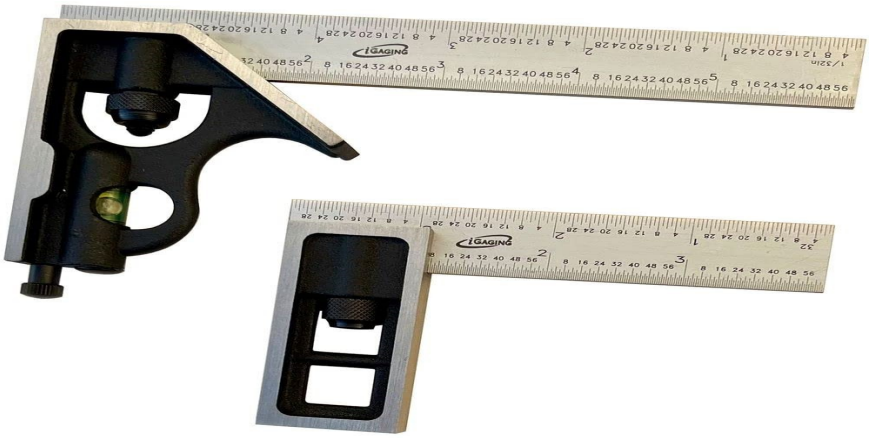
You need a collection of high-quality tools to become a competent technician, such as a craftsman, carpenter, or joiner. A high-quality tool will always function as intended, and if used appropriately and by a skilled user, it will do each task swiftly and effectively.

As a consequence of experience, the young woodworker must be able to handle his or her tools correctly. He or she must be able to identify each tool, know its name, and be aware of what it is capable of. He or she must also maintain them in proper working order.

Classification of Hand Tools

Layout, marking and measuring, tools

Figure 16a combination square & **b:** Try square



c) combination square & d) Try square

Tape measure: A typical tape measure is made of thin, flexible steel and has graduations for imperial and SI (millimetre, centimetre, and inch) units of measure.

Saws: These are used for cutting timber to size and shape with minimal waste and effort. A saw cuts the wood by taking out small pieces in the form of dust called "**Saw Dust**". The cut made by a saw in the wood is called 'Kerf'. Saws are divided into four groups.

Table 1: Hand-saw classification

	1	**2**	**3**	**4**
	Hand saws	**Back saws**	**Tension saws**	**Miscellaneous saws**
I	Rip	Tenon	Coping	Pad or Keyhole
II	Half-rip	Dovetail	Bow	Compass
III	Crosscut	Light-back	Fret	Next of saws
IV	Panel			

Hand Saws

1. **Rip Saws:** Teeth are shaped like tissue edges. They are used for cutting with the grain of timber (Figure 16).

Figure 16: 8TPI Rip saw

Half-rip Saw: This is similar to a rip saw but smaller. Because of its smaller teeth, it is used for fast ripping.

Crosscut Saw: It has pointed teeth with knife-like teeth edges but smaller than those of a rip saw. It is used for cutting across the grain of thick timber; it could be used for ripping thin wood (Figure 17).

Figure 17: 12TPI Panel saw

Panel Saw: Teeth similar to crosscut saw but smaller. It is generally used for cutting thin timber across the grain (Figure 17b).

Back Saws

Tenon Saw: It has a brass or steel for strengthening or it is folded over the blade buckling. It has a closed handle. It is used for general bench work (Figure 18).

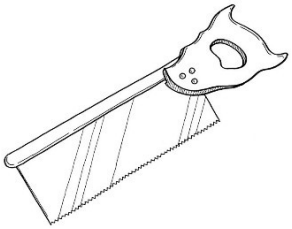


Figure 18: Tenon saw

Dovetail Saw: This is similar to a tenon saw but smaller and sometimes has an open handle. It is used for fine and very accurate joints and light sawing (Figure 19).

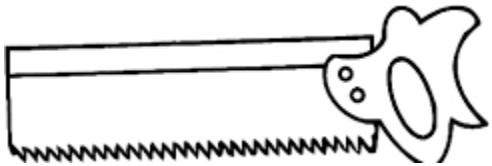


Figure 19: Dovetail saw

Light-back Saw: It has a very small, thin blade with steel or brass on the back. It is the smallest of the three saws. Its handle is plain, rough, like a chisel handle. It is used where extremely fine, accurate work is required, e.g., dovetail, cutting veneer, etc. (Figure 2o).

Figure 20: Light-back saw

Tension Saws

Coping Saw: It has a very fine, thin blade held by a spring steel frame. The blade is tensioned by turning the handle on the stud

holding the blade. It is used for cutting flat or sharp curves in thin timber such as plywood (Figure 21).

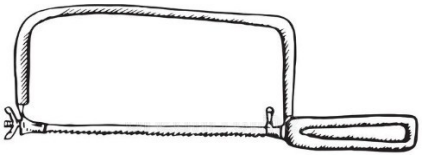


Figure 21: Coping saw

Bow Saw: The blade is held in a wooden frame made of beech. Tension is applied to the blade by means of turning the CORD and winding LEVER. It is extensively used for external curve cutting in fairly thick timber (Figure 22).

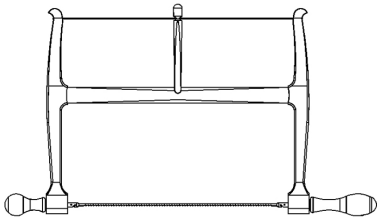
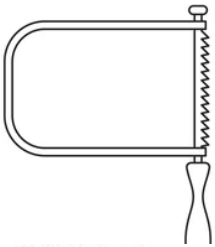


Figure 22: Bow saw

Fret Saw: It has a blade similar to a coping saw but with finer teeth. The blade is held in a rectangular spring frame. It is used for cutting curves in thin wood, giving a clean cut without splintering. It can be used farther from the edge than a coping saw (Figure 23).



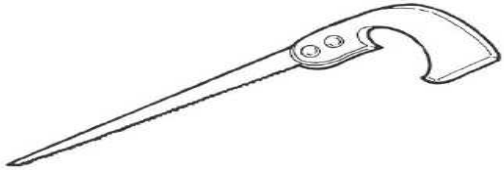
Miscellaneous Saws

Pad or Keyhole Saw: It has a narrower blade than the compass saw and is fitted with a round handle. It is mainly used for internal curves where the bow saw cannot be used (Figure 24).

Figure 23: Fret saw

Figure 24. Keyhole saw

Compass Saw: A narrow blade fitted to a shaped open handle. It cuts large interior and exterior curves (Figure 25).



Nest of Saws: They consist of three separate blades and one inter-changeable opened handle (figure 25).

Blades: a. Pruning blade – used for straight and large flat curves.

b. Compass blade – for sharp curves and

c. Keyhole blade – for sharp curves.

Figure 26: Nest of saws

Chisels: They are used for cutting mortises and pairing general work. All chisels consist of two main parts: the Handle, made of tough timber (usually ash or beech) or plastic, and the Blade, made of tool steel. The blade may be secured to the handle by means of

a Tang. Chisels with wooden handles usually have brass or iron Ferrules at one or both ends to prevent the wood from splitting. Never use a hammer to hit chisels. Chisels are divided into three groups:

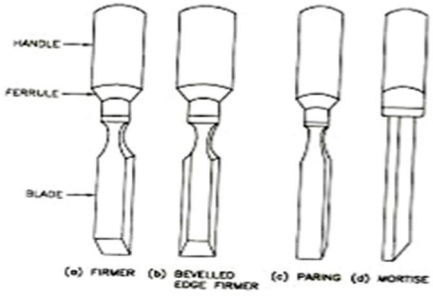
I. Firmer chisels,
II. Mortise chisels and
III. Paring chisels.

Firmer Chisels: This is fairly strong and can be used for light chiselling with a mallet. The blade is rectangular in section.

Mortise Firmer Chisels: For heavy work such as mortising, where the use of a mallet is necessary, a firmer chisel with an end of the wooden handle is a stronger pattern (Figure 27a).

Bevel-Edged Firmer Chisel: It could be included in pairing chisels. It is more convenient for paring and lighter work. Two edges of the blade are beveled along the length, thus making the blade lighter and thinner at the edge (Figure 27b).

Paring Chisels are most suitable for all pairing work, such as finishing joints. They are also used by pattern makers for paring complex shapes of wooden patterns. They are available in different sizes. The blade is longer than the rest of the chisels and should not be used with a mallet or a hammer (Figure c).



Mortise Chisels: For extra heavy mortising. The blade is thicker and stronger than other chisels. It can withstand the blows of the mallet and leave out the curse of mortises (Figure 27d**)**.

Figure 27a-d: Chisels

Hammers: These are used to strike nails into the wood (timber). Hammer handles are usually made from ash, an elastic wood. Hickory is generally used to handle heavier tools such as sledges and axes. In recent developments, handles for hammers have been made of plastic. They are of different types and sizes.

i. Claw Hammer,

ii. Warrington Hammer, and

iii. Ballpein Hammer.

Claw Hammer: It is used for heavy work, e.g., in carpentry, where large nails need to be driven into the timber (Figure 28).

Figure 28: Claw Hammer

Warrington Hammer: Used for general cabinet work and light hammering (Figure 28).

Figure 3o. Ball pein hammer

Ballpein Hammer: mainly used by metal workers for forging or bending (Figure 30).

Figure 29: Warrington hammer

Planes: Planes consist of a piece of sharpened steel called the **Cutting Iron** (blade) fitted into a wooden or metal stock. They are used for smoothing the surface of timber by reducing the wood to the required size by taking off thin shavings. There are various types of planes for different purposes. They are designed to serve their purpose of planning.

Planes may be divided into the following groups:

1. Bench Planes: used for producing flat or plain surfaces include:

Jack Plane: It is used to smoothen or remove saw marks from rough timber and reduce it to the required size quickly (Figure 31).

Figure 31: Jack plane

Try or Jointer Plane- used after jack plane to produce true flat surfaces and perfect straight edges (Figure 32).

Figure 32: Jointer plane

Smoothing Plane: This tool is used for cleaning up the surfaces and edges of members ready for assembly (Figure 33).

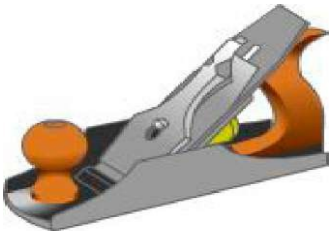


Figure 33: Smooth plane

2. Curve Cutting Planes: used for producing curve surfaces and edges.

Spoke Shaves: There are two types of spoke shave.

- **Flat Faced** – for smoothing flat or convex edges and narrow surfaces (Figure 34).

Figure 34: Flat-faced spoke shave

- **Round Faced** – for smoothing concave edges (Figure 35).

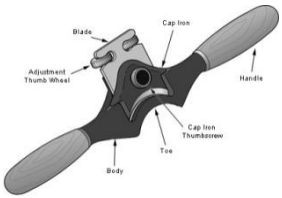


Figure 35: Round-faced spokeshave

3. Compass or Circular Plane: used for smoothing curved surfaces and edges, which are TRUE ARCS of a circle (Figure 36).

Figure 36: Compass plane

4. Special Purpose Planes: used for making rebates, tongues and grooves.

Rebate Plane: used for planning or finishing rebates (Figure 37).

Figure 37: Rebate plane

Fillister Plane: There are two types (side fillister and sash fillister), which are both used for planning rebates (Figure 38).

Figure 38. Fillister plane

Bullnose rebate plane: used to clean up rebates and stop rebates and chamfers (Figure 39).

Figure 39: Bullnose Rebate Plane

Plough Plane: for cutting grooves along the grain of faces or edges (Figure 40).

Figure 40: Plough Plane

Router Plane (Old Women's Tooth): used to surface the bottom trenches and produce uniform depth (Figure 41).

Figure 41: Router plane

Multi-Purpose Plane: can be set up as special purpose planes.

Combination Plane: This plane is the smallest and lightest of the multi-purpose planes. It contains many types of planes and cutting irons in place of all special-purpose planes (Figure 42).

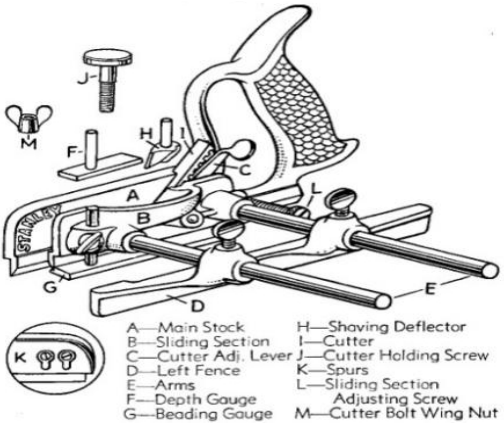


Figure 42: Combination plane

Screw Drivers: They consist of an alloy steel blade and a handle used for driving screws into the wood or metal. They are mainly of two types but of different sizes.

Phillips Head: Commonly called “star screwdriver” (Figure 43), used to fix or loosen Phillip’s head screws.

Figure 43: Phillips head screwdriver

Flat Head: Commonly called “flat screwdriver” (Figure 44), used to fix or loosen flat head screws.

Figure 44: Flat screwdriver

Both screwdrivers are used to drive screws into the wood or metal. The type of screw head usually determines the type of screwdriver to be used.

Woodworkers' Bench and its appliances (Figure 45).

Bench: It is made of wood (red beech preferably) and used to support the job while setting it out. The centre part of the bench's top is lower and is called the tool well. Tools in use are laid out neatly in the well, and those not in use should be kept in the tool rack or taken to the store. The bench should be protected from damage by putting a piece of waste wood underneath the work while sawing, nailing, screwing, drilling or chiselling (figure 45)

Figure 45: Woodwork Bench

Vice: Fitted at the side of the bench, and used for holding the wood for a job. The jaws of the woodworkers' vice are lined with wood and should not be damaged by gripping metal objects (figure 46).

Figure 46. Bench vice

Bench Stop: used to prevent the work from slipping while planning the face (figure 47)

Figure 47. Bench stops

Bench Hook: used for holding the job while sawing, pairing and/or preventing the bench from damage (figure 48). The stock is held firmly with the palm against the inner face of the stopper while it is being worked.

Figure 48. Bench hook

Tool Rack: fixed at the ends of the bench or attached to a wall and used for keeping tools not in use (figure 49).

Figure 49 Tool rack

G - Cramp: a metal cramp used for holding the job to the bench while sawing, chiselling and glueing two pieces of small parts together (Figure 50).

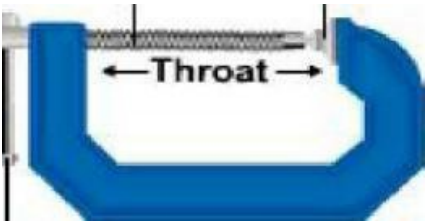


Figure 50: G-cramp

Files:

Files have shaped blades, including tapered, parallel-edged and blunt. They are available in flat, square, round, half-round, and triangular shapes. Files have a distinctive bit and feel when in use. However, it is advisable to hold the file at both ends once it has been stroked over the surface of the wood to start cutting (Figure 51).

Do not attempt to force the file into the material because this causes “ploughing” (a series of irregular grooves). The workpiece should be held in a vice, lifting the file on its return journey because it cuts on the forward stroke. Attempting to do any

prolonged filing with a handle-less file is dangerous. Handles are cheap enough, and they are supplied in any size to fit the vast range of files.

Figure 51: Files.

Care for Files: The finer-cut files may clog up with the material if they are in constant use, and it is a good idea to use a wire brush (file card). A brick brushing across the cut of the file will remove any debris and restore the tool to its efficiency.

Types of cuts

1. **Single-Cut File:** Have straight-edged teeth at an angle, it gives a smooth surface.
2. **Bastard-Cut File:** This file has teeth across the basic cuts, creating points rather than cutting edges. It is used to rapidly and efficiently remove waste material but produces a rough surface.
3. **Rough-Cut:** It is like a series of small chisels. The cutting action on wood is harsh. It takes time to smooth out the grooves the teeth make, but it is very helpful for coarse work.

4. **Second-Cut File:** It has widely spaced teeth. It is used mainly for metalworking but could also be used when working with hard, resilient wood.
5. **Smooth-Cut File:** As the name implies, it can remove roughness and impart an even bevel to an edge.

Rasps

Rasps are very similar to files, differing primarily in how the cutting edges are formed. Instead of ridges, a rasp has individually raised teeth. The roughest and fastest way to remove material is through wood rasps. They leave behind an extremely rough surface and are either circular or half-round in cross-section. The cabinet rasp comes next on the spectrum of smoothness. These resemble wood rasps; except they have wider curved radii and slightly finer teeth. The most common rasp used by woodworkers is the patternmakers' rasp. It has randomly spaced, individually raised teeth all over its face. They are much finer than the other two, and the random distribution results in a fast cut while still leaving a relatively smooth surface behind (Figure 52).

Figure 52. Rasps.

Evaluation

1. With the aid of sketches, show the difference between a Bevel edge chisel and a mortise chisel. When is each used?
2. Make a labelled sketch of a claw hammer and state the function of each central part. What advantage does the claw hammer have over the Warrington hammer?
3. Name four holding devices in woodwork and state the specific use of each/

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CHAPTER FIVE

WOODWORKING POWER TOOLS AND METHODS

Objectives

At the end of this chapter, you should be able to;

1. Define machine tools
2. Give steps for sharpening the blade
3. Give safety in workshop

Hand and power woodworking equipment are crucial to your job as a woodworker. You must be able to efficiently handle and maintain a wide array of field and workshop tools if you want to become a professional woodworking artisan. You must choose and utilise the appropriate instrument for the task at hand if you do your work swiftly, accurately, and safely. Without the right equipment and know-how, you lose time, work less efficiently, and risk hurting yourself or others. Power tools are not only necessary for completing specific tasks, but they also contribute significantly to your regular work activities. Remember that you are in charge of being aware of and adhering to any safety measures that apply to your tools and equipment. You must utilise the hand and power tools to become proficient with them. For further information, you should also review the operator's and maintenance manuals provided by the manufacturer for any tool you use.

Machine Tools

When using various power tools, one must learn and refine one's abilities and practices to become a skilled woodworker. The most

popular power tools found in a woodworker's workshop or utilised on a job site are addressed while considering the safety measures that apply to the specific power tool. It should be reminded that using power tools for woodworking can be risky, and everyone is responsible for their safety.

1. Shop Radial Arm Saw

A cutting device called a radial arm saw has a circular saw placed on a movable horizontal arm. It has so many applications that it is appropriately called its workshop. It has a steel column that rises above a metal platform. An arm stretches out from the column, holding the saw and allowing it to be swung in all directions, making it suitable for conventional straight sawing, cross-cutting, and beveled work when tilted.

The saw can be moved along the arm, giving it a wide scope. There are two main types:

1. The single arm.
2. The double arm.

The size of this machine is determined by the distance the saw can move along the arm and the target diameter of the blade it can use. To fix this blade, the teeth point away from the operator. Figure 3.1 illustrates a typical shop radial arm saw.

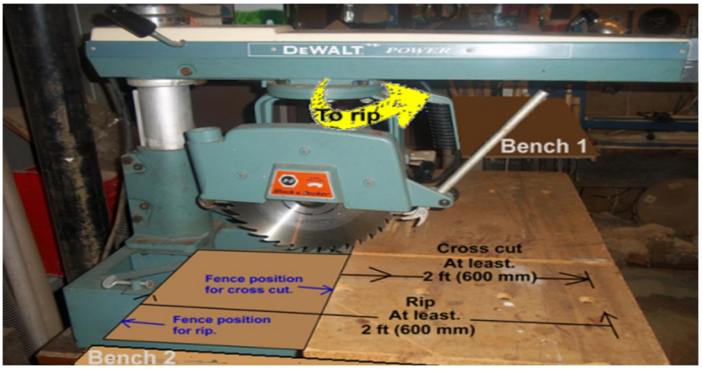


Figure 53. A shop radial arm saw

Radial Arm Saw Safety

1. Tie back long hair and remove or secure loose garments such as long sleeves, jackets, and neckties.
2. Avoid donning gloves.
3. Take off any jewellery, including bracelets and finger rings.
4. Put on ear and eye protection of industrial grade.
5. Keep debris, sawdust, oil, and grease away from the area where the saw is used. The section of the floor where the operator stands should employ anti-skid strips.
6. Before beginning work, inspect the saw blade for fractures and missing teeth. Ensure that the blade is installed correctly. Keep the saw blade and cutting-edge tidy.
7. Don't use the saw without your instructor's authorisation.
8. Before using the saw table, make sure any hand tools and loose stock have been removed from it.
9. Never remove wood scraps or leave the radial arm saw before turning off the power and ensuring the blade has stopped revolving.
10. Before changing the blades, turn off the electrical service at the source.
11. There should always be guards present and in use.
12. Give the task at hand your full attention. Use the radial arm saw silently, avoiding conversation or "horseplay."
13. Avoid difficult work positions, as they may lead to slips that might cause the saw blade to contact the ground. Before starting to see, choose a comfortable position.
14. Before cutting, check the stock for loose knots, screws, and nails.
15. always draw the saw gently through the stock to ensure complete control. You might need to hold the saw back on thick stock since it tends to pull itself into the job.

16. After the cut, put the saw back behind the table before taking out the stock. The radial arm saw should be equipped with a safety return spring mechanism that triggers an automated return to the back of the table.
17. Before cutting, ensure the material is tightly clamped to the guide fence and table. Support lengthy stock parts.
18. Keep oil and debris off the blade and arbour flanges.
19. Check that all locking handles and clamps are securely fastened before using the radial arm saw.
20. Lock the saw yolk in place so it cannot advance when the power is switched on.
21. let the saw achieve its maximum speed before beginning a cut.
22. always stand with your body and face to one side of the blade when using a saw.
23. Never saw a stock that is less than 12 inches long.
24. Do not stop the blade by letting it cut into a board after the power is turned off.

1. Tilt-Arbor Table Bench Saw (Circular Saw)

An arbour tilt table Bench saw (Figure 54) gets its name because the arbour may be tilted to cut bevels on the saw blade. The tilt handwheel operates the arbour, which is positioned below the table. The table was slanted in older models of bench saws, and the saw blade stayed stationary. Most contemporary table saws are of the tilt-arbour variety, and a canted (tilted) saw table is dangerous in numerous ways.

Remove the cut-off gauges and place the rip fence at a distance from the saw equal to the required width of the piece to be ripped off to rip stock. The item is passed through using the fence as a guide, with one edge against the barrier.

Set the ripping fence to the outer edge of the table, away from the stock to be cut, and the cut-off gauge at 90 degrees to the line of

the saw to cut Stock Square. After that, feed the item through by moving the indicator down its slot while holding it firmly with one edge against the cut-off gauge. Similar steps are used when cutting stock at an angle other than 90° (known as mitre cutting), except that the cut-off gauge is adjusted such that the piece will be brought to the required angle along the saw's line.

The saw blade should reach 1/8 to 1/4-inch over the top of the table for routine ripping or cutting, plus the thickness of the material to be sawed. The cut hand wheel's depth, depicted in Figure 3-2, adjusts the saw's vertical position. The tilted hand wheel regulates the saw blade's angle. The guard must remain in place unless removal is necessary.

The throat is the opening in the table through which the saw blade extends. The neck plate is a small, detachable portion of the table that houses the throat. When removing the saw blade requires a wrench, the throat plate must be removed.

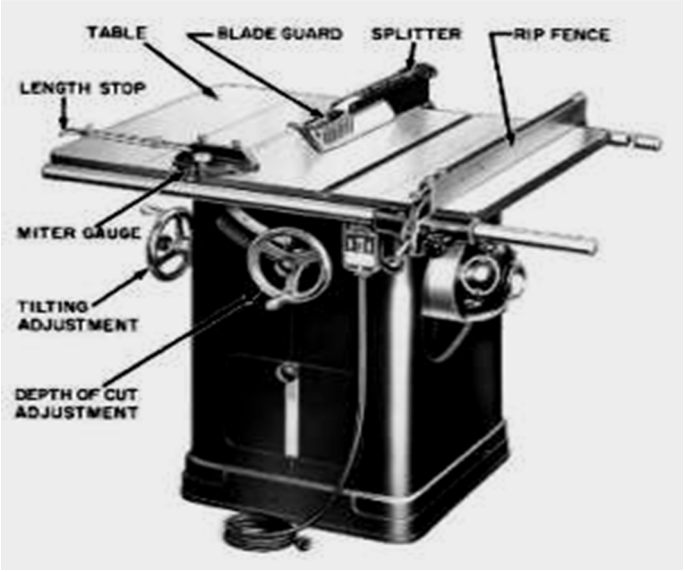


Figure 54: Tilt-arbor bench saw

The arbour nut secures the blade to the arbour. A saw typically has many throat plates with throats of different widths. A bigger throat is necessary when a dado head is used on the saw. A dado head comprises two outside grooving saws, similar to combination saws, and as many intermediate chippers or chisel-type cutters as necessary to create the desired groove or dado width. Since grooving saws are typically I/S inches thick, one will produce a 1/8-inch groove, and two working together will make a 1/4-inch groove. There are many thicknesses of intermediate cutters.

Saw Blades: to specify a circular saw blade, you should list the kind, diameter, gauge, number of teeth, and arbour hole size. The common types of blades are:

1. Rip saw blade
2. Crosscut saw
3. Rough cut saw blade
4. Combination saw blade
5. Standard or flat ground
6. Hollow ground combination
7. Carbide tipped blade

Types of operations on the circular saw

1. Cutting plywood
2. Cutting angles
3. Bevels and tapers
4. Cutting rebates
5. Dados and grooves

Steps for sharpening the blade

1. **Jointing:** the rounding of the blade so that all the teeth have the same height and thickness.
2. **Setting:** the method used to bend the tooth of a blade in alternate directions, either in swage, spring or hollow ground form.

3. **Filing:** maintaining an even depth of each tooth's blade gullet and bevel.
4. **Gumming:** grinding and shaping the saw gullet (area between teeth).

Observe the following safety precautions when operating the tilt-arbor table bench saw:

- Never use a crosscut saw blade for ripping or a ripsaw blade for crosscutting. Installing a combination blade can help you avoid changing blades when you frequently tear and crosscut. Before usage, check whether the saw blade is sharp, undamaged, and without cracks. If the blade becomes worn, fractured, chipped, or twisted, it has to be replaced.
- Ensure the saw blade is correctly adjusted above the table to cut through the wood.
- Always use a push stick to push short, thin parts between the saw blade and the gauge to reduce the risk of being struck by materials brought on by kickbacks.
- Never reach over the saw to get material from the other side.
- Prevent stock and scraps from gathering on the saw table and near the work area.
- To ensure free and clean cuts, don't feed wood into the saw blade too quickly.
- Never leave the saw powered on unattended.

2. Band Saw

The band saw (Figure 55) may be used for straight cutting even though it is primarily intended for curved cuts. Unlike the circular saw, the band saw is widely used for freehand cutting.

Similar to how a belt is moved on pulleys, the band saw features two big wheels on which a continuous thin saw blade, or band, rotates. The bottom wheel, which is situated beneath the work surface, is used as the driving pulley and is attached to the motor

either directly or via pulleys, gears, or both. The driven pulley is located on the top wheel.

Two sets of blade guides, one fixed below the table and the other above with a vertical sliding adjustment, guide and maintain the alignment of the saw blade. A mechanism on the underside of the top wheel allows the blade alignment to be changed. Another adjustment just behind the upper wheel allows for tightening and loosening of the blade tension.

Cut-off gauges and ripping fences are occasionally provided for use with band saws, although you'll complete the majority of your work freehand with the table clean. Using gauges or fences with this kind of saw might make it challenging to achieve precise cuts.

The diameter of the wheels determines the band saw's size. Wheel machines with diameters of 350, 40, 450, 50, 750, 90, 1050, and 120 mm are typical sizes. The smallest feasible band saw is 350 mm. With the exception of capacity, band saw maintenance, operation, and adjustment are largely the same across the board.

Figure 55: Band saw

Many Seabees follow the general guideline that the blade's breadth should be one-eighth, which is the minimum radius to be cut. Therefore, the operator should use a 12.5mm blade if the component has a 100mm radius. Contrary to popular belief, the ratio reflects the realistic upper limit for high-speed band saw operations rather than the smallest radius that may be cut, which is eight times the width of the blade.

Band saws are designated by the points (tooth points per inch), thickness (gauge), and width of the blades or bands. Adding the circumference of one wheel to twice the distance between the wheel centres yields the necessary length for a blade. The length can change up to double the range of the tension adjustment.

The fronts of band saw teeth are filed at a 90° angle to the saw's line because they are formed like the teeth in a hand ripsaw blade. The reconditioning techniques are the same as for a manual ripsaw, except that extremely tiny band saws with very narrow teeth typically require specialised machinery to set and sharpen them.

Observe the following safety precautions when operating a band saw:

- Keep your fingers away from the moving blade.
- Keep the table clear of stock and scraps so your work will not catch as you push it along.
- Keep the upper guide just above the work, not excessively high.
- Don't use cracked blades. If a blade develops a click as it passes through the work, the operator should shut off the power because the click is a danger signal that the blade is cracked and may be ready to break. After the saw blade has stopped moving, it should be replaced with one in proper condition.
- If the saw blade breaks, the operator should shut off the power immediately and not attempt to remove any part of the saw blade until the machine is completely stopped.
- If the work binds or pinches on the blade, the operator should never attempt to back the work away from the blade while the saw is in motion since this may break the blade. The operator should always see that the blade works freely through the cut.

- A band saw should not be operated in a location with a temperature below 45°F. The blade may break due to the cold.
- Using a small saw blade for significant work or forcing a wide saw on a small radius is a terrible practice. The saw blade should, in all cases, be as wide as the nature of the work will permit.
- Band saws should not be stopped by thrusting a piece of wood against the cutting edge or side of the blade immediately after the power has been shut off; doing so may cause the blade to break. Band saws with 900mm-wheel diameters and larger should have a hand or foot brake.
- Particular care should be taken when sharpening or brazing a band saw blade to ensure the blade is not overheated and the brazed joints are thoroughly united and finished to the same thickness as the rest. It is recommended that all band saw blades be butt welded where possible; this method is much superior to the old style of brazing.

3. Drill Press

The drill press is an electrically operated power machine originally designed as a metal-working tool; as such, its use would be limited in the average woodworking shop. However, accessories, such as router bits or shaper heads, jigs, and special techniques, now make it a versatile woodworking tool as well (Figure 56).

The motor (10) is mounted to a bracket at the rear of the head assembly (1) and designed to permit V-belt changing for the desired spindle speed without removing the motor from its mounting bracket. Four spindle speeds are obtained by locating the V-belt on any one of the four steps of the spindle-driven and motor-driven pulleys. The belt tensioning rod (16) keeps proper tension on the belt so it doesn't slip.

The controls of all drill presses are similar. The terms "right" and "left" refer to the operator's position standing in front of and facing

the drill press. "Forward" applies to movement toward the operator, and "Rearward" applies to movement away from the operator.

The on/off switch (11) is located in the front of the drill press for easy access.

The spindle and quill feed handles (2) radiate from the spindle and quill pinion feed (3) hub, which is located on the lower right-front side of the head assembly (1). Pulling forward and down on any of the three spindles and quill feed handles, which point upward at the time, moves the spindle and quill assembly downward. Release the feed handle (2), and the spindle and quill assembly return to the retracted or upper position by spring action.

The quill lock handle (4) is located at the lower left front side of the head assembly. Turn it clockwise to lock the quill at a desired operating position. Release the quill by turning it counterclockwise. However, in most cases, the quill lock handle will be in the released position.

The head lock handle (5) is located at the left-rear side of the head assembly. Turn the head-leek handle clockwise to lock the head assembly on the bench column at a desired vertical height. Turn the head lock handle counter-clockwise to release the head assembly. When operating the drill press, you must ensure that the head lock handle is tight at all times.

The head support collar handle (6) is located at the right side of the head support collar and below the head assembly. The handle locks the head support collar, which secures the head vertically on the bench column and prevents the head from dropping when the head lock handle is released. Turn the head support collar lock handle clockwise to lock the support to the bench column and counter-clockwise to release the support. When operating the drill press, ensure that the head support collar lock handle is tight at all times.

As you face the drill press, the tilting table lock handle is located at the right-rear side of the tilting table bracket. The lock pin secures the table at a horizontal or 45° angle. This allows you to move the table to the side, out of the way, for long pieces of wood. The table support collar (8) will enable you to raise or lower the table. Turn the tilting table lock handle counter-clockwise to release the tilting table bracket to move it up and down or around the bench column. Lock the tilting table assembly at the desired height by turning the lock handle clockwise. When operating the drill press, ensure that the tilting table lock handle is tight at all times.

The adjustable locknut (14) is on the depth gauge rod (17). Its purpose is to regulate depth drilling. Turn the locknut clockwise to decrease the spindle's downward travel. When operating the drill press, the locknut must be secured against the depth pointer (13). The depth of the hole is shown on the depth scale (15).

Observe the following safety precautions when operating a drill press:

- Before starting the drill press, ensure the drill is properly secured in the chuck (12) and the chuck key (9) is removed.
- Make sure your material is properly secured.
- Operate the feed handle with slow, steady pressure to prevent the drill bit from breaking or the V-belt from slipping.

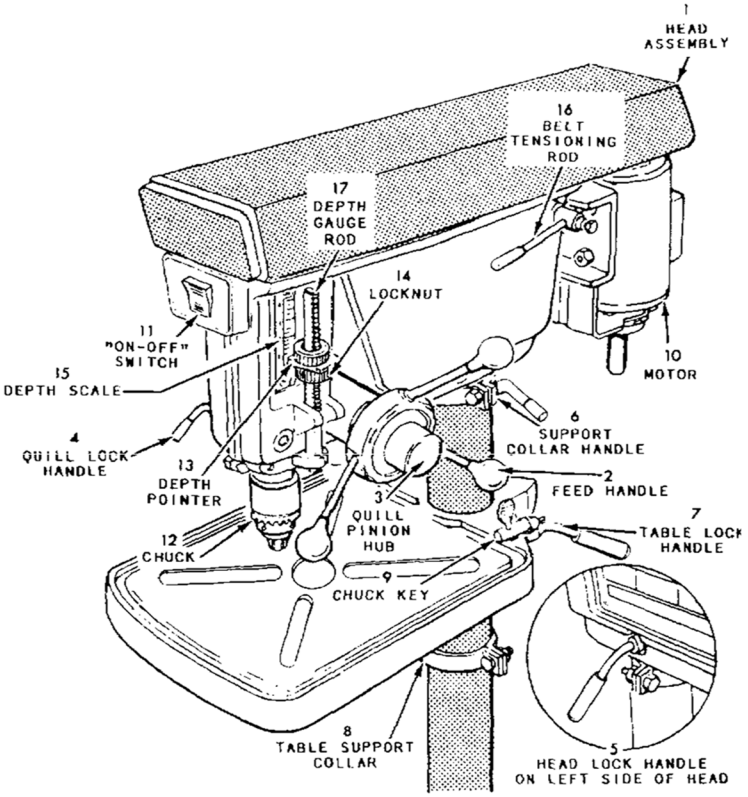


Figure 56: Drill press

- Make sure all locking handles are tight and the v-belt is not slipping.
- Make sure the electric cord is securely connected and in good shape.
- Make sure you are not wearing hanging or loose clothing.
- Listen for any sounds that may be signs of trouble.
- After you have finished operating the drill press, make sure the area is clean.

4. Woodworking Lathe

The woodworking lathe is, without question, the oldest of all woodworking machines. In its early form, it consisted of two holding centres with the suspended stock rotated by an endless rope belt. It was operated by having one person pull on the rope hand over hand while the cutting was done by a second person holding crude hand lathe tools on an improvised beam rest.

The actual operations of woodturning performed on a modern lathe are still largely done with woodturners' hand tools. However, machine lathe work is becoming increasingly common with the introduction of newly designed lathes for that purpose.

The lathe is used to turn or shape round drums, disks, and any object that requires a true diameter. The maximum diameter of the work determines the size of a lathe it can swing over its bed. There are various sizes and types of wood lathes, ranging from very small sizes for delicate work to large surface or bull lathes that can swing jobs 4500 mm in diameter.

Figure 57 illustrates a type of lathe that you may find in your shop. It is made in three sizes to swing 400, 500, and 600mm diameter stock. The lathe has four major parts: bed, headstock, tailstock, and tool rest. It has an iron bed and comes in assorted lengths. The bed is a broad, flat surface supporting the machine's other parts. The headstock is mounted on the left end of the lathe bed. All power for the lathe is transmitted through the headstock. It has a fully enclosed motor that gives variable spindle speed. The spindle is threaded at the front end to receive the faceplates. A faceplate attachment to the motor spindle is furnished to hold or mount small jobs with large diameters. There is also a flange on the rear end of the spindle to receive large faceplates held securely by four stud bolts.

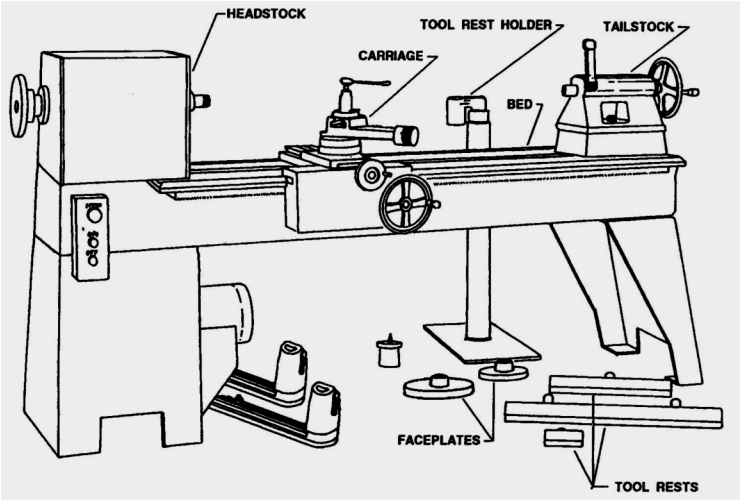


Figure 57: Wood Lathe

The tailstock is located on the right end of the lathe and is movable along the length of the bed. It supports one end of the work while the headstock spur turns the other. The tail centre can be removed from the stock by simply backing the screw. The shank is tapered to centre the point automatically.

Most large sizes of lathes are provided with a power-feeding carriage. A cone-pulley belt arrangement includes power from the motor, and trackways are cast to the inside of the bed for sliding the carriage back and forth. All machines have a metal bar that can be attached to the lathe bed between the operator and the work. This hand tool rest supports the operator in guiding tools along the work. It may be of any size and is adjustable to any desired position.

In lathe work, wood is rotated against special cutting tools (illustrated in figure 58). These tools include turning gouges (view A), skew chisels (view B), parting tools (view C), round-nose (view D), square-nose (view E), and spear-point (view F) chisels. Other cutting tools are toothing irons and auxiliary aids, such as callipers, dividers, and templates.

Figure 58: Lathe cutting tools

Turning gouges are used chiefly to rough out nearly all shapes in spindle turning. The gouge sizes vary from 3 to 50mm or more, with the most common sizes being 6 to 18mm and 25mm.

Skew chisels are used to make smooth cuts to finish surfaces, turn beads, trim ends or shoulders, and make V-cuts. They are made in widths from 3 to 62 mm and in right-handed and left-handed pairs.

Parting tools are used to cut recesses or grooves with straight sides and a flat bottom and to remove finished work from the faceplate. They are available in sizes ranging from 3 to 18mm.

Scraping tools of various shapes are used for the most accurate turning work, especially for most faceplate turning. Views D, E, and F of Figure 58 illustrate a few of the more commonly used shapes. The chisels shown in views B, E, and F are old jointer blades that have been ground to the required shape; the wood handles for these homemade chisels are not shown in the illustration.

A toothing iron (figure 59) is a square-nose turning chisel with a series of parallel grooves cut into the top surface of the iron. These turning tools are used for rough turning of segment work mounted on the face plate. The points of the toothing iron created by the

parallel grooves serve as a series of spear point chisels (detail A); therefore, the tool is not likely to catch and dig into the work like a square-nose turning chisel. The toothing iron is made with coarse, medium, and fine parallel grooves, varying from 12 to 5 mm in width.

Figure 59: Toothing iron lathe tool

Lathe turning can be extremely dangerous. You, therefore, must use particular care in this work.

Observe the following safety precautions:

- When starting the lathe motor, stand to one side. This helps you avoid the hazard of flying debris in the event of defective material.
- The tool rest must be used when milling stock.
- Adjust and set the compound or tool rest for the start of the cut before turning the switch on.
- Take very light cuts, especially when using hand tools.
- Never attempt to use callipers on interrupted surfaces while the work is in motion.

5. Jointer

The jointer is a machine for power planning stock on faces, edges, and ends. A typical 150mm jointer is illustrated in Figure 60b. The planning is done by a revolving cutter-head equipped with two or more knives, as shown in Figure 60a. Tightening the set screws forces the throat piece against the knife to hold the knife in position. Loosening the set screws releases the knife for removal. The size of a jointer is designated by the width, in inches, of the cutter head; sizes range from 100 to 900 mm. A 150mm jointer is shown in Figure 60a.

The principle on which the jointer functions is illustrated in Figure 60c. The table consists of two parts on either side of the cutter head. The stock is started on the in-feed table and fed past the cutter head onto the out-feed table. The surface of the out-feed table must be exactly level, with the highest point reached by the knife edges. The surface of the in-feed table is depressed below the surface of the out-feed table, an amount equal to the desired depth of cut. The usual depth of cut is about 1.56 to 3.125mm.

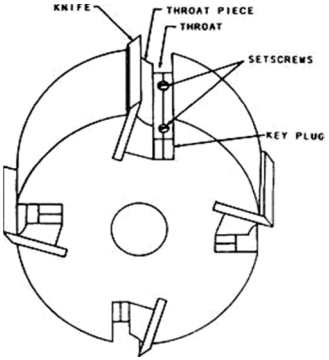


Figure 60a: Four-knife butter-head for a jointer

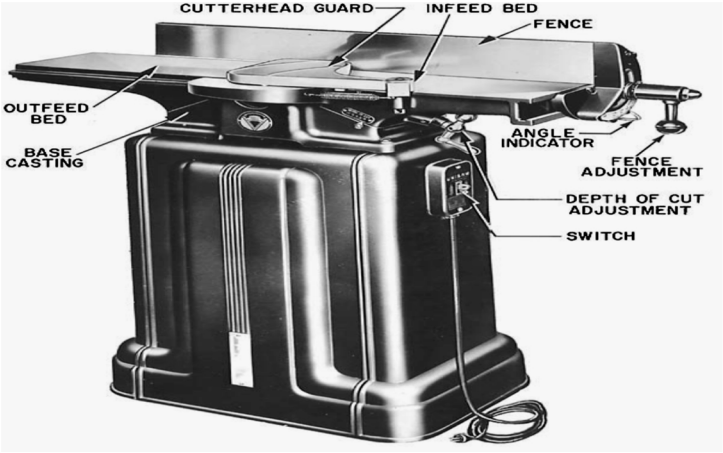


Figure 60b: 150mm jointer

The level of the out-feed table must be frequently checked to ensure the surface is precise, even with the highest point reached by the knife edges. If the outfeed table is too high, the cut will become progressively shallower as the piece is fed through. If the outfeed table is too low, the piece will drop downward as its end leaves the in-feed table, and the cut for the last inch or so will be too deep.

To set the out-feed table to the correct height, first feed a piece of waste stock past the cutter head until a few inches of it lies on the out-feed table. Then, stop the machine and look under the out-feed end of the piece. If the out-feed table is too low, there will be a space between the table's surface and the piece's lower face. Raise the out-feed table until this space is eliminated. If no space appears, lower the out-feed table until a space does appear. Now, run the stock back through the machine. If there is still a space, raise the table just enough to eliminate it.

Note that the cutter head cuts toward the in-feed table; therefore, you must place the piece with the grain running toward the in-feed table to cut with the grain. A piece is edged by feeding it through on edge with one of the faces held against the fence. A piece is surfaced by feeding it through a flat with one of the edges against the wall. However, this operation should be limited to straightening the face of the stock. The fence can be set at 90° to produce squared faces and edges or at any desired angle to produce beveled edges or ends.

Only sharp and evenly balanced knives should be used in a jointer cutting head. The knives must not be set to take too heavy a cut because a kickback is almost sure to result, especially if there is a knot or change of grain in the stock. The knives must be securely refastened after the machine has been standing in a cold building over the weekend.

Each hand-fed jointer should be equipped with a cylindrical cutting head, the throat of which should not exceed 11mm in depth or 15.6mm in width. It is strongly recommended that no cylinder

be used in which the throat exceeds 9.375mm in depth or 12.5mm in width. Each hand-fed jointer should have an automatic guard covering all the head sections on the working side of the fence or gauge. The guard should automatically adjust horizontally for edge jointing and vertically for surface work, and it should remain in contact with the material at all times.

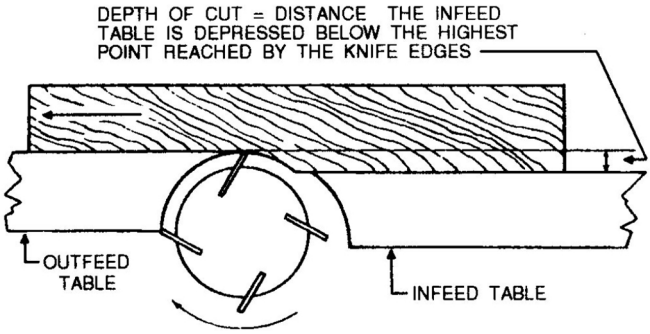


Figure 60c: Operating principle of a jointer

When operating the jointer, observe the following safety precautions:

- Always plan with the grain. A piece of wood planned against the grain on a jointer may be kicked back or even break towards the end.
- Never place your hands directly over the inner cutter head. Should the piece of wood kick back, your hands will drop on the blades. Start with your hands on the in-feed bed. When the piece of wood is halfway through, reach around with your left hand and steady the piece of wood on the outfeed bed. Finish with both your hands on the outfeed bed.
- Never feed a piece of wood with your thumb or finger against the end of the wood fed into the jointer. Keep your hands on top of the wood at all times.
- Avoid jointing short pieces of wood whenever possible. Join a longer piece of wood and cut it to the desired size. If you

must joint a piece of wood shorter than 45omm, use a push stick to feed it through the jointer.

- Never use a jointer with dull cutter blades. Dull blades tend to kick the piece, and a kickback is always dangerous.
- Keep the jointer table and the floor around the jointer clear of scraps, chips, and shavings. Always stop the jointer before brushing off and cleaning up those scraps, chips, and shavings.
- Never joint a piece of wood that contains loose knots.
- Keep your eyes and undivided attention on the jointer while you work. Do not talk to anyone while operating the jointer.

Remember, the jointer is one of the most dangerous machines in the woodworking shop. Only experienced and responsible personnel should be allowed to operate it using the basic safety precautions provided above.

6. Surfacer

A single surfacer (also called a single planer) is shown in Figure 61. This machine surfaces stock on one face (the upper face) only. (Double surfacers, which surface both faces at the same time, are used only in large planning mills.)

The single surfacer cuts with a cutter head like the one on the jointer, but on the single surfacer, the cutter head is located above instead of below the drive rollers. The part adjacent to the cutter head is pressed against the feed bed by the chip breakers (just ahead of the cutter head) and the pressure bar (just behind the cutter head). The pressure bar temporarily straightens out any warp a piece may have; a piece that goes into the surfacer warped will come out still warped. This is not a defect in the machine; the surfacer is designed for surfacing only, not for truing warped stock. If true plane surfaces are desired, one face of the stock (the face that goes down in the surfacer) must be trued on the jointer before the piece is fed through the surfacer. If the face that goes

down in the surfacer is true, the surfacer will plane the other face true.

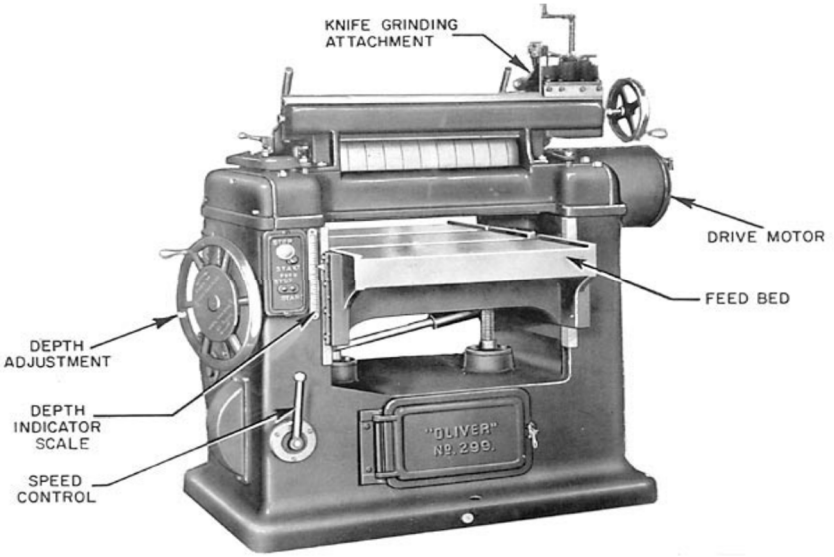


Figure 61: Single surfacer

observes the following safety precautions when operating a surfacer:

- Metal guards should cover the cutting head.
- A hood or a semi-cylindrical guard should guard feed rolls.
- Never force wood through the machine.
- If a piece of wood gets stuck, turn off the surfacer and lower the feed bed.

8. Shaper

The shaper is designed primarily for edging curved stock and for cutting ornamental edges, as on mouldings. It can also be used for rebating, grooving, fluting, and beading. The flat cutter on a shaper is mounted on a vertical spindle and held in place by a hexagonal spindle nut. A grooved collar is placed below and above the cutter to receive the knives' edges. Ball-bearing collars are available for

use as guides on irregular work where the fence is not used. The part of the edge that is to remain uncut runs against a ball-bearing collar underneath the cutter, as shown in the bottom view of Figure 62. A three-wing cutter (top view of Figure 62) fits over the spindle. Cutters come with cutting edges in a great variety of shapes.

For shaping the side edges on a rectangular piece, a light-duty shaper has an adjustable fence, like the one shown on the shaper in Figure 63. For shaping the end edges on a rectangular piece, a machine of this type has a sliding fence similar to the cut-off gauge on a circular saw. The sliding fence slides in the groove shown on the tabletop. On larger machines, the fence consists of a board straightedge clamped to the table with a hand screw, as shown in Figure 64. A semicircular opening is seen in the straightedge's edge to accommodate the spindle and the cutters. A guard of the type shown in the figure should be placed over the spindle whenever possible.

For shaping curved edges, there are usually a couple of holes in the table, one on either side of the spindle, in which vertical starter pins can be inserted. When a curved edge is being shaped, the piece is guided by and steadied against the starter pin and the ball-bearing collar on the spindle.

THREE-WING SOLID CUTTER

GROOVED SHAPER COLLAR

Figure 62*:* Three-wing cutter for a shaper

Figure 63: Light-duty shaper with adjustable fence

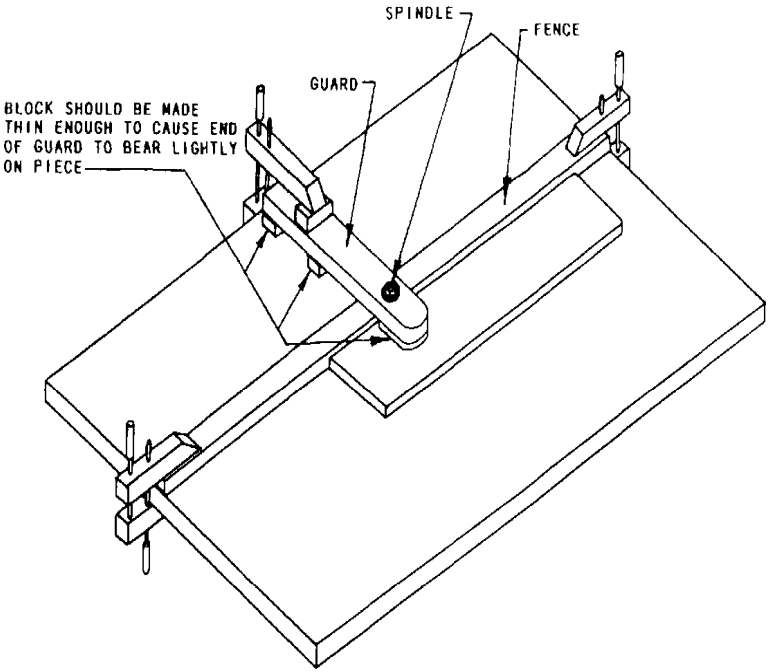


Figure 64 Shaper table showing straightedge fence and guard

When operating a shaper, observe the following safety precautions:

- Like the jointer and surfacer, the shaper cuts toward the in-feed side of the spindle, which is against the rotation of the spindle. Therefore, stock should be placed with the grain running toward the in-feed side.
- Make sure the cutters are sharp and well-secured.
- If curved or irregularly shaped edges are to be shaped, place the stock in position and ensure the collar will rub against the part of the edge, which should not be removed.
- Whenever the straight fence cannot be used, always use a starting pin on the tabletop.
- Never make extremely deep cuts.
- Make sure the shaper cutters rotate toward the work.

- Whenever possible, always use a guard, pressure bar, hold-down, or jig.
- If possible, place the cutter on the shaper spindle so that the cutting will be done on the lower side of the stock.
- Do not attempt to shape small pieces of wood.
- Check all adjustments before turning on the power.

Safety Note

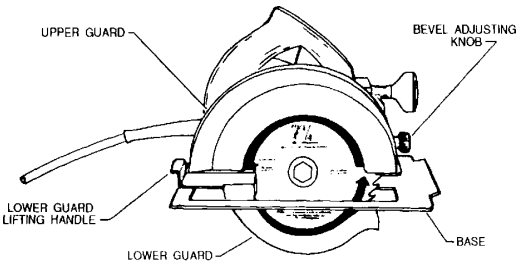
The spindle shaper is one of the most dangerous machines used in the shop. Use extreme caution at all times.

Power Hand Tools

In addition to using power shop tools, you must operate different types of portable hand tools in the field. You, therefore, need to understand the safety precautions associated with these.

1. Portable Electric Circular Saw

The portable electric circular saw is used chiefly as a tremendous labour-saving device for sawing wood framing members. The size of a circular saw is determined by the diameter of the most enormous blade it can use. The most commonly used circular saws are the 190mm and 215mm saws. There are two different types of electric saws, as shown in Figure 65: the side drive (view A) and the worm drive (view B). Circular saws can use many different types of cutting blades, some of which are shown in figure 66.



VIEW A

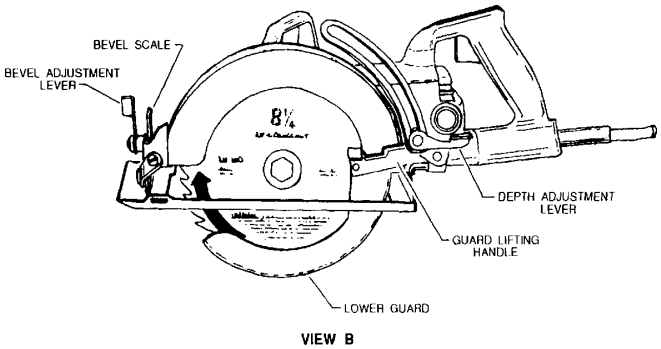


Figure 65: Side-drive (view A) and worm-drive (view B) circular saws

Combination Crosscut and Rip Blades

Combination blades are all-purpose for cutting thick and thin hardwoods and softwoods, both with or across the grain. They can also be used to cut plywood and hardwood.

Crosscut Blades: Crosscut blades have fine teeth that cut smoothly across the grain of hardwood and softwood. They can be used for plywood, veneers, and hardboard.

Rip Blades: Rip blades have more prominent teeth than combination blades and should be used only to cut with the grain. With this blade type, a rip fence or guide will help you make an accurate cut.

Hollow-Ground Blades: Hollow-ground blades have no set. They make the smoothest cuts on thick or thin stock. Woodcut with these blades requires little or no sanding.

Abrasive Blades: Blades are used to cut metal, masonry, and plastics. These blades are handy for scoring bricks so they can be easily split.

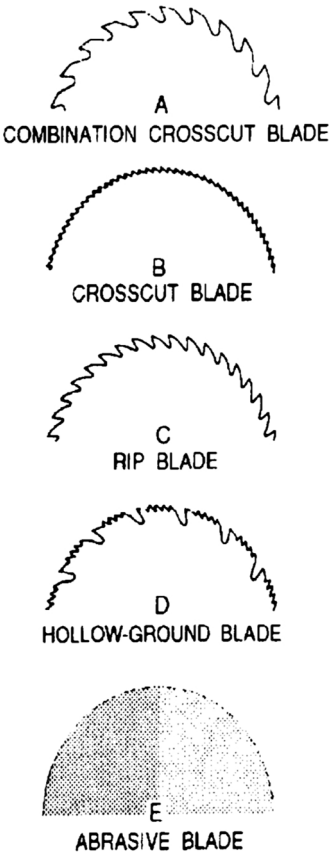


Figure 66: Circular saw blades

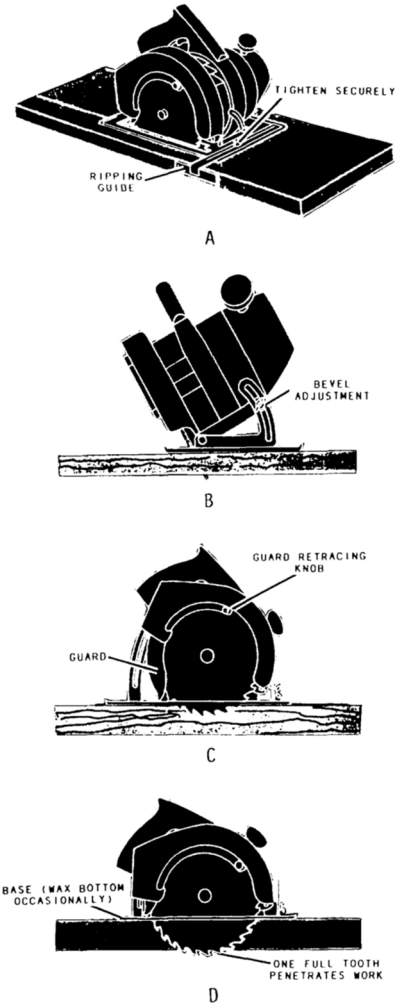


Figure 67: Different ways to use a circular saw

Figure 67 shows how versatile the circular saw can be. To make an accurate ripping cut (view A), the ripping guide is set a distance away from the saw equal to the width of the strip to be ripped off. It is then placed against the edge of the piece as a guide for the

saw. To make a bevel angle cut up to 45° (view B), you just set the bevel adjustment knob to the angle you want and cut down the line. To make a pocket cut (views C and D), a square cut in the middle of a piece of material, you retract the guard back and tilt the saw to rest on the front of the base. Then, lowering the rear of the saw into the material, hold it there until it goes through the wood. Then, follow your line.

Observe the following safety precautions when operating a circular saw:

- Don't force the saw through heavy cutting stock. If you do, you may overload the motor and damage it.
- Before using the saw, carefully examine the material to be cut and remove nails or other metal objects. If possible, avoid cutting into or through knots.
- Disconnect the saw from its power source before making any adjustments or repairs, including changing the blade.
- Make sure all circular saws are equipped with guards that automatically adjust themselves to the work so that none of the teeth protrude above the work. Adjust the guard over the blade so it slides out of its recess and covers the blade to the depth of the teeth when you lift the saw off the work.
- Wear goggles or face shields while using the saw and cleaning up debris afterwards.
- Grasp the saw with both hands and hold it firmly against the work. Take care to prevent the saw from breaking away from the job, causing injury.
- Inspect the blade at frequent intervals and always after it has locked, pinched, or burned the work. Disconnect the saw from the power source before performing this inspection.
- Inspect daily the electric cords that you use for cuts or breaks. Before cutting boards, make sure the cord is not in the way of the blade

1. Sabre Saw

The Sabre saw (figure 68) is a power-driven jigsaw that cuts smooth and decorative curves in wood and light metal. Most Sabre saws are light-duty machines and not designed for extremely fast cutting. Several different, easily interchangeable blades (figure 69) are designed to operate in the Sabre saw. Some blades are designed for cutting wood, and some for cutting metal. Using this tool is the best way to learn how to handle it. Before trying to do a finished job with the Sabre saw, clamp down a piece of scrap plywood and draw some curved and straight lines. You will develop your way of gripping the tool, which will be affected somewhat by your particular tool. For example, guiding is easier if you apply downward pressure on some tools as you move them forward. The tool will vibrate excessively and roughen the cut if you don't use a firm grip. Do not force the cutting faster than the design of the blade allows, or you will break the blade.

You can make a pocket cut with a Sabre saw just like a circular saw, although you must drill a starter hole to begin work. A Sabre saw can also make bevel-angle and curve cuts.

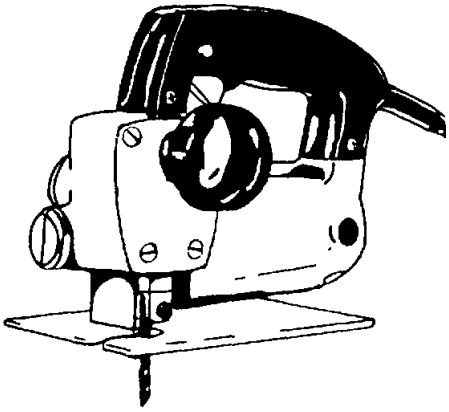


Figure 68: Sabre Saw

Figure 69: Sabre Saw Blades

Observe the following safety precautions when operating the Sabre saw:

- Before working with the Sabre saw, remove your rings, watches, bracelets and other jewellery pieces.
- If you are wearing long sleeves, roll them up. Be sure the Sabre saw is properly grounded.
- Use the proper saw blade for the work, and ensure the blade is securely locked in place.
- Be sure the material to be cut is free of any obstructions.
- Keep your full attention focused on the work being performed.
- Grip the handle of the saw firmly. Control the forward and turning movements with your free hand on the front guide.
- To start a cut, place the forward edge of the saw base on the edge of the material being worked, start the motor, and move the blade into the material.

2. Portable Reciprocating Saw

The portable reciprocating saw (saw-all) (figure 70) is a heavy-duty power tool that you can use for various woodworking maintenance work, remodelling, and roughing-in jobs. You can use it to cut rectangular openings, curved openings, along straight or curved lines, and flush. Blades for reciprocating saws are made in various sizes and shapes. They vary in length from 62.5 to 300 mm and are made of high-speed or carbon steel. They have cutting edges similar to those shown in Figure 69.

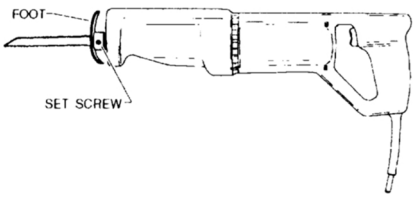


Fig. 70: Reciprocating saw

Before operating this saw, be sure you are using the right blade for the job. The manufacturer's instruction manual shows the proper saw blade for a particular material. The blade must be pushed securely into the opening provided. Rock it slightly to ensure a correct fit, then tighten the set screw.

To start a cut, place the saw blade near the material to be cut. Then, start the motor and move the blade into the material. Keep the cutting pressure constant, but do not overload the saw motor. Never reach underneath the material being cut.

Observe the following safety precautions when operating a reciprocating saw:

- Disconnect the saw when changing blades or making adjustments.
- Place the foot of the saw firmly on the stock before cutting.
- Don't cut curves shaper than the blade can handle.
- When cutting through a wall, don't cut electrical wires.

3. Router

The router is a versatile portable power tool that can be used freehand or with jigs and attachments. Figure 71 shows a router typical of most models. It consists of a motor containing a chuck into which the router bits are attached. The motor slides into the base in a vertical position. The depth adjustment ring allows for easy regulation of the depth of a cut. Routers vary in size from 6 to 62,5 horsepower, and the motor speed varies from 18,000 to 27,000 rpm.

One of the most practical accessories for the router is the edge guide. It guides the router in a straight line along the edge of the board, which is handy for cutting grooves on long pieces of timber. The two rods on the edge guide slip into the two holes provided on the router base. The edge guide can be adjusted to move in or out along the two rods to obtain the desired lateral depth cut.

There are two classifications of router bits. Built-in, shank-type bits fit into the chuck of the router. Screw-type bits have a threaded hole through the centre of the cutting head, which allows the cutting head to be screwed to the shank. Figure 72 shows a few of the most common router bits.

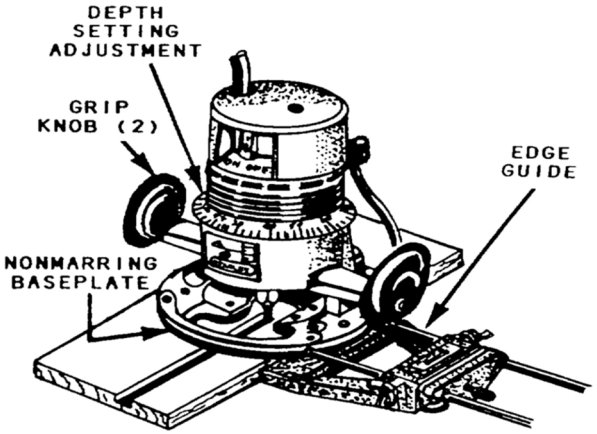


Figure 71: Portable router with edge guide

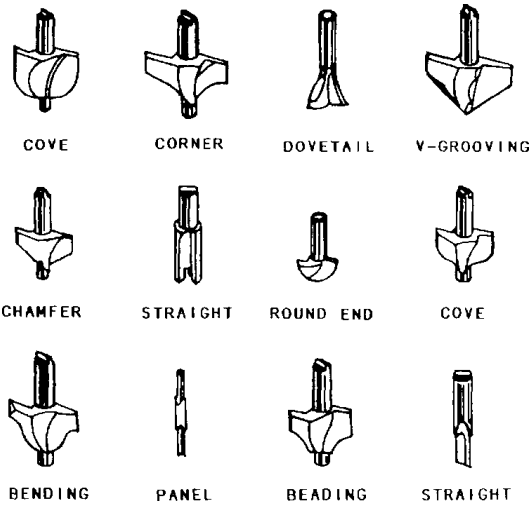


Figure 72: Router bits

Observe the following safety precautions when operating a router:

- Before operating a router, be sure the work piece is well secured and free of obstruction.
- Make sure the router is disconnected from the power source before making any adjustment or changing bits.
- Don't overload the router when cutting the material.
- Use both hands to hold the router when cutting material.

4. Portable Power Plane

The portable electric power plane (figure 73) is widely used for trimming panels, doors, frames, and so forth. It is a precision tool capable of exact depth of cut up to 4.7mm on some of the heavier models. However, the maximum safe depth of cut on any model is 2.34mm in any one pass. The power plane is essentially a high-speed motor that drives a cutter bar, containing either straight or spiral blades, at high speed.

Operating the power plane is simply a matter of setting the depth of cut and passing the plane over the work. First, make careful

measurements of the piece, where it is to fit, and determine how much material has to be removed. Then, the stock being planed should be held in a vice, clamped to the edge of a bench, or otherwise firmly held. Check the smoothness and straightness of all the edges.

If a smoothing cut is desired, make that cut first and then recheck the dimensions. Make as many passes as necessary with the plane to reach the desired dimensions, checking frequently so as not to remove too much material. The greater the depth of the cut, the slower you must feed the tool into the work. Feed pressure should be enough to keep the tool cutting but not so much as to slow it down excessively. Keep wood chips off the job because they can mar the surface of the stock as the tool passes over them. When a cut is finished, keep your hands away from the butterhead or blades. The plane's L-shaped base, or fence, should be pressed snugly against the work when planning, assuring that the edge will be cut square. For bevel cuts, loosen the setscrew on the base, set the base at the desired bevel, and then retighten the setscrew.

Observe the following safety precautions when operating a portable power plane:

- Make sure that the plane is turned off before plugging it in.
- Make sure you disconnect the plug before making any adjustments.
- Don't attempt to power the plane with one hand—you need two.
- Always clamp your work securely in the best position to perform the planning.
- When finished planning, make sure you disconnect the power cord.

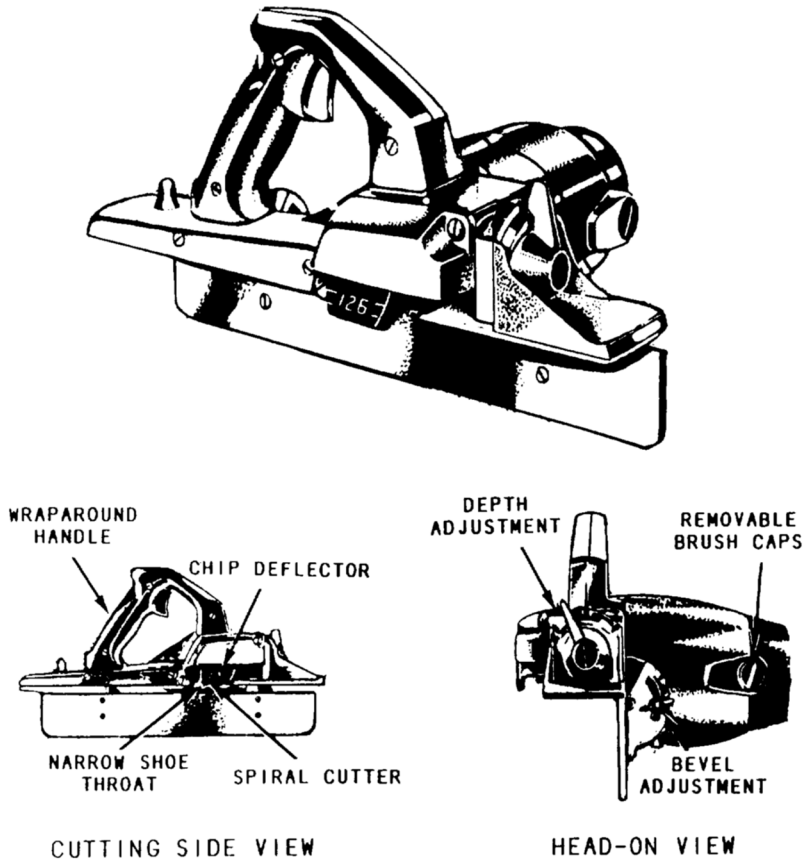


Figure 73: Portable electric power plane

5. Portable Power Drills

Portable power drills have generally replaced hand tools for drilling holes because they are faster and more accurate. Variable-speed controls and special clutch-drive chucks can also be used as electric screwdrivers. More specialised power-driven screwdrivers are also available, significantly increasing the efficiency of many fastening operations in construction work.

The two basic designs for portable electric drills (figure 74) are the spade design for heavy-duty construction (view A) and the pistol-grip design for lighter work (view B). The sizes of power drills are based on the diameter of the largest drill shank that will fit into the drill's chuck.

The right-angle drill is a specialty drill used in plumbing and electrical work. It allows you to drill holes at a right angle to the drill body.

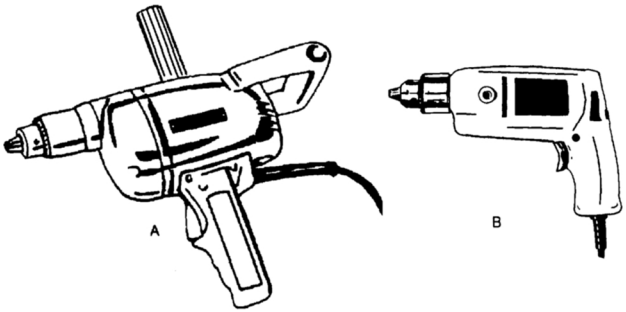


Figure 74: Heavy-duty 6mm portable drill (view A) and light-duty 6mm portable drill (view B)

observe the following safety precautions when operating a portable drill:

- Make Ensure the drill or bit is securely mounted in the chuck.
- Hold the drill firmly as prescribed by the manufacturer of the drill.
- When feeding the drill into the material, vary the pressure you apply to accommodate the different kinds of stock. Be careful not to bind the drill or bit.
- When drilling a deep hole, withdraw the drill several times to clean the drill bit.

6. Portable Sanders

There are three types of portable sanders: belt, disk, and finish sanders. When using a belt sander (Figure 75), be careful not to gouge the wood. The size of a belt sander is usually identified by the width of its sanding belt. Belt widths on heavier-duty models are usually 75 or 1oomm. Depending on the make and model, belt lengths vary from 525 to 675mm. Different grades of abrasives are available.

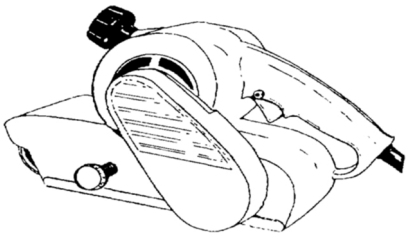


Figure 75: Belt sander

The disk sander (figure 76) is a useful tool for removing old finishes, paint, and varnish from siding, wood flooring, and concrete. For best results, tip the machine lightly with just enough pressure to bend the disk. Use a long, sweeping motion, back and forth, advancing along the surface. When using a disk sander, always operate it with both hands.

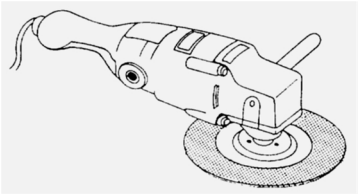


Figure 76. Portable disk sander

The finishing sander (Figure 77) is used for light and fine sanding. Two kinds are available: one operates with an orbital (circular) motion (view A) and the other has an oscillating (back-and-forth) movement (view B). Finish sanders use regular abrasive paper (sandpaper) cut to size from full sheets.

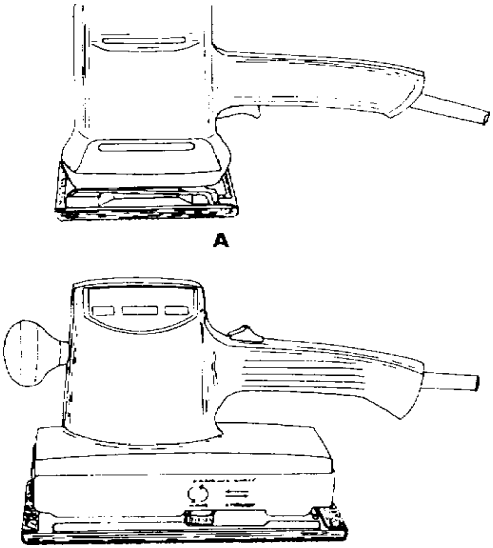


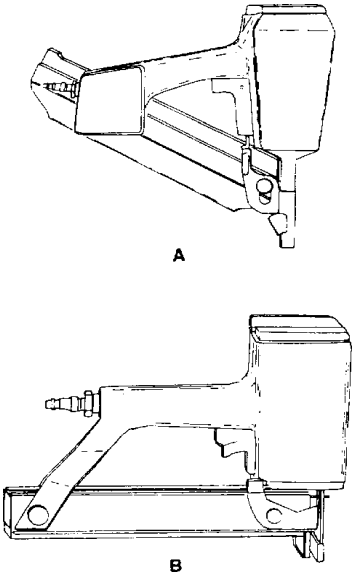
Figure 77: Two types of finish sanders: orbital (view A) and oscillating (view B)

observe the following safety tips when operating portable sanders:

- Make sure the sander is off before plugging it in.
- Make sure that you use two hands if using the belt sander.
- Don't press down on the sander. The weight of the sander is enough to sand the material.
- Make sure the sander is disconnected when changing sandpaper.
- Keep the electrical cords away from the area being sanded.

6. Power Nailers and Staplers

There is a wide variety of power nailers and staplers available. Figure 78 shows a typical example of each. A heavy-duty nailer is used for framing or sheathing work, while finish nailers are used for panelling or trimming.



There is also a wide variety of staplers that you can use for jobs, such as fastening sheeting, decking, or roofing. These tools are often driven by compressed air. The amount of pneumatic, or air, pressure required to operate the tool depends on the tool size and the operation you are performing. Check the manufacturer's manual for the proper air pressure to operate the tool. The power nailer and power stapler are great timesaving tools, but they are also **very dangerous** tools.

Figure 78: Heavy-duty pneumatic nailer (view A) and pneumatic stapler (view B)

Observe the following safety precautions when using them:

- Use the correct air pressure for the particular tool and job.
- Use the right nailer or stapler for the job and the correct nails and staples.
- Keep the nose of the tool pointed away from your body.
- When you are not using a nailer or stapler or if you are loading one, disconnect the air supply.

Evaluation

1. State the three groups of geometrical tools and give one example of each. State the application of each of the examples
2. Name four holding devices in woodwork and state the specific use of each

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CHAPTER SIX

WOODWORKING METHODS, PLANNING AND SQUARING TO DIMENSIONS

Objectives

At the end of this chapter, you should be able to;

1. Follow the operational sequence to carry out the task
2. Identify and select some essential marking tools
3. Setting out and cutting list

Planning and squaring a small piece of board to dimensions are the first lessons in woodworking. Like many other things you may have tried to do, it looks easy until you try it. When planning a piece of timber square, you must know the tools to use in the operation. For example, the possible tools that can be used for planning or preparing a piece of timber include the following.

1. Jack Plane
2. Smoothing Plane
3. Marking Gauge
4. Pencil
5. Rule
6. Tenon Saw
7. Try Square

Operational Sequence

Remove shavings only where needed; otherwise, the timber will not be finished to the required size. Sight the plane (jack plane) to

ensure the blade is correctly adjusted. If not, read just the blade; you must sharpen the blade for a good result.

Select the surface to start with. The broader surface of the timber, the face side, is generally planned first, not the edge. The wood is placed flat on the bench, and the end of the timber is set against the bench stop. Then, you prepare or plane a true side, which is called the face side, usually identified with a symbol of the face side mark " ".

At the start of planning, the main pressure should be on the forward part of the stroke with the plane. During the latter part of the cut, the main pressure should be at the back of the plane. Each stroke should be taken through the entire length of the piece of timber.

When planned, the surface must be tested for accuracy. This is done by placing a straight edge (winding strips) on the timber close to the two ends. The two are then sighted together to see whether the surface of the wood is true with the straight edge. When this surface is true, it may be marked with a face side mark "".

Select one edge and plane it straight, flat and square to the face side. Use a try square to test for squareness. With surfaces (face side & face edge) accurately prepared, the timber may be marked to width. This is done with a marking gauge. The gauge must be used with the stock against the face edge. Care must be taken not to plane beyond the gauge line. The timber is now marked to thickness, again using the gauge with the stock against the face side, and the wood is then plane to the gauge line. This way, all four sides of the timber are planned, and the wood is true and finished to the required size.

NOTE: Sketch a piece of timber on the chalkboard showing side, edge, end, face side, and face edge symbols.

End grain planning is somewhat more complex. To plane an end grain, use a piece of wasted timber to support the piece in both planning directions. This will not allow your piece to split in either

direction; the waste pieces will split. A shooting board is the best aid for planning end grain squares.

It frequently happens that timber fibres plane better in one direction than the other. This is due to the direction of the grain. If a piece of timber tends to tear up, turn it around the other way.

Figure 79 illustrates and describes the six major steps in this process. You should practice these steps until you can get a smooth, square board with minimal planning.

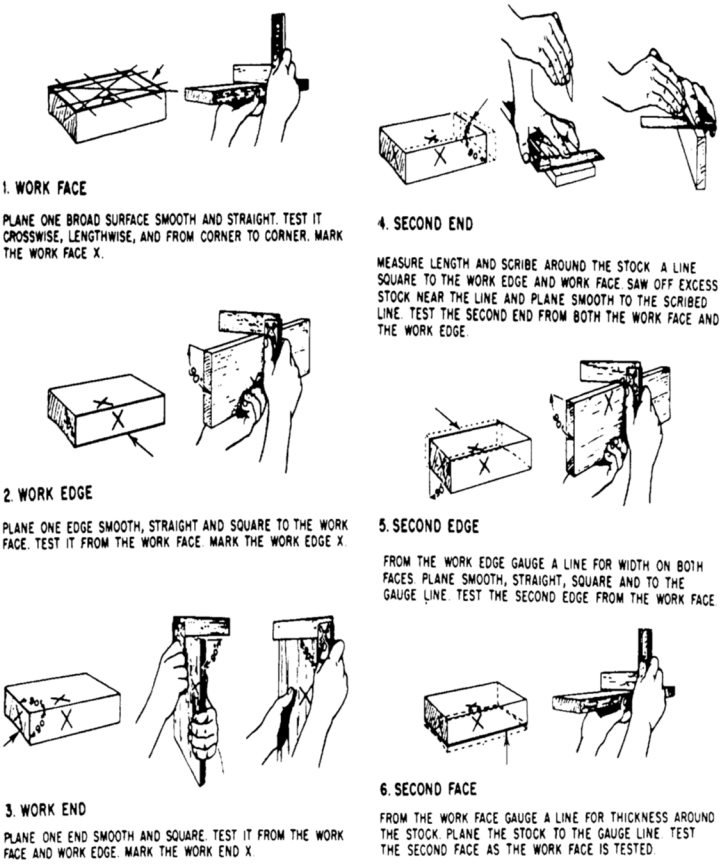


Figure 79: Planning and squaring to dimensions

When setting aside the plane, always place it sideways or over the well of the bench so as not to damage the blade's cutting edge.

Cutting Out a Piece of Timber

When marking out with a pencil for cutting from the board, ample allowances must be made for planning and squaring of ends. The amount of these allowances will depend on the operator's skill in sawing accurately; the beginner must remember his lack of experience.

About 4mm on the width and thickness and about 12mm on the length should be allowed for planning and for squaring the ends. In the process, the shoulder and elbow serve as fulcrums; the eyes, wrist, and saw tip should be in the same plane (the same level) or the same line.

Sawing Timber on the Bench

Back saws are commonly used at the bench. Sawing is started at the far side on the WASTE side of the line, and the saw lowers to the horizontal as cutting proceeds.

The standing POSTURE is important, with the left foot pointing toward sawing (if you are right-handed), with the knee flexed, and the right leg braced firmly with the foot towards the right. This allows the weight to be transferred by the left arm to the work, holding it firmly. Remember – The saw point, eyes, wrist, elbow, and shoulder should all be in the same vertical plane. Otherwise, the saw will quickly wander off the course.

Testing and marking out of Timber

Testing: All markings or testing should always be done from the face side or the true face edge. Also, every measurement must be taken from the two faces. Therefore, the two faces (side and edge) must be accurate, that is, flat on faces and square (90^{o}) to each other. To ensure a surface is flat in all directions, the following

tests should be carried out with reliable straight edges (winding strips).

I. Along the length of the surface,

II. Across the width of the surface, and

III. Diagonally, from corner to corner, to ensure that the surface is not in wind or twist.

Some Basic Marking Tools

A. Rule: It is important; any measurement should begin at the end of the rule or tape. To obtain the maximum accuracy in marking off measurements, the graduations on the rule or tape should be in close contact with the face of the work. But for accuracy to be relied upon, it must be certain that the eye of the observer is positioned immediately above (perpendicular) the required graduation and the pencil held at a right angle to the edge of the tape. Should the eye be slightly to one side, the mark on the work corresponding with the graduation on the rule will appear slightly to one side of the correct position.

The thicker the rule, the greater the error since the path of the light rays beyond the graduation is longer. For the same reason, the more the eye is inclined from the vertical, the greater the error.

B. Pencil: used for temporary marking and labelling of parts (Figure 80).

Fig. 80: Pencil

Use pencil only for:

i. all temporary and rough marking out,

ii. where a cut line would be seen,

iii. free hand curves,
iv. lines which run slightly oblique to the general direction of the grain,
v. marking out chamfers.

C. Marking Knife: Used for marking all lines across the grain to be sawn or chiselled, such as shoulders of tenons, sides of housing, end of wood, etc. It must be knifed to obtain a clean edge to the joint (Figure 81).

Fig. 81: Marking Knife

Setting Out and Cutting a List

Setting out: Regardless of the size of a job, it should first be "SET OUT." This means that the FULL-SIZED DRAWINGS should serve as a guide when you begin to mark out and work the timber.

The drawings should be arranged so that each piece of wood/timber needed for the job can be seen and measured in length, width and thickness while all the mouldings, grooves, rebates, mortises, etc., are indicated correctly. All the essential information/'s' is usually found by drawing both vertical and horizontal sections of the work.

Setting out is sometimes done directly onto the timber from a setting out rod or full-size working drawing, but this can cause mistakes which seem to grow into the job as it progresses. Use a pencil to draw all the lines; do not gauge them with a knife.

Cutting List: In any cabinet or joinery work, the "CUTTING LIST" forms an important link in the progress of each job through

the factory and is one of the first items prepared after the job is set out.

Cutting list ensures that each piece of work is commenced in an orderly manner without omissions or duplications of parts. Each item is identified by name or number on the piece-list, e.g. A, B, C, …. or 1, 2, 3, …. With its finished (planned) sizes with any remark which may be necessary (Table 3).

When ordering materials from the timber merchant, it is important to state or give the specification required, e.g., the sizes of "FINISHED" (prepared timber) or "SAWN" (unplanned timber) sizes of wood.

Table 3: Cutting list

CUTTING LIST

Job number.....…..... Name of project…….....…… Quantity……..... Timber Used…….Type of Finish……...Date……...							
Student's Name…….....……							
Admission No…….. Class ……..							
ITEM	**QUANTITY**	**FINISHED SIZE**			**SAWN SIZE**		
		L	W	T	L	W	T

Joints and Joining

One basic skill of woodworking is the art of joining pieces of wood to form tight, strong, well-made joints. The two pieces that

are to be joined together are called members. The two major steps in making joints are:

1. Laying out the joint on the ends, edges, or faces. and
2. Cutting the members to the required shapes for joining.

The instruments normally used for laying out joints are the try square, mitre square, combination square, sliding T-bevel, marking or mortising gauge, scratch awl, and sharp pencil or knife for scoring lines. Various saws and chisels are essential for cutting the more complex joints by hand. The rebate-and-fillister plane (for rebate joints) and the router plane (for smoothing the bottoms of dadoes and gains) are also helpful.

Simple joints, like the butt (figures 82 and 83), the lap (figure 84), and the mitre joints (figure 85), are used primarily on rough or finished carpentry. However, they may be used occasionally in millwork and furniture making. More complex joints, like the rebate joints (figure 86), the dado and gain joints (figure 87), the blind mortise and tenon and slip-tenon joints (figure 88), the box corner joint (figure 89), and the dovetail joints (figure 90), are used mostly in making furniture and cabinets and in millwork. Of the edge joints shown in Figure 91, the dowel and spline joints are primarily used in furniture and cabinet work, whereas the plain butt and the tongue-and-groove joints are used in practically all types of woodworking.

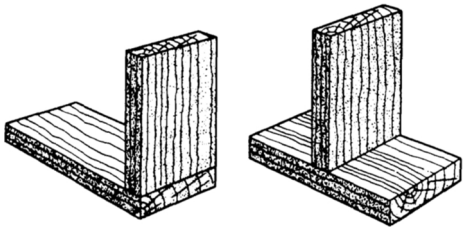


Fig. 82: 90° plain butt Joints

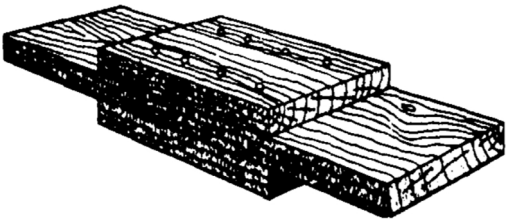


Fig. 83. End butt joints with fishplates

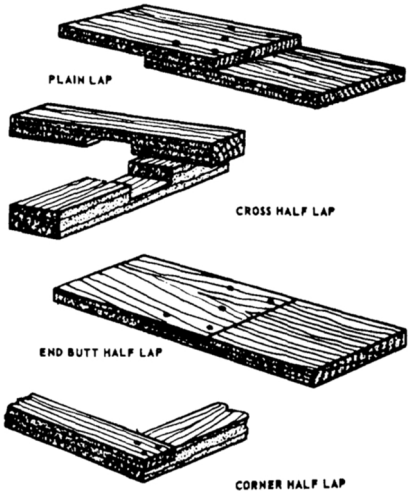


Fig. 84. Lap Joints

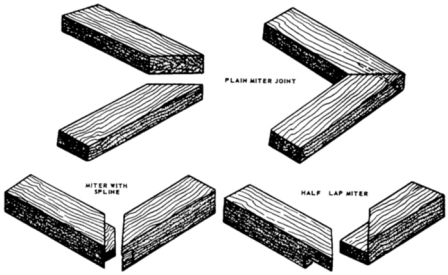


Fig. 85 Mitre joints

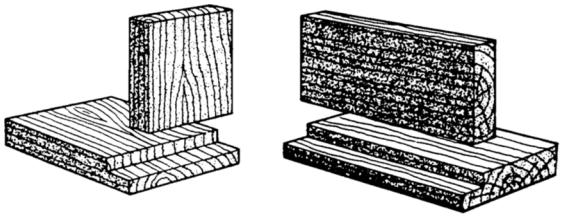


Fig. 86. Rebate joints

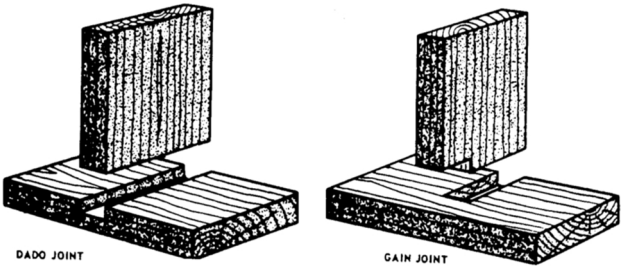


Fig. 87. Dado and gain joints

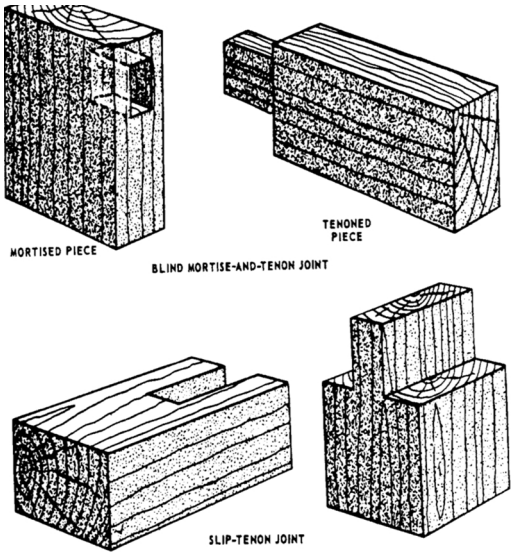


Fig. 88: Tenon joints

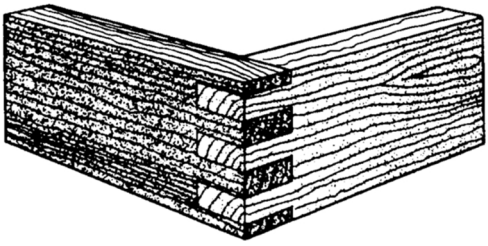


Fig. 89: Box corner joint

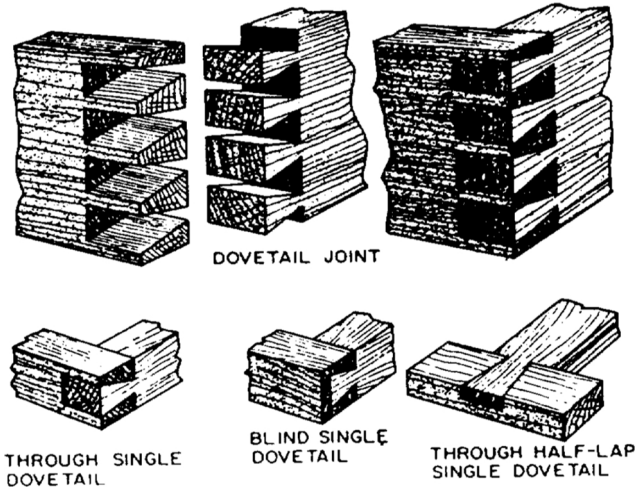


Fig. 90. Dovetail joints

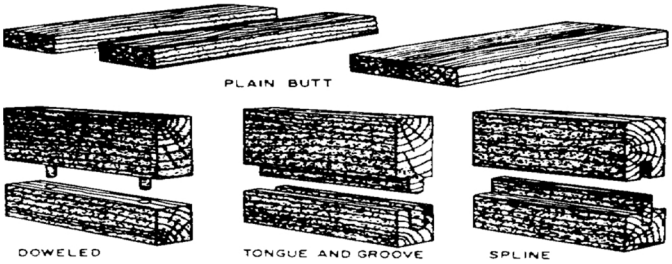


Fig. 91. Edge Joints

The joints used in rough and finished carpentry are, for the most part, nailed together. Nails in a 90° plain butt joint can be driven through the member abutted against and into the end of the abutting member. The joints can also be toenailed at an angle through the faces of the abutting member into the face of the member abutted against, as shown in Figure 92. Studs and joists are usually toenailed to soleplates and sills.

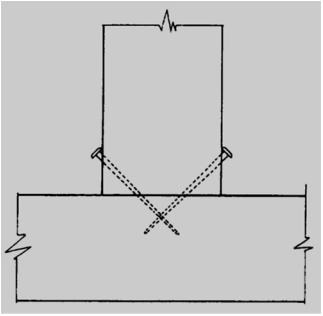


Fig. 92: Toenailing

The more complex furniture and cabinet-making joints are usually fastened with glue. Dowels, splines, corrugated fasteners, keys, and other types of joint fasteners can provide additional strength. The interlocking character of the joint is an additional factor in fastening in the dado joint, the gain joint, the mortise and tenon joint, the box corner joint, and the dovetail joint.

All the joints mentioned can be cut either by hand or by machine. Whatever method is used and whatever type of joint, remember: to ensure a tight joint, always cut on the waste side of the line; never on the line itself. Preliminary grooving on the waste side of the line with a knife or chisel will help a backsaw start smoothly.

Half-Lap Joints

For half-lap joints, the members to be jointed are usually of the same thickness, as shown in Figure 84.

The method of laying out and cutting an end butt half lap is to measure off the desired amount of lap from each end of each member and square a line all the way around at this point. For a corner half lap (figure 84 bottom), measure off the width of the member from the end of each member and square a line all the way around. These lines are called shoulder lines.

Next, select the best surface for the face, set a marking gauge to half the thickness, and score a line (called the cheek line) on the edges and end of each member from the shoulder line on one edge to the shoulder line on the other edge. Be sure to gauge the cheek line from the face of each member. This ensures that the faces of each member will be flush after the joints are cut.

Next, make the shoulder cuts by cutting along the shoulder lines' waste side down to the cheek line's waste side. Then, make the cheek cuts along the waste side of the cheek lines. When all cuts have been made, the members should fit together with faces, ends, and edges flush or near enough to be made flush with the slight paring of a wood chisel.

Other half-lap joints are laid out similarly. The main difference is in the method of cutting. A cross half-lap joint (figure 84 middle) may best be cut with a dado head or wood chisel rather than a handsaw. Others may easily be cut on a band saw, being certain to cut on the waste side of the lines and making all lines from the face of the material.

Mitre Joints

A mitre joint is made by mitring (cutting at an angle) the ends or edges of the members to be joined together (figure 93). The angle of the mitre cut is one-half of the angle formed by the joined members. In rectangular mirror frames, windows, door casing boxes, and the like, adjacent members form a 9o° angle, and consequently, the correct angle for mitring is one-half of 90°, or 45°.

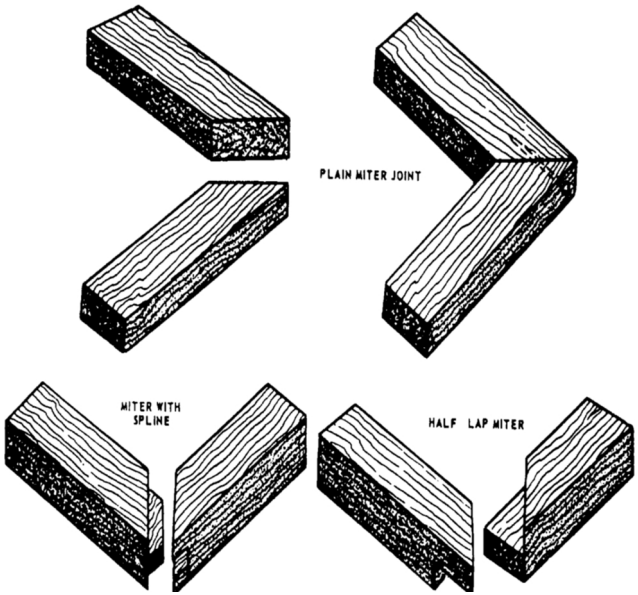


Figure 93: Mitre joints.

For members forming an equal-sided figure with other than four sides (such as an octagon or a pentagon), the correct mitring angle can be found by dividing the number of sides the figure will have by 180° and subtracting the result from 90°. For an octagon (i.e., eight-sided figure), determine the mitring angle by subtracting from 90°180° divided by 8 or 90° minus 22.5° equals 67.5°. For a pentagon (a five-sided figure), the angle is

$$90° - (180° + 5) \text{ or } 90° - 36° = 54°$$

Members can be end mitred to 45° in the wooden mitre box and to any angle in the steel mitre box by setting the saw to the desired angle, or on the circular saw, by setting the mitre gauge to the desired angle. Members can be edge mitred to any angle on the circular saw by tilting the saw to the required angle. Sawed edges are sometimes unsuitable for glueing. However, if the joint is to be glued, the edges can be mitred on a jointer, as shown in Figure 94.

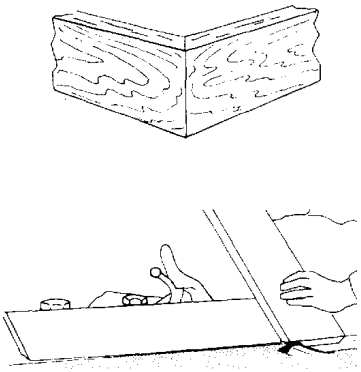


Fig. 94: Bevelling on a jointer for a mitred edge joint

Safety Note

This is a dangerous operation, and caution should be taken. Since abutting surfaces of end-mitred members do not hold well when merely glued, they should be reinforced. One type of reinforcement is the corrugated fastener. This corrugated metal strip has one edge sharpened for driving into the joint. The fastener is placed at a right angle to the line between the members, half on one member and half on the other, and driven down flush with the member. The corrugated fastener mars the appearance of the surface into which it is driven; therefore, it is used only on the backs of picture frames and the like.

The slip feather is a more satisfactory type of fastener for a joint between end-mitred members. This is a thin piece of wood or veneer glued into a kerf cut in the thickest dimension of the joint. First, see halfway through the wood from the outer to the inner corner, then apply glue to both sides of the slip feather, pushing the slip feather into the kerf. Clamp it tightly and allow the glue to dry. After it has dried, remove the clamp and chisel off the protruding portion of the slip feather.

A joint between edge-mitred members can also be reinforced with a spline. This thick piece of wood extends across the joint into

grooves cut into the abutting surfaces. A spline for a plain mitre joint is shown in Figure 93 top. The groove for a spline can be cut either by hand or by a circular saw.

Grooved Joints

A three-sided recess running with the grain is called a groove, and a recess running across the grain is called a dado. A groove or dado that does not extend across the wood is called a stopped groove or a stopped dado. A stopped dado is also known as a gain (figure 95). A two-sided recess running along an edge is called a rebate T (figure 96). Dadoes, gains, and rebates are not, strictly speaking, grooves, but joints that include them are generally called grooved joints.

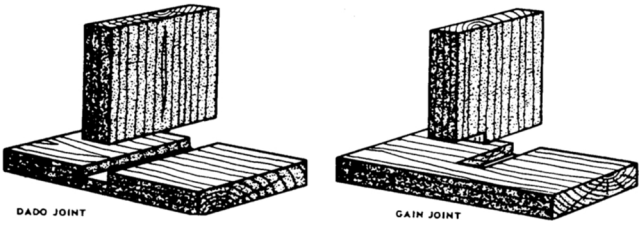


Fig. 95: Dado and gain joints.

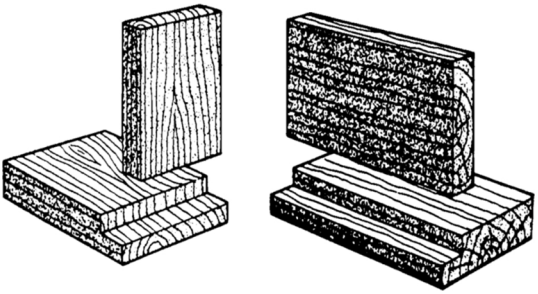


Fig. 96. Rebate joints.

A groove or dado can be cut with a circular saw as follows: Lay out the groove or dado on the end wood (for a groove) or edge

wood (for a dado) that will first come in contact with the saw. Set the saw to the desired depth of the groove above the table, and set the fence at a distance from the saw, which will cause the first cut to run on the waste side of the line that indicates the left side of the groove. Start the saw and bring the wood into light contact with it; then stop the saw and examine the layout to ensure the cut will be on the waste side of the line. Readjust the fence, if necessary. When the position of the wall is correct, cut. Then, reverse the wood, set it and test it as before for the cut on the opposite side of the groove. Make as many recut as necessary to remove the waste stock between the side kerfs.

The procedure for grooving or dadoing with the dado head is about the same, except that, in many cases, the dado head can be built up to take out all the waste in a single cut. The two outside cutters alone will cut a groove 6mm wide. Inside cutters vary in thickness from 3 to 6mm.

A stopped groove or stopped dado can be cut on the circular saw, using either a saw blade or a dado head, as follows: If the groove or dado is stopped at only one end, clamp a stop block to the rear of the table in a position that will stop the wood from being fed any farther when the saw has reached the place where the groove or dado is supposed to stop. If the groove or dado is stopped at both ends, clamp a stop block to the rear of the table and a starting block to the front. The starting block should be placed so the saw will contact where the groove is supposed to start when the in-feed end of the piece is against the block. Start the cut by holding the wood above the saw, with the in-feed end against the starting block and the edge against the fence. Then, gradually lower the wood onto the saw and feed it to the stop block.

A rebate can be cut on the circular saw as follows: The cut into the face of the wood is called the shoulder cut, and the cut into the edge or end is the cheek cut. To make the shoulder cut (which should be made first), set the saw to extend above the table a distance equal to the desired depth of the cheek. Be sure to

measure this distance from a sawtooth set to the left or away from the ripping fence. If you measure it from a tooth set to the right or toward the wall, the cheek will be too deep by an amount equal to the width of the saw kerf.

Using the dado head, you can cut most ordinary rebates in a single cut. First, build up a dado head equal in thickness to the desired cheek width. Next, set the head to protrude above the table at a distance equal to the desired depth. Clamp a 1-inch board to the fence to guide the piece, and put the wall so the board's edge barely contacts the right side of the dado head. Set the piece against the mitre gauge (90°), hold the edge or end to be rebated against the l-inch board, and cut.

On some jointers, a rebating ledge attached to the outer edge of the in-feed table can be depressed for rebating, as shown in Figure 97. The ledge is located on the outer end of the butterhead. To rebate on a jointer of this type, you depress the in-feed table and the rebating ledge the depth of the rebate below the out-feed table and set the fence the width of the rebate away from the outer end of the butterhead. When the piece is fed through, the unabated part feeds onto the rebating ledge. The rebated portion feeds onto the out-feed table.

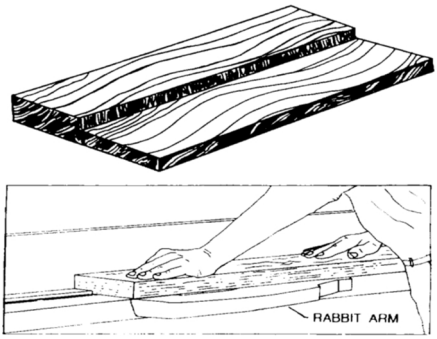


Fig. 97: Rebating on a jointer with a rebating ledge

Various combinations of grooved joints are used in woodworking. The tongue-and-groove joint combines the groove and the rebate,

with the tongued member rebating on both faces. In some types of panelling, the tongue is made by rebating only one face. A tongue of this kind is called a bare-faced tongue. A joint often used in making boxes, drawers, and cabinets is the dado and rebate joint, shown in Figure 98. As you can see, one of the members is rebated on one face to form a bare-faced tongue.

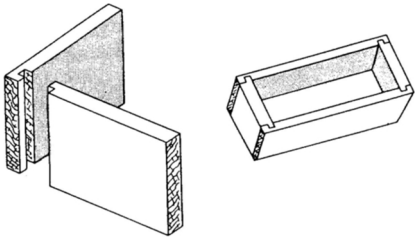
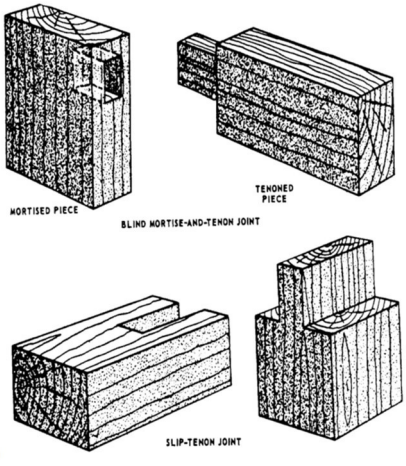


Fig. 98: Dado and rebate joint

Mortise and Tenon Joints

The mortise and tenon joints are most frequently used in furniture and cabinet work. In the blind mortise and tenon joint, the tenon does not penetrate the mortised member (figure 99).



b

Fig. 99a & b: Tenon joints

A joint in which the tenon does penetrate all the way through is a through mortise and tenon joint (figure 100). Besides the ordinary stub joint (view A), there are hunched joints (view B) and table-hunched joints (view C). Haunching and table-haunching increase the strength and rigidity of the joint.

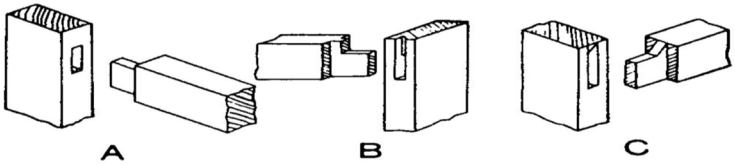


Fig. 100: mortise and tenon joints. Stub (view A), hunched (view B), and table-hunched (view C)

The layout procedure for an ordinary stub mortise and tenon joint is shown in figure 101. The shoulder and cheek cuts of the tenon are shown in figures 102 and 103. To maintain the stock upright while making the cheek cuts, use a push board similar to the one shown in figure 103. Tenons can also be cut with a dado head by the same method previously described for cutting end half-lap joints.

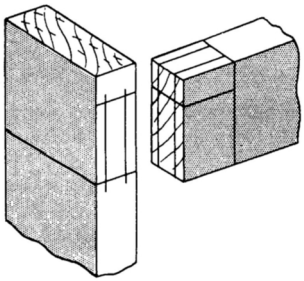


Fig. 101: Layout of stub mortise and tenon joint

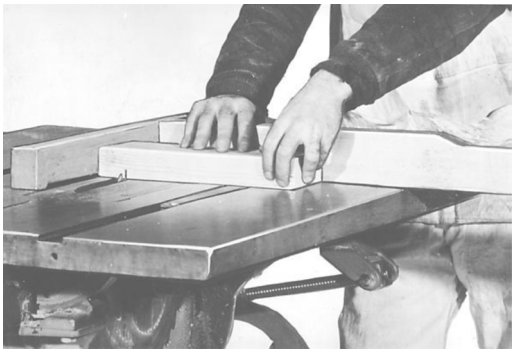


Fig. 102: Making tenon shoulder cut on a table saw

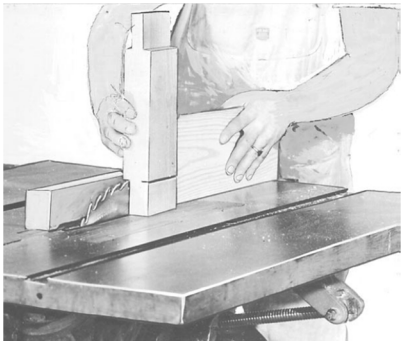


Fig. 103: Making tenon cheek cut on a table saw using a push board

Mortises are cut mechanically on a hollow-chisel mortising machine like the one shown in figure 104. The cutting mechanism on this machine consists of a boring bit encased in a square, hollow, steel chisel. As the mechanism is pressed into the wood, the bit takes out most of the waste while the chisel pares the sides of the mortise square. Chisels come in various sizes, with corresponding sizes of bits to match. If a mortising machine is not available, the same results can be attained by using a simple drill press to take out most of the waste and a hand chisel, for paring the sides square.

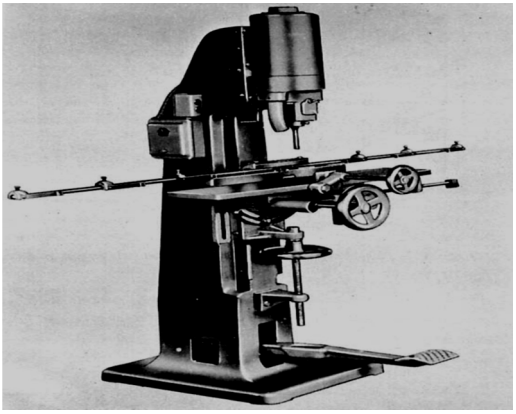


Fig. 104: Hollow-chisel mortising machine

In some mortise and tenon joints, such as those between rails and legs in tables, the tenon member is much thinner than the mortise member. Sometimes, a member of this kind is too thin to shape in the customary reamer, with shoulder cuts on both faces. A barefaced mortise and tenon joint can be used when this is the case. In a barefaced joint, the tenon member is only shoulder cut on one side. The cheek on the opposite side is simply a continuation of the face of the member.

Mortise and tenon joints are fastened with glue and additional fasteners, as required.

Dovetail Joints

The dovetail joint (figure 105) is the strongest of all the woodworking joints. It is used principally for joining the sides and ends of drawers in fine grades of furniture and cabinets. You will seldom use dovetail joints in the Seabee units since they are laborious and time-consuming.

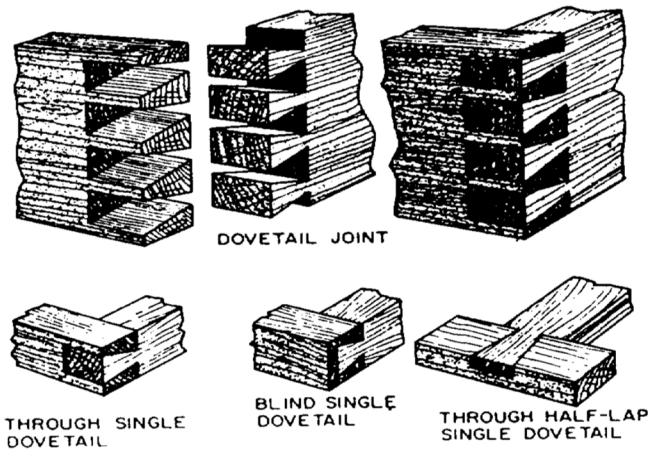


Fig.105. Dovetail joints

A through dovetail joint is one in which the pins pass through the tail member. Where the pins pass only part way through, the member is known as a blind dovetail joint. The simplest of the dovetail joints is the dovetail half-lap joint, shown in Figure 106. Figure 107 shows how this type of joint is laid out, and Figure 108 shows the completed joint.

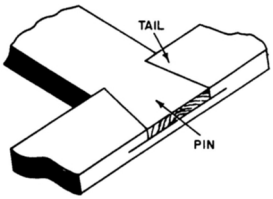


Fig. 106. Dovetail half-lap Joint

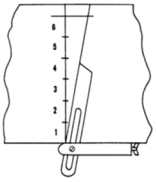


Fig. 107. Laying off 1o° angle for dovetail joint

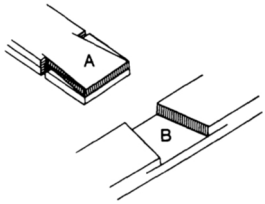


Fig. 108: Making a dovetail half-lap join

Figure 109 shows a multiple dovetail joint; Figure 110 indicates how the waste is chiselled from the multiple joints.

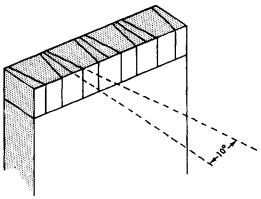


Fig. 109: Laying out a pin member for a through multiple-dovetail joint

Fig. 110: Chiselling out waste in a through-multiple-dovetail joint

Box Corner Joints

With the exception of the obvious difference in the layout, the box corner joint (figure 111) is made similarly to the through-multiple-dovetail joint.

Fig. 111: Box corner joint

Coping Joints

Inside corner joints between moulding trim members are usually made by butting the end of one member against the face of the other. Figure 112 shows the method of shaping the end of the abutting member to tit the face of the other member. First, see off the end of the abutting member square, as you would for an ordinary butt joint between ordinary flat-faced members. Then, the end is at 45°, as shown in the first and second views of Figure 4.33. Set the coping saw at the top of the line of the mitre cut, hold the saw at 9o° to the piece's lengthwise axis, and see off the segment shown in the third view, following closely the face line left by the 45° mitre cut. The end of the abutting member will then match the face of the other member, as shown in the third view. A joint made in this reamer is called a coping joint. You will have to cut coping joints on a large variety of mouldings. Figure 4.34 shows the simplest and most common mouldings and trims used in woodworking.

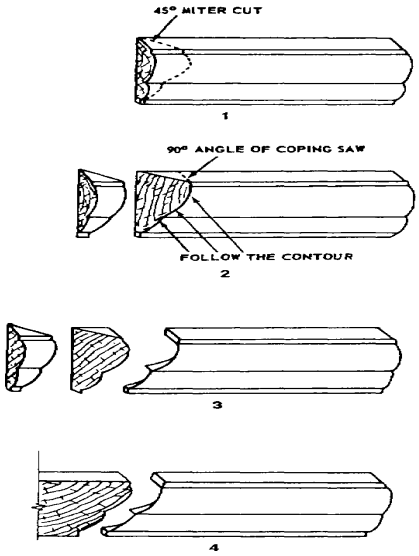


Fig.112. Making a coping Joint

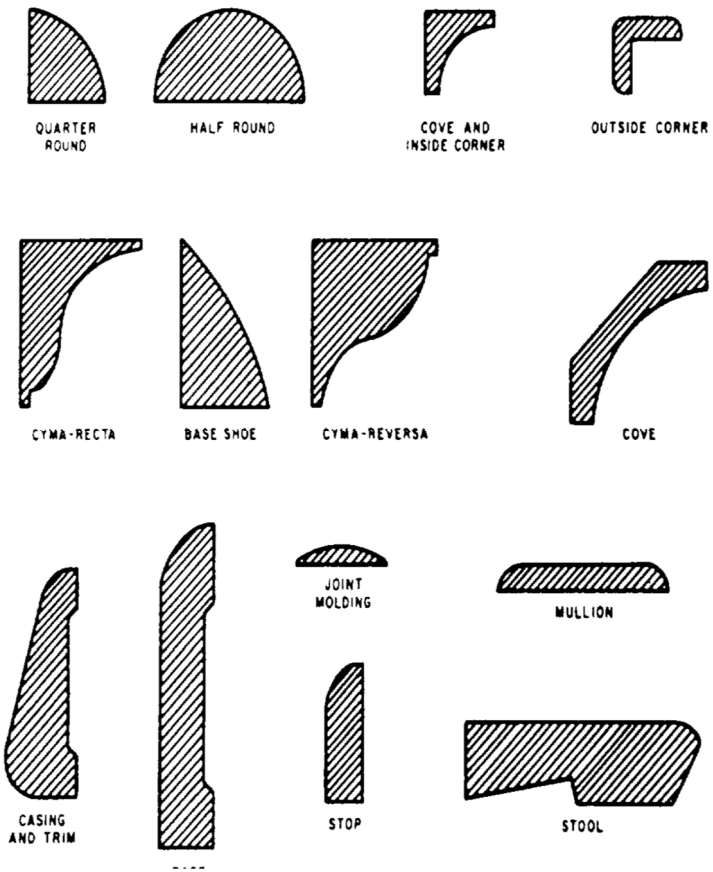


Fig. 113. Simple moulding and trim shapes

Evaluation

1. Define cutting list
2. List and classify the classification of joints.
3. Discuss in detail the preparation of timber

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CHAPTER SEVEN
FORESTRY

Objectives

At the end of this chapter, you should be able to;

i. Define forestry
ii. Types of forestry
iii. Name and explain forestry occupations
iv. Techniques used to obtain timber from the forest

Forestry is the science and craft of creating, managing, using, conserving, and repairing forests, woodlands, and associated resources to meet desired goals, needs, and values for human and environmental benefits. It is practiced in plantations and natural stands. The science of forestry has elements that belong to the biological, physical, social, political, and managerial sciences.

Modern forestry generally embraces a broad range of concerns in what is known as multiple-use management, including the provision of timber, fuel wood, wildlife habitat, natural water quality management, recreation, landscape and community protection, employment, aesthetically appealing landscapes, biodiversity management, watershed management, erosion control, and preserving forests as 'sinks' for atmospheric carbon dioxide. A practitioner of forestry is known as a forester. Other terms, such as verderer and silviculturist, are standard terms. Silviculture is narrower than forestry, concerned only with forest plants, but is often used synonymously with forestry.

Forest ecosystems have become seen as the most important component of the biosphere, and forestry has emerged as a vital applied science, craft, and technology.

Forestry is an important economic segment in various industrial countries. For example, in Germany, forests cover nearly a third of the land area, wood is the most important renewable resource, and forestry supports more than a million jobs and about €181 billion of value to the German economy annually.

Forestry as a Science

over the past centuries, forestry has been regarded as a separate science. The applied sciences have been reordering with the rise of ecology and environmental science. In line with this view, forestry is a primary land-use science comparable to agriculture. Under these headings, the fundamentals behind the management of natural forests come from natural ecology. Forests or tree plantations, those whose primary purpose is extracting forest products, are planned and managed utilising a mix of ecological and agroecological principles.

Forestry is the theory and practice that constitutes the creation, conservation and scientific management of forests and the utilisation of their resources (Anon, 1966). It includes all thinking and all actions about the creation and management of forests, including harvesting, marketing and utilising all forest products and services. It consists of the management of existing forests and the creation of new forests.

Types Of Forests

Tropical Rainforest

Location: Tropical rainforests contain the greatest diversity of species of all biomes on earth. They are found around the equator, between 23.5 degrees N latitude and 23.5 degrees S latitude. They include West, North, and Central Africa.

Climate: Temperatures in tropical rainforests remain between 68- and 77 degrees Fahrenheit each year. Winter is absent in these

forests. Most tropical rainforests receive 1oo centimeters of rain per year.

Soil: Because the temperature is warm and the air moist, decomposition happens very quickly in tropical rainforests. High levels of rainfall often lead to the leaching of nutrients from the soil, creating nutrient-poor soils.

Plants: Trees in tropical rainforests grow between 27 and 38 meters tall and are typically broad-leafed trees. Other plants include ferns, vines, mosses, palms and orchids.

Animals: Dense-growing trees create a thick canopy layer in tropical rainforests that keeps the sun from penetrating the lower layers of the forest. This means most animals here must be adapted to living in the trees. Various birds, bats, monkeys, snakes, and other animals can be found in tropical rainforests.

Threats: Unsustainable forestry practices are the biggest threat to tropical rainforests. Other threats include road construction, agricultural land clearing, other development activities, and climate change.

Temperate Deciduous Forest

Location: Eastern United States and Canada, Western Europe and parts of Russia, China and Japan.

Climate: Temperate deciduous forests have four distinct seasons, and precipitation falls throughout the year, as rain in the spring and summer and snow in the winter. These forests receive 30-60 inches of rain per year.

Soil: The soil in these forests is very fertile.

Plants: The forest floor in temperate deciduous forests supports mosses, ferns, and wildflowers, and the understory supports a variety of shrubs and ferns. Maple, oak, and birch trees are some examples of the deciduous trees that dominate these forests. There are also small numbers of evergreen trees, such as pines and firs.

Animals: Animals living in temperate deciduous forests must be adapted to cold winters. Common species in temperate deciduous forests include red foxes, hawks, woodpeckers, and cardinals.

Threats: Acid rain caused by industrial and vehicular emissions poses the biggest threat to temperate deciduous forests. Over time, acid rain damages tree leaves, causes trees to produce fewer and smaller seeds and reduces disease resistance. Other threats include unsustainable forestry, strip mining, and the spread of invasive, non-native species that compete for space and food. Climate change is also a threat.

Temperate Coniferous Forest

Location: Temperate coniferous forests are typically found in coastal areas with mild winters and heavy rainfall or in mountainous regions with mild climates. Examples of where these forests are found are the Pacific Northwestern United States and Canada, southwestern South America, southern Japan, New Zealand, and small parts of northwestern Europe (Ireland, Scotland, Iceland, and Norway).

Climate: Temperate climate with temperature that fluctuates little throughout the year. High precipitation levels (50-200 inches per year) cause a moist environment and a long growing season.

Soil: Soils are generally rich with a thick layer of decaying material.

Plants: Evergreen conifers dominate these forests. Due to the high levels of precipitation and moderate temperatures, the growing season is long, resulting in trees that grow very tall. Dominant tree species in temperate coniferous forests include cedar, cypress, Douglas fir, pine, spruce, and redwood. Some deciduous trees, such as maple, are present, and mosses and ferns are common.

Animals: Examples of animals that live in temperate coniferous forests are deer, marmot, elk, black bear, salmon, spotted owl, marbled murrelet

Threats: Unsustainable forestry, road construction, and other development-related activities are the biggest threats to temperate deciduous forests.

Boreal (Taiga) Forest

Location: This is the northernmost forest type, found between 50- and 60-degrees north latitude. Boreal forests are found in Canada, northern Asia, Siberia, and Scandinavia (Denmark, Norway, Sweden, and Finland). About two-thirds of the world's boreal forests are found in Scandinavia.

Climate: Boreal forests are characterised by long winters and short summers. Most precipitation is snow; these forests receive between 37.5 and 40cm of yearly precipitation.

Soil: Because of cold temperatures, decomposition takes a long time, resulting in thin soil.

Plants: Trees are primarily evergreen and include spruce, fir, and pine species. Because the canopy is so dense, the understory is limited.

Animals: The animals found here must be adapted to long, cold winters and usually have thick fur. Some examples are deer, moose, elk, caribou, snowshoe hare, wolves, grizzly bears, lynxes, and wolverines.

Techniques Used to Obtained Timber from Forest

Timber has played a key role in the construction industry for many years. While it’s always been a popular material, the process of how and where it arrives is often overlooked.

In this guide, we’ll walk you through the journey of timber—how it travels from the forest to your builders’ merchant, ready for you to embark on your next project.

Stage one: Felling

The first stage of preparing the timber for commercial use is called ‘felling’ - downing individual trees. In this case, the person cutting the tree is called the ‘feller’ - while the harvesting machine is called a ‘feller buncher’.

A forestry worker will determine when and which trees should be cut down, depending on when they reach their economically ‘mature’ stages. Trees can range from 40 to 150 years old before they stop growing vigorously and are ready to be cut down. The differences in age at felling can depend on the tree species. For example, conifers grow at a much quicker rate than broad-leaved species. Environmental factors, such as soil nutrients, can also affect their growth. Felling is typically carried out in winter because the trees usually have less moisture content than in summer, where they can have more than fifty per cent water content.

Finally, felled trees should be replaced with saplings so that the forest can grow once again, providing a sustainable resource for future generations.

Stage Two: Storing/ Transporting

Next, the logs are stored in a clearing or the forest until they are needed at the sawmill. This also allows some of the ‘free’ water content to evaporate, reducing the weight of the tree/log and lowering the cost of transporting and handling.

The trees are usually cut into smaller lengths on-site and then picked up by a timber lorry, transporting the timber to a processing site, such as a sawmill, paper mill, pallet, fencing, or construction producer.

Stage Three: On Site

The logs are debarked and bucked at the chosen site or cut to the required length. Then, they are cut into boards using circular

saws and bandsaws. This is called ‘conversion’. The first stage of conversion is a process called ‘breaking down’ - which means rough sawing. The second stage is called ‘re-sawing’ and refers to more precise cutting and finishing, such as planning and further machining. Two types of rough sawing can be used in the breaking down process - through sawn and quarter sawed.

The ends of each log are trimmed to ensure they are straight and cut into boards. Large circular saws are then used to process the boards further, removing the curved edges. Each processed piece of wood now looks like a board.

Stage Four: Seasoning

Seasoning natural wood is the process of removing excess water/moisture content. When a tree is felled, it still contains much water/moisture—usually between forty and fifty percent water content.

Water is held inside a tree in two ways:

1. Free Water: Water held in the vessels and cells to distribute nutrients inside the tree.
2. Cell water: Also known as ‘bound’ water, it is essential to the tree’s cell walls.

During seasoning, a tree loses its free water and a large proportion of its cell water, making it less likely to warp or deform.

Wood that has not been seasoned and still has a high-water content is called ‘green wood’ and can be more challenging to work with because it tends to change shape.

Stage Five: Preparing for the Market

After turning trees into timber through sawmilling, covered in stage three – also referred to as primary processing, the market value of wood can be further increased through manufacturing sawn timber products – called secondary processing. This involves

the wood being made (either by man or machine) into a more refined product, such as a door, window or furniture, made to a specific size and dimensions.

At this stage, any preferred treatments for timber, such as fire or rot resistance, are added. Treated wood in sawn form is used directly in construction or to prepare components, such as timber frame panels. Planed joinery components, on the other hand, are usually treated after assembly.

Finally, the timber is ready to be shipped to market once all modifications are made.

organ

Evergreen

The evergreen tree is a complete contrast to the deciduous tree. As the name implies, evergreen foliage remains on the tree throughout the year. There is no seasonal leaf shedding. Evergreen plants have a vast deviation within them. They include most conifers and angiosperms, such as hemlock, cycads, and eucalyptus trees.

This does not mean that evergreens never shed their foliage. Old leaves of evergreen trees are replaced by new growth as they age. Evergreen trees favour warm, temperate climates. Many tropical rainforests are considered evergreens.

What are the differences between a deciduous and an evergreen tree?

There are several significant differences between a deciduous and an evergreen tree. We will list them for you here:

- Deciduous and evergreen trees are opposite each other. Deciduous trees shed their leaves seasonally, and evergreen trees keep their foliage throughout the year.
- Deciduous trees are adapted to tolerate cold and dry weather conditions by shedding their leaves, while evergreens do not.

- Evergreens can survive with low soil nutrients. A vast portion of internal nutrients is removed during the defoliation of deciduous trees.
- Nutrient requirements of evergreens are somewhat higher than those of deciduous trees during bad weather because of the need for foliage maintenance. In deciduous trees, it is high after harsh weather when the foliage is renewed.
- Deciduous trees are more sensitive to temperature and rainfall than evergreen trees.

We hope this article has helped you better understand deciduous and evergreen trees, especially their differences. If you have questions about what types of trees you have, please call us at 512-341-8888. We'll be happy to help you determine whether you have deciduous or evergreen trees.

In botany, an **evergreen** is a plant with leaves throughout the year, always green. This is true even if the plant retains its foliage only in warm climates and contrasts with deciduous plants, which completely lose their foliage during the winter or dry season. There are many different kinds of evergreen plants, both trees and shrubs. Evergreens include:

- Most species of conifers (e.g. pine, hemlock, blue spruce, red cedar, and white/scots/jack pine), but not all (e.g., larch)
- live oak, holly, and "ancient" gymnosperms such as cycads
- most angiosperms from frost-free climates, such as eucalypts and rainforest trees
- clubmosses and relatives

Deciduous trees shed their leaves, usually adapting to a cold or dry/wet season. Evergreen trees lose leaves, but each tree loses its leaves gradually, not all at once. Most tropical rainforest plants are considered to be evergreens, replacing their leaves gradually throughout the year as the leaves age and fall. In contrast, species growing in seasonally arid climates may be evergreen or

deciduous. Most warm temperate climate plants are also evergreen. In cool temperate climates, fewer plants are evergreen, with a predominance of conifers, as few evergreen broadleaf plants can tolerate severe cold below about −26 °C (−15 °F).

In areas with a reason for being deciduous, e.g., a cold or dry season, being evergreen is usually an adaptation to low nutrient levels. Deciduous trees lose nutrients whenever they lose their leaves. In warmer areas, species such as some pines and cypresses grow on poor soils and disturbed ground. In Rhododendron, a genus with many broadleaf evergreens, several species grow in mature forests but are usually found on highly acidic soil where the nutrients are less available to plants. In taiga or boreal forests, it is too cold for the organic matter in the soil to decay rapidly, so the nutrients in the soil are less readily available to plants, thus favouring evergreens.

In temperate climates, evergreens can reinforce their survival; evergreen leaf and needle litter have a higher carbon-nitrogen ratio than deciduous leaf litter, contributing to a higher soil acidity and lower soil nitrogen content. These conditions favour the growth of more evergreens and make it more difficult for deciduous plants to persist. In addition, the shelter provided by existing evergreen plants can make it easier for younger evergreen plants to survive cold and/or drought.

Deciduous means "falling off at maturity" and "tending to fall off" about trees and shrubs that seasonally shed leaves, usually in the autumn, to the shedding of petals after flowering, and to the shedding of ripe fruit.

Deciduous is a term that refers to trees that seasonally shed unnecessary parts, such as leaves, from their structure. Most deciduous trees are broad-leaf trees. Because of the structure of the leaves and the pattern of leaf arrangement, the effectiveness of photosynthesis is very high in deciduous trees. Unfortunately, deciduous trees have both positive and negative aspects to them.

Since they shed their leaves seasonally (usually during autumn and winter), they are susceptible to wind and other winter weather conditions.

The falling of the leaves helps trees prepare for winter conditions. It ensures better winter survival, high-water conservation, and protection against predatory actions. Deciduous tree characteristics are observable in many woody trees like oak and maple. There are two characteristic deciduous forests where most trees shed their foliage at the end of their typical growing season: temperate deciduous forests and tropical (and subtropical) deciduous forests. Trees in temperate deciduous forests are sensitive to seasonal temperature variations, whereas tropical deciduous trees respond to seasonal rainforest patterns.

Generally, the term *deciduous* means "the dropping of a part that is no longer needed" and the "falling away [of a part] after its purpose is finished". In plants, it is the result of natural processes. "Deciduous" has a similar meaning when referring to animal parts, such as deciduous antlers in deer, deciduous teeth (baby teeth) in some mammals (including humans), or decidua, the uterine lining that sheds off after birth.

Wood from deciduous trees is used in various ways in several industries, including lumber for furniture, construction, and flooring (oak), ornamental, bowling pins, and baseball bats (maple), and furniture, cabinets, plywood, and panelling (birch).

In botany and horticulture, deciduous plants are trees, shrubs and herbaceous perennials that lose all of their leaves during the part of the year. The process is called abscission. In some cases, leaf loss coincides with winter, particularly in temperate or polar climates like Europe. In other parts of the world, including tropical, subtropical, and arid regions (North and West Africa), plants lose their leaves during the dry season or other seasons, depending on variations in rainfall.

The converse of deciduous is evergreen, where foliage is shed on a different schedule from deciduous trees, therefore appearing to remain green year-round. Intermediate plants may be called semi-deciduous; they lose old foliage as new growth begins.[9] other plants are semi-evergreen and lose their leaves before the next growing season, retaining some during winter or dry periods. Some trees, including a few species of oak, have desiccated leaves that remain on the tree through winter; these dry, persistent leaves are called marcescent leaves and are dropped in the spring as new growth begins.

Many deciduous plants flower when they are leafless, increasing pollination's effectiveness. The absence of leaves improves wind transmission of pollen for wind-pollinated plants and increases the visibility of the flowers to insects in insect-pollinated plants. This strategy is not without risks, as the flowers can be damaged by frost or, in dry season regions, result in water stress on the plant. Nevertheless, there is much less branch and trunk breakage from glaze ice storms when leafless, and plants can reduce water loss due to the reduction in availability of liquid water during cold winter days.

Leaf drops or abscission involve complex physiological signals and changes within plants. Photosynthesis steadily degrades the supply of chlorophylls in foliage; plants usually replenish chlorophylls during summer. When autumn arrives and the days are shorter or when plants are drought-stressed, deciduous trees decrease chlorophyll pigment production, allowing other pigments in the leaf to become apparent, resulting in non-green-coloured foliage. The brightest leaf colours are produced when days grow short and nights are cool but remain above freezing. These other pigments include carotenoids that are yellow, brown, and orange. Anthocyanin pigments produce red and purple colours, though they are not always present in the leaves. Instead, they are made in the foliage in late summer, when sugars are trapped in the leaves after abscission begins. Parts of the world with showy displays of

bright autumn colours are limited to locations where days become short and nights are cool. In other parts of the world, the leaves of deciduous trees fall off without turning the bright colours produced by the accumulation of anthocyanin pigments.

Further Information: Autumn Leaf Colour

The leaf drop starts when an abscission layer is formed between the leaf petiole and the stem. This layer is formed in the spring during active new growth of the leaf; it consists of layers of cells that can separate from each other. The cells are sensitive to a plant hormone called auxin produced by the leaf and other parts of the plant. When auxin coming from the leaf is made at a rate consistent with that from the body of the plant, the cells of the abscission layer remain connected; in autumn, or when under stress, the auxin flow from the leaf decreases or stops, triggering cellular elongation within the abscission layer. The elongation of these cells breaks the connection between the different cell layers, allowing the leaf to break away from the plant. It also forms a layer that seals the break so the plant does not lose sap.

Several deciduous plants remove nitrogen and carbon from the foliage before they are shed and store them as proteins in the vacuoles of parenchyma cells in the roots and the inner bark. In the spring, these proteins are used as a nitrogen source during the growth of new leaves or flowers. Deciduous plants in mid-to-high latitudes shed their leaves as temperatures drop in autumn.

Plants with deciduous foliage have advantages and disadvantages compared to evergreen foliage. Since deciduous plants lose their leaves to conserve water or to survive winter weather conditions better, they must regrow new foliage during the next suitable growing season; this uses resources which evergreens do not need to expend. Evergreens suffer more significant water loss during the winter and can experience more tremendous predation pressure, especially when small. Losing leaves in winter may reduce insect

damage; repairing and keeping them functional may be more costly than losing and regrowing them. Removing leaves also reduces cavitation, which can damage xylem vessels in plants. This then allows deciduous plants to have xylem vessels with larger diameters and, therefore, a greater rate of transpiration (and hence Co_2 uptake as this occurs when stomata are open) during the summer growth period.

Deciduous Woody Plants

The deciduous characteristic has developed repeatedly among woody plants. Trees include maple, many oaks and anthophagous, elm, aspen, and birch, among others, and several coniferous genera, such as larch and metasequoia. Deciduous shrubs include honeysuckle, viburnum, and many others. Most temperate woody vines are deciduous, including grapes, poison ivy, Virginia creeper, wisteria, etc. The characteristic is useful in plant identification; for instance, deciduous and evergreen oak species may grow side by side in parts of Southern California and the American Southeast.

Periods of leaf fall often coincide with seasons: winter in the case of cool-climate plants or the dry season in the case of tropical plants. However, there are no deciduous species among tree-like monocotyledonous plants, e.g. palms, yuccas, and dracaenas. The hydrangea hirta is a deciduous woody shrub found in Japan.

Deciduous forests are forests where most trees lose their foliage at the end of the typical growing season. They are found in many areas worldwide and have distinctive ecosystems, understory growth, and soil dynamics.

Two distinctive types of deciduous forests are found growing around the world.

Temperate deciduous forest biomes are plant communities distributed for cultivation purposes in North and South America,

Asia, the southern slopes of the Himalayas, Europe, and Oceania. They have formed under climatic conditions with significant seasonable temperature variability, with growth occurring during warm summers, leaf drop in autumn, and dormancy during cold winters. These seasonally distinctive communities have diverse life forms that are significantly impacted by the seasonality of their climate, mainly temperature and precipitation rates. These different ecological conditions produce distinctive forest plant communities in other regions.

Tropical and subtropical deciduous forest biomes have developed in response not to seasonal temperature variations but to seasonal rainfall patterns. During prolonged dry periods, the foliage is dropped to conserve water and prevent death from drought. Leaf drop is not seasonally dependent as it is in temperate climates, and can occur any time of year and varies by region of the world. Even within a small local area, there can be variations in the timing and duration of leaf drops; different sides of the same mountain and places with high water tables or areas along streams and rivers can produce a patchwork of leafy and leafless trees.

Deciduous and evergreen are two opposite types of trees. They are categorised by the pattern and seasonality of their foliage growth. Plants between deciduous and evergreen are known as semi-deciduous trees. They have characteristics of both. This article will explain the main differences between an evergreen and a deciduous tree.

1. **Absorbing and storing carbon**: Because trees absorb carbon dioxide and turn it into wood, where the carbon stays bound up for hundreds or even thousands of years, living forests are an essential part of the earth's climate system. Growing trees soak CO_2 from the atmosphere and store it in their trunks, roots, leaves, and forest soils.
2. **Source of jobs and livelihoods**: More than 1.6 billion people worldwide depend on forests to some extent. Some 60 million

indigenous people depend entirely on forests for all aspects of their survival. About 10 million people are employed in forest management and conservation worldwide.

3. **Wood for furniture, lumber, firewood and other products**: Many local communities sustainably harvest mahogany and other wood, as well as chicle, which is used to make chewing gum. Panama hats are made from an understory palm from the coastal dry forests of Ecuador. About 30 percent of the world's forests produce wood and non-wood products (food, resins, medicines, etc.).

4. **Habitat for mammals, birds, and insects**: Forests are home to almost half of the world's species, with some of the richest biodiversity in tropical forests. Insects and worms help cycle nutrients through the soil. Many rare and endangered species, such as orangutans, gorillas and pandas, depend on dense patches of isolated forest.

5. **Preventing flooding**: During heavy rainfall, lowland forests, such as those in floodplains, prevent damage to soil, property, and buildings. Lowland forests, such as the blackwater swamps of the Southeast, are also spectacularly beautiful habitats for a wide range of wildlife.

6. **Conserving soil and water**: Trees are an important part of the water cycle. By helping slow runoff and allowing water to filter into the soil, they can preserve groundwater supplies important to people, such as drinking water, fish, and other aquatic life in nearby streams. Trees also help hold soil in place, reducing erosion by both water and wind. Deforestation plays a role in dust storms that afflict Beijing and other East Asian cities.

7. **Regulating regional climate**: When trees are planted in cities, they can help ease the "heat island" effect and provide cooling shade for homes and buildings, reducing energy usage for air conditioning in the summer. When planted strategically, they can give practical wind barriers. Extensive forests also

play a role in weather and rainfall patterns and micro-climates. For example, it creates conditions that result in regular precipitation for lands to the south that are productive agricultural areas and are thought to enhance rainfall in the Great Plains.

8. **Natural beauty:** Trees and forests are sources of human inspiration and enjoyment—even from afar. Trees are a symbol of life and, in modern times, of a movement to sustain the environment that all people depend upon. Polling by The Nature Conservancy shows that more than ninety percent of Americans report that trees give them peace and tranquility.

9. **So, we can put trail blazes on something:** Establishing protected areas and parks often allows for the development of trails for hiking, snow sports, and bird-watching, providing people outside of forests with a refuge for recreation, tourism, and educational activities. Walking in a forest can be a source of spiritual renewal for many (stillness broken by the whispering of pines, the call of an owl or the rustling of a small animal through brush and dried leaves).

The following steps should be taken for the conservation of forests:

1. Regulated and Planned Cutting of Trees:

One of the main reasons for deforestation is the commercial felling of trees. According to an estimate, about 1.6 billion cubic meters of wood have been used for various purposes worldwide. Although trees are considered a perennial resource, their revival cannot be possible when exploited on a huge scale.

Therefore, cutting should be regulated by adopting methods like:

(i) Clear-cutting,

(ii) Selective cutting, and

(iii) Shelter wood cutting.

The clear-cutting method is helpful for areas with the same types of trees over a large area. In that case, trees of the same age group can be cut down in a selected location and then marked for replantation.

Only mature trees are selected for selective cutting, which is to be done in rotation. Shelterwood cutting involves removing useless trees first, followed by medium—and best-quality timber trees.

The time gap between these cuttings is helpful in re-growing trees. In regulated cutting, only one-tenth of the forest area is selected for use, and a rotational system is always followed for their protection.

The forest can be managed so that a timber crop may be harvested indefinitely year after year without being depleted. This technique is called the 'sustained yield' method, and many countries worldwide have adopted it.

2. Control over Forest Fire:

Destruction or forest loss by fire is relatively common because trees are highly exposed to fire, and once started, it becomes difficult to control. Sometimes, fire starts naturally, e.g., by lightning or by friction between trees during speedy winds, while in most cases, it is started by man, either intentionally or unintentionally.

According to an estimate, from 194o to 1950, in the US alone, fires consumed an average of 21.5 million acres of timber yearly. As many as 1,175,664 cases of forest fires occurred during the 1955 to 1964 period.

Forest fires are common worldwide; in most cases, they were begun by man. As John D. Guthrie, former fire inspector of the US Forest Service, has written: "To stage a Forest Fire you need only a few things – a forest, the right atmospheric conditions, and a

spark either from a lightning bolt or a match in the hands of a fool or a knave. The formula is simple – the larger the forest, the drier the air, the bigger the fool, the bigger the fire you will have".

To save forests from fire, the latest firefighting techniques must be adopted. Some fire suppression techniques are to develop three-meter-wide five lanes around the fire's periphery, backfires, and the arrangement of water spray. Fire retardant chemicals should be sprayed from the back tank and, if possible, by helicopters. A trained staff of firefighters must be present to control the fire.

3. Reforestation and Afforestation:

The sustained yield concept dictates that the denuded area must be reforested whenever timber is removed, either by block cutting or selective cutting. Natural or artificial methods may do this. Similarly, any forested land destroyed by fire or mining activities should be reforested. In rugged terrain, aerial seeding is the method of choice.

Besides all this, fresh afforestation programmes should be started. New plantations will increase the forest cover and help restore the eco-balance. Trees should be selected according to local geographical conditions for afforestation, and care must be taken during the trees' initial growth.

4. Check over Forest Clearance for Agricultural and Flabitation Purposes:

Most present-day agricultural land was once forested and cleared for agricultural use. But now, it has reached the stage where further clearance will be dangerous for the entire ecosystem.

There are tribals in some parts of Asia, Africa, and South America where shifting cultivation is still a part of their land procurement system. According to an estimate, about 2 million tribals worldwide use about 4 million sq km of land for this purpose.

Forest conservation should be checked, and an alternative system should be suggested. Similarly, forest lands have been cleared for the development of villages, towns, and cities, and this process continues to this day, causing a loss of forest cover. This also should be checked, and green belts around cities should be developed.

5. Protection of Forest:

The existing forests should be protected. Apart from commercial cutting, unorganised grazing is also one reason. Forest diseases from parasitic fungi, rusts, mistletoes, viruses, and nematodes destroy trees. The forests should be protected either by chemical sprays, antibiotics, or the development of disease-resistant strains of trees.

6. Proper Utilisation of Forest Products and Forests:

Generally, forests have been cut for logs, and the rest of the trees – stumps, limbs, branches, foliage, etc., are left out in the forest as worthless debris. Further waste occurs at the sawmill. There is a need to use all this waste material. Several uses have been developed, and products like waterproof glues, boards, etc., can be obtained.

Similarly, forests can easily be used or developed as tourist centres. A country can earn substantial foreign exchange by using them as tourist centres. Many countries, both developed and developing, have adopted this practice.

The concepts of ‘national park’ and ‘game sanctuary’ have become popular, and every country has developed its unique forest area as a ‘national park’. In India alone, there are as many as 21 national parks. This scheme is a suitable method of forest conservation.

Forestry is the science, art and practice of understanding, managing and wisely using natural resources associated with and derived from forest lands. These resources include timber, water, fish, wildlife, soil, plants, and recreation. Forest lands are

instrumental in the beauty and spiritual impact of our landscape. The utilisation of all of these resources is part of the cultural heritage of British Columbia, and modern resource management embraces these values. Finding a balance between these multiple uses while sustaining and conserving forest resources is the basis of this challenging and exciting program of study.

The diverse degree programs offered at the UBC Faculty of Forestry reflect the spectrum of forest resources and the businesses they generate. Students learn to combine social and biological sciences with technical skills, striving to balance society's ever-increasing need for goods and services and environmental sustainability.

Graduates' career paths include forest biologists, professional foresters, wood engineers, forestry business administrators, conservationists, and renewable resource managers. As an applied science, a forestry education can also serve as a foundation for entry into other professions such as education, business, and law.

Aims and Objectives of Forestry

Aim - Quality of Life

Objectives

1. Encourage and enable a diverse range of people to access the woodlands.
2. offer lifelong learning opportunities that meet the needs of current and new audiences.
3. Continue to develop an attractive and inspiring woodland environment.

Aim - Economic Sustainability

Objectives

1. Maximise revenue from the existing timber resource and continue investment in productive crops.
2. Provide an income from visitor services and facilities that enables us to manage them sustainably.
3. Promote sustainable development opportunities while supporting the local economy and employment.

Aim - Sustainable Management

Objectives

1. Pursue a policy of diversification of tree species and silvicultural systems to provide maximum marketing opportunities and to mitigate against climate change and other environmental factors.
2. Help to minimise impacts of climate change through awareness raising and education
3. Pursue a policy of protecting and sustainably managing priority habitats and species.

Stage one:

The ‘felling’ of a tree is the first stage of preparing the timber for commercial use. This is usually carried out in winter when the tree has less moisture content. In the summer months, trees can have more than fifty percent water content. This increased weight adds to the cost of transport, handling, and initial preparation for the sawmill. Even in winter, trees have a high-water content.

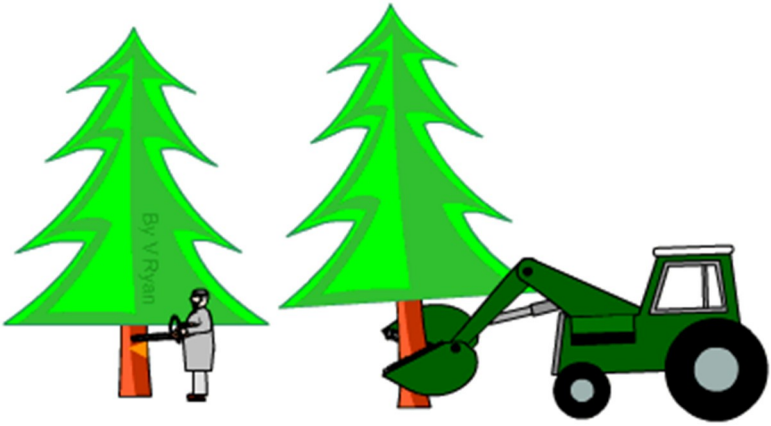

Figure 114: a) chainsaw method; b) Tractor harvester

A forestry worker selects mature trees. Only older trees are chosen, allowing the younger trees to mature. Felled trees are replaced with saplings. Consequently, the forest is sustainable (it should not run out of trees).

If small numbers of trees are harvested each day, a skilled forestry worker will use a chainsaw (Figure 114a). When high numbers of trees are to be harvested, a team of forestry workers will work together to fell trees. Alternatively, in large forests, such as in Norway, specially designed 'tractors' with cutters and grabbers (Figure 114b) will fall hundreds of trees in one day.

Stage Two:

Tree trunks (logs) are stored/stacked in a clearing. Sometimes, logs are stored in the forest until they are needed at the sawmill (Figure 114). This also allows some of the 'free' water content to evaporate, reducing the weight of the tree/log.

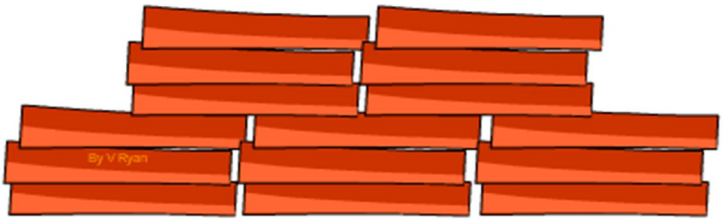

Figure 115: Stacked logs

Stage Three:

Logs are transported to the sawmill using vehicles equipped with lifting gear (Figure 116). In the Tropics, large numbers of logs are transported by floating in rivers, allowing the current to carry them downstream to sawmills.

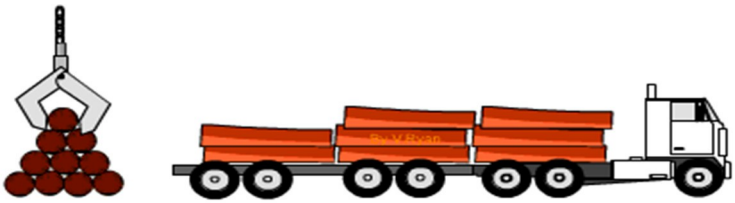

Figure 116: Transporting logs to sawmills

Stage Four:

The sawmill's logs are cut into ‘boards’ using equipment such as circular saws and bandsaws (Figure 117). This is called ‘conversion’. The first stage of conversion is a process called ‘breaking down’, which means rough sawing. The second stage is ‘resawing’, which refers to more accurate/precise cutting and finishing, such as planning and further machining. Two types of rough sawing for the breaking down process are shown below.

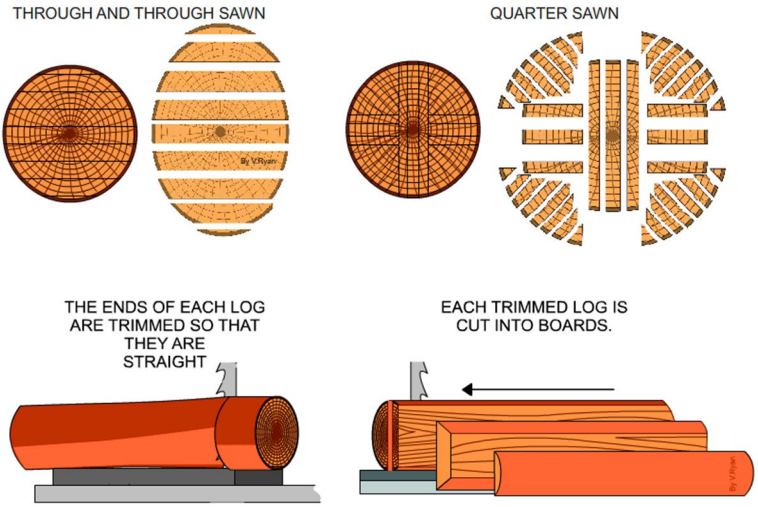

Figure 117: Methods of conversion

Large circular saws are then used to process the boards further, removing the curved edges (Figure 118). Each processed piece of wood now looks like a board.

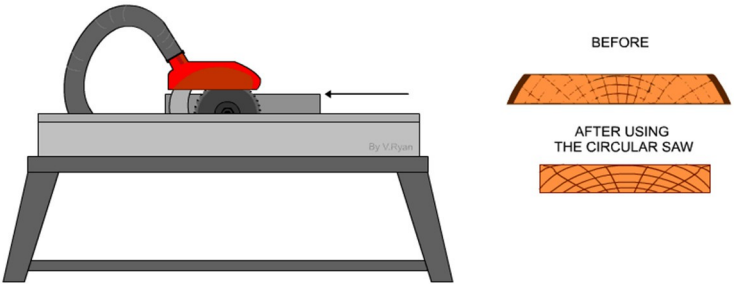

Figure 118: Resawing or edging

Stage Five: What is Seasoning, and Why is It Necessary?

When a tree is felled, it contains much water/moisture. Many felled trees have forty to fifty percent water content. Seasoning natural

wood is the process through which excess water/moisture is removed, typically leaving fifteen to twenty percent water content.

Wood that has not been seasoned and still has a high-water content is called ‘green wood’. Wood with reduced water content is called ‘seasoned wood’.

Water is held inside a tree in two ways. ‘Free Water’ is water held in the vessels and cells, and its purpose is to distribute nutrients inside the tree. ‘Cell’ water (or' bound') is an intrinsic part of the tree’s cell walls. During seasoning, a tree loses its ‘free’ water and a high proportion of its ‘cell’ / ‘bound’ water.

Seasoned wood is used to make furniture and most other wood-based products because it is less likely to ‘deform’ and ‘warp’. It can be shaped accurately with tools such as planes, saws, routers, and hand tools. Adhesives can also be used with seasoned wood.

On the other hand, ‘green wood’ (unseasoned wood) tends to warp and change shape, making it difficult to make precise products. Working with green wood is a skilled craft in its own right, requiring years of training and dedication.

Silviculture is the practice of controlling the establishment, growth, composition, health, and quality of forests to meet diverse needs and value; silviculture is the science and art of growing and tending forest crops, based on a knowledge of silvics, i.e., the study of the life history and general characteristics of forest trees and stands, with particular reference to locality factors.[2] More particularly, silviculture is the theory and practice of controlling forests' establishment, composition, constitution, and growth. No matter how forestry as science is constituted, the kernel of the forestry business has historically been silviculture, as it includes direct action in the forest, and all economic objectives and technical considerations ultimately converge.[3] The focus of silviculture is regeneration, but more recently, recreational use of forestland has challenged silviculture as the primary income

generation from forests due to increasing recognizance of forestland's use for leisure and recreation.

Some distinctions between forestry and silviculture are that silviculture is applied at the stand level, and forestry is broader. For example, John D. Matthews says "complete regimes for regenerating, tending, and harvesting forests" are called "silvicultural systems".

Adaptive management is common in silviculture, where forestry can include natural, conserved land without applying stand-level management and treatment. A common taxonomy divides silviculture into regenerating, tending, and harvesting techniques.

Natural Regeneration is the process by which woodlands are restocked by trees that develop from seeds that fall and germinate in situ.

For most of the last two or three centuries, foresters have restocked and created woodlands using transplants grown in nurseries. Natural regeneration was rarely used until the late 1980s, when a combination of factors, including a desire to “do things more naturally” and a change in the grant structure, made it more widespread. However, few woodland managers have experience successfully using natural regeneration, which is much less predictable than restocking using transplants.

Restocking by natural regeneration is often unsatisfactory, frequently for unknown reasons, which demonstrates the need for research to understand the processes occurring. After a survey, which tried to define the state of naturally regenerating woodlands, studies of the following topics were begun:

- **Storm Damage** to woodlands in southeast England on the night of 16 October 1987 was extensive, and a survey to investigate restocking by natural regeneration has recently been completed.

- **The ground Flora** can develop extensively following forest operations to promote natural regeneration. Changes in the ground flora within both temporary and permanent plots have been observed at various sites der to investigate how they may influence the survival and growth of tree and shrub seedlings.
- **Seedling Establishment** of some species has been observed by following the growth and survival of tree species growing after silvicultural operations to promote natural regeneration.
- **Browsing Damage** by deer is a serious problem in most lowland woodlands, and it can retard or prevent satisfactory natural regeneration. The influence of simulated browsing damage on seedling growth and survival has been studied.
- **Competition** with other vegetation can inhibit the growth or cause the death of tree seedlings. Nursery studies have investigated the competition between tree seedlings and grass

Afforestation: the establishment of a forest or stand of trees (forestation) in an area without previous tree cover. Afforestation is planting trees or sowing seeds in a barren land devoid of trees to create a forest. The term should not be confused with reforestation, which is the process of specifically planting native trees into a forest that has decreasing numbers of trees. While reforestation is increasing the number of trees in an existing forest, afforestation is the creation of a 'new' forest.

Our Earth has been constantly trying to cope with how humans use natural resources, clear forest lands, cut trees, and contaminate the air, land, and water. The Industrial Revolution, population bursts, and pollution create permanent damage to the earth, resulting in global warming and climate change. In such situations, increasing natural resources and decreasing their exploitation can help extend the life of the planet and its living organisms.

By planting trees and creating forests, many of human beings' commercial needs are fulfilled while not destroying what is left of the planet. Afforestation is, therefore, a practice that has been propagated by government and non-government agencies of many countries as a way to stop the overexploitation of nature.

Importance

It is important today because it is mainly used for commercial purposes. In a natural forest or woodland, the trees are heterogeneous. Owing to their sensitivity to overuse and slow growth, these forests cannot be used continuously for commercial purposes like wood products. Planting trees in empty lands helps promote the fast propagation of specific types of trees for the wood industry.

With the increasing demand for wood fuels and building materials, this process helps to meet these demands without cutting down the natural forests. Deforestation can lead to the depletion of trees in water catchments and riverside zones. Afforestation ensures trees and plants that hold the soil in these sensitive areas remain protected.

Many countries have introduced the practice of planting trees along with crops in croplands. The benefits of this practice, which is called agroforestry, are:

Planting trees always has environmental benefits, whether on barren land or as a method of regenerating a depleted forest. Trees help check atmospheric carbon dioxide, and large-scale afforestation can curb the problems caused by burning fossil fuels, industrialisation, and so forth.

Reforestation is the natural or intentional restocking of existing forests and woodlands (forestation) that have been depleted, usually through deforestation. Reforestation can be used to rectify or improve the quality of human life by soaking up pollution and dust from the air, rebuilding natural habitats and ecosystems,

mitigating global warming since forests facilitate biosequestration of atmospheric carbon dioxide,[2] and harvest for resources, particularly timber, but also non-timber forest products.

A similar concept, afforestation, another type of forestation, refers to the process of restoring and recreating areas of woodlands or forests that may have existed long ago but were deforested or otherwise removed at some point in the past or lacked it naturally (e.g., natural grasslands). Sometimes, the term "re-afforestation" is used to distinguish between the original forest cover and the later regrowth of forest in an area. Special tools, e.g., tree planting bars, are used to make tree planting easier and faster.

Importance of Afforestation and Reforestation

Reforestation is the natural or intentional restocking of existing forests and woodlands that have been harvested or depleted, and afforestation is the establishment of a forest in an area without trees. For economic and practical purposes, reforestation and afforestation have similar goals and processes and thus can be treated as identical activities. Although reforestation and afforestation have a long history, large-scale reforestation and afforestation activities started with industrialisation, which caused a scarcity of timber and forest-based ecosystem services. In a unified economic model of reforestation and afforestation, factors influencing investments in reforestation and in afforestation on private and public lands include timber prices, unit reforestation cost, interest rate, the responsiveness of tree growth to silviculture, and the value of nontimber benefits, such as ecosystem services. Market and public policies may facilitate, enhance, or hinder reforestation and afforestation activities, and nontimber benefits are an increasingly important motive for reforestation and, especially, afforestation efforts worldwide.

Environmental Benefits

One of the main benefits of increasing tree cover, and one of the outcomes that is also effective globally, is carbon sequestration, wherein greenhouse gases such as carbon dioxide are absorbed by flora, leading to climate change mitigation. Tree planting also leads to purifying air. Increasing forest cover, primarily through afforestation, helps reduce soil erosion and water runoff. The soil fertility can, in time, be restored, bringing in new plants and trees and increasing plant diversity. As important host plants are established, birds, insects, and other dependent animals will reside in the area, improving the place's biodiversity. Soil restoration also helps agriculture. When water run-off is prevented, it has time to seep into the soil, recharging groundwater aquifers and improving water supply for humans, plants and animals.

Economic Benefits

Reforestation is a means to grow trees that can be harvested for timber and firewood. When reforestation and afforestation recharge groundwater sources, they can improve water supply from wells for agriculture or provide safe water for drinking and household uses. With two-thirds of the world's population dependent on wells for their water supply, water scarcity is one of the world's most significant challenges. One in ten persons cannot access safe water, so planting trees can significantly improve human living standards. Afforestation can create forests supporting livelihoods, especially in developing and least developed countries, as 1.6 billion people worldwide rely on forests. New forests can also be sites for recreation, bringing in revenue for locals.

Protecting Species: In addition to the climate benefits, reforestation has the potential to preserve endangered species. A recovering forest restores habitat loss and degradation, which threatens species' health.

Erosion and watersheds: Deforestation damages and destroys habitats through erosion. Forest restoration can reverse this damage. Regional watersheds, a vital resource for human development, adversely impacted by deforestation can be brought back to health through reforestation.

The benefits of reforestation—and avoiding deforestation in the first place—are clear. Forests help to fight global climate change and help restore endangered species from extinction. They will also enable humans to better address world hunger issues and issues related to water usage and availability.

Why is forest fire regarded as a forest enemy?

A forest fire is an uncontrolled fire occurring in nature. Sometimes, the forest fire is so large that it takes a long time for the firefighting crews to gain control of the situation. This could result in massive destruction. In Norway, an average of about 1100 forest fires occur each year. Most of these are small and relatively easy to control. Only two per cent of the registered forest fires in Norway are larger than 1oo acres (100,000 m2).

Many forest fires are due to human activity.

The number of forest fires varies from year to year, and quite a long time may elapse between large forest fires. Climatic conditions have the greatest impact on the extent of forest fires. The forest is most vulnerable in spring and summer seasons when long dry spells exist. Weather conditions such as precipitation and wind, as well as the layout of the terrain, are essential factors in determining the size of the forest fire.

It is estimated that as many as nine out of ten forest fires are caused by humans, although the causes of many forest fires remain unknown. Open flames and disposable barbecue grills are the most common cause of such fires. Even a cigarette that is not adequately extinguished can cause a forest fire. Some forest fires also start due to downed power lines, sparks from trains, sparks from edge

trimmers along roadways or sparks from tools and forestry machinery doing work in the forest. Natural forest fires are due to lightning strikes.

In some cases, fires are set deliberately. The June 2oo8 forest fire in Froland in Aust Agder county is the most significant and most serious recent example. This fire burned for 13 days, and large crews from the fire service, the civil defense, and the Armed Forces participated in the extinguishing efforts. At most, 15 helicopters were in the air to extinguish the fire. 77 residents in the community of Mykland had to be evacuated from their homes for some time. The fire affected an area of 27000 acres, of which 19ooo acres were productive forests.

Forest fires kill people and animals, destroy property, and can cost millions of dollars to fight. However, they have an upside: They help relieve water shortages in the western United States.

That is the conclusion of a study reported this week in Ecohydrology, which found that—between 1990 and 2008—trees lost to fires saved more than 76 billion litres of water that would have otherwise been lost through evaporation from leaves to the atmosphere. To study this "evapotranspiration," hydrologists and ecologists used a combination of satellite data (the intensity of "green" indirectly indicates the amount of evapotranspiration going on) and tower-based measurements, which measure actual water loss from trees in forests in two California river basins.

For a century, forest managers have sought to prevent forest fires. As a result, western forests are too dense for the local water supply and more susceptible to wildfires. Thinning forests by cutting down smaller trees or with controlled burns would reduce fire risk and lead to more water in local rivers that could be used for power, irrigation, and other areas where water is needed; they are not.

Human Causes

Human activities near or within forested areas are the number one cause of forest fires. Smoking near vegetation can cause a widespread fire when a smoker throws a cigarette into vegetation without completely extinguishing its burning butt. While most smokers throw lit cigarettes innocently, their actions have caused several forest fires throughout history. Some fires may take a few hours before being noticed as the fire starts small and spreads slowly before gaining momentum. Equipment such as machinery used in logging and hunting can also cause fires. Bullets hitting on some dry vegetation may result in fires. Petroleum products used in logging equipment can cause fires when there is a leak in the vegetation. Other causes include campfires that are not well monitored or put off entirely. Electrical faults from facilities or electricity plants near forests can also cause fires. In some extreme cases, people deliberately cause fires during hunting to corner wild animals, while others burn forests to clear the way for agriculture or development activities. Lastly, some people just start fires without any reason (arson). Up to 90% of forest fires in the US are caused by humans.

Natural Causes

Lightning is the most significant natural cause of forest fires. The different lightning strokes of varied electric voltages cause fire by directly igniting vegetation with high currents. Lightning fires are always more common immediately after dry seasons when vegetation is still dry. Lightning fires destroy more vegetation than human-caused fires. This is because lighting fires occur in remote areas far from human presence and are not noticed in time, unlike fires caused by human activities. Lightning-caused fires also happen in rough terrains and dangerous places, which makes it hard for fire suppression equipment and personnel to reach the fire on time. In rare occurrences, volcanic activities such as eruptions and lava flow can cause fires which are difficult to put out because

of the lava flow and other associated risks. In most cases, firefighters try to create a buffer zone to manage the fires. Spontaneous combustion of dry leaves and vegetation may also be responsible for some fire outbreaks.

Prevention

Most natural fires are usually monitored and allowed to burn to balance a forest's ecology. Vegetation may also be burned occasionally to balance species. Authorities have undertaken awareness campaigns on the causes of fires to reduce human-initiated fire incidences. In some cases, firefighters burn sections of forest vegetation to control possible future fires by creating buffer zones. Wildfire suppression can be done in various ways. Simple techniques, such as throwing layers of soil, can be used. In some cases, unmanned aerial planes can drop water and fire retardants.

Precautions

- Always keep an emergency kit within reach (at the cottage or in your backpack when hiking in the forest).
- Control vegetation (in French only) around your home.
- Store building materials, firewood, and propane tanks more than 10 m away from any building on your land; clear away all vegetation within a radius of 3 m of the propane storage tank to reduce the risk of a fire spreading.
- Keep a hose or a water supply of at least 200 litres near your home to intervene promptly if a fire starts.
- Choose a cleared location, out of the wind, for a fire outside; have a shovel, a bucket of water, or a rake nearby. Constantly monitor your fire, and to extinguish it, spray it with abundant water and cover it with ash, sand, or earth.
- Burn anything (waste, dead leaves) at the end of the day when there is no wind, far from vegetation and in compliance with municipal by-laws.

- If you smoke outside, put out your cigarette butt on a rock or bury it in the ground.

Evaluation

1. Why is forest fire regarded as a forest enemy?
2. Explain five forestry occupations.
3. What is Seasoning, and why is it Necessary?

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CHAPTER EIGHT
TIMBER

Objectives

At the end of this chapter, you should be able to;

i. Define timber
ii. Nature of wood
iii. Structure of wood

Not all trees provide timber suitable for Woodworking. Although there are many species, only a few are available commercially.

Each timber has its own characteristics: colour, strength, weight, durability, and so on. Some bend easily without snapping, some carve well, some are oily or resinous, some take paint well, and others are water—and weather-resistant. Some woods have beautiful grain patterns. The first job of the woodworker is to select the most suitable timber for the job in hand.

Most of the timber used in Britain is imported. Hardwoods arrive from the temperate climate of Central Europe and the tropical forests of West Africa, Central and South America and the Asian Far East. Most softwoods come from the cool northern parts of Europe, around the Baltic, Scandinavia and Russia. Once covered by forests, Britain is not a timber-producing country; only limited amounts of home-grown timber are available.

Some timbers in everyday use are shown opposite together with the purposes for which they are best suited; others include:

Ash is a European hardwood that is very tough but springy. It is used for cricket stumps, hammer handles, and ladders.

Agba: West African hardwood is fine-grained and easy to work with. Used for joinery and furniture.

Beech: It is from Central Europe. It is very close-grained, clean, and hygienic. It is helpful for breadboards, rolling pins, spoons, unpainted toys, and kitchen chairs.

Birch is Scandinavian. It is white and close-grained. It is mainly used for plywood but also match sticks and matchboxes.

Obeche is a soft hardwood often used in school craftwork. It is pale yellow and free of knots.

Western Red Cedar: A softwood from Canada. Very weather resistant. Used for the external cladding of buildings and unique roofing tiles called 'shingles.'

A Tree in The Forest

Forest lands constitute one of our greatest natural resources. Nearly one-third of the nation is either in the forest or well suited by their growth. Our forests provide the raw materials for a wide range of wood-using industries. In addition, they help prevent excessive soil erosion, furnish ideal conditions for wildlife, and provide outdoor recreation, e.g. Yankari in Bauchi State.

Today, our supply of trees is no longer entirely dependent on nature. Tree crops are grown and harvested like other farm crops, so today's forests will also be our forests of tomorrow. Modern methods and equipment are used to plant tree seeds in nurseries and then transplant them into the forests. These trees are sprayed to control insects and diseases by manual spray guns or airplanes.

World forest regions are divided into groups where climatic conditions favour a tree's growth. Conditions essential for forest growth are as follows:

a. Suitable temperature
b. Adequate moisture from rain
c. Snow
d. Dew
e. Suitable soils, etc.

Timbering (Felling of Trees)

Timbering is cutting down trees in the forest to be converted into useable sizes by carpenters, joiners or craftsmen.

Trained foresters select and mark the trees that will be harvested. In addition to good timber, they also choose trees susceptible to insects and diseases. Some trees are selected because when they are removed, a nearby tree will grow more rapidly. Trees selected for harvest are cut down with power saws. Limbs are removed, and the trunk is cut down to suitable lengths. The process is called "bucking".

The logs are skidded to a central point with crawler tractors, where they are loaded on trucks (lorries) or railroad cars for the trip to the sawmill. Logs could also be transported by floating down streams to the mill. Logs are kept or stored in water until they are sawed because it prevents them from end-checking and insect damage. It is also easier to sort heavy logs by moving them around in the water. Some hardwood logs do not float very well, and they are usually stacked in the mill yard, where they are sprayed with water to keep them from drying out.

The best time of the year to fall trees for timber is during the winter months. Some of the reasons are:

1. The wood's moisture content (M.C) is at its lowest, and the subsequent seasoning will be shorter.
2. If logs are delayed in the forest for any reason, there will be great danger of degradation (end split from rapid drying by the sun).
3. The danger of attack by fungi causing discoloration or attack by insects.
4. Lack of foliage makes stripping the trunk easier, and the head of the tree is lighter. This reduces the possibility of damage from felling shakes or splits caused by heavy falls.

History of Wood (Timber)

Wood was one of the first materials ever used. Today, it is still the most extensively used of all materials. The consumption per person, for example, in the United States, is about double that of steel. The major reasons for wood's prolific use are its availability, low cost, and easy workability. In addition, its lightweight and relatively high strength add up to a good strength-to-weight ratio.

Wood is one of the most popular and versatile raw materials for construction. It can be easily formed, shaped, and smoothened and offers a variety of tones, grain patterns, and surface textures. The designer fully uses these characteristics in products with important visual aspects (appearance).

The porosity or cellular structure of wood provides a material that is light on weight, relatively strong and makes possible the driving and fitting of nails, screws and other metal fasteners.

Nature of Wood

The basic structure of wood consists of long, narrow tubes or cells (called fibres in hardwood or tracheid in softwood) that are not larger around than human hair. Wood is vegetable matter, of course, composed of two principal ingredients:

i. 70% (by volume) cellulose and
ii. 20 to 30% lignin is nature's glue for holding the cellulose together.

A slight residue comprises minerals, waxes, tannins, and oils, often giving wood unusual properties. For example, the oils in cypresses provide decay resistance, and the aromatic oils in cedars give them a distinctive scent that makes them desirable for storage chests.

Structure of Wood

Wood comprises long, thin, hollow tubes or cells like all living vegetable matter. The cell walls consist of cellulose fibres (tracheid) bonded together by lignin (natural cement or glue) and

aligned parallel to the axis of the cell. The cellulose fibres comprise cellulose-Cham polymers that, in turn, are composed of glucose monomers joined end-to-end. The glucose (simple sugar) monomer is a molecule of carbon, oxygen, and hydrogen atoms. The cellulose polymers are joined to each other by strong intermolecular forces, giving them a high rigidity and crystallite.

Cells of Wood

Wood cells, sometimes referred to as fibres, are aligned predominantly parallel to each other and to the axis of the tree trunk or limb (cells along the length of the wood). A second system of cells called rays or medullary rays runs perpendicular to the axis of the trunk (cells running at right angles or radially to the tree) (Figure 119).

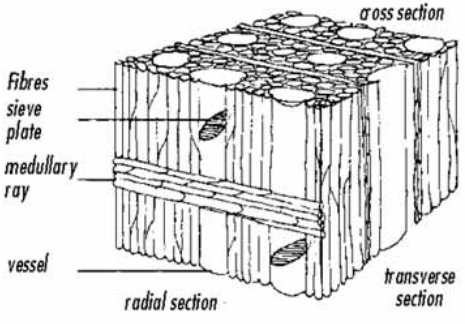

Fig. 119: Cells of wood

The strength of the wood depends on the thickness and structure of the cell walls rather than the cell size. Wood cells look like a honeycomb when magnified. Because the cells are hollow, wood is not a solid material like most cellulose and lignin in the cell walls is about the same for all kinds of wood; the bulk density (weight per unit of volume) varies considerably, depending on cell wall thickness and cell cavity size. The thicker the tubular cell walls, the higher the bulk density. Wood cells are highly hygroscopic (taking up and returning moisture), and the M.C.

significantly influences wood's properties. Rigidity and dimensional stability, in particular, decrease as M.C increases.

Hardwoods contain some relatively large cells called vessels that provide the main arteries in the movement of sap. Other cells, called parenchyma, are found in both hard and soft woods and function mainly for the storage of food. These various cells, which differ in size, shape, and arrangement, along with deposits of resin and other colouring matter, all add together to provide interesting and attractive grain patterns and textures.

Microstructure of Wood

Wood's microstructure is directly related to the structural characteristics of the tree's/shrub's growth cycle. Trees grow in thickness in concentric layers called annual or growth rings. The rings are divided into two parts:

i. The timber part called springwood, which is formed first in the growing season is usually lighter in weight, denser and more substantial,

ii. The outer part of the ring, which grows later, is called summerwood.

In the spring, trees proliferate, and the cells produced are large and thin-walled. As growth slows during the summer months, the cells produced are smaller, thicker-walled, and appear darker in colour. The change from springwood may be abrupt or gradual, depending on the type of wood and the growing conditions.

The annual growth rings are primarily responsible for the grain patterns observed on the surface of boards cut from a log. In tropical climates (e.g. African climates), tree growth is influenced more by wet or dry seasons than by temperature changes. Generally, the growth rings of woods in these areas are not as quickly defined. The wood's grain, texture, and colouring are primarily determined by the thickness of the growth rings and the

relative amounts of springwood and summerwood. In general, the thicker the growth rings, the coarser the texture.

A wood's structure and properties also vary across the cross-section of the tree trunk. The older, central growth rings, termed the heartwood, contain more minerals and other chemical residues than the outer rings, called the sapwood. Some trees are mainly composed of sapwood, e.g. maples, ponderosa pines, etc. There is little distinction between some species, such as firs and spruces. Heartwood is usually darker than sapwood, although there are several exceptions, e.g., hemlocks, basswoods, firs, etc. Heartwood is also more decay-resistant but not necessarily stronger than sapwood; it is denser because of chemical residues.

Kinds of Wood

Many botanists define a tree as a woody plant that grows to 6.7 meters (20 feet) tall, usually with a single self-supporting stem or trunk. This definition separates trees from shrubs, which are also woody but normally do not exceed 6.7 meters in height, and from lianas or climbing woody vines, which lack a self-supporting stem.

Remember, you are accustomed to seeing wood every day in many forms, such as paper or in solid form, much as it came from the tree.

Classification of Wood

Timber is a converted solid wood suitable for building and construction purposes. The process of cutting logs (trunks) into timber is called conversion. Timber trees are classified broadly into two categories.

A. **CONIFERS:** A class of trees belonging to a sub-division called gymnosperms, which are non-flowering plants. The seeds, called "naked seeds", are formed in scaly cones. Nearly all conifers are evergreen and generally have scale-like or needle-like leaves. The timber from this class of trees

is called non-pored or softwood, e.g., pines, firs, larch, cedar, etc.

B. **DECIDUOUS:** Dicotyledons are seed trees that form plants called angiosperms, which are flowering plants with seeds encased in the fruit. These trees could be evergreen or deciduous, shedding leaves; they usually have broad or flat leaves. Timber from dicotyledons is called pored wood or hardwood, e.g., ash, walnut, elm, beech, etc.

The classification of the wood should be based on the nature of the tree, which is mostly satisfactory.

Difference between Wood and Timber

Generally, we use the terms wood and timber as having the same meaning, but it is more correct to use wood when referring to the actual composition of the wood elements or tissues, e.g., fibres, vessels, grain, rays, etc., the elements between the pith and the bark (cross-sectional view) of the growing tree.

TIMBER is the solid wood of a tree that has been sawn up or converted, dried, or seasoned and is ready for construction purposes.

Some Softwood and Harwood

1. Yellow Pine 1. Ash.
2. Pitch 2. Beech
3. Douglas Fir 3. Mahogany
4. Kauri Pine 4. Mansonia
5. obechi 5. Ebony
6. Hemlock 6. Abura
7. Poplar 7. Afara (medium hard)
8. Yew 8. Box

   Etc. 9. Chestnut, etc.

Evaluation

1. Differentiate between Wood and Timber with examples
2. What do you understand by the cells of wood and the structure of wood

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CHAPTER NINE
CROSS-SECTIONAL VIEW OF A TREE

Objectives

At the end of this chapter, you should be able to;

1. Differentiate parts of the tree
2. Properties of a timber
3. Conversion of timber

A tree's growing, working parts are the tip of the roots, the leaves, and a layer of cells just inside the bark called cambium. The roots absorb water and travel through the sapwood to the leaves, combining it with carbon dioxide from the air. Through the miracle of photosynthesis, sunlight changes these to food (carbohydrates), which is then carried back to the various parts of the tree. New cells are formed in the cambium layer; the inside area of the layer (xylem) develops new wood cells, while the outside area (phellem) develops cells that form the bark. The following are views that could be inside a tree (Figure 120):

1. **Bark (Cortex):** is the tree's outer skin. It protects the tree from extreme temperatures, fire, insects, defects and animals.
2. **Bast:** a thin, moist layer under the bark along which the plant food travels.
3. Cambium layer: where new cells are formed that turn into sapwood.
4. **Sapwood:** newly woody tissue (xylem) produced by the cambium layer. Sapwood consists of live wood or living cells that form heartwood as the sapwood becomes inactive.

Sapwood is as strong and heavy as heartwood but not as durable when exposed to weather.

5. **Heart or True Wood:** This is the dead part of the tree, even in a living tree. It is darker than sapwood because it is the matured section of the sapwood. A growing tree can live quite well without any heartwood.
6. **Medullary Rays** are lines of thin-walled cells running from the bark to the pith. These cells reserve food for the tree in case of drought or damage.
7. **Growth Rings** are produced by periodic changes in the growth rate. They are the new layers of wood formed each growth season, also called Annual Rings.
8. **Pith:** the very centre of the tree, usually brown, soft and spongy.

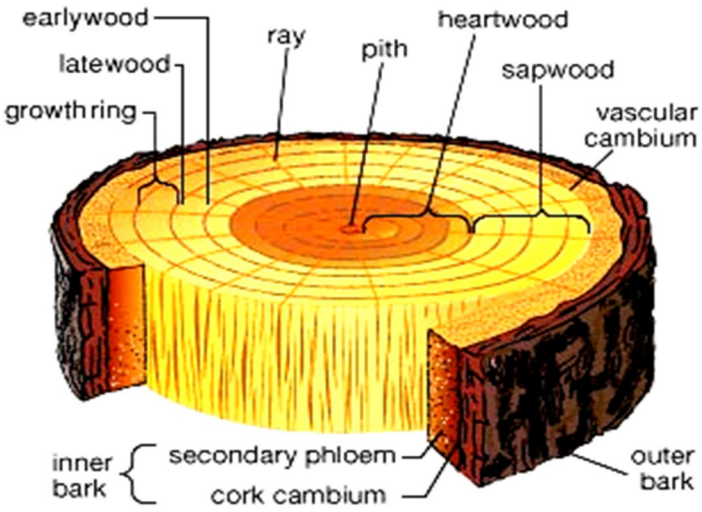


Fig. 120. Cross section of a tree trunk

Parts of a Tree

Timber is obtained from a tree. The type of timber will depend on the type of tree; for example, mahogany timber must come from a mahogany tree (Figure 121).

Parts and Functions:

1. **Roots:** they collect plant food from the soil and hold the tree firmly to the ground.
2. **Flowers:** create beauty and give new seeds for a fresh growing tree.
3. **Branches also provide timber;** they spread the leaves to collect air and sunlight.
4. **Leaves** collect air and sunlight, providing shade and food for animals and insects.
5. **Trunk:** provides timber for the woodworker.
6. Seeds: the product of new fresh trees.

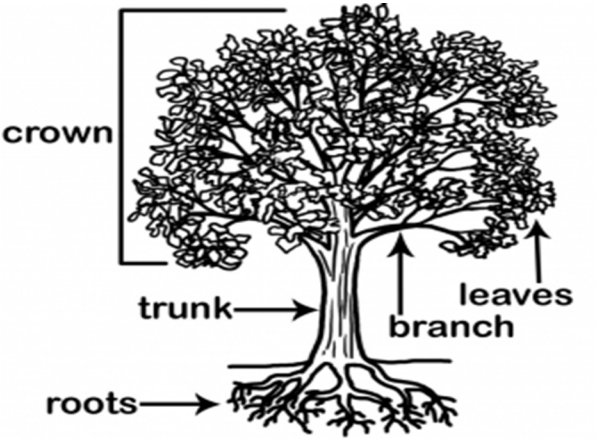


Fig. 121. Parts of a tree

Properties of Timber

To select timber (wood) wisely, you must know two basic things:

1. The properties of the timber you are considering, and
2. The properties of timber which are important for the job you are planning.

   For example, toughness (the ability to withstand sudden shock) is the most important quality for specific sports equipment, such as a baseball bat.

   Prime requirements in furniture construction are an attractive appearance and desirable wood grain. Wood must also have a delicate, pleasing finish and a minimum tendency towards warp age, excessive shrinking, and swelling.

Properties:

1. Density: the amount of wood tissues, moisture and cell deposits in timber.
2. M.C (moisture content): the weight of moisture in a piece of wood.
3. **Durability:** the natural property of wood which resists defects.
4. **Compressive Strength:** resisting loads that might crush the wood.
5. **Tensile Strength:** the ability to resist stretch.
6. Shearing Strength: resisting loads that tear the fibres.
7. **Bending Strength:** the ability to carry the load without breaking.
8. **Stiffness:** the ability to resist bending when loads are applied.
9. **Elasticity:** property which enables the wood to return to shape after bending.
10. **Toughness:** resisting shocks without breaking, e.g. tool handles.
11. **Hardness:** ability to resist indentation, bruising and abrasion.

Other properties of timber include

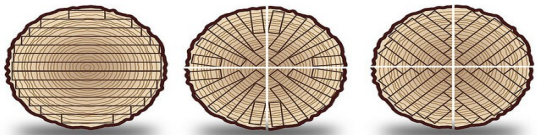
12. Weight.
13. Freedom from shrinking and swelling.
14. Freedom from warping.
15. Ease of working with hand tools.
16. Ease of finishing.
17. Nail-holding power.
18. Surface appearance or figure, etc.

Conversion of Timber

Conversion is the process of cutting logs into timber. It involves sawing logs into square-edged pieces suitable for use in various shapes and sizes (Figure 122).

Method of Conversion

1. Plain sawing (Live or through & through): The log is cut into the board by a series of parallel cuts. It is the simplest and most economical method, with little waste, and is suitable for rapid production.
2. Rift Sawing (Back or tangential cut): the log is sawn so that the board's width is tangential to the growth rings. This allows the sawing around the faulty parts of the log.
3. Quarter Sawing: The log is sawn so that the boards' widths are in the general direction of the medullary rays. This involves turning the log to new positions to obtain the desired cut, and it is not economical.



Plain sawing Rift sawing Quarter sawing

Fig. 122. Conversion of timber

Saws used for Conversion

1. **Circular Saw:** used for re-sawing.
2. **Band Saw:** is a vast steel strip with cutting teeth on one or both edges; the blade runs over two flat pulleys.
3. **Reciprocating Log Saw:** operates much the same way as a hand rip saw.
4. **Frame Saw:** consists of several saw blades stretched in a frame, cutting with reciprocating motion and capable of converting a whole log at one operation.

Seasoning of Timber

Drying the excessive moisture in timber is called "seasoning." It is not wise to use timber in a wet state, as seasoning removes the M.C. to enable timber to suit seasonal variations in climate and local weather conditions. The most common methods of seasoning are illustrated below.

Methods:

1. Air Seasoning (Natural): The timber is exposed to the outside air. Timber is carefully stacked with stackers (wood strips) between each layer so air can circulate through the pile. Boards are spaced well apart in the layers so air can move vertically. It isn't easy to approximate the air-drying time for any particular species or thickness because of climate and weather conditions. The M.C. of thoroughly air-dried timber falls between 12% to 18%. See figure 6.4 below:

Fig. 123: Air seasoning

2. Kiln Seasoning (Artificial): Timber is kiln-dried by placing it in the oven where the temperature and humidity are accurately controlled. The boards are stacked in about the same way as for air-drying (Figure 123). Steam keeps the humidity and temperature low when the green timber is first placed in the kiln. Generally, the temperature is raised, and the humidity is reduced. Fans are used to keep the air in constant circulation over the surfaces of the wood. Each species is also timed to enable accurate standard seasoning. Kiln seasoning can be regulated to give as low a percentage as desired (figure 124).

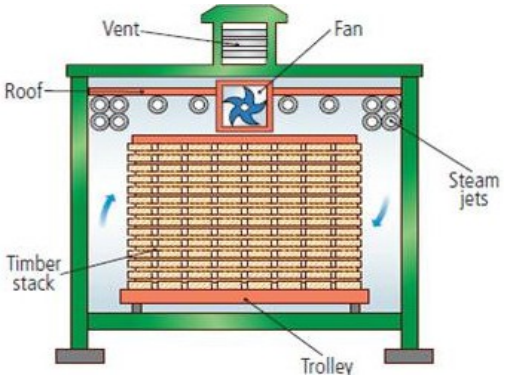


Fig. 124: Kiln seasoning

3. Air & Kiln Seasoning: Timber is air-seasoned initially and then taken for kiln seasoning. This method is expensive and takes time for production. Some hardwoods split badly if put in the kiln without some air seasoning first.

4. The fourth possible method is expensive but not always used if put in the chemical seasoning. It is as the name indicates.

Defects caused by Seasoning

Improper drying, either air or kiln, can result in such seasoning defects as splits, checks, warpage, loosened knots, honeycomb and internal stress called case-hardening. Most of these are caused

by drying the wood too rapidly. In case-hardening, the surface layers dry, shrink and become fixed or set before the inside portion of the board. As the interior dries below the fibre saturation point and shrinks, it pulls on the outside shell, creating both compression and tension forces. When the board is cut, these forces are released, causing the kerf to close on (pinch) the saw blade or the stock to warp in various directions.

Other Defects in Timber

Defects in timber usually lower the strength, durability and appearance. Some of the common types are:

1. Knots: An embedded limb and branch of the tree. It reduces the strength but, in some cases, may add to the appearance (figure 125).

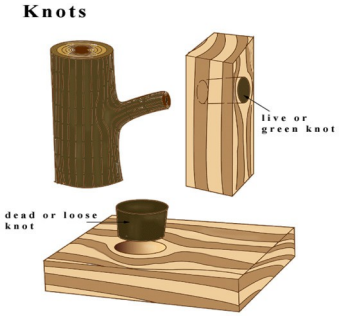


Fig. 125. Knots

2. Pitch Pockets: Internal cavities that contain resinous materials and sometimes bark (figure 126).

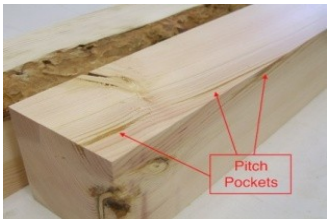


Fig. 126. Pitch pockets

3. Honeycombing: Separation of wood fibres in the interior of wood, usually along the wood rays and may not be visible at the surface (figure 127).

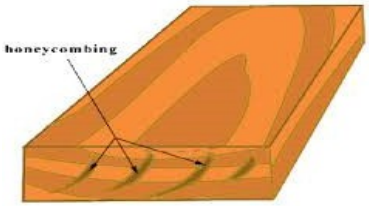


Fig. 127. Honeycomb

4. Splits and Checks: A separation of the wood along the grain and across the annual growth rings (figure 128).
5. Shakes: A separation along the grain and between the annual growth rings (figure 128).
6. Wane: The presence of bark or the absence of wood along the edge of a board. It forms a bevel and reduces the useable width (figure 128).
7. Warp: Is any variation from a true surface and may include any one or combination of the following (figure 128):
    i. Cup.
    ii. Bow.
    iii. Crook, and
    iv. Twist or wind.

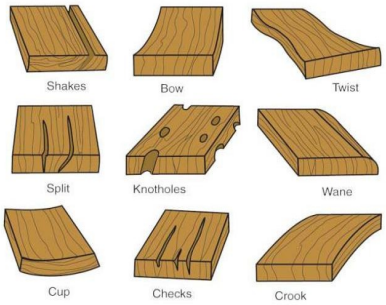


Fig. 128. Splits, Checks, Shakes, Wane and Warps.

8. Shrinkage: During seasoning, the M.C. is dried out, and the cells dry and shrink (close). The timber's shrinkage is not the same in all directions, which creates certain complications (Figure 129).

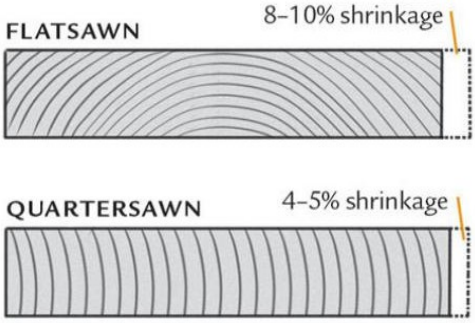


Fig. 129. Shrinkage

9. Fungus Attack: The result is usually to stain the wood with grey streaks or patches (figure 130).

Fig. 130. Fungi attack

10. Insect Attack: The furniture beetle makes several small woodworm holes that weaken the strength of the timber (figure 131).

Fig. 131: Insects attack

Protection and Preservation of Timber

Woodworkers should have methods of protecting and preserving timber for durability to prevent defects, insects, and destruction.

Protection: This method is used after the object has been made and a finish is applied for beauty or otherwise.

Timber always requires a finishing treatment, whether for inside or outside work. The precise type of finish will depend on the conditions under which the timber is to render service and the particular wood being used.

Some timbers are naturally immune (accustomed) to all the destructive agents that quickly lead others into decay.

Preservation: Involves impregnation of the following chemical preservatives;

i. Oil of tar-creosote,

ii. Water-soluble – chemical preservatives,

iii. Solvent – not soluble in water.

Methods:

1. Creosote: This is usually "forced" into the cells of the timber hot and under high pressure.
2. Brush Application: Though not practical, timber must withstand prolonged immersion.
3. Water Soluble: Used where the timber is to serve under dry conditions.
4. Chemicals: These include sodium fluoride, zinc chloride, and mercuric chloride, but they are poisonous.
5. Solvent: Chemical is dissolved and applied to the timber. It penetrates deeply into the timber, and the water evaporates, leaving the chemical in the wood cells.

Sizes of Timber

The timber (converted wood) is obtained along the length of the trunk. The fibres that form the woody tissues are like strands of string that run up and down the trunk. These fibres are called the GRAIN of wood. When the fibres are cut across, the part cut is known as the END GRAIN because the ends are exposed.

Fibres strengthen timber and make it durable. Cutting the trunk into timber is known as converting timber. Logs are cut into square-edged pieces of timber suitable for use by carpenters, joiners, cabinet makers, and craftsmen. They are cut into various shapes and sizes.

The following terms apply to various sizes of timber available in the market.

1. Log – Felled tree after trimming of branches.
2. Balk – The log after squaring up.

Width Thickness

1. Planks 27.9 – 45.7cm by 7.6 – 15.5cm.
2. Deals 22.8cm by 5.1 – 11.45cm.
3. Battens 17.8cm by 3.8 – 5.1cm.
4. Boards over 15.2cm by less than 3.8cm.
5. Quartering 5.1 – 15.2cm by 5.1 – 15.2cm.
6. Scantling (odd-cut stuff)
   7.6cm by 5.1cm.
   1o.15cm by 5.1cm.
   1o.15cm by 7.6cm.
7. Laths up to 11.45cm by 1.25 – 3.85cm.

Evaluation

1. Explain defects caused by seasoning
2. Explain the protection and preservation of timber

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CHAPTER TEN
VENEER AND VENEERING

Objectives

At the end of this chapter, you should be able to;

1. Gives types of veneers
2. Methods of cutting veneers

A veneer is a thin sheet of wood about one millimetre thick, obtained from logs or flitches (sections of logs). Veneers are used to decorate furniture, manufacture plywood, make laminated bent and moulded shapes, and surface various types of composite boards.

Types of Veneers

1. Core Veneers.
2. Cross-band or Counter Veneers.
3. Back Veneers.
4. Face Veneers.

Method of Cutting Veneers

a. Sawing: Large, thin gauge circular saws cut hard, brittle wood with grain into veneers. Thickness ranges between 1.3mm to 6mm with approximately 1.6mm kerf waste (figure 132).

Fig. 132. Sawing

b. Rotary Cutting (Peeling): The most economical method, the sheets are large. These are used to manufacture plywood, block board, and particle board. The log is fixed between centres in a large lathe and forced to rotate against a knife that peels off a continuous sheet of veneer between 0.8mm and 6mm thick (figure 133).

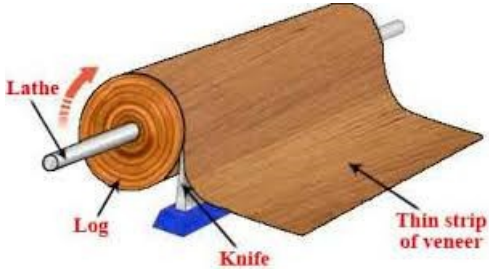

Fig. 133: Rotary cutting

c. Half or Semi-Rotary Cutting: used for producing radial or quarter-cut figures. The figured log is quartered and fixed in a lathe with a sapwood corner at the centre. When rotated, the knife slices off the veneer, cutting from the heart towards the sapwood (figure 134).

Fig. 134: Half rotary

d. Slice Cutting: Used for cutting valuable, high-grade decorative face veneers, usually radial cut (figure 135).

Fig. 135: Slice cutting

e. Veneering: Is the art or process of decorating by glueing a thin sheet of figured, expensive wood called veneer to a backing called the ground or core of cheap but straight-grained wood or "man-made" boards such as plywood, particle board, etc. (figure 136).

Fig136: Veneering

Plywood: Consists of glued wood panels (veneers) made up of layers or plies with the grain of one or more layers at an angle, usually 90°, with the grain of the others. The outside plies are called faces, the centre plies are called the core, and the plies immediately below the faces, which are laid at cross angles to them, are called cross-bands (Figure 137a).

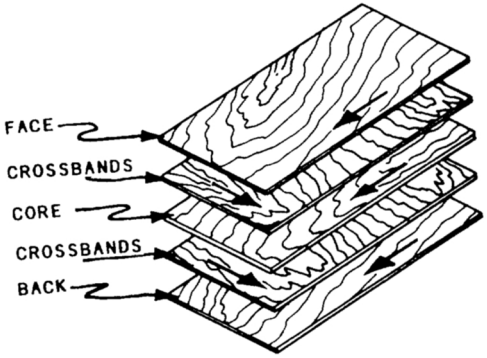

Fig. 137a. Grain direction in a sheet of plywood

The number of plywood constructions is almost endless, considering the amount of wood available, the number of plies used, the placement, and the types of adhesives. The number of layers may be 3,5,7,9, etc., usually in odd numbers. Logically, you cannot have plywood in an even number because it would warp (figure 137b).

There are two broad classes of plywood: hardwood and softwood. The grade of plywood is determined by the quality of the veneer or face, and the moisture resistance determines the type. Plywood is available in practically any size, but the industry standard production size is 101.6mm by 203.2mm (1200 by 2400mm) panel. Most plywood is produced to standards by the plywood industry. However, there are a number of special-purpose kinds, such as marine, decking, siding texture, brushed, embossed, and grooved.

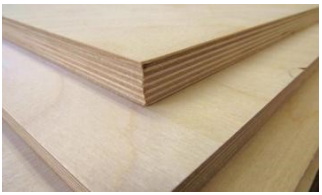

Fig. 137b. Plywood

Properties of Plywood: The properties of plywood depend on the following:

a. Characteristics of the wood species used.
b. Number of plies.
c. Thickness of the plies.
d. Grain directions

Other notable features of plywood's properties include:

1. Its high strength-to-weight ratio.
2. Ability not to split because it has no line of cleavage.
3. Restriction to expansion and contraction within individual plies because of M.C.
4. The beautiful decorative effects that can be produced in plywood.
5. It can be worked by typical woodworking equipment.
6. Any mechanical fastener and adhesive bonding can join it.

Hardboard: It is produced by pulverising wood, forming it into mats, and pressing the mats into boards. The cellulose provides reinforcing fibres, and the lignin binds the fibres into a solid mass. Binders or other materials may be added during manufacture to improve or obtain specific properties, but the material is primarily bonded together by fibre interfelting (figure 138).

Fig. 138: Hard Boards

Particle Board: It comprises small, discrete pieces of wood bonded together by a synthetic resin adhesive under heat and pressure. Particles range in shape and size from fine, fibre-like elements to large flakes. Urea and phenolic binders give sufficient

heat, provide moisture resistance for many outdoor uses, and provide some better strength than urea resins. Particle board has lower strength properties than hardwood (figure 139).

Fig. 139: Particleboard

Particle board, depending on the type of particles used in its manufacture, is also known as chipboard, flake board, shaving board, and waste wood board.

Lamin Board: This consists of a core of wood strips glued together to make a board that is faced on both sides with one or more veneers (figure 140).

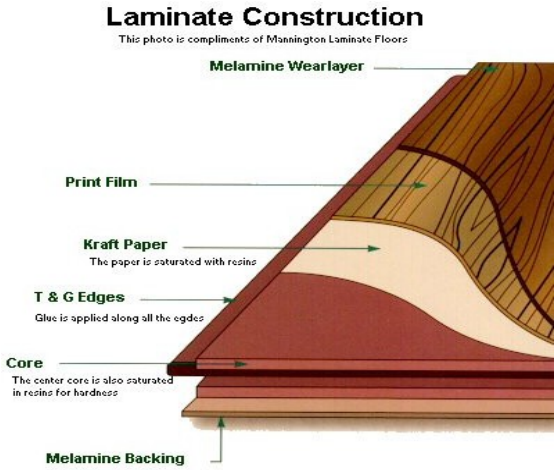

Fig.140: Lamin board

Block Board is similar in construction to the laminated board, but the core is made of larger strips, usually square in section (Figure 141).

Fig. 141: Blockboard

Plastic Laminates: Plastic laminate is a rigid thin sheet or a veneer rather than a board. It provides a hard, smooth wear and scratching. Plastic laminate is unharmed by boiling water, alcohol, oil, grease and ordinary house chemicals. Because of these characteristics, they are widely used as a surface material for tops of furniture and cabinet work. It could also be used for home wall panelling. A sample of these plastic laminates includes Formica. Although the laminate is very hard and brittle, it does not possess great strength and is serviceable only when bonded to plywood, particle board or hardboard.

Layout and Cutting: Plan your work carefully so that the pattern position will be correct and there will be minimal waste. Plastic laminates can be cut to rough sizes with a hand saw, table saw, portable saw, or router. Use fine-toothed blades and support the material close to the cut. Handle large sheets carefully because they can be easily cracked or broken. Also, be careful not to scratch the decorative side with a sharp or pointed tool.

Applying Adhesive: Although various types of adhesives can be used, contact cement is preferred because no sustained pressure is required. This is applied with a spreader, roller or brush to join both surfaces.

Drying and Bonding: Let both surfaces dry for at least 15 minutes or longer. You can test the dryness by lightly pressing a piece of paper against the coated surface. If no adhesive sticks to the paper,

it is ready to be bonded. This bond can be made anytime within an hour. If the assembly cannot be made within this time, the adhesive can be reactivated. Bring the two surfaces together in the exact position required because they cannot be shifted once contact is made. The application of momentary pressure secures the total bond.

Trimming and Finishing: Trimming and smoothing the edge is one of the most important steps in applying a plastic laminate. A block plane or file can be used for trimming the edge. However, an electric router with a carbide-tipped bit can also be used.

When working with plastic laminates, be especially careful that files, edged tools or abrasive paper do not scratch or damage the finished surfaces.

Evaluation

1. With the aid of sketches, explain trimming and finishing
2. Explain the properties of plywood

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CHAPTER ELEVEN
WOOD FASTENERS

Objectives

At the end of this chapter, you should be able to;

1. Explain types of nails and their uses
2. Types of adhesives

A. Nails

Nails are a quick and easy method of joining pieces of wood, though nails alone do not make a strong joint. Glue is often used in conjunction with the nails. The primary function of the nail is to hold the wood while the glue sets.

However, the nails may be clinched over for outdoor work, where appearance is not of first importance. It is advisable always to dovetail the nails when joining two pieces together. Whichever nail is used, always try to nail from thin to thick wood. In outdoor work, use galvanised nails because they resist corrosion.

Type of Nails (figure 142)

1. **Round Wire Nails:** Also called French Nails, they are used for all general-purpose work.
2. **Oval Wire Nails:** There is less tendency to split wood; they could be punched below the wood surface.
3. **Panel Pins:** obtainable only in small sizes, used for light work.
4. **Lost Head Nails:** Large versions of the panel pins used when the nail is to be punched below the wood surface.

5. **Tacks:** Used mainly for fixing canvas, carpets, or upholstery.
6. **Clout Nails**: Large flat heads used for fixing roofing felt.
7. **Cut Nails:** Used mainly by builders for fixing floorboards, etc.

Fig. 142: Nails

B. Screws

The woodworker uses screws for many different purposes. They join parts of a wooden structure and attach fitments, e.g. hinges, door bolts or handles. They are also used sometimes to join parts in such a way that they may be easily removed or shifted by losing the screws. Screws do not grip well when used in end grain.

Type of Screws:

1. Counter Sunk Head: Used for all general work (figure 143).

Fig. 143: Counter-sunk screw

2. Round Head: Used for fixing metal fittings that are not counter-sunk (figure 144).

Fig. 144: Round head screw

3. Raised Head: Combined the good work of both the counter sunk and round head screws and are neater than both in appearance (figure 145).

Fig. 145: Raised head screw

4. Coach Screws: Used where a bolt would be more desirable but for some reason, cannot be used (figure 146).

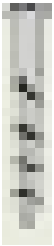

Fig. 146: Coach screw

C. Wood Adhesives

Uses: The surface of the wood is full of tiny holes, even though these are not visible to the naked eye. When two pieces of wood are glued together, the adhesive is squeezed into these little holes. The pieces of wood are held firmly together while the glue sets. In this way, the adhesive holds two pieces of wood together so firmly. The more the adhesive is squeezed into the wood's pores, the stronger the finish. To squeeze the adhesive well into the wood pores, it is usually important to pull tight the glued joint with cramps, nails, screws, or wedges while the adhesive sets.

Types of Adhesives

1. Polyvinyl Resin Emulsion Glue (P.V.A): This glue is generally called polyvinyl or white glue, excellent for interior construction. It comes ready to use in a plastic container and is easily applied. This glue sets up rapidly, does not stain the wood or dull tools, and holds wood parts securely.

   Polyvinyl glue hardens when its M.C. is removed through absorption into the wood or through evaporation. It is not water-proof and should not be used in assemblies subjected to high humidity or moisture.

2. Urea Formaldehyde Resin Glue: Ura Resin is available in dry powder form containing a hardening agent. It is mixed with water to a creamy consistency for use. Urea resin is moisture resistant, dries to a light colour, and holds wood surfaces securely. It hardens through chemical action when water is added and sets at room temperature for four to eight hours. Urea resin is also available in liquid form.

3. Resorcinol-Formaldehyde Resin Glue: It is available only in two-part forms: a dark reddish liquid resin and a powdered or liquid hardener. It is strong, durable, and water-proof.

Resorcinol glue stains wood with a dark glue line. It sets up at room temperature in 8 to 1o hours. It is used for water skis, boats, and other structures that will be exposed for a long period to high humidity or water.

4. Epoxy resin Glue: This relatively new adhesive is so strong that it replaces rivets in many aircraft assemblies. Epoxy resin bonds all sorts of porous and non-porous surfaces, but it works best on rigid materials.

5. Contact Cement: It is applied to each surface and allowed to dry for up to 15 minutes or more. The surfaces are then pressed firmly together, and bonding takes place immediately. Contact cement is available in liquid form and ready to use. It works well for joining any combination of wood, cloth, leather, rubber, plastics, veneer, or thin metal sheets that are difficult to cramp. Its vapours may be harmful, so be sure the work area is well-ventilated and avoid breathing them.

6. Casein Glue: It is made from milk curd, hydrated lime, and sodium hydroxide. It is supplied in powder form and mixed with cold water to use. After mixing, it should be set for about 15 minutes before it is applied. It is classified as a water-resistant glue.

7. Animal Glue: This glue is made from cattle hides, tendons, and bones. It is available in liquid form and packaged in plastic squeeze bottles. This form holds wood parts securely and is easy to handle, but it is not waterproof.

8. Hot-melt glue: This type of glue is a thermoplastic adhesive material that becomes fluid when heated and sets up when cooled. The glue must be so hot that it thoroughly wets the surface. Bonding occurs in less than a minute, so the surface must be brought together immediately.

WARNING: Do not touch the hot glue; it is about 530°F (177°C). Wear gloves and goggles as a precaution.

Evaluation

1. Differentiate between Polyvinyl Resin Emulsion Glue (P.V.A.) and Casein Glue regarding their uses.
2. 2. List and explain the types of adhesives.

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CHAPTER TWELVE
IRONMONGERY

Objectives

At the end of this chapter, you should be able to;

i. Type of ironmongery
ii. Kinds of locks

There is a vast variety of ironmongery used in joinery, and its design and applications cannot be fully described, particularly since new designs are constantly being introduced.

The quality of fittings (ironmongeries) depends on:

a. The materials used, e.g. steel, aluminium, brass or plastic.
b. Their construction method, e.g., solid cast, drawing, or pressing to shape.
c. Type of finish applied, e.g. bright, galvanised, oxidised, etc.
d. In some cases, they may be right or left-hand fittings.

Many fittings require the use of nails and screws for security. The underlined below are some of the most common types of ironmongery woodworkers use.

A. Hinges: There are various types.

1. **Butt Hinges:** They are used for hanging doors and hinging lids. The flaps are let into the edge of the door, and screws hold the framing surrounding the door. Butt hinges are made of cast iron, wrought iron, etc. and can be obtained in a wide variety of sizes (figure 147).

Fig. 147: Butt hinges

2. **Projecting Butt Hinges:** They are used when a door has to open back against a wall and clear an obstruction.
3. **Skew or Rising Butt Hinges:** They have a specially shaped helical joint, the purpose of which is to make the door rise when it is opened. It is appropriately used when a door has to rise to clear a carpet or for an uneven floor which cannot be smoothed.
4. **Back Flaps:** They are used for face fixing on thin doors and shutters and are suitable for the edge fixing of but hinges.

   Other hinges include:
5. Parliament hinges
6. Strap hinges (figure 9.2).

Fig. 148. Strap hinges

7. Counter flap hinges
8. Link plate hinges
9. Band and Gudgeon hinges
10. Tee hinges (figure 9.3)

Fig. 149: Tee hinge

11. Etc.

B. Locks: These are for cabinet doors and drawers; they may be of three types according to the method of fitting.

1. **Straight Locks** – Usually a cheap type, screwed flat on the side face of the drawer or door (figure 150).

Fig. 150: Straight lock

2. **Cut Locks** – These are stronger and neater, let into cut recesses in the back of the drawer or door (figure 151).

Fig. 151: Cut lock

3. **Mortise Locks** – Fitted into a mortise cut into the edge of the door or drawer (figure 152).

Fig. 152: Mortise lock

Locks for doors may be left or right hand. A left hand cut door lock is let into the left-hand stile of the door and vice-visa for the right-hand lock.

Kinds of Lock:

1. **Dead Locks**: A box containing a sliding bolt held in position by means of offspring-loaded levers. It can be operated by turning the key, which releases the levers, enabling the bolt to slide in or out (figure 153).

Fig. 153. Deadlock

2. **Rim Latches:** Are used on the inside of bathroom and laboratory doors, where the door is locked from the inside (figure 154).

Fig. 154: Rim latches

3. **Rim Locks:** These combine deadlock and rim latch. They are used in work where appearance is unimportant (figure 155).

Fig. 155: Rim lock

4. **Mortise Locks:** These are used on a better class of work where the rim lock would be unsightly. A mortise must be made in the edge of the door to accommodate the case, the end plate being let into the edge of the door and secured with screws.

5. **Hasp and Staples:** There are numerous types and sizes of these, used with pad-locks for locking garage doors, gates and boxes. They are screwed or bolted to the surface of the job (figure 156).

Fig. 156. Hasp and Staple

other fittings include:

6. **Handles and Knobs** (figure 157a and 157b)

Fig. 157a. Handles Fig. 157b. Knobs

7. Catches and Hooks (figure 158a. and 158b)

Fig. 158a. Catches Fig. 158b. Hook

8. Rollers and Castors (Figures 159a and 159b)

Fig. 159a: Rollers

Fig. 159b: Castors

Evaluation

1. Describe the types of ironmongery with appropriate examples.
2. List and explain the various kinds of locks.

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CHAPTER THIRTEEN
DESIGN CONCEPT

Objectives

At the end of this chapter, you should be able to;

1. Define design concept
2. Explain the terms fitness for purpose, shape and proportion
3. Explain the elements of a good design

Designing is a complex activity that includes creating, inventing, searching and developing. It is a selective process where ideas are studied, tried out, analysed, and then either discarded or incorporated into the design. These ideas are recorded in words, drawings, or models. Designing is a purposeful mental and artful in nature for creative objectivity.

At the outset, you should identify a problem requiring solution, formulate a clear, concise statement of the problem identifying it as an original design or a modification and improvement of an existing design. The statement should include the description of the purpose and use of the product and any specific requirements concerning materials, size and shape; even time is an important aspect to be considered in designing

Some Important Design Factors

1. **Functional**: this is fitness for purpose. The requirement grows out of the use and purpose of the product. It must serve the purpose for which it is designed; e.g. a chair must provide a comfortable support for the human anatomy.

2. **Material**: the right use of material is very important the requirements are developed through a study of those that will be most suitable and appropriate. Consideration must be given to

strength, beauty, durability and economy of the materials. Select a material (wood) that has the quality and characteristics required.

3. **Methods**: the methods of construction must be considered as materials are selected. Sound construction of component parts assembled together is very essential. The size of structural parts and types of joints or fasteners will not be the same for weak, soft textured woods as for those that are strong and hard, similarly among non-wood materials.

4. **Appearance**: very difficult to handle for the beginners. In good design you must recognise such principle, lines (horizontal, diagonal, vertical; and can be distinguished by how thick or thin they are, and whether they are straight or curved lines); shapes, (may be geometrical, organic or abstract); form (has length, width and depth); correct proportion of the parts to one another, proper balance and stability; unity and harmony among the various elements; point of emphasis and interest; compatible colours; and interesting textures.

There are no firmly established rules or standard that can be applied to appearance, so learning to recognize good design will take time and effort. Your ability in this area will grow through experience, practice, and reflection.

Today, designers of wood products place great emphasis on function. They build the design through the use of smooth, trim lines, simple shapes and forms; and interesting grain patterns, colours and textures. They are cautious about using extra shapes, carvings and inlays just to add to the appearance.

Their purpose is to create pleasing visual aspects that seem to grow from and blend with the function, the materials, and practical construction techniques. A design may over time become unfashionable and regarded as old, the design can be modified to fit the current taste of people in the society or recircle it. However, a well-designed and crafted product becomes antique after many years of usage, and sometimes considered priceless.

Evaluation

1. Explicitly explain design concept
2. Explain the elements of a good designed product
3. What is fitness for purpose, shape and proportion?

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CHAPTER FOURTEEN
TIMBER FINISHES

Objectives

At the end of this chapter, you should be able to;

i. Explain bleaching and colouring
ii. Explain the process of timber finishing
iii. State types of finishes
iv. Select a good finish

Wood, in its natural condition, has a particular beauty, which can be enhanced by the addition of a professional finish. Finishing means "the process of coating or polishing that gives a job its final beauty appearance."

1. **Preparation:** The first move is to examine the surface to be finished with the utmost care, taking note of any scratches or blemishes. If any job is done correctly, there will not be any scratches, but some surfaces are bound to become marked with handling. In this case, all scratches will show through the finish. Removing them will be much more difficult unless the piece is stripped and finishing is started all over, an arduous process.

Other methods of removing scratches and preparing the surface for its final finish include steel wool, but it should be used with care by the beginner. Some wood finishers prefer glass paper, garnet paper, aluminium oxide, flint paper, or emery cloth.

Regarding the fineness of the abrasive, the action must always be with the grain or a series of fines that are difficult to remove. Surface finishes are applied to wooden structures for the following reasons:

2. Protection: of the wood surface with paints, vanishes, and enamels, which form a protective coating against dirt, moisture abrasion and some chemicals.

a) **Paint:** It consists of finely divided solid colouring substances, which dry by evaporation of the solvent and/or oxidation.

b) **Varnish:** A glossy, transparent finishing material consisting of gums or resins in a solvent.

c) **Enamel:** A varnish used for top finishing coats.

d) **Solvent:** A liquid or mixture of liquids which dissolve certain materials.

3. Decoration: to beautify the appearance of the work. The type of finish applied depends on the timber used and the article's use.

4. **Hygiene:** timber surfaces that are covered or protected with a smooth film are easier to clean and kept free of dust, dirt, stains, etc., than those left ''in the white'', uncoated with polish or paint.

Before any type of finish is applied to new or old work, the surface should be dried and cleaned, free from dust, wax, and oil. New timber should be dried to less than 15% M.C. before applying finishing coats. Cleanliness is essential for all finishing processes.

Types of Finish

a) **Bleaching:** a process of lightening the colour of wood with chemical solutions.

b) **Colouring:** a process used to correct the colour of members or parts of a job made from mixed or different timbers.

c) **Curing:** the drying and hardening the finishing material after application.

d) **French polish:** a spirit varnish made from shellac (an animal resin) dissolved in alcohol-methylated spirits.

e) **Gloss** refers to the brightness or polish on the dried finishing film

f) **oil,** which is a greasy material

g) **Stain:** colouring matter used to change the colour of the wood.

h) **Wax finish:** a transparent eggshell gloss-finish produced by rubbing a wax over stained, filled and sealed surface.

i) **Filler:** a material used to level porous surfaces

Evaluation

1. Explain the process of timber finishing
2. Explain bleaching and colouring
3. State types of finishes
4. Select a good finish

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CHAPTER FIFTEEN
GLOSSARY OF TECHNICAL TERMS

1. **Adhesive:** substance used to hold materials together by surface attachment; e.g., cement, glue, paste and or mucilage.
2. **Annual Growth Ring**: the growth ring of a tree formed in a single year.
3. **Architraves:** are mouldings which surround door or window openings.
4. **Arris Edge**: is the sharp edge formed by two adjacent surfaces.
5. **Batten:** a strip of wood placed across a wood surface to cover joints or to strengthen the assembly.
6. **Beveled Edges:** When the whole of an edge is planed off to an angle other than a right angle, the edge is called a "bevelled edge".
7. **Bleaching:** lightening the colour of wood by applying a chemical solution.
8. **Blemish:** any defect, scar or mark that tends to detract from the appearance of a wood surface.
9. **Cant:** a log with slabs cut off so that it is no longer round but flat on two or four sides; ready to be cut into boards, also called a FLITCH.
10. **Carcass:** The framing of a structure prior to covering or sheeting with ply or hardboard (or the box-like cabinet) before fitting drawers, doors, shelves, etc., and before decorative features are applied.
11. **Carpenter:** a woodworker who constructs, erects, installs and repairs structures and fixtures of wood, plywood and wall board.

12. **Chamfer:** corner has the corner between an edge and end cut of at 45^{o}.
13. **Chamfering**: When it is desired to take off more than the arris edge, and a definite amount is gauged and planed off carefully to the lines, the new surface produced is called a "chamfer", and the operation is known as "chamfering". If the chamfer runs the entire length of the timber, it is known as "through chamfering", and is usually planned with a jack, smoothing or block plane, although a special chamfer plane may be purchased for chamfering. When chamfering end grain, it is best to hold the plane on the screw to produce a slicing cut. If the chamfer is stopped at either end, it is called a "stopped chamfer" and is produced with either a chisel, spokeshave or bull-nose rebate plane. Usually, chamfering is done to improve the appearance of the work, although sometimes the edges of skirting boards, plinths, and edges of door nails are chamfered to prevent dust settling. Chamfers are usually planed at 45^{o} to the side or edge.
14. **Checks:** small splits parallel to the wood grain, usually caused by improper seasoning.
15. **Cleat**: A narrow board or batten fixed across a wide board to prevent it from warping. Usually secured by means of nails, screws or buttons.
16. **Cleavage:** Direction or line of dividing or splitting of wood cells/fibres.
17. **Clinch:** Nails made to hold more securely by bending down the ends of the protruding points.
18. **Collapse:** A seasoning defect resulting in the breakdown of wood cells caused by two rapid or improper seasonings.
19. **Core:** The centre of a plywood panel. Plywood cores may be made of either sawed timber or veneer.
20. **Cornice**: The moulding at the junction of walls and ceilings.

21. **Counter Boring:** To enlarge a hole through part of its length by boring.
22. **Counter Sinking:** To recess a hole conically for the head of a screw or bolt.
23. **Countersinking**: enlarging the top of a screw hole in metal or wood by means of a countersink bit or drill to take the head of the countersunk screw.
24. **Dado:** A groove cut across the grain of a board.
25. **Decay:** Disintegration of wood substance due to the action of wood-destroying fungi.
26. **Degrade:** Any condition that reduces the quantity and market value of timber before reaching the consumer, e.g., defects like shakes, splits, discolouration, or warpage.
27. **Dowelling**: joining pieces of timber using cylindrical pins known as dowels glued into holes bored in each piece. Dowel pins are used to strengthen butt, mortise and tenon, mitred and bridle joints—diameters 6, 8, 1o, 13, 16 and 19 mm.
28. **Dutchman:** A piece fitted into the work to cover a defect or an error.
29. **Emulsion:** The suspension of tiny particles of oil in water or water in oil with the aid of an agent.
30. **Evaporation is the change from liquid to gas that** occurs when solvents leave a wet paint film.
31. **Fence:** An adjustable metal bar or strip mounted on the table of an M/C or tool to guide the work.
32. **Figure:** The pattern produced on a wood surface by the annual growth rings, wood rays, and knots.
33. **Fillet**: is the name applied to a small piece of timber nailed, screwed or glued to the side of a job to support a shelf.
34. **Flitch:** A portion of a log sawed on two or more sides and intended for remanufacture into timber or sliced veneer.

35. **Flow:** The property of a finishing material to spread or level to an even film.
36. **Fluting:** Parallel grooves or furrows cut out of the surface of wood, usually to secure a decorative effect.
37. **Foxtail Wedging**: A method of wedging mortise and tenon joints where the tenon does not pass right through the stile. Generally used in high-class cabinet work when tenon end, grain is concealed.
38. **Furring:** Narrow strips of wood attached to a base surface or frame upon which other materials are fastened.
39. **Glue Block:** Small blocks of wood, usually triangular in shape, that are glued along the inside corner of a joint to add strength.
40. **Grain:** The direction, size, arrangement, appearance or quality of the fibres in wood.
41. **Grooving**: is the process of planning or cutting a sinking or recess along the grain either on a side or on an edge. Square or rectangular grooves can be planed with a plough plane. other forms of grooves such as hollow and "V" grooves, which are usually produced by milling machines, are sometimes used. Grooves which are stopped at one or both ends are known as "stopped grooves". They are cut with a chisel, and may be finished with a router plane, used in T. & G. joints, panelled frames, fixing bottoms of drawers and sliding doors.
42. **Gusset:** A thin piece of metal or wood that forms a plate and is fastened to the surfaces of two or four structural members to secure or reinforce the joint.
43. **Halving**: is the operation used in the construction of half lap joints, where each member is halved in its thickness so that the facts of the assembled joint are flush.
44. **Hardboard:** a manufactured material made by forming wood fibres into sheets, using heat and pressure.

45. **Haunch**: is the small left on the tenon of a hunched mortise and tenon joint to give added strength and prevent the rail from twisting. To form the haunch, the tenon is cut narrower, this allows it to be wedged in the mortise.
46. **Heading Screws**: When the slots of the screws run in the same direction, usually in the direction of the grain which surrounds them. It is done to improve the appearance of the work.
47. **Holidays:** areas of surface missed by a painter
48. **Housing**: is the fitting of the end of one piece of timber into a trench in the side of another piece. E.g., shelving. Termed "through housing" when the shelf is fitted through trench; "stopped housing" when a stopped trench is used; "dovetailed housing" when a dovetail trench is used; "shouldered housing when the trench is narrower than the thickness of the shelf. Used for fixing shelves in cabinets and sometimes for joining backs of drawers to the sides and for fixing treads of stairs and step ladders.
49. **Inlay:** a decoration where the design is set into the wood surface.
50. **Jig:** a device which holds the work and/or guides the tool while forming or assembling wood parts.
51. **Kerf:** the split or space made by the blade of any hand or power saw.
52. **Keying**: A method of strengthening mitred joints by gluing small pieces of veneer into saw kerfs across the corner of the joint.
53. **Kiln:** a heated chamber for drying timber, veneer, and other wood products.
54. **Knot**: cross section of a branch or limb imbedded in the wood during the growth of the tree.

55. **Laminate:** to form a product by bonding together two or more layers of materials. Each layer is called lamination or ply.
56. **Lignin:** a natural cement or gummy substance that holds together the tiny strands or fibres which make up the wall cells of a tree.
57. **Member**: In framed work each piece which goes to make up the frame is called a member. In framed doors, the members have special names. The vertical members are called stiles and the horizontal members are called rails.
58. **Metre:** base unit for length in metric measure. one metre equals 1.09 yards.
59. **Mitre:** the joining of two pieces at an evenly divided angle. A cut made at an angle, usually 45^{o}.
60. **Moulding:** strips of wood, usually shaped for decorative effect, that are applied to surfaces, corners and edges of structures to provide a finished appearance.
61. **Moulding**: is the process of shaping the faces and edges of timber for ornamental purposes and breaking the continuity of plain surfaces; common forms are Bead, ovolo, Cavetto, Quarter Round, Half Round. Used on ornamental picture frames, edges of table tops, architraves, picture rails, etc.
62. **Natural Resins:** those resins used in finishes that are exuded from trees or secured from fossilized vegetable matter in the earth.
63. **Nosing**: When the edge of a board overhangs a vertical surface, e.g., front edge of window nosing boards, stir treads, etc., it is called “nosing”. If the edge is rounded to a semi-circle, it is called “rounded nosing”, or a form of moulding called “Torus”.
64. **Notching**: is the “checking” or the cutting out of a recess in one member so that it may fit over another, thus checking its movement.

65. **Particle Board:** a manufactured board composed of wood chips held together with an adhesive.
66. **Planning**: is the smoothing of the surfaces and edges of sawn timber by taking off shavings by planes (hand or machine). Planed wood is called 'Dressed Timber'. Hardwood species of timbers (at present), which have been machine-dressed on both surfaces and edges (DAR), are about 5mm undersize in thickness and 6mm under in width. A piece of 1oo * 25 mm dressed finishes about 94 mm * 20 mm thick.
67. **Plinth**: The name applied to the framework fixed underneath cabinets, wardrobes, etc., to raise the bottom off the floor instead of using legs.
68. **Plumb:** exactly vertical; perpendicular to a level line.
69. **Pocketing:** is the term applied to boring holes for the head of screws where countersinking would not be sufficient; frequently used when fixing table tops. Cut the pockets with a gauge or Forstner bit.
70. **Quarter Round:** A moulding with a cross-section of one-quarter (1/4) of a cylinder.
71. **Rebate** (rebate): A cut made on the edge of a board to form a joint with another piece.
72. **Rebating**: the cutting of a rectangular recess along the edge or across the edge of the timber. Used in picture frames, window sashes, a framework for panelling, and the meeting stiles of doors, etc. Rebates are planned with either side fillister, sash fillister, or rebate planes. Stopped rebates are chiselled and finished with a bull-nose rebate plane. Also used for rebated butt joints.
73. **Relative Humidity:** The Ratio of water vapour actually present in the air as related to the greatest amount of vapour the air can carry at a given temperature.
74. **Resawing:** Ripping a board to reduce its thickness or to make it into two thinner pieces.

75. **Rotary Cut:** A method of cutting veneer where the entire log is centred in a huge lathe and against a broad knife.
76. **Rounded Edge**: The corner between the edge and the end is rounded.
77. **RPM:** Revolution per minute
78. **Runs:** The irregularities in a surface finish usually caused by too heavy an application. Also called SAGS and CURTAINS.
79. **Saturation Point:** The final capacity for wood cells or fibres to retain moisture in them.
80. **Sawing:** is the cutting of wood by means of saws, either by hand or machine. Sawn timber is called 'sawn timber' or 'rough timber'.
81. **Scribing**: Chiefly used where mouldings meet at an internal angle. The end of one piece is shaped to fit over the profile of the other, forming an ascribed joint. E.g., skirting and cornice mouldings, which meet at corners of rooms, are scribed to fit one another so that if any shrinkage takes place, tiny gap appears, as often happens when a mitred joint is used. The mouldings need not necessarily be the same shape or contour.
82. **Shake:** A defect in wood running parallel to the grain. The separation of the spring and summer growth rings causes it.
83. **Shooting**: is the planning of the edges or ends of boards perfectly straight and square to the face side.
84. **Slice:** A method of cutting veneer where a section of a log is thrust down along a knife edge that sheers off the veneer in sheets.
85. **Slot Screwing**: Used where screws are not seen for fixing cleats, drawer runners, table tops, etc., to allow for the "working" (expansion and contraction) of the timber.
86. **Splayed Edge**: This surface is produced when the size is placed at an angle other than Chamfered Corner, which has

the corner between an edge and end cut at 45o to the edge, e.g., the edge of Tee Square and Straight Edges.

87. **Stickers:** strips of wood used to separate the layers in a piece of timber so that air can circulate each board.
88. **Straight Edge:** A straight strip of wood is used to lay out and check the accuracy of the work.
89. **Taper:** A gradual and uniform decrease in the size of a hole, cylinder, or rectangular part.
90. **Template**: A temporary pattern cut out of cardboard, plywood or metal, used for setting out shaped work.
91. **Template:** A pattern, guide, or model used to lay out work or check its accuracy.
92. **Timber:** A converted log into usable pieces by carpenters, joiners and cabinet makers.
93. **Tongue:** A projecting bead cut on the edge on the edge of a board that fits into a groove on another piece.
94. **Tracking:** The alignment of a blade as it runs on the band saw wheel.
95. **Trenching** is the cutting of a recess across the grain, the sides being sawn, the waste chiselled out, and the bottom surfaced with the router plane. If the trench extends across the timber, it is called a “through trench;” if stopped at either end, it is called a “stopped trench.” Trenching is chiefly used for housed joints, e.g., fixing shelves into cupboards, etc., and may be done with a Multi-Plane or Power Router.
96. **Trim:** A general term that applies to the various wood strips and mouldings used to finish door and window openings and corners where walls join the ceiling and floor.
97. **Veneer:** A thin sheet of wood sliced, cut or sawed.
98. **Vessels:** Wood cells of large diameters set above one another to form continuous tubes. The openings of the vessels on the surface of the wood are referred to as Pores.

99. **Wane:** The presence of bark, or the lack of wood from any cause, on the edge or corner of a piece of timber.
100. **Warp:** any variation from a true or plane surface. Timber may include bow, cup, crook, or wind (twist).
101. **Web:** A thin pattern section connecting two heavier sections to add strength in the metal casting.
102. **Wedging:** A method of strengthening mortise and tenon joins using tapered pieces of wood, usually used in pairs and driven into the tenon to spread it in the mortise. Allowance for the wedges is about 4mm for each 35mm in the width of the tenon.

EVALUATION

ESSAY QUESTIONS

1. What do you understand by the terms planning, sawing and shooting?
2. What is an arris edge? How and why is an arris edge removed?
3. Sketch the difference between a through chamfer and a stopped chamfer.
4. Name the tools used in setting out and cutting a stopped chamfer.
5. Why are chamfers used?
6. Show by sketches the difference between splayed edge and a bevelled edge.
7. Sketch a rounded edge and a rounded nosing. How are they produced?
8. Sketch a rounded corner and a chamfered corner.
9. What do you understand by the terms "round timber" and "dressed timber"?
10. Make a sketch showing a stopped groove and a through groove. What plane is used for planning a through groove? State some uses for grooves.
11. Sketch a rebate. State uses and name tools used to produce rebates.
12. Define the term "housing". Sketch a through and stopped trench.
13. Describe a mitred joint. How are they cut, cramped and strengthened?
14. Illustrate three joints which use dowels or dowel pins.
15. What is scribing? State the uses of scribed and mitred joints.

16. Explain the terms – haunch, wedging and foxtail wedging. Add sketches.
17. Explain and illustrate the terms countersinking, counterboring, pocketing, slot screwing and heading screws, state uses of each.
18. Define "moulding". Name and sketch five simple mouldings. How are they made?
19. What is a plinth, a cornice, an architrave? Name the joints at the corners of each.
20. Sketch mouldings suitable for a cornice, an architrave and a picture frame.
21. Define the following and illustrate where possible
    a) Framed panelled door; framed flush door; solid core door.
    b) Stiles (hanging, locking, meeting); Rails; Muntin; Panel.
    c) Mouldings – Planted; Stuck; Bolection.
    d) Veneers; Laminate; Plywood; Solid core board; Hardboard; Particle board.
    e) Illustrate four warp defects in timber.
    f) Cleat; Fillet; Buttoning; Escutcheon; Clinching; Kerf; Glue blocks.
    g) Template; Tongue; "In the White"; Natural finish.
    h) Carcass; Framed car case; Solid carcass.
    i) Drawer slip; Drawer guide; Drawer runner; Drawer kicker; Drawer rail.
    j) Carpentry; Joinery; Cabinet making.

MULTIPLE CHOICE QUESTIONS

Choose the correct answer option from A-D, that best completes the statement or answers the question.

1. Which of the following is **not** softwood?

A. Pine
B. Redwood
C. Birch
D. Cedar

2. Which of the following is **not** a hardwood?
   A. Fir
   B. Maple
   C. Walnut
   D. Cherry

3. The first step in timber processing is called
   A. selective cutting.
   B. barking.
   C. air drying.
   D. kiln drying.

4. The top grade of hardwood timber is labelled
   A. factory timber.
   B. yard timber.
   C. FAS.
   D. common yard timber.

5. Which of the following is **not** a step in problem solving?
   A. State the problem clearly.
   B. Select the best solution.
   C. Collect information.
   D. Rank the solutions according to effectiveness.

6. A worker who finishes plans begun by an architect is a
   A. millwright.
   B. forestry technician.
   C. precision woodworker.
   D. drafter.

7. Employers appreciate workers who
   A. have a positive attitude.
   B. cooperate.
   C. can accept criticism.
   D. all of the above.

8. Wood's greatest commercial importance is in
   A. production of synthetics and plastics.
   B. making paperboard and cardboard.
   C. furniture, cabinetmaking, and building construction.
   D. engineered wood production.

9. A fire safety plan should include
   A. a map of the building.
   B. at least four escape routes.
   C. escape routes that can be opened during an emergency.
   D. none of the above.

10. Most fires can be extinguished by
    A. increasing the heat so the fire burns more quickly.
    B. removing the source of fuel.
    C. increasing the level of oxygen.
    D. all of the above.

11. Which of the following is **not** involved in an electric shock that kills?
    A. A slowed heart rate.
    B. Ventricular fibrillation.
    C. Respiratory-centre paralysis.
    D. Paralysis of the hand or other muscles.

12. Which of the following is **not** a helper used to feed stock into a tool?
    A. Push stick

B. Feather board
C. Push block
D. Straightedge

13. Which type of gloves should be worn when working with sharp edges and rough materials?
    A. Plastic
    B. Leather or thick fabric
    C. Lightweight cotton
    D. rubber

14. If a chemical splashes into someone's eye, the person should rinse the eye with
    A. alcohol.
    B. a gentle stream of cool water.
    C. mercurochrome.
    D. cold tea.

15. The three keys to good design include:
    A. proportion, balance, symmetry.
    B. appearance, sound construction, function.
    C. function, harmony, emphasis.
    D. sound construction, scale, evaluation.

16. A three-view working drawing usually includes ____ views.
    A. front, back, and left-side
    B. top, front, and right-side.
    C. back, front, and top.
    D. left-side, right-side, and front.

17. An adjustable metal bar mounted on the machine table to guide the work is known as
    A. blade.
    B. fence.
    C. guard

D. Lever.

18. Which of the following would **not** be found on a bill of materials?

A. Finished size of each wood part.
B. Rough size of each wood part.
C. Fasteners.
D. Accessories.

19. Which of the following formulas is used to calculate board feet?

A. L ´ W
B. aa + bb + cc
C. (T ´ W ´ L) ÷ 12
D. T ´ W ÷ L

20. When using a crosscut saw, which of the following is **not** recommended?

A. Hold the saw at a 45-degree angle.
B. Apply light pressure on the push cuts.
C. Cut with the grain.
D. Cut on the waste side of the cutting line.

21. Which of the following is used to cut irregular shapes?

A. Backsaw
B. Dovetail saw
C. Ripsaw
D. Compass saw

22. Which of the following is **not** used as a marking tool?

A. Scratch awl
B. Triangle
C. Lead pencil
D. Utility knife

23. The reciprocating saw is used primarily for
    A. rough cutting.
    B. curved cuts.
    C. finish cutting.
    D. all of the above.

24. A hammer of which weight is best for everyday use?
    A. 16 ounces
    B. 5 ounces
    C. 18 ounces
    D. 20 ounces

25. Which of the following is recommended for driving nails?
    A. Grasp the hammer near the head.
    B. Hold the nail close to the point.
    C. Watch the hammer, not the nail.
    D. Put several nails along the same grain.

26. A hammer is a type of
    A. gooseneck.
    B. fulcrum.
    C. wedge.
    D. lever.

27. The size of a power drill is determined by the size of its
    A. bit.
    B. chuck.
    C. torque.
    D. collar.

28. A hand drill is generally used to drill holes _____ or less in diameter.
    A. ¼ inch (6mm)
    B. 1 inch (25mm)
    C. ¾ inch (18mm)
    D. 1/8 inch (3mm)

29. On some power drills, a chuck key is used to
    A. tighten the jaws around the bit.
    B. lock the drill for safety reasons.
    C. loosen screws that are too tight.
    D. none of the above.

30. A power drill for woodworking should be variable speed and
    A. cordless.
    B. heavy.
    C. reversible.
    D. all of the above.

31. Before planning, inspect the surface for
    A. sawdust.
    B. correct dimensions.
    C. warp.
    D. finishes.

32. Which of the following is **not** recommended for planning?
    A. If you are right-handed, grasp the knob in your left hand.
    B. Lift the plane off the board on the return stroke.
    C. Always plane with the grain.
    D. None of the above.

33. Which of the following is **not** recommended for chiselling?
    A. Secure the work-piece with clamps.
    B. Keep the chisel close to your body.
    C. Always hit the tool squarely on top of the handle.
    D. Never allow the edge to touch other tools.

34. Which of the following is **not** recommended for sanding?

A. Always sand against the grain.
B. Take care to prevent round corners.
C. Sand end grain in only one direction.
D. Never use a coarser grit than necessary.

35. When operating a portable power sander,
A. make sure the abrasive belt is in good condition.
B. wear goggles or a face shield.
C. start the tool above the work surface.
D. all of the above.

36. Butt joints are made by joining together the edge, end, or face surface of one piece of wood to the ____ of another.
A. edge
B. end
C. face surface
D. all of the above

37. The two main types of butt joints include edge butt joints and
A. end butt joints.
B. face butt joints.
C. corner butt joints.
D. angled butt joints.

38. Butt joints can be strengthened using corner blocks, biscuits, dowels, or
A. straps.
B. metal fasteners.
C. joists.
D. tape.

39. Biscuits are made from compressed
A. maple.
B. oak.

C. beech.
D. plywood.

40. When making biscuit joints, the slots should be slightly longer than the biscuits to allow for
A. easy removal.
B. padding.
C. adjustments and expansion.
D. compression.

41. Dowel centres are
A. small metal pins used for marking.
B. the wooden cores of dowel rods.
C. pieces of dowel rod used to strengthen joints.
D. none of the above.

42. When using dowels to strengthen joints, their diameter should never be more than _____ the thickness of the wood.
A. half
B. one-quarter
C. twice
D. three-fourths

43. When making a dowel joint in a frame, use a _____ to locate the dowels on the face surface.
A. gouge
B. try square
C. straightedge
D. tape measure

44. A rebate is a _____ placed along the end or edge of a board.
A. ridge
B. slot

C. L-shaped cut
D. dovetail

45. Rebate joints are commonly used in the construction of cases, cabinet frames, and
A. tabletops.
B. drawers.
C. roofing members.
D. picture frames.

46. The width of the cut made for a rebate joint is determined by the
A. size of the saw blade.
B. desired strength of the joint.
C. size of the project.
D. thickness of the stock.

47. The depth of a rebate is usually ____ the thickness of the stock.
A. one-half to two-thirds
B. one-fourth to one-half
C. equal to
D. twice

44. When cutting a rebate by hand, make the shoulder cut with a _____
A. backsaw.
B. dovetail saw.
C. reciprocating saw.
D. sharp file.

48. Trim excess stock from a rebate using a _____
A. file.
B. chisel.

C. jigsaw.
D. sanding block.

49. Position the fence on a table saw so the distance from the outside of the blade to the fence is the same as the rebate's _____
A. depth
B. length
C. width
D. none of the above

50. Do not allow your fingers to come closer than ____ to the blade on a table saw.
A. 50mm
B. 75mm
C. 100mm
D. 125mm

51. In a dado joint, a/an _____ across one board receives the end of another board.
A. L-shaped cut
B. Dado
C. Groove
D. lap

45. To lay out a dado, superimpose the end of the second board across the ____ of the first.
A. face
B. end
C. Edge
D. none of the above

46. The correct depth for a dado is usually _____ the thickness of the stock.
A. one-fourth

B. one-half
C. three-fourths
D. twice

47. After cutting a dado, use ____ to check the depth throughout.
A. a tape measure
B. callipers
C. combination square
D. a try square

48. When wood pieces are simply lapped without additional processing, the joint is called a/an
A. butt joint
B. surface lap joint
C. end-to-end half-lap joint
D. top-lap joint

49. The most common lap joint is the ____ joint.
A. surface-lap
B. end-to-end half-lap
C. cross-lap
D. half-lap

50. Short pieces of wood can be made into a longer, more usable piece by joining them with ____ joints.
A. surface-lap
B. end-to-end half-lap
C. cross-lap
D. half-lap

51. When pieces of different thicknesses are joined, a ____ joint is used.
A. surface-lap
B. cross-lap

C. finger-lap
D. full-lap

52. Box joint is another term for a ____ joint.
A. surface-lap
B. cross-lap
C. finger-lap
D. full-lap

53. The end of each piece in a mitre joint is commonly cut at an angle of ____ degrees.
A. 90
B. 30 or 60
C. 45
D. none of the above

54. A ____ is used to hold the glass in place in a picture frame.
A. rebate edge
B. dowel
C. dado
D. metal clip
E.

62. A is used along with a saw to cut mitres.
A. dado cutter
B. mitre box
C. framing jig
D. try square

55. Built-in ____ allow you to lock a power mitre saw into position at a variety of angles.
A. metal clips
B. angle irons
C. index plates

D. none of the above

56. The width of a tenon should be ____ or less.
    A. 125mm
    B. 100mm
    C. 75mm
    D. 50mm

57. The thickness of a tenon should be ____ the thickness of the piece in which the mortise will be cut.
    A. twice
    B. between one-third and one-half
    C. less than one-fourth
    D. three-fourths

58. The width of the mortise should be the same as the ____ of the tenon.
    A. width
    B. length
    C. thickness
    D. radius

59. An assembled mortise and tenon joint looks like a simple ____ joint.
    A. cross-lap
    B. mitre
    C. dado
    D. butt

60. Hand tools used to cut a mortise include a drill and a
    A. chisel.
    B. dado cutter.
    C. mitre box.
    D. all of the above.

61. Hand tools used to cut a tenon include a backsaw or
    A. fine crosscut saw.
    B. table saw.
    C. dovetail saw.
    D. ripsaw.

62. The ends of the socket piece in a dovetail joint are called
    A. pins.
    B. half-pins.
    C. tails.
    D. blind ends.

63. When using a router with a jig and dovetail bit,
    A. begin cutting from left to right.
    B. certain joints must be cut on certain sides of the jig.
    C. label the jig as well as the work-pieces so that all parts match properly.
    D. all of the above.

63. One way to support shelves in a bookcase is to drill holes in the sides and insert
    A. brackets.
    B. cleats.
    C. shelf pins or dowels.
    D. screws.

64. There are three basic steps to installing a drawer in a table: ……, making the drawer, and installing drawer guides.
    A. cutting a rebate
    B. cutting the rail
    C. measuring the lip
    D. drilling for brackets

65. When making a panelled door, use _____ joints to connect stiles and rails.
    A. mortise and tenon
    B. dovetail
    C. butt
    D. half-lap

66. When pre-drilling wood for screws, drill the ___ in the first piece of stock, then hold this piece over the second piece to mark the location for the pilot hole.
    A. plug hole
    B. shank clearance hole
    C. countersink
    D. counterbore

67. A screw-mate drill and countersink can be used with
    A. dowel screws.
    B. wood plugs.
    C. flathead screws.
    D. roundhead screws.

68. Special wood screws with widely spaced threads are available for use with
    A. composition panels.
    B. pocket holes.
    C. sheet metal.
    D. tabletops.

69. Wooden parallel clamps from 6 to 2o inches long are called
    A. bar clamps.
    B. pipe clamps.
    C. C-clamps.
    D. hand screws.

70. A/An ____ is used to clamp multi-sided projects.
    A. band clamp
    B. C-clamp
    C. pipe clamp
    D. edging clamp

71. When making edge joints, pieces of stock wider than ____ inches should be ripped into narrower strips and the strips glued together.
    A. 50 to 100mm
    B. 100 to 150mm
    C. 150 to 200mm
    D. 200 to 250mm

72. The two basic types of hardware are cabinet hardware and
    A. surface hardware.
    B. structural hardware.
    C. metal fasteners.
    D. metal guides.

79. A hinge is a piece of hardware used as a
    A. joint.
    B. support.
    C. repair plate.
    D. none of the above.

73. A device for holding a door closed is called a
    A. knob.
    B. pull.
    C. T-plate.
    D. catch.

74. Side drawer guides require ____ clearance on each side.

A. 3mm
B. 6mm
C. 12mm
D. 18mm

75. Repair plates include mending plates and
A. flat corner irons.
B. bent corner irons.
C. T-plates.
D. all of the above.

76. Veneering techniques have been used for at least ____ years.
A. 500
B. 1,000
C. 2,000
D. 3,000

77. Boyle's law refers to the relationship between
A. adhesion and cohesion.
B. volume and pressure of gases.
C. heating and cooling.
D. veneers and laminates.

78. A sheet of veneer is usually ____ thick.
A. 0.78mm
B. 0.89mm
C. 1.5mm
D. 3.13mm

79. All veneer slices cut from a single log are kept in bundles called_____
A. books.
B. collections.
C. flitches.

D. cuts.

80. Flat cutting produces a _____
    A. flat grain.
    B. irregular grain.
    C. patterned grain.
    D. cathedral grain.

81. When white or yellow glue is used to apply veneer, the veneer is pressed with a _____
    A. household iron.
    B. cast-iron weight.
    C. rubber roller.
    D. none of the above.

82. Which of the following can be used to cut veneer?
    A. craft knife
    B. utility knife
    C. paper cutter
    D. all of the above

83. The ____ presses firmly on the top of the wood to prevent the grain from tearing out.
    A. infeed roll
    B. chip breaker
    C. pressure bar
    D. outfeed roll

84. When planning a board, first _____
    A. adjust the machine for the correct thickness.
    B. start the stock into the planer.
    C. measure the thickness of the board at the thickest point.
    D. turn on the power.

85. For rough work, never try to remove more than ____ thickness from a board.
    A. 1.56mm
    B. 3.13mm
    C. 5.0mm
    D. 6.0mm

86. The jointer is used to ____ boards.
    A. straighten
    B. smooth
    C. square up
    D. all of the above

87. The cutterhead on a jointer holds ____ knives.
    A. two
    B. three
    C. four
    D. five

88. When edge jointing, hold the work face of the stock flat against the ____ throughout the operation.
    A. fence
    B. outfeed table
    C. pressure control
    D. T-bevel

89. The most common saw blades are ____ blades.
    A. ripsaw
    B. crosscut
    C. combination
    D. all of the above

90. When ripping with the table saw, use the _____ to keep the saw kerf from closing.
    A. anti-kickback pawls

B. arbour
C. splitter
D. try square

91. The first step in crosscutting operations is to put the ____ in place.
A. mitre gauge
B. rip fence
C. sliding T-bevel
D. stop block

92. A typical dado head has two outside blades that are each ____ inch thick.
A. 1.56mm
B. 4.16mm
C. 6mm
D. 9.4mm

93. To make a mitre cut, adjust the mitre gauge to the correct angle and proceed as for
A. ripping.
B. crosscutting.
C. chamfering.
D. cutting a taper.

94. The elevating crank is used to adjust
A. cutting width.
B. angle of cut.
C. depth of cut.
D. none of the above.

95. When crosscutting, adjust the depth of cut so the teeth of the blade is about ____ below the table surface.
A. 1.56mm

B. 3mm
C. 6mm
D. 9.4mm

96. When making a mitre cut, adjust the _____ to the angle desired.
A. table
B. overarm
C. blade guard
D. column

97. To cut a bevel, adjust the track for
A. ripping.
B. duplicate parts.
C. straight crosscutting.
D. cutting from the bottom.

98. The radial-arm saw is sometimes called a ____ saw.
A. cutoff
B. table
C. combination
D. back

99. When cutting rectangular openings,
A. first, make straight cuts down the length of each side.
B. backtrack out of the second cut and cut a curve to the second corner.
C. make nibbling cuts as needed to clear away waste.
D. all of the above.

100. In cutting curves,
A. apply even, forward pressure.
B. guide the work with your right hand.

C. make relief cuts to within 1/4-inch of the layout line.
D. all of the above.

101. A commercial circle jig has an adjustable ____ that the operator sets to the correct distance for cutting a circle.
A. mitre gauge
B. pivot pin
C. radius measurement
D. blade guide

102. When cutting compound curves, first
A. remove the waste stock.
B. nail or tape the waste stock in place.
C. make a pattern.
D. resaw the stock to thickness.

103. Cutting several pieces at one time is called ____ sawing.
A. pad
B. duplicate
C. repeat
D. pattern

104. The compound mitre saw is referred to as "compound" because
A. it can do both crosscutting and ripping.
B. there is more than one mitre gauge installed on the saw table.
C. it can cut two angled surfaces at the same time.
D. it can cut from above or below the work-piece.

105. When adjusting the sliding compound mitre saw, loosen the locking handle or lever and tilt the ____ to the desired angle.
A. saw head

B. fence
C. turntable
D. clamping device

106. While making a cut, the blad7e of the saw extends into a slot in the
A. turntable.
B. kerf board.
C. fence.
D. angle indicator.

107. Which of the following is **not** an advantage of the sliding compound mitre saw?
A. It can cut dadoes.
B. It is safer than a radial-arm saw.
C. It can cut angles easily.
D. It can be taken to construction sites.

108. The scroll saw is also called a
A. compass saw.
B. jigsaw.
C. coping saw.
D. band saw.

109. If the pattern for your work-piece includes loose curves, choose a ____ blade.
A. thin, narrow
B. long
C. wide, thick
D. Sabre

110. When making intricate internal cuts,
A. drill a relief hole in the centre of the waste stock.
B. run the blade through a relief hole.
C. adjust the guide to the correct height.

D. all of the above.

111. When making straight cuts,
    A. choose the widest blade possible.
    B. make a “sandwich” of the material.
    C. use a special V fixture.
    D. all of the above.

112. The size of a drill press is expressed as twice the distance from the centre of the ____ to the column.
    A. table
    B. bit
    C. chuck
    D. spindle

113. The drill press can be used for
    A. drilling holes of various sizes and depths at various angles.
    B. mortising.
    C. sanding.
    D. all of the above.

114. Multispur bits are used to
    A. cut perfectly round, flat-bottomed holes.
    B. create countersinks.
    C. cut dowels.
    D. cut rough holes.

115. Large machines with two belts arranged on three pulleys are capable of ____ speed settings.
    A. three
    B. six
    C. nine
    D. twelve

116. Which of the following cuts can be made with router bits?
    A. Dovetail
    B. V-grooving
    C. Cove
    D. All of the above

117. Which of the following is usually **not** cut with a plunge router?
    A. Dado
    B. Edge
    C. Mortise
    D. Rebate

118. To install a router bit, insert the shank of the bit as far as possible, then pull it out about ____ inch.
    A. 3mm
    B. 6mm
    C. 9.4mm
    D. 12mm

119. A typical router operates at ____ revolutions per minute.
    A. 5,000
    B. 9,000
    C. 16,000
    D. 25,000

120. To cut a groove for a strip of inlay, use a ____ bit.
    A. beading
    B. left-hand spiral
    C. V-grooving
    D. core box

121. During sanding, the movement of the abrasive against the wood generates
    A. static electricity.
    B. adhesion.
    C. friction.
    D. tension.
122. When changing the belt on the stationary belt sander, first
    A. turn the belt-tension knob.
    B. remove the guards.
    C. centre the belt on the rollers.
    D. adjust the idler pulley.
123. Which of the following **cannot** be sanded with a power sander?
    A. End grain
    B. Curves
    C. Irregular shapes
    D. None of the above
124. Which sander is most helpful in getting into hard-to-reach places?
    A. Narrow belt sander-grinder
    B. Oscillating spindle sander
    C. Stationary disc sander
    D. Stationary belt sander
125. Sanding discs are installed using
    A. two wrenches of different sizes.
    B. a tension knob.
    C. pressure-sensitive adhesive.
    D. a chuck key.

126. Spindle turning involves turning stock held between the live centre and the
    A. spur.
    B. headstock.
    C. tool rest.
    D. dead centre.

127. Rough turning is begun using a
    A. gouge.
    B. roundnose.
    C. spindle.
    D. none of the above.

128. Which is **not** true for finish turning?
    A. The tool used is a skew.
    B. Either cutting or scraping methods may be used.
    C. Work is begun at the centre of the workpiece.
    D. None of the above.

129. The vertical part of a shoulder is cut with a
    A. gouge.
    B. skew.
    C. parting tool.
    D. hermaphrodite caliper.

130. Standard finishes are made with _____ that emit(s) pollutants into the air.
    A. water-based ingredients
    B. solvents
    C. fillers
    D. rottenstone

131. Which of the following is a penetrating finish?
    A. Varnish

B. Enamel
C. Shellac
D. Danish oil

132. A shallow dent in wood can sometimes be repaired by
A. using steam to swell the wood.
B. filling it with a sliver of wood.
C. filling it with glue.
D. rubbing it with white shellac.

133. Pumice is used to
A. remove old paint.
B. remove excess glue.
C. clean brushes.
D. rub down a finish.

134. When storing a brush for a period of time, which of the following should **not** be done?
A. Wrap the brush in waxed paper.
B. Soak up the wetness with newspaper.
C. Wash it in detergent mixed with water.
D. Comb the bristles with a metal comb.

135. Which is **not** done when applying an oil-based stain?
A. Wear rubber or vinyl gloves.
B. Sponge the wood surface with water.
C. Apply a thin coat of linseed oil to the wood.
D. Wipe all surfaces with a tack rag.

136. To mix a white stain, combine _____ with oil and turpentine.
A. zinc oxide
B. raw sienna
C. burnt umber
D. white pumice

137. When applying a water-based stain, brush the end grain with ____ to prevent it from absorbing too much stain.
    A. linseed oil
    B. zinc oxide
    C. water
    D. solvent

138. Create a wash coat of one-part _____ to seven parts alcohol.
    A. linseed oil
    B. varnish
    C. lacquer
    D. shellac

139. When spraying finishes, wear
    A. rubber gloves.
    B. an apron.
    C. a mask or respirator.
    D. all of the above.

TRUE/FALSE QUESTIONS

Indicate whether the sentence or statement is ***TRUE*** or ***FALSE***.

140. Air seasoning of wood may take from six months to five years.
141. When a wood product is built, the wood should contain the amount of moisture it is expected to have, on average, during its use.
142. The tempered hardboard has been hardened by being dipped into plastics and air-dried.
143. The *Occupational Outlook Handbook* is a good source of information about jobs in demand.

144. More than 11,500 people die from work-related injuries each year.
145. OSHA requires Material Safety Data Sheets for all hazardous materials in a shop.
146. Toxic woods include fir and maple.
147. A cutting diagram shows how parts should be arranged so they can be produced with the minimum number of cuts.
148. Working drawings give the dimensions of the object.
149. When using power saws, always wear eye protection.
150. Ripsaws are used to cut stock to width
151. The backsaw has a thick blade with coarse teeth.
152. The set of a saw affects the width of the kerf.
153. Toenailing is nailing the end of one piece to the side of another by driving nails into both sides at an angle.
154. When nailing hardwood, drill starter holes and apply a little glue to the nail.
155. Pneumatic nailers increase nailing accuracy.
156. Cordless drills have rechargeable batteries.
157. You can convert a power drill into a small drill press with a depth stop.
158. Drill guides help drill perfectly aligned holes.
159. Sanding dust can lead to health problems such as dermatitis and respiratory illnesses.
160. The size of the grains on a sandpaper sheet is called grit.
161. When installing dowels for an end-to-face butt joint, drill the holes in the face pieces first.
162. Edge butt joints are often used to make tabletops from narrow boards.
163. The fence on a biscuit machine cannot be adjusted to angles other than 90 degrees.
164. Screws used in end grain should be short and thick for more holding power.

165. A laser router never actually touches the wood.
166. Rebates cut in the back edge of a cabinet frame should be cut a bit deeper than the thickness of the panel to be inserted.
167. When cutting a rebate by hand, lock the workpiece in a vice.
168. Technically, a dado is cut across the grain; a groove is cut with the grain.
169. Decorative cuts on the front ends of shelves can make dado joints more attractive on a bookcase.
170. Wooden drawer bottoms should be glued and nailed to the drawer frames to prevent changes caused by humidity.
171. A rebate-and-dado joint is used when increased strength and stiffness are required.
172. If the second piece of the joint fits a bit snugly into the first piece, use sandpaper to smooth out the channel.
173. The length of a blind dado should be laid out to within ½ to 18mm of the front edge.
174. For a cross-lap joint, the material is removed from only one piece.
175. Use a chisel to remove waste stock from cuts made for lap joints.
176. Use a backsaw to cut half-lap joints by hand.
177. When making a finger-lap joint, making the fingers and notches the same width as the thickness of the stock provides the most glue area.
178. It is extremely important to cut precise angles when making mitre joints; one or two degrees of error can result in a gap.
179. Mitre joints can be used to join two pieces of different widths.
180. Use a try square to check that the corners of a frame fit correctly.
181. The rebate for a picture frame should be about 9.4mm wide.

182. When designing a mortise and tenon joint, the tenon length depends on whether glue will be used or not.
183. When one tenon is too broad, multiple tenons can be used.
184. Dovetail joints were developed during a time when suitable glues and mechanical fasteners were not available.
185. A half-blind dovetail joint can be seen from the side but not from the front.
186. A screw-mate counterbore creates a wood plug that can be used to cover the screw head after it is installed.
187. Twin-threaded utility screws are preferred for fine hardwoods.
188. Always make sure that the tip of a standard screwdriver is the same width as the diameter of the screw head being driven.
189. A trial assembly allows you to adjust all clamps to the correct width.
190. During a trial assembly, parts should be checked with a square.
191. A respirator with a charcoal filter is not enough to protect your lungs from adhesive fumes.
192. Resorcinol glue provides complete protection from both fresh and salt water.
193. Invisible hinges are used on both flush and overlay doors and cannot be seen when the door is closed.
194. T-plates are used to strengthen shelves.
195. A broken screw can be removed by drilling out the damaged area and glueing it in a hardwood dowel of the proper size.
196. Around 1850, almost all highly styled furniture was veneered.
197. When adhering to the veneer with contact cement, place a block of softwood over the veneer and press it with a hot iron.

198. When planning table legs, ensure that each side of all four legs is of identical width.
199. Never pull on a board being planned.
200. Face planning is the same as surfacing.
201. Set the jointer to make a fairly deep cut when planning a face.
202. The guard must be removed from the jointer to cut a rebate.
203. Basically, a bevel is any angle, including a right angle.
204. During processing on the jointer, the cutter head moves in a clockwise direction.
205. The gauge showing a tilt angle for cutting bevels and chamfers is on the front of the saw just below the table.
206. A dado head can be cut either with or across the grain.
207. Because a dado head is larger than a saw blade, the throat plate on the table saw must have a wider opening.
208. Do not attempt to cut cylindrical (round) stock on the table saw.
209. The over-arm can be rotated in a complete circle around the column.
210. The saw unit is held stationary for crosscutting, and the workpiece is moved.
211. The workpiece is held stationary for ripping, and the saw unit is moved.
212. Make shortcuts before long cuts on the band saw.
213. Move the stock slowly into the blade to prevent wood burning.
214. Step on the blade when folding a band saw blade to hold it to the floor.
215. The table of the band saw can be tilted to do chamfering.
216. When resawing, use the narrowest possible blade.
217. The sliding compound mitre saw is pulled rather than pushed through materials clamped to its table, which is a safety factor.

218. A cut made by pressing too hard can result in burning the wood.
219. Mitre and bevel settings on the saw cannot be used independently.
220. Slower speeds make it easier to cut metals and plastics.
221. When installing a blade, be sure the teeth are pointing up.
222. One method for cutting an exterior corner is to make a slightly curved cut at the corner and then trim off the stock.
223. When cutting an angle or bevel, the workpiece must always remain on the same blade side.
224. Always use a drill bit with a square shank.
225. Use a faster speed for large holes and a slower speed for small holes.
226. When operating the router, hold it with one hand while turning the workpiece with the other hand.
227. Feeding a router into the workpiece too slowly will cause it to heat.
228. A router bit rotates clockwise.
229. Sanding done on the stationary disc sander should be done only on the upward-moving side of the disc.
230. Some sander discs rotate clockwise; others rotate counterclockwise.
231. Cutting Vs is done with a parting tool.
232. When cutting a bead, raise and twist the skew handle until the toe shears the wood.
233. In scraping, the tool digs into the revolving stock to peel away small shavings.
234. The split ends on flagged bristles should be snipped off.
235. Sealing should be done before staining.
236. Wax can be used as a finish for most woods.
237. A planer or jointer causes mill marks.

238. Use pumice mixed with linseed oil to gently rub a varnished surface.
239. Water-based stain has less tendency to bleed into lacquer than oil-based stain.

KEYS/ANSWERS

MULTIPLE CHOICE------- 1 – 150

TRUE/FALSE----------151 – 250

S/no.	Ans	S/no.	Ans	S/no.	Ans	S/no.	Ans
1	C	**64**	C	**127**	D	**190**	*T*
2	A	**65**	A	**127**	B	**191**	*T*
3	B	**66**	B	**129**	A	**192**	*F*
4	C	**67**	C	**130**	D	**193**	*F*
5	D	**68**	D	**131**	B	**194**	*T*
6	D	**69**	C	**132**	C	**195**	*T*
7	D	**7o**	C	**133**	B	**196**	*T*
8	C	**71**	A	**134**	D	**197**	*T*
9	A	**72**	B	**135**	A	**198**	*F*
10	B	**73**	C	**136**	C	**199**	*T*
11	A	**74**	B	**137**	D	**200**	*T*
12	D	**75**	A	**138**	A	**201**	*T*
13	C	**76**	B	**139**	D	**202**	*F*
14	B	**77**	C	**140**	B	**203**	*T*
15	B	**78**	A	**141**	B	**204**	*T*
16	B	**79**	D	**142**	D	**205**	*F*
17	B	**80**	A	**143**	A	**206**	*T*
18	A	**81**	D	**144**	D	**207**	*T*
19	C	**82**	B	**145**	B	**208**	*F*
20	C	**83**	A	**146**	B	**209**	*T*

21	D	**84**	D	**147**	A	**210**	*T*
22	B	**85**	C	**148**	C	**211**	*T*
23	A	**86**	D	**149**	D	**212**	*F*
24	A	**87**	D	**150**	D	**213**	*T*
25	B	**88**	B	**151**	*F*	**214**	*F*
26	D	**89**	B	**152**	*T*	**215**	*T*
27	B	**90**	C	**153**	*F*	**216**	*T*
28	A	**91**	D	**154**	*T*	**217**	*T*
29	A	**92**	A	**155**	*T*	**218**	*T*
30	B	**93**	D	**156**	*T*	**219**	*T*
31	C	**94**	B	**157**	*F*	**220**	*T*
32	D	**95**	C	**158**	*T*	**221**	*F*
33	B	**96**	B	**159**	*T*	**222**	*F*
34	A	**97**	D	**160**	*T*	**223**	*T*
35	D	**98**	B	**161**	*T*	**224**	*F*
36	D	**99**	A	**162**	*F*	**225**	*T*
37	A	**100**	D	**163**	*T*	**226**	*T*
38	B	**101**	C	**164**	*T*	**227**	*F*
39	C	**102**	A	**165**	*F*	**228**	*F*
40	C	**103**	B	**166**	*T*	**229**	*T*
41	A	**104**	B	**167**	*T*	**230**	*F*
42	A	**105**	C	**168**	*F*	**231**	*T*
43	B	**106**	A	**169**	*T*	**232**	*F*
44	C	**107**	B	**170**	*T*	**233**	*T*
45	B	**108**	C	**171**	*T*	**234**	*T*
46	D	**109**	A	**172**	*F*	**235**	*F*
47	D	**110**	D	**173**	*T*	**236**	*F*
48	A	**111**	A	**174**	*F*	**237**	*F*

49	B	**112**	B	**175**	*F*	**238**	*T*
50	C	**113**	C	**176**	*T*	**239**	*T*
51	D	**114**	A	**177**	*T*	**240**	*F*
52	B	**115**	C	**178**	*T*	**241**	*T*
53	A	**116**	A	**179**	*T*	**242**	*F*
54	B	**117**	B	**180**	*T*	**243**	*F*
55	C	**118**	A	**181**	*F*	**244**	*F*
56	B	**119**	B	**182**	*T*	**245**	*F*
57	C	**120**	C	**183**	*T*	**246**	*F*
58	B	**121**	D	**184**	*T*	**247**	*T*
59	D	**122**	A	**185**	*F*	**248**	*T*
60	C	**123**	C	**186**	*T*	**249**	*F*
61	C	**124**	D	**187**	*T*	**250**	*T*
62	A	**125**	A	**188**	*F*		
63	B	**126**	D	**189**	*T*		

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