CHAPTER ONE

# introduction

Woodworking can be as interesting to study as it is enjoyable and relaxing to work at. It is an activity that involves the combined use of the mind and the hands for the creation of something worth while. The project undertaken may be a large and involved one, requiring many hand tools, power machines, and materials, or a small, simple one made from materials and tools at hand.

Woodworking is many things to many people. To some it is a hobby that provides relaxation and change from their usual daily activities; to others it is a useful and economical means of maintaining and repairing their own homes or cottages. Some who become quite proficient build or remodel their homes, an accomplishment that affords them a great deal of satisfaction as well as a saving of money. For still others, woodworking forms the basis of their occupation.

The study of woodwork is offered as a general subject in the school curriculum as part of a basic education and is aimed at providing students with a manual skill, regardless of their future occupation. For many students, however, this may kindle an interest in the subject and a desire for further training, which can lead, in turn, to an interesting and rewarding career in some branch of the building industry. Woodworking courses also provide an excellent grounding for studies beyond the secondary school level. Students entering such fields as engineering, architecture, art, furniture design, and interior design at colleges and universities will find that they benefit from having taken woodwork in high school.

It helps if you begin the study of woodwork with the realization that it is a subject that will be of value to you in many ways, and one most people enjoy. Do your best in each project you undertake; the better you do anything the more you will enjoy doing it. Do not give up if the job does not turn out as well as you had hoped; perfection in woodworking comes only with practice. Each well-made project will add to your skill and confidence.

Although we do live in a machine age, when machines perform most manufacturing operations, including those involved with products made from wood, there are still many advantages to being proficient in a hand skill such as woodworking. Hand skills are still fundamental to the woodworking and building industry. Once such a skill is acquired it will remain with you as a valuable accomplishment. It develops an appreciation for the good work of others and a sense of pride in your own. The planning and reading of woodworking drawings promote clear and logical thinking, and the layout, cutting, and assembling of a project develop a high standard of accuracy, precision, and neatness. Working with your hands can also be good for your physical and mental well-being because it is generally enjoyable and relaxing. Building things with wood and hand tools also requires planning and offers great scope for creative design.

Wood as a structural material is one of the most satisfactory media in which to express oneself, for it is a living substance with warmth, texture, and beauty. Although many materials are used as a substitute, none has the same qualities as wood. On the other hand, metal and





plastics may be employed effectively in combination with wood for some projects.

With the growth of our country and the advance in building, the skills of the woodworker have found an ever-widening field in all branches of construction. Building construction, with all of its related trades, is our largest industry, and woodworking is one of the most important parts of that industry.

In the past there has been a shortage of persons skilled in furniture making and design, and this gap has been filled largely by imported labour. With our increase in population there has been a corresponding rise in the demand for trained carpenters and cabinetmakers.

Some of the possible occupational goals in woodworking and its related fields are:

(a) To enter the construction industry as an apprentice with the aim of becoming a journeyman/woman carpenter for work on residential, commercial, or industrial buildings.

(b) To work for a large construction firm in a supervisory role as foreman/woman, layout person, estimator, or construction superintendent. People who are capable of filling these positions are in great demand. They are usually graduates of a high school, junior college, or technological institute, who have a good background in mathematics and English as well as a specialized technical training.

(c) To become a speculative home-builder. A large percentage of our homes are produced by builders who purchase land and construct homes on it, and then sell them to prospective home-owners. This is one method of entering the building business for yourself after you have gained experience working for others.

(d) To become a general contractor. This is another method of owning and managing your own business. These persons engage in commercial, industrial, and residential construction, generally on a contract basis. Often the general contractor is a skilled carpenter who hires and supervises other buildings tradespeople such as bricklayers, plumbers, and electricians, as they are required.

(The following are some of the possibilities in branches of the woodworking industry not directly connected with the building industry.)

(e) To work as a cabinetmaker in a furniture factory or in a custom shop that specializes in furniture, store fixtures, or commercial display work.

(f) To become a pattern maker. The highly skilled tradespeople in this branch make wooden patterns for parts that are to be cast in metal. The patterns are set into damp sand and then removed to form a mould. The hollow left in the sand when the pattern is taken out becomes a receptacle of the correct shape and size into which molten metal can be poured to produce the desired metal part, which is called a casting. The pattern maker plays an important role in modern industrial development.

(g) To find employment in the boat-building industry. This is a specialized branch of woodworking that offers growing opportunities for an interesting future. While steel, plastic, and fibreglass are also used for boats, none is able to reproduce the fine lines and excellent qualities of a wooden hull.

There is a bright future in woodworking, especially in building construction,

for anyone who is interested in it and who is willing to prepare himself or herself for the opportunities that are available. In a large country such as ours with a fast-expanding building program it is obvious that the possibilities for those who are skilled in the use of wood and other types of building materials will increase for many years to come.

All the tradespeople referred to above, although employed in different branches of the woodworking industry, use the same basic materials, tools, and machines. The same skills and knowledge of general woodworking are fundamental to all of them. It is this general information that is covered in this book.

## ASSIGNMENT

1. List the various branches of the woodworking industry.
2. State two occupational possibilities in building construction for a well-trained woodworker.
3. What factors do all branches of the woodworking industry have in common?
4. In what practical way would the study of woodwork be of value to persons who do not intend to make any branch of the woodworking industry their life work?
5. List some of the advantages of acquiring a hand skill.
6. In which academic subjects should you have a good general knowledge, if you wish to hold a responsible position in the building construction industry?
7. State any special interest or appeal that the study of woodwork and working with tools and machines have for you.

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*Fig. 1:1*



CHAPTER TWO

# shop safety

Modern tools and power machines can save you a great deal of time if you learn how to use them safely and correctly. Safety is an aspect of woodworking that cannot be overstressed. The moving parts and sharp knives or cutting edges become a serious hazard if the equipment is not properly used. Many of the machines require special safety precautions, and these are described in later chapters. Listed here are the general safety rules to be followed in any shop.

1. The best precaution is to be safety-minded at all times. Be aware of the hazards in the shop and be willing to take proper safety precautions. There is no point in learning safety rules unless you are willing to take them seriously. Safety must become a habit.

2. Promote safety in the shop by conducting yourself in a businesslike manner, and by treating tools and machines with respect, and your fellow workers as yourself. Take the subject seriously, and realize that woodwork is an important part of your education. "A good worker is a safe worker."

3. Dress safely. Do not wear a jacket or a loose sweater. Shirt sleeves should be rolled up. If you are wearing anything around your neck, such as a tie, a scarf, or a chain necklace, remove it or tuck it in before starting to work. A shop apron should be worn to protect your clothing. Always wear safety glasses when operating or standing near any type of woodworking machinery. Long hair should be tied back.

4. Never operate machines until you have been given full instructions on their use. Whether or not you are permitted to operate machines may well depend on your knowledge of the equipment and your general attitude toward safety.

5. Do not use machines until all the guards are in place.

6. Be neat. Keep your bench and working area clear of unnecessary material such as scrap wood, especially wood with projecting nails. Always keep your tools and supplies in order.

7. Be careful when carrying sharp-edged tools such as chisels. Keep the edges pointing down so as not to injure others. Never carry such tools in your pocket.

8. All injuries, no matter how slight, should be reported immediately to the instructor for first-aid treatment. Remember that any unattended injury might become seriously infected.

9. Pay strict attention to what you are doing. Do not carry on a conversation with anyone while you are operating a machine; a power woodworking machine demands your undivided attention.

10. Place all paint or oily rags in closed metal containers.

11. Be ready and willing to co-operate and assist other students at all times. Many accidents have resulted when one person has attempted to perform

Central Technical School, Toronto — James C. Fish Photography

*Fig. 2:1* Students Properly Dressed for Work

an operation that required the assistance of a second person.

12. Acquire safety habits. Perform all operations the safe way. Remember, eyes and fingers can never be replaced.

Safety is strongly stressed in industry. Most companies conduct safety campaigns in an effort to prevent accidents, which are costly both to employees and to the company. They are assisted in these programs by many private and government-sponsored organizations and associations actively involved in industrial safety. The most important of these is the Industrial Accident Prevention Association, which, together with its affiliated branches dealing with specific areas such as construction, chemical, and highway accident prevention and the workers' compensation boards in the various provinces across the country, campaigns vigorously through training programs and publicity to promote safer working conditions in all branches of industry and to encourage the safety habits and attitudes of all industrial workers.

We are all expected to adhere to





safety rules throughout our lives in such matters as driving, or working in a shop, in a factory, or on a construction site, or in any other form of industrial activity. Likewise, for your own safety in the school shop, you will be expected to observe the foregoing list of general shop safety rules. You are asked to accept them not as arbitrary restrictions but rather as a part of a constructive program for your own benefit and safety. You will be a better worker if you adopt a mature attitude toward safety rules.

## ASSIGNMENT

1. Why should "Safety First" be stressed in woodworking?
2. Good general shop conduct is an aid in preventing accidents. Why is this so?
3. How should you be dressed for shop work?
4. Why is neatness a factor in shop safety?
5. Why should even slight injuries receive first aid?
6. List any safety precautions other than those given here that you consider should be observed in a woodworking shop.
7. Why are industries very concerned about maintaining a good safety record?
8. What should your attitude be regarding safety in the school woodworking shop?

### Research Assignment

9. Design an original safety poster that could be displayed on the shop bulletin board. You may wish to study some of the safety bulletins issued by the Industrial Accident Prevention Association for ideas and inspiration, but do not copy one of these.

CHAPTER THREE

# introduction to metric measuring and layout tools

To make anything worth while of wood or of any other material requires accurate measuring and layout with hand tools. It is important that you develop the skill necessary to make precision layouts. You will then be able to make each piece of wood the correct shape and size to fit properly together with others to make a complete and attractive project.

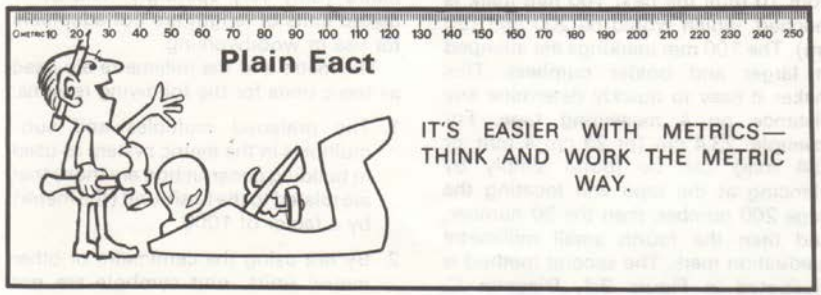
Over the years, people have, of necessity, used all manner of devices and methods of establishing standards for the measuring of distances and quantities so that they could communicate and deal with each other in terms which everyone understood. For these standards or measuring devices they often used units of time or distance that were common to all and that they could easily relate to, such as the length of the day, the quantity of material needed to fill a common household container, or a part of the human body. This was the origin of the foot and the yard (the distance from the tip of a person's nose to the end of the fingers of the outstretched arm). As the need arose, other devices were used to determine standards of weight and measurement.

These standards varied from country to country and even within the same country. Thus a hodgepodge of weights and measures developed that made it extremely difficult and cumbersome for people of different countries to deal with each other.

The metric system of measurement was created by the French in the eighteenth century in an attempt to produce a more rational system of weights and measures. Since that time it has gradually spread throughout the world to become the system used by the majority of countries.

It became apparent to those countries still using the imperial system of weights and measures that there was much to be gained in terms of efficiency and increased trade with the rest of the world from a change-over to the metric system. The United Kingdom, Australia, New Zealand, South Africa, Canada, and the United States, all decided to convert to metric units over a period of time.

The metric system has undergone many changes since it was originally introduced in France. The version now being adopted by most nations is called








SI, from its French name, *Le Système International d'Unités*.

The metric system is simple and easily understandable because almost all units are related to the power of 10, which means that converting from one unit of metric measurement to another is a simple matter of moving the decimal point either to the right or to the left. The metre, for example, which is the basic unit of length, equals ten decimetres, or one hundred centimetres, or one thousand millimetres. Therefore, to convert 28.634 m to centimetres, we simply move the decimal point two places to the right, which gives us 2863.4 cm, or by moving it three places, the result would be 28 634 mm.

In this book only metric terms and dimensions are given, with no conversion tables and few references to imperial measuring systems. It is desirable when learning a new language of measurement to use and work with that language. "Think and Work Metric" rather than spending time converting.

Some woodwork measuring tools are marked off in graduations of metres and centimetres only and some in 2 mm intervals, but the better tools, those used for more accurate work, have millimetre graduations. There are two common methods of indicating the number of millimetres. Figure 3:1, Diagram B, illustrates one method: the tool is marked off in 10 mm (1 cm) intervals from 10 to 100. Then the numbering begins again from 10 until the next 100 mm mark is reached, which would be 200 mm (20 cm). The 100 mm markings are stamped in larger and bolder numbers. This makes it easy to quickly determine any distance on a measuring tape. For example, 23.4 cm (or 23 cm 4 mm, or 234 mm) can be found simply by glancing at the tape and locating the large 200 number, then the 30 number, and then the fourth small millimetre graduation mark. The second method is illustrated in Figure 3:1, Diagram C,

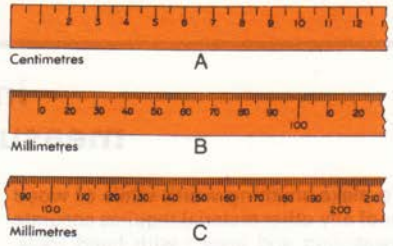



*Fig. 3:1* Metric Graduations

where the millimetres are marked in 10s, or 1 cm intervals, continuously from 10 to 1000, or 1 m. In long tapes the 10 mm designations will be repeated after the 1 m mark. When this marking is used on a tape, a graduation number such as 640 represents millimetres. To read this in centimetres, simply move the decimal point mentally to the left one place, resulting in 64 cm.

In this book we shall be dealing mainly with lineal measurements (measurements of length), as they apply to woodworking. You will remember from your study of mathematics that the metric units of length are as shown in the table on the next page.

In practical woodwork we are concerned mainly with the metre (m) and the millimetre (mm), as they are the basic units to be used in building construction and woodwork. The centimetre (cm) is used to a lesser extent, and the decimetre (dm) very sparingly. The other metric units of length are not adaptable for use in woodworking.

The metre and the millimetre are used as basic units for the following reasons:

1. The preferred multiples and submultiples in the metric system as used in building construction are those that are related to the basic unit (the metre) by a factor of 1000.
2. By *not* using the centimetre or other metric units, unit symbols are not

| Name | Symbol | Metres— Multiplying Factor | Can be written as |
|---|---|---|---|
| megametre | Mm | 1 000 000 | $10^6$ |
| kilometre | km | 1000 | $10^3$ |
| hectometre | hm | 100 | $10^2$ |
| decametre | dam | 10 | $10^1$ |
| *metre | m | 1 | $10^0$ |
| decimetre | dm | 0.1 | $10^{-1}$ |
| centimetre | cm | 0.01 | $10^{-2}$ |
| *millimetre | mm | 0.001 | $10^{-3}$ |
| micrometre | $\mu$m | 0.000 001 | $10^{-6}$ |

required after the dimensions on drawings; whole numbers will always indicate millimetres, and dimensions followed by a decimal will indicate metres. For example: the dimensions 1400 and 1600 indicate millimetres, and 1.400 and 1.600 indicate metres (always indicate the three decimal places).

3. By using only metres and millimetres there is less chance of error and misunderstanding in drawings and layout.

On most working drawings for buildings or woodworking projects you will find the note "All dimensions are in millimetres unless otherwise indicated."

## Measuring tools

The size of the measuring tool that woodworkers should use will depend on the type of work they are doing. To measure the foundation of a house, they might use a 20 m or 30 m tape. If they were making a footstool, they would use a folding rule or a 300 mm metal scale. (Metal rules 150 mm or 300 mm long are referred to as *scales*.) Some of the many types of rules used by woodworkers for various purposes are shown in Figures 3:2 to 3:6.

Although each of these measuring tools is used for a special purpose, all

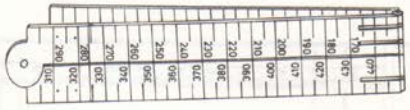


*Fig. 3:2* 600 mm Folding Rule

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*Fig. 3:3* *Zigzag folding wooden rule*


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*Fig. 3:4* 3 m Steel Tape






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*Fig. 3:5* 30 m Steel Tape

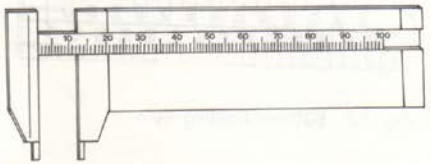


*Fig. 3:6* Caliper Rule

are marked off in graduations equal to the standard metric units used in linear measure.

The steel pocket tape can be very useful in making inside measurements, as shown in Figure 3:7.

The degree of accuracy with which we use a rule will depend on the purpose of the measurement. If the rule is being used only to determine the dimensions of a piece of rough stock or to cut a piece of stock to a rough length, not quite as much care needs to be taken as when a final layout for a finished part is being made, where precision measuring is required. There are definite procedures that are generally followed when making final layout operations:

1. *Measure to length.* Before measuring a piece of stock to the correct length, one end should be squared and the layout started from there. With a try square and a sharp pencil or a knife, mark a line all the way around the stock about 12 mm in from the end. With a back saw cut along this line.

Place the rule flat down, with the number indicating the desired length exactly over the squared end of the piece. With a sharp pencil, make a mark at the end of the rule, as shown in Figure 3:8. Another method is to place the rule on edge, with the end of the rule at the squared end of the stock, and make a mark opposite the required length on the rule, as in Figure 3:9.

2. *Measure to width.* When marking a piece of stock to the correct width, place the end of the rule on the face edge of the stock and mark at the desired width, as shown in Figure 3:10. A marking gauge (described on page 15) may also be used for this operation.

If a piece of stock is to be divided into several equal widths, it may be easier to place the rule across the board diagonally so that the divisions can be marked off from the whole numbers, as shown in Figure 3:11.

## Layout tools

There are several hand tools generally used for layout purposes:

*Try square*

The try square is a small, accurately made tool consisting of a wood or metal handle with a steel blade generally 150 mm long. The handle and the blade form a fixed 90° angle. This makes it an excellent tool for laying out and checking right angles. It is also used as a testing tool as shown in Figure 3:12, or as a rule or a straightedge.

For making any layout with a square, a rule, or a straightedge, the lines should be distinct and drawn or scribed as close as possible to the edge of the tool being used. If a pencil is used, it should

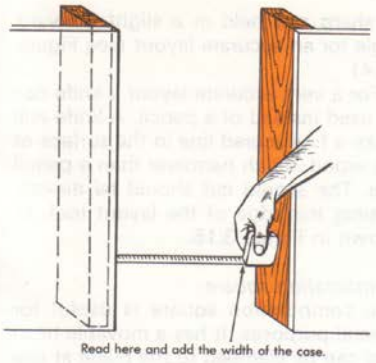



*Fig. 3:7* Inside Measurement

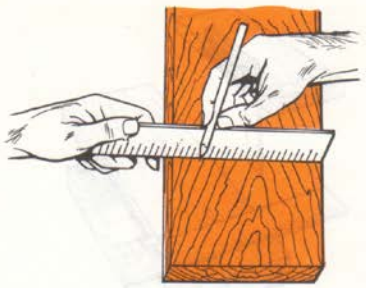


*Fig. 3:10* Measure to Width

*Fig. 3:8* Measure to Length

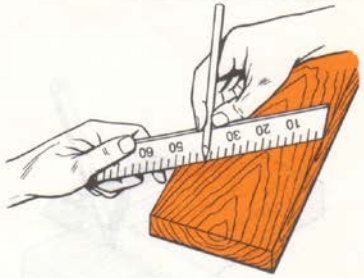



*Fig. 3:11* A Convenient Method of Dividing a Piece of Stock into Five Equal Parts

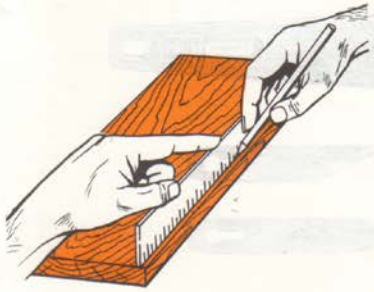


*Fig. 3:9* Measure to Length

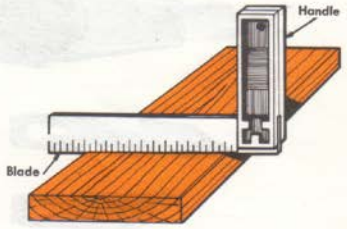



*Fig. 3:12* A Try Square Used to Test a Piece of Stock for Flatness





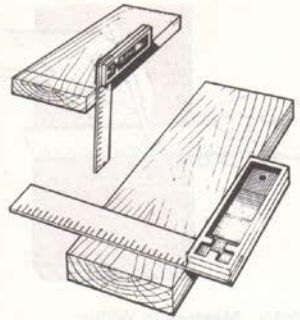


*Fig. 3:13* Squaring a Line on the Face and the Edge of a Piece of Stock

be sharp and held at a slight outward angle for an accurate layout (see Figure 3:14).

For a very accurate layout a knife can be used instead of a pencil. A knife will make a fine scored line in the surface of the wood, much narrower than a pencil line. The scored cut should be directly against the edge of the layout tool, as shown in Figure 3:15.

*Combination square*

The combination square is useful for several purposes. It has a movable head that can be clamped to the blade at any position, thus enabling it to be used as a marking gauge. The head has two faces, one machined at 45° and the other at

*Fig. 3:14* Hold the pencil at a slight outward angle for an accurate layout.

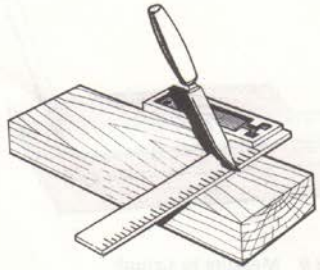
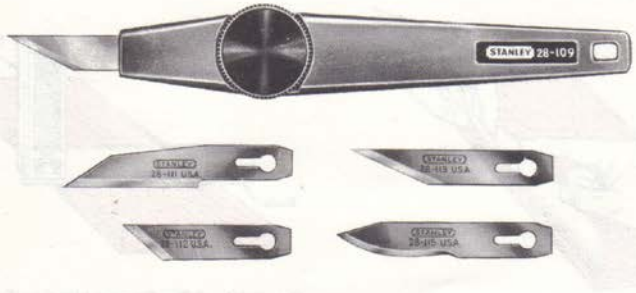


*Fig. 3:15* Using a Knife for a Very Accurate Layout




*Stanley Tools*

*Fig. 3:16* Layout and Marking Knife

90°, so that either a mitred (45°) layout or a right-angle (90°) layout may be made with it. Most combination squares are provided with a spirit level for levelling and plumbing (checking work to see that it is in an upright position). A scriber is also provided for more accurate layout. Some of the uses of the combination square are shown in Figure 3:18.

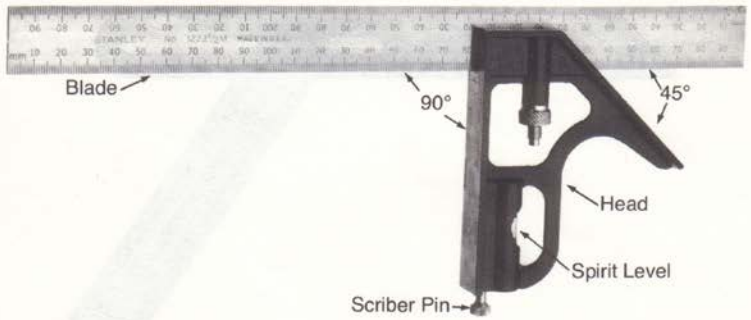



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*Fig. 3:17* Combination Square

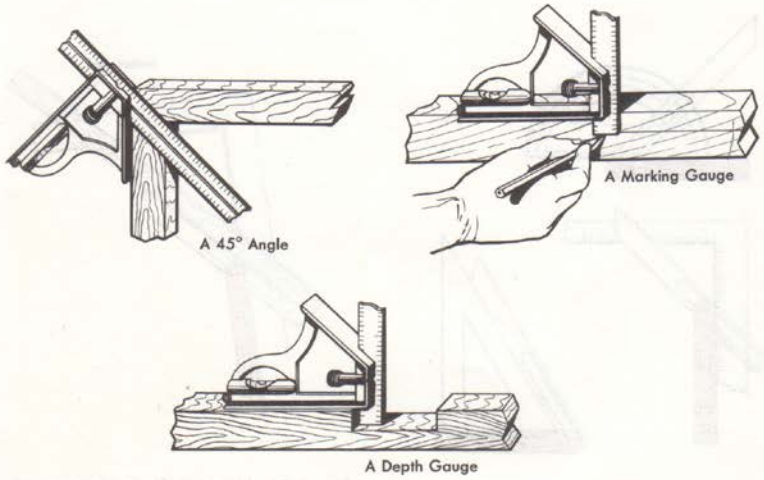



*Fig. 3:18* Uses of the Combination Square



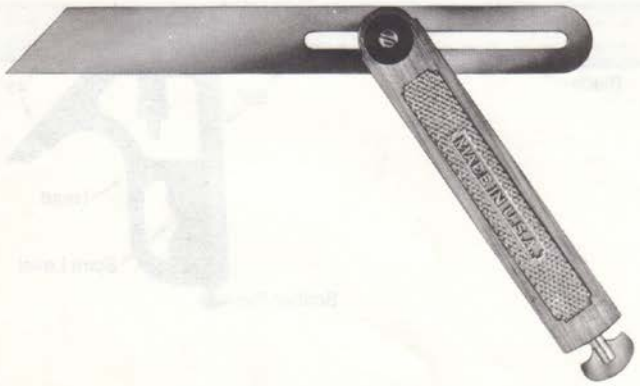


*Sliding T-bevel*

The sliding T-bevel has an adjustable blade that can be clamped to the handle at any desired angle. These tools are made in several sizes and may have either wooden or metal handles.

The sliding T-bevel is useful for laying out any angle cut, as the bevel may be set to various angles with the aid of triangles, a framing square, or a protractor, as shown in Figure 3:20.

To set the sliding T-bevel to a given angle with a framing square, these figures may be used:



Stanley Tools

*Fig. 3:19* Sliding T-Bevel

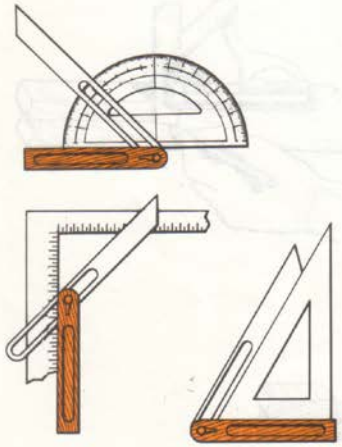


*Fig. 3:20* Setting the Sliding T-Bevel to an Angle

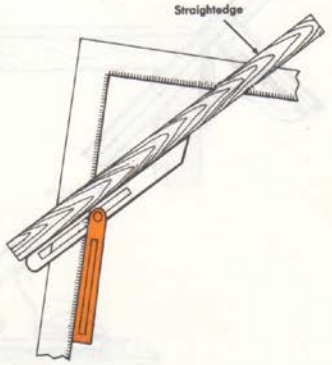


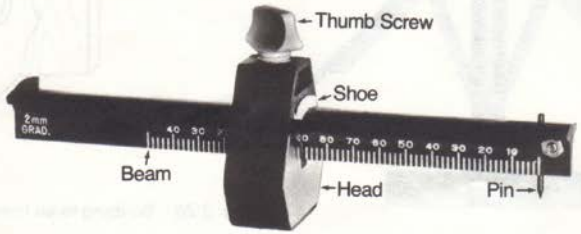

*Fig. 3:21* Using a Straightedge with a Framing Square to Set the T-Bevel to an Angle

For a 60° angle use 305 mm and 54 mm
For a 45° angle use 305 mm and 305 mm
For a 30° angle use 305 mm and 176 mm
For a 20° angle use 305 mm and 111 mm
For a 10° angle use 305 mm and 54 mm

Since the blade of the T-bevel is not long enough to reach diagonally across the square between these numbers, a straightedge can be used and the T-bevel blade set to it.

*Marking gauge*

The marking gauge is a tool used for the accurate scribing of lines parallel to a planed edge or face. It is generally made from a light, though tough, wood or plastic. It has a sliding head that can be tightened on the beam at any desired position by a thumbscrew. The beam is graduated into millimetres to a length of 150 mm. A steel marking-pin is mounted through the beam at the start of the measuring scale. The face plate and the shoe protect the head and the beam from excessive wear. The pin may become bent or pushed off the first graduation mark, and it is therefore advisable to measure the distance between the pin and the face plate, as shown in Figure 3:23.




Stanley Tools

*Fig. 3:22* Marking Gauge

Stanley Tools

*Fig. 3:23* Setting the Marking Gauge

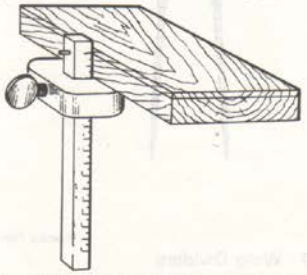


*Fig. 3:24* Scribing Stock to Thickness

*Mortise gauge*

The mortise gauge is similar to the marking gauge with the exception that it has two pins and two beams instead of one. It is used for laying out mortise-and-tenon joints, where double layout lines are required. The newer mortise gauge, such as the one shown in Figure 3:25, is an all-metal tool. A tool used for bisecting angles is shown in Figure 3:26.

Stanley Tools

*Fig. 3:25* Mortise Gauge

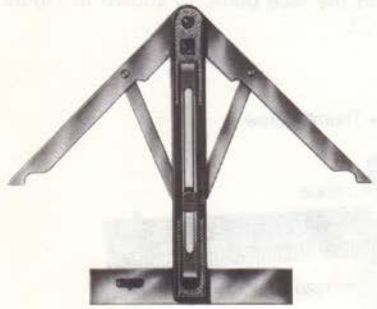




*Tools for curved layouts*

Many tools are available for making circles and arcs, and there has been some confusion about the names of these tools. There is the standard *compass* that you have probably often used for drawing circles. *Scribers* are a similar tool made from pressed steel, with one leg fitted with a steel point, while the other adjustable leg holds a short pencil. They can be used for drawing circles or arcs, but are more often used for fitting a wooden member to an irregular surface, as shown in Figure 3:28.

*Dividers* also are similar to the compass, but differ in that both legs are of solid metal. They are usually equipped with a spring tension bar that has an



Stanley Tools

*Fig. 3:26* Angle Dividers

*Fig. 3:27* Scribers

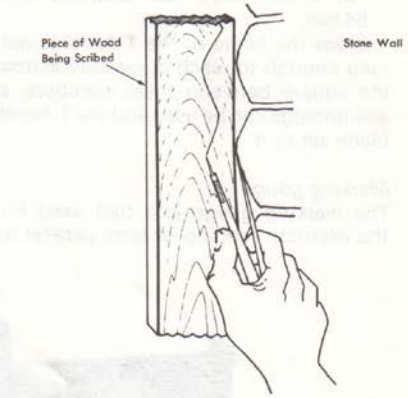



*Fig. 3:28* Scribing to an Irregular Surface

Stanley Tools

*Fig. 3:29* Wing Dividers

adjusting screw and locking device to maintain the divider setting once a precision measurement has been made. Dividers are generally used for stepping off distances or equal spaces from a rule or for making more accurate layouts than can be made with a compass. Dividers or compasses can be used for laying out such geometric forms as triangles, hexagons, and octagons. The method of laying out these forms is shown in Figures 3:32 and 3:33.

*Trammel points* are used for making large arcs and circles of almost any size. They consist of two metal frames fitted with metal points or a pencil. The frames can be clamped onto a light wooden strip of any length, referred to as the beam.

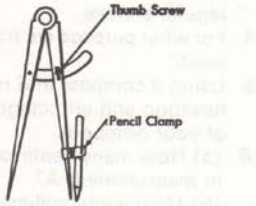



*Fig. 3:30* Combination Dividers and Compass

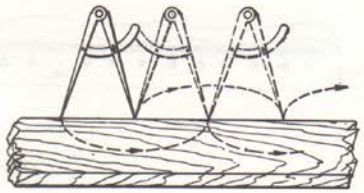


*Fig. 3:31* Marking Off Distances with Dividers

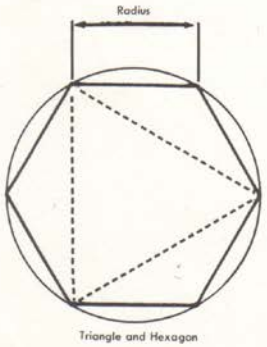



*Fig. 3:32* Laying Out a Triangle and a Hexagon Using a Pair of Dividers or a Compass

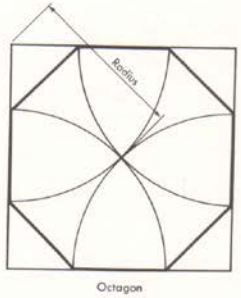



*Fig. 3:33* Laying Out an Octagon Using Dividers or Compass


*Fig. 3:34* Trammel Points





## ASSIGNMENT

1. List two important advantages of the metric system of measurement as compared to the imperial measuring system.
2. (a) What are the two basic metric units of lineal measurement used in general woodwork and building construction?
   (b) Why are they used as basic units of length?
3. How many millimetres are there in (a) 3 m? (b) 4.724 m? (c) 67 cm?
4. How many metres are there in (a) 422 cm? (b) 6487 mm? (c) 726 mm?
5. In the metric system what term does the abbreviation "SI" represent?
6. List four types of rules.
7. What is the advantage of placing a rule on edge when measuring?
8. List eight layout tools.
9. What is the principal purpose of a try square?
10. List four uses of the combination square.
11. Why should you check the setting of a marking gauge with a rule?
12. What is the main purpose of a marking gauge? of a mortise gauge?
13. Explain how a piece of stock can be marked with a scriber to fit an irregular surface.
14. For what purpose are trammel points used?
15. Using a compass and rule, lay out a hexagon and an octagon on a page of your notebook.
16. (a) How many centimetres are there in measurement A?
    (b) How many millimetres are there in measurement B?