Join Solid Timber
Learner’s Guide
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Learner’s Guide
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Section 1 – Introduction

This topic of the furnishing training package explores how to join solid timber for the manufacture of solid-timber flat surfaces. This will include learning about:

- types, characteristics (including cupping, expansion, twist, bowing, spring and grain direction), uses and limitations of timbers
- joining techniques and their effect on timbers
- types of sawing methods, including back sawn and quarter sawn, and the impact of these on joining
- workflow in relation to furniture production.

As part of the assessment requirements for this training package, you must be able to:

- interpret a work order and locate and apply relevant information
- apply safe handling procedures for equipment, products and materials, including use of personal protective equipment
- follow work instructions, operating procedures and inspection practices to:
  - minimise the risk of injury to self or others
  - prevent damage to goods, tools, equipment or products
  - maintain required production output and product quality
- join at least four solid-timber tops of a minimum of three sections and using a minimum of four different widening joints
- work effectively with others
- modify activities to cater for variations in workplace contexts and environment.
Required resource materials

As you work through this topic you will be required to obtain information to complete some exercises. Whilst some of this information can be provided by reflecting on your experiences from the workplace and through discussion with your lecturer/trainer, other information can only be obtained from the relevant presentation delivered by your lecturer/trainer or through your own research. You may find the following resources useful.

Suggested text resources


Suggested web-based resources

www.geoffswoodwork.co.uk

www.timber.org.au

Suggested audiovisual resources

Hardwood uses & preparation 2007, video recording, Marcom Projects, Eight Mile Plains, Qld (originally published 1991, Meridian Education). Part of the Woodworking series, this DVD examines the advantage of hardwood and details the history of its use, the ease with which it is repaired and refinished, and the difference between softwood and hardwood. It also outlines how to turn rough board into lumber and discusses moisture content.

Timber: Production & processing, parts A & B 2004, video recording, Double D Technical Productions, Chadstone, Victoria. This is a two-part DVD on the production and processing of timber.

Part A includes classification and structure of various examples of hardwood, softwood, harvesting, structure of a tree trunk, saw milling, drying and use of hardwood.

Part B includes characteristics of commercial examples of softwood, plantation management and propagation, thinning, clear-felling, milling, drying and grading, particle board, glue laminates, veneers, fibreboard and more.
Section 2 – Joining solid timber

The use of widening joints in the furniture-making industry is extensive. Boards are joined at their widths to create panels for doors, ends and backs for solid timber furniture, cabinet and kitchen benchtops, beams for construction joinery in homes and bridges, and wall panels and partitions in commercial and office environments.

Although sheet materials have established their presence in many of these applications, the prestige and opulence of solid timber is not lost on a large section of the population.

There are three main reasons for manufacturing wide panels from narrow strips of timber. These are:

- the over-harvesting of large-diameter trees has depleted the availability of large-width material
- the ill-effects of defects, such as knots, can be minimised
- the physical stresses in a wide board, which normally cause the board to cup, are controlled (and in most cases almost eliminated) by joining small-section timber with the growth rings facing in alternate directions.
Selecting boards for joining

Selecting timber for joining (through the process of edge jointing) often has a considerable effect on the appearance, strength and durability of the final furniture product. It is important to carefully select timber – taking into consideration the orientation of the growth rings – in order to maximise the figure and strength characteristics of the timber chosen for joining. Therefore, some understanding of how timber is cut from a log is beneficial at this stage.

Timber conversion

Timber is derived from tree logs usually obtained from the main trunk of the tree, but large boughs may also be converted into timber for manufacturing purposes. The process selected to convert these logs and boughs to timber can expose figurative grain or maximise the strength characteristics of the timber. There are three methods used for converting logs to timber. These are:

- back sawing
- quarter sawing
- live sawing.

Back sawing

A tabletop that is manufactured from solid timber with the intention of showing the distinct and figurative growth-ring markings should be manufactured from boards that have been ‘back sawn’, also referred to as a ‘tangential cut’.

A board that has been milled to ‘back sawn’ requirements shows the following growth-ring characteristics.
Activity 2.1

Draw in the growth rings.

During the back-sawing process, logs are rotated with the express purpose of extracting as many boards as possible with this growth-ring configuration, while at the same time minimising any waste.
Activity 2.2

Complete the sketch below to show how the logs are cut specifically to obtain back-sawn boards.

Fig 2.2 Back sawing (method 1)

Fig 2.3 Back sawing (method 2)
Advantages and disadvantages of back-sawn boards

- They show the timber’s growth rings to the best effect.
- They show knots in their typical circular appearance after conversion.
- They are most likely to be the boards that cup.

Typical uses of back-sawn boards

- feature-grade furniture
- joists and other load-bearing timbers.

Quarter sawing

On the other hand, a benchtop that is manufactured from solid timber with the intention of maximising the timber’s inherent strength should be manufactured from boards that have been ‘quarter sawn’.

A board that has been milled to quarter-sawn requirements shows the following growth-ring characteristics.

Activity 2.3

Draw in the growth rings.

Fig 2.4 Quarter-sawn board
Some timbers (usually oaks) have a pronounced medullary ray, and the process of quarter-sawing exposes interesting features in this grain. Timber that has been quarter sawn is dimensionally stable – that is, it is less likely to be affected by shrinkage than back-sawn boards and is also less likely to warp during seasoning. Again, the logs are rotated regularly during conversion to extract as many boards as possible with this growth-ring configuration.

**Activity 2.4**

Complete the sketch below to show how the logs are cut specifically to obtain quarter-sawn boards.

![Fig 2.5 Quarter sawing]

**Advantages and disadvantages of quarter-sawn boards**

- They are stable and are less likely to warp, check or split.
- They are extremely hard-wearing and wear evenly.
- They are more expensive to produce due to the excessive rotation of the log and the excess waste generated during the conversion process.

**Typical uses of quarter-sawn boards**

- joinery timber, such as architraves and door frames
- floorboards
- feature-grade furniture – where any grain irregularities, such as wavy or curly grain and interesting medullary features (as seen in silky oak) are exposed for effect.
Live sawing

The pressures on business today require all workplaces to be competitive. The timber milling industry is no different. Overhead costs such as forestry fees and taxes, labour, felling and hauling equipment and transport costs are driving up raw material prices for cabinet-makers every year. In order to keep costs minimal, many mills use the live-sawing technique for conversion (also known as ‘through and through’ sawing) to help maximise output and keep milling costs down. The only problem with this method of milling is that it yields both quarter-sawn and back-sawn boards from the same log, so the cabinet-maker needs to be aware of exactly what materials are being purchased for the job.

The live-sawing technique is usually carried out by passing the log through a gang of saws that converts the log into numerous boards in one single pass.

Activity 2.5

Complete the sketch below to show how the logs are cut specifically to obtain live-sawn boards.

Advantages and disadvantages of live-sawn boards

- They are inexpensive to produce because the logs do not have to be rotated during the conversion process.
- Live sawing yields a mixture of board types.
- Live-sawn boards may contain more timber defects, such as knots and shakes, due to the limited handling at the mill.
Typical uses of live-sawn boards

- similar to those of quarter-sawn and back-sawn boards, if the boards have been sorted and graded after milling
- packing cases – where timber quality is not an issue
- lightweight and low-stress structures, such as fencing and scantling for roofing.

Discussion

Discuss timber selection and jointing methods for project work that requires students to manufacture at least four panels comprising a minimum of three boards, each using four different joints.

Defects and widening joints

One advantage of joining numerous boards to obtain a wider board is that defects can be cut out of the material before you begin the join. This leads to a stronger and visually more pleasing finish to the product. Another advantage is that where defects cannot be removed (for example, knots), their weakening effects can be minimised by dispersing them more evenly throughout the final product, as is the case with timber laminated beams. To overcome other defects, such as attacks by insects, termites, mould and fungus, various chemicals and additives can be added to the adhesive. Another quality of timber laminated beams is fire resistance, which can be requested and is also achieved by incorporating fire retardant chemicals into the adhesive.

Other defects exist that can only be overcome with good selection and working practices. These defects are collectively known as 'warping'. Warping results from the build-up of internal stresses in timber due to seasoning or poor handling and storing practices. Warping exerts itself on timber in one of four ways. These are:

- **twist** (also known as wind) – a spiral distortion of the board to the extent that it is similar in appearance to a propeller. Twist is visible along the length of the board and can be tested with winding sticks, which accentuate and confirm the problem.

Fig 2.7 Twist
Activity 2.6

Twist

Explain how winding sticks are used.

- **cupping** – a curvature across the wide face of the board, visible when you look directly across the end grain. It can be tested using a straight edge across the grain. Cupping generally only occurs on back-sawn boards.

  (The primary reason that every board will shrink and therefore always cup in the same direction is that the face of the board closest to the sapwood contains more moisture than the face that is closest to the heartwood (middle of the tree). As a greater amount of moisture is removed from one face than the other, a greater level of shrinkage occurs across this face. This creates a build-up of stress across the face that can only be accommodated by the board either cupping or splitting.)

Activity 2.7

Cupping

Show which way the growth rings would appear on the end of the timber board after the board has cupped as shown. Refer to the section on ‘Converting Wood’ in Chapter 1 of the Collins text or the Section 4 topic ‘Shrinkage of Timber’ in the Walton text.

![Fig 2.8 Cupping](image-url)
• bowing – a curvature along the edge of the board affecting only the edge and not the face, best seen when looking along the edge of the board from the end

![Fig 2.9 Spring and bowing](image)

• spring – a curvature along the face of the board affecting the face but not the edge, best seen when looking along the length of the board from the end.

Each of these defects has a direct result on the amount of time needed to join the required boards to form, for example, a tabletop. Good material-selection practices will help to save time. Always check across the end and then along the length of the board, looking specifically for these defects, before you decide to use it for a job.

**Other considerations for joining solid timber edge-to-edge**

• Use only timber that has been seasoned to the correct moisture content, as excess moisture in the timber will adversely affect the glue bond.

• Allow the adhesive to dry thoroughly before starting the cleaning up of the surface, because the moisture in the adhesive causes local swelling in the timber along the line of the join. If this swelling is cleaned off before the timber dries out sufficiently, slight subsidence may occur along the join. This is generally not a problem but may be noticeable on panels (commonly for tabletops and benchtops) that are to be highly polished.

• Ensure the material to be jointed is **free of twist**. The slightest twist in the material will be accentuated over the width of the final board.

• Remember that materials should be thicker than the required finished thickness. This allows the board and the joint to be flattened on one face before gauging to the required final thickness.
• Ensure that the combined width of the jointed board is wider than the required finished width. This allows the board to be planed flat along one edge before it is gauged to the required final width.

• If you are considering a moulded joint, be careful to make an allowance in the width of each board being joined to make up for the overlapping sections of the joint.

\[
\begin{array}{c}
\text{40 mm} \\
\text{50 mm} \\
\end{array}
\]

\[
\begin{array}{c}
\text{50 mm} \\
\text{40 mm} \\
\end{array}
\]

2 × 50 mm boards when joined yield 1 board 90 mm wide. (10 mm lost to joining technique)

Fig 2.10

After you have carefully selected timber that is free from obvious defects to be formed into a single wide board, it is important to match the boards for colour and grain direction before joining. Good colour-matching helps to create an almost invisible join, while considering and organising the grain direction will make the process of flattening the board (by machining or planing), gauging it to thickness and then determining the dimensions for its final size much easier.

Explaining how to determine the grain direction is very lengthy and there are often exceptions to the rules. The best method is to run the plane over the face of the material and observe the outcome. Difficulties in planing nearly always indicate that the grain is running in the opposite direction from that of the planing.

Fig 2.11 Panel joined incorrectly

Fig 2.12 Panel joined correctly
Discussion

Why does solid timber expand and contract? To what extent does it occur? What will this do to furniture? How do we accommodate it in various situations?

Finally, you need to remember that the capacity of timber to expand and contract beyond our control is considerable. It is therefore necessary to facilitate the expansion and contraction of the timber in furniture products that use wide solid-timber panels. The wider the panel, the greater the tendency for movement in the timber. Wide panels are often used as benchtops and tabletops; to protect the furniture from destruction due to the stresses of expansion from the top, one of following three standard practices is adopted.

- Mechanical fittings that allow for movement are incorporated in the construction.
- Timber equivalents may be used.
- Screw holes may be slotted to allow for movement.

Activity 2.8

Refer to Chapter 2 'Designing in Wood' of the Collins text to make a sketch of a metal shrinkage plate and a table button below.

These practices are necessary if we do not wish our furniture to virtually self-destruct after completion.
Section 3 – Edge joining techniques

An awareness of edge joining techniques in the furniture-making industry is a must for all those involved in the manufacture of solid timber wide-sectioned panels.

The following joining methods each have their advantages and disadvantages. Techniques by both hand and machine are used to construct the following joints.

Butt joint

There are many variations of butt joint, all of which require the same preparation. These joints must have a long, straight edge that is square to the face of the timber. To do this, either plane the edge of the timber with a trying plane (No. 7) or use a ‘buzzer’ or surface planer machine.

It is possible to make modifications to this joint depending upon the availability of various tools and equipment.

Rub glued joint

If the joint has been planed accurately enough – with no gap along the entire length of the join – the boards can be rub-glued together, a process that requires the application of adhesive to one edge of one of the adjoining pieces only. The other piece is then brought into contact with the adhesive and the two pieces are rubbed together with a little pressure. The joint will become progressively more difficult to rub until the two pieces have acquired a firm bond. This takes approximately 15 to 30 seconds. The two pieces are then left to set. Rub gluing is a useful process for timber up to approximately one metre in length and where many boards are to be assembled as quickly as possible. Rub gluing is also a suitable process for attaching glued blocks to corner joints for additional strength purposes.
Dowels and biscuits (plates)

If the timber has a slight bow planed into the edge being joined, this requires the use of a sash cramp to pull the two boards together. Although the joint can be glued and cramped without any further treatment, it is recommended that the joint also incorporates the use of either biscuits or dowels to assist with accurately locating the two pieces before cramping. Using a single sash cramp in the middle of the boards being joined will exert pressure at the end of the join, as the gap is closed when pressure is applied.

Slot screwing

Slot screwing is a technique used to join boards where the join is to be temporary because the two boards will need to be separated again for some reason. It is also a technique that can be adopted in situations where cramping pressure is desirable but not possible. Screws are inserted into one of the joining edges of the board, and a series of holes is drilled into the other. This series of holes should be wide enough to accommodate the shanks of the screws in the other piece of timber, but with a single hole at one end of the slot that is large enough to accommodate the head of the screw. The slot is then undercut to accommodate the angle of the screw heads and the joint is assembled dry with the aid of a mallet. The screw heads will then cut a channel that holds the two pieces of timber together. To separate the two pieces, simply slide them apart. To apply pressure to the joint without a cramp simply give the screws a quarter-turn or a half-turn before applying the adhesive and reconnecting.
The following jointing methods are exclusively machined joints cut in the edge of the boards to be joined. This enables the rapid and accurate location of the joining faces. Crucially, they each significantly increase the width of the mating surface and therefore the overall gluing area. This allows for maximum strength in the glued surface.

**Finger joint**

A series of small v-shaped fingers, cut into the edge of each piece to be joined, significantly increases the gluing surface in the join. This joint is only suitable for lengths of timber that are relatively flat and will therefore align with each other fairly readily.
Lightning joint

This is a similar joint to the finger joint, but with the added advantage that when pressure is applied to the join, the two pieces of timber are self-aligning. It is advantageous to arris the sharp corners on the leading edge of the joint in order to allow room for any trapped glue to accumulate.

![Fig 3.5 Lightning joint](image)

Slip tongue joint

A slip tongue joint is a common method of increasing the strength of a joint by adding an additional gluing surface to it. This is achieved by sawing a groove along the edge of the two pieces of timber to be joined and inserting a plywood feather (slip) into the join.

![Fig 3.6 Slip tongue joint](image)

Tongue and half joint

The tongue and half is similar to the lightning joint in that the joint is self-aligning when pressure is applied to the two boards. Its advantage over the lightning joint is that it has a greatly increased gluing surface, therefore is theoretically a much stronger joint.

![Fig 3.7 Tongue and half](image)
The following jointing methods are also machined joints cut in the edge of the boards to be joined. This facilitates the rapid and accurate location of the joining faces. These joints are more readily suited to dry-jointing situations, such as flooring and cabinet backs. This allows the timber to expand and contract naturally over the large surface areas that it is applied to and offers resistance to the passage of light, air and dust.

**Rebate joint**

The rebate joint is a very similar joint to the butt joint, but the big difference between the two is that one of the ends of the timber has a groove cut out of it to enhance the holding strength.

Even with the extra strength the joint is still relatively easy to construct and its appearance is also more appealing compared with a regular butt joint, making it a better joint for cabinet making or carpentry.

If more strength is still required you can also add nails, screws or dowels to the joint — just like you would on a butt joint — but no timber blocks should be needed in the corner because the rebate joint already has a large surface for adhesives to be applied.

![Fig 3.8 Rebate joint](image_url)
Tongue and groove joint

A tongue and groove joint is a unique joint that is attached edge-to-edge with two or more pieces of timber. It is made with one edge consisting of a slot that runs down the entire length of the timber and a tongue that fits into the slot.

This tongue and groove feature creates a reasonably strong and aesthetically pleasing joint that can be used in areas such as floorboards, lining boards, wood panelling and tabletops.

It is easy to attach together because of its simplicity, and allows for a tight fit that has plenty of surface area for adhesives.

It is worth noting that these joints can be very difficult to make without the right woodworking machinery.

![Fig 3.9 Tongue and groove joint](image-url)
Section 4 – Case study

Read the following case study and explain, in detail, what Dave needs to do to successfully complete the task assigned so that there will be no future problems with the top bowing.

Dave is a furniture-making apprentice who has been given the task of matching up and joining a large jarrah tabletop for a boardroom table. This top is constructed of seven boards, each measuring 3600 mm long × 200 mm wide × 40 mm thick.

The boards have all been machined to size and the finger joint is the chosen joining method.

Explain the steps required to manufacture this top, which is required to be finished to a size of 3400 mm long × 1350 mm wide × 35 mm thick.
DESCRIPTION
This learner’s guide has been developed to assist in the delivery of Certificate I, II and III in furniture-making and cabinet-making qualifications within the furnishing training package. It contains information and activities that cover the types and characteristics of timber, types of sawing methods, workflow in the workplace and practical methods involved in joining.

EDITION
Second edition

CATEGORY
Building and Construction

RELATED PRODUCTS
BC2012 Work Safely in the Furniture-Making Industry
BC2014 In the Workshop
BC2015 Use Furniture-Making-Sector Hand Tools and Power Tools
BC2017 Apply Sheet Laminates by Hand
BC2018 Prepare Surfaces for Finishing
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