Hand Make Timber Joints
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 timber by constructing joints using hand tools and portable power tools. This will include learning about:

- characteristics, properties and selection criteria of adhesives used
- matching requirements of adhesives and fasteners to timber/materials used

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.
- select appropriate joint types for the furniture item
- use at least three different types of adhesive
- produce a minimum of four different joint types as specified in the range statement in accordance with industry standards on tolerances with at least two produced substantially by hand operations
- 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 fill in the blanks throughout this learner’s guide. 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 from your own further research. You may find the following resources useful.

Suggested text resources


Suggested web-based resources

www.titebond.com

Suggested audiovisual resources

*The Mortise and tenon joint* 1976, video recording, Open College of Further Education: Educational Multi-media [production company], Adelaide, SA. A five-part series detailing the history, application and variety of mortise and tenon joints, important points in joint construction and machines used in commercial manufacture. Distributed by and purchasable from the Short Film Marketing Division, South Australian Film Corporation. Please quote the EMU production no. 76055.

*Dovetail a drawer: with Frank Klausz* c1985, video recording, The Taunton Press, Newtown, CT, USA. A 55-minute recording that details the methods and techniques used in constructing a drawer using dovetail joints.

*Gluing, clamping and joinery* 2007, video recording, Marcom Projects, Eight Mile Plains, Qld (originally published 1991, Meridian Education). Part of the Woodworking series, this DVD explains the aspects of gluing, clamping and joinery, including all you need to know about the expansion and contraction of wood, moisture content, grain direction, types and application of glue, reinforcing and joining wood, dowels, biscuits, spline, tongue and groove, dado, rabbets, mortises and tenon, dovetail and more.
Section 2 – Mitre joints

Joint making

Joint making is an important skill that furniture-makers are required to learn using a variety of accurate cutting techniques. The joint produced must be functional and provide strength to the overall style of the project.

The majority of joints are primarily designed to hide the methods used to join the components together. However, there are others – such as dovetails – that are made to form a decorative feature on a piece of furniture.

Discussion

Discuss in class with your lecturer/trainer the construction methods used in your workplace, and explore the various types of joints used in the construction of furniture pieces such as solid cabinets, chairs, tables, door frames, drawers, etc.

Activity 2.1

After viewing a presentation or discussing with your lecturer/trainer, complete the following information describing the types of joints and their appropriate use.
Mitre joints

A mitre joint is where two pieces of timber of _______ size are cut at the same angle and joined together. If the pieces are each cut at 45°, then a 90° angle is formed, which is known as a _______________ mitre. Mitre joints are used at corners in order to hide the end grain of the timber.

![Fig 2.1 Mitre joint](image)

**Uses**

Mitre joints have a variety of purposes. They can be used for flat panel __________ construction (joining ends to tops and bottoms). They can be used for doors, _______________, frames, etc, for framing joints. Picture _________________ are nearly always joined by mitre joints. Solid timber beads can be _______________, glued and _______________ around veneered particle board tops.

Joints may be cut by:

- hand __________ and planed
- mitre box
- __________
- machine (using various types of electrically powered saws).
Joints may be assembled by:

- ____________ or ____________ cramps
- the string and ____________ method
- ____________ cramps
- sash cramps
- screws (only in certain conditions).

**Types of mitre joints**

**Mitred and glue-blocked**

The mitred and glue-blocked joint is often used for plinth constructions, where the glued block – used to provide extra strength to the joint – is not seen. The joint is sometimes nailed as well as glued.

![Fig 2.2 Mitred and glue-blocked joint](image)
Mitred and veneer keyed

The mitred and veneer-keyed joint is used in box-like constructions, with the veneer keys across the join strengthening the joint. It is preferable to veneer or laminate the outside after completion of the joint to conceal the veneer keys.

![Fig 2.3 Mitred and veneer-keyed joint](image)

Mitred and dovetail keyed

The mitred and dovetail-keyed joint occurs when the corner joints have been glued together and, after the glue has dried, a dovetail recess is cut into the joint and a solid key is glued in. Using a solid key provides even greater strength to the mitre joint.

![Fig 2.4 Mitred and dovetail-keyed joint](image)
Mitred and tongued

The mitred and tongued joint is one of the most popular types of mitre joint. The ‘tongue’ is usually a piece of cross-grained ply used for extra strength.

Note When constructing this joint, the ________________ should not be ________________ tight. If tight, the joint will be difficult to cramp when glued.

Mitred and lapped

The lap on a mitred and lapped joint makes it easier to position the joint when cramping, and provides a greater area for gluing.
Mitred and dowelled

The mitred and dowelled joint is used frequently. The mitre joint can be dry dowelled, taken apart and then glued and assembled on-site for some items of built-in furniture.

Fig 2.7 Mitred and dowelled joint
Section 3 – Housing joints

When the end of a board is to be joined to the face of another, the housing joint provides a solid and durable method of attachment.

One of the following joints can usually be employed in the construction of solid furniture, if the craftsperson fully understands the uses to which housing joints can be put.

Through housing joint

The through housing joint is the simplest form of housing joint and uses a plain open ____________________________, that is the exact ____________________________ of the timber into which it is to be housed. This housing joint is usually used in ____________________________ construction and types of work can be glued and nailed, secret nailed or screwed. Through housings may be concealed by the application of thin strips of ____________________________ or ____________________________ edging and timber fillets.

![Fig 3.1 Through housing joint](image-url)
**Stopped housing joint**

The stopped housing joint is necessary when the appearance of the open housing is displeasing to the eye. It is used in shelf construction and can be glued, secret nailed or screwed.

![Stopped housing joint](image)

**Fig 3.2 Stopped housing joint**

**Dovetail housing joint**

The dovetail housing joint is very strong and the most satisfactory type of housing used with nearly all types of \______________ timber, requiring only to be glued. The ‘trench’ may be open or stopped, and is shouldered on one or \______________ sides.

![Dovetail housing joint](image)

**Fig 3.3 Dovetail housing joint**
Section 4 – Mortise and tenon joints

The mortise and tenon joint is the _____________ of all _____________ joints. It was used over 4000 years ago in constructions including Greek chariots, Egyptian chairs and Roman sailing vessels.

Parts of a mortise and tenon joint

This joint consists of:

- the mortise – a recess or hole cut in the _____________ of a _____________ or leg
- the tenon – a cut on the end of the _____________ that fits into the mortise; the thickness of the tenon is usually _____________ third of the _____________ of the wood
- the shoulder – the part of the rail, near the _____________, that butts up against the _____________.
Through, or common, mortise and tenon joint

The through, or common, mortise and tenon joint is used where the ____________ meets the ____________ some distance from the end. The ____________ passes through the stile, and the joint can be strengthened by the use of wedges.

Fig 4.2 Through mortise and tenon joint

Haunched mortise and tenon joint

The haunched mortise and tenon joint is used where a rail meets a stile or leg at the end (its corner joint). The purpose of the haunch is to _________________ the joint whilst allowing for _________________ on the end of a stile. The haunch also prevents the rail from _________________. This joint can be used for window sashes, door frames and top rails on tables.

Fig 4.3 Haunched mortise and tenon joint
**Long and short shoulder mortise and tenon joint**

The long and short shoulder mortise and tenon joint is used where the stile and rail are ______________________ for ______________________ panel or ______________________. One shoulder of the tenon is cut longer to fill up the rebate on the stile.

![Diagram](image1)

**Fig 4.4 Long and short shoulder mortise and tenon joint**

**Stub mortise and tenon joint**

The stub mortise and tenon joint is used on work where the ______________________ of the tenon is not seen on the ______________________ of the stile or leg. Added strength may be obtained by using ______________________ wedges inserted into saw cuts in the tenon. The ______________________ must be dovetailed on the inside. This joint can be used for span or stretcher rails on tables, chairs and stools.

![Diagram](image2)

**Fig 4.5 Stub mortise and tenon joint**
**Bareface mortise and tenon joint**

The bareface mortise and tenon joint is used where the rail is of a thinner material than the stile or leg. The tenon has only ___________ shoulder and is ___________ the ___________ of the rail. These joints can be used for joining top rails to chair or table legs.

![Fig 4.6 Bareface mortise and tenon joint](image)

**Double mortise and tenon joint**

The double mortise and tenon joint is used where the joining rail is wide, as in the middle and bottom rails of panelled doors. The ___________ is that the width of the tenon must not ___________ six times its ___________ (two tenons). A wide tenon could shrink and make the joint loose.

![Fig 4.7 Double tenon joint](image)
Twin mortise and tenon joint

The twin mortise and tenon joint is used where the timber is very _________________.

By making two tenons side by side, it reduces the ________________ effect on the joint.

Fig 4.8 Twin mortise and tenon joint
Section 5 – Dovetail joints

The dovetail joint is the strongest form of angle joint used in cabinet work.

Parts of a dovetail joint

Dovetail joints are made up of ____________________, ____________________, and _____________________.

![Fig 5.1 Dovetail joint](image)

Dovetail rules

1. Pins are marked ____________________ on ____________________ grain.
2. Pins slope from ____________ in ____________ to 1 in ____________.
3. The sum of the ____________________ at the widest part must not add up to more than ____________________ the ____________________ of the timber.
4. Never make the pins at the ____________________ part more than the ____________________ of the ____________________ carrying the nails.
5. For all dovetails, use small ____________________ and big ____________________.
6. Always use a ____________________ pencil when marking out.
7. Be careful to saw and chisel on the ____________________ side of markings.
Dovetail angles (pitch)

The strength of the dovetail joint is obtained from the slope of the bevel of the pins and tails, technically referred to as the _________________. The pitch of a dovetail in cabinet work is between 1 in 4 and 1 in 8.

![Excessively sloped and insufficiently sloped angles](image)

**Fig 5.2 Dovetail angles (pitch)**

Types of dovetail joints

The following is a list of the different types of dovetail joints:

- single
- tee halving
- through, or common
- lapped
- double lapped
- secret mitre.

**Note** For illustration and construction methods for double lapped and secret mitre dovetail joints, refer to the chapter entitled ‘Joint Making’ in the Collins Complete Woodworker’s Manual.
Single dovetail joint (a framing or angle joint)

The single dovetail joint is a very strong joint that is used for connecting the __________ and __________ rails of cabinet ends together.

![Fig 5.3 Single dovetail joint](image)

Dovetail tee halving joint

The dovetail tee halving joint is used for flat frames where an outside strain occurs.

![Fig 5.4 Dovetail tee halving joint](image)
Through, or common, dovetail joint

The through, or common, dovetail joint is used in box-like constructions. It is most commonly used for ________________ backs where all ________________ are hidden.

Fig 5.5 Through dovetail joint

Lapped dovetail joint

The lapped dovetail joint is used where one ________________ must not show the joint and the ________________ are set back by a small ________________ or lip. It can be used for solid carcase or ________________ construction such as fixing the bottom to the sides of a cabinet. It is most commonly used for joining drawer sides to drawer fronts.

Fig 5.6 Lapped dovetail joint
Section 6 – Adhesives

On completion of this section, you should be able to explain the characteristics, properties and selection criteria for the following types of adhesives:

- PVA (polyvinyl acetate) glue
- yellow glue (aliphatic resin)
- epoxy resins
- formaldehyde adhesives
- contact cement.

You should also understand the following terms, as they relate to adhesives:

- shelf life
- pot life
- open assembly time
- closed assembly time
- clamping/cramping time
- setting time
- gap-filling properties.

**Note** Atmospheric conditions, such as temperature and humidity, may affect the adhesives in certain ways. For example, types of resin adhesives will set more rapidly on hot days because heat serves to accelerate the curing process, while PVA glues may not cure quite as quickly on humid days because the curing process relies on the evaporation of moisture from the adhesive after bonding.
What are adhesives?

Adhesives are substances used to bond two or more components together either by

…………………………………………………………………………………… (adhesion) or

…………………………………………………………………………………… (cohesion).

It is not necessary for cabinet-makers and furniture-makers to have an in-depth
knowledge of the science behind the way adhesives work. It is simply sufficient to
note that we use certain adhesives on penetrable materials – such as timber, sheet
materials and fabric – and other adhesives on non-penetrable materials – such as
laminate, granite and even glass.

What this does highlight though, is that in today’s ever-changing science, we need to
…………………………………………………………………………………… from time to time of the makers of
the adhesives in order to keep up-to-date with the best products for the applications to
which we wish to put them.

Adhesives that were once very important in the manufacture of furniture (such as
casein glue and hide glue) have no place in the busy schedules of most companies
today, where the focus is on the speedy production of furniture to meet the needs of
a rapidly growing population. Casein glue (made from milk curd) and hide glue (made
from animal offal) both require……………………………………………………………………
when they are compared with the convenience of pre-packaged adhesives that come
ready to use.
Choosing the appropriate adhesive

Many types of adhesive are commercially available, and it is often difficult to match the properties of the adhesive to the particular requirements of the job. There are three major factors that you must consider before deciding which adhesive to use. These are:

• Cost is a major consideration when selecting an adhesive. There are two ways in which cost may be calculated, and both costs should be taken into account when choosing between adhesives.

   The first is purely the cost of the adhesive product itself. Consider the following:

   • Cost is influenced by the:
   • Cost is influenced by the:
   • Cost is influenced by the:
   • Cost is influenced by the:
   • Cost is influenced by the:
   • Cost is influenced by the:

   The second measure of cost is factoring in how much time is involved with the use of a particular product. Consider the following:

   • Time is influenced by the:
   • Time is influenced by the:
   • Time is influenced by the:
   • Time is influenced by the:
   • Time is influenced by the:
   • Time is influenced by the:
Type of material to be bonded

The type of material to be bonded plays a large part in the selection of the appropriate adhesive for the job. Some materials are absorbent, so PVA glue would be more suitable. PVA adhesive forms what is referred to as a mechanical bond is created when the PVA is absorbed into the timber fibres of the surrounding surfaces being glued and, once set, is deeply rooted into the fibres of both pieces of material and cannot give up its bond.

In other words, a mechanical bond is created. On the other hand, some materials – such as sheet laminate – are not so absorbent, and require the use of an adhesive that has high tack value. As the adhesive is not absorbed into the surrounding material, the bond relies on how well the adhesive hangs onto the surface, its ‘tack’ value. In this case, contact cement provides the tack value required for this application.

Other materials may be non-absorbent, a characteristic that prevents the adhesive from being absorbed into the surrounding surface. Teak is one such material and so responds very poorly to PVA glue. As contact cement is a rubber-based product, its suitability for joining solid timber is questionable, simply because it does not dry as hard as other adhesives and therefore does not have the same strength in this situation. Another product that has both the strength required and the tack value is suitable for this type of situation, but it comes at a price. The extra expense of the adhesive in this situation would be a cost-saving measure, though, as you have the assurance that there will be
Atmospheric conditions

Some adhesives – such as contact cement – are available in winter and summer mixes. The summer mix has additional thinning agents, or retardants, in it to prevent the solvent from evaporating too quickly. This gives the manufacturer sufficient time to prepare/spray all surfaces and bond the materials before the adhesive becomes too dry to perform as it should.

As the solvent's evaporation is critical to the functioning of contact cement, heat is beneficial to some extent. As heat is generally scarce during winter, the winter mix minimises the reliance on warm conditions by using less solvent or by incorporating a solvent that evaporates more rapidly. This allows the manufacturer to continue production rather than lose time waiting for the adhesive to dry out sufficiently for the bond to be made.

Adhesives that are essentially two-part and chemical by nature will also respond to the heat of the day. This is because the chemical reaction that takes place in the adhesive after mixing causes the adhesive to become warm before it sets. The artificial application of heat will reduce the time delay in the chemical reaction taking place. In this same way, warm weather hastens the chain reaction that causes the adhesive to set.

As you can see, atmospheric conditions in the factory can play a part in the selection of which type of adhesive is suitable for a situation.
### Research

Using your reference books and consulting other sources, if necessary, explain each of the following glue types under the following headings:

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>liquid, powder, already prepared, two-part, catalyst, accelerator (if required), gap-filling properties, preparation (if required), shelf life, pot life etc</th>
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</thead>
<tbody>
<tr>
<td>Application</td>
<td>scraper/spreader, brush, spray, roller</td>
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<tr>
<td>General uses</td>
<td>internal, external, marine, structural</td>
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#### PVA glue

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<tr>
<td>Application</td>
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<td>General uses</td>
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Yellow glue (aliphatic resin)

Characteristics

Application

General uses

Epoxy resin

Characteristics

Application

General uses
### Urea-formaldehyde

**Characteristics**

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**Application**

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**General uses**

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### Phenol-formaldehyde

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**General uses**

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Contact cement

Characteristics

Application

General uses

Preparation for gluing

Before glue comes into contact with wood, it is essential that the correct preparation is carried out. The following list is a general requirement for gluing, but can be applied to most gluing situations (with few adjustments).

•

•

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Assembling components

After the required cramps are set for the task and the correct preparation has been carried out, you need to:

1. 
2. 
3. 
4. 
5. 
6. 
7. 
8. 
9. 

Good cramping procedure

- and the job when cramping up panels to prevent them from under pressure.

- Use where possible to prevent to the of the component being assembled.

- Place under the cramps to the workbench from unnecessary build-up of potentially damaging lumps of on the bench surface.

Consult the relevant textbooks for further information.
Section 7 – Fasteners

Fasteners used in the attachment of timber joints are limited, due to the fact that most joints by their very nature are self-locking or self-locating. Therefore, joints require very little in terms of fasteners. They simply require some form of cramping pressure to hold the components until the adhesive has dried.

The fastenings used in the manufacture of handmade joints are:

• ________________________________
• ________________________________

Each of these devices is not a fastener in its own right, in that a fastener will apply pressure to a join to hold it in place. They are better referred to as ‘locating devices’, which assist the cabinet-maker in ensuring that their adjoining timbers are located accurately.

Other fasteners that do apply some – albeit limited – pressure to a join and hold the adjoining pieces whilst the adhesive dries are:

• ________________________________
• ________________________________
• ________________________________

Biscuits

Biscuits, also referred to as ______________________, are available in numerous sizes and types. Used mostly in widening joints, they are also available in two-part plates that will allow the timber to be disassembled if required.

Fig 7.1 Biscuits
Biscuits are available in a range of sizes. These are:

<table>
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<th>Product</th>
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The cost should be taken into consideration when selecting these items.

**Dowels**

Dowels will probably never become obsolete in the furniture-making industry, but have largely lost their importance due to the ease with which biscuit joinery is carried out. Biscuits are more forgiving in terms of accuracy, and are faster in terms of preparation and application. However, dowels are arguably stronger than biscuits and, used in the right context – such as framing, where rails meet stiles or vice versa – the dowelled joint will certainly lead to a stronger join.
Dowels are available in many lengths, including lengths of 1 metre or more, and they can be cut to suit any situation. They are also available in numerous thicknesses – from 4 mm through to 18 mm. The only problem with a dowel is that when it is inserted into a drilled hole, the adhesive has trouble escaping from the hole. To avoid any damage resulting from the compression of adhesive in the hole, dowels may be fluted or grooved to allow the pressure of compressed adhesive to escape. This type of dowel is also likely to form a stronger bond due to ________________, provided that sufficient adhesive has been used.

**Nails**

Occasionally there is the need for a nail (or three) when joining timber, but when the timber has been joined with an appropriate joint most joins will not need to be nailed. The exception to this might be where a ________________ and there are insufficient cramps to knock up a large number of drawers and leave them to dry. It would be perfectly correct in the name of production to pull this type of joint up with a cramp and then nail the back in place, as this construction is not likely to be noticed on the completed article. The nailing will usually be done with a nail gun nowadays, rather than with a hammer and nails.
Screws

Some manufacturers use nail guns extensively in the production of cabinet carcases. The types of joints used in most occurrences of carcase construction are the butt joint, the housing joint or the rebate joint. While a nail will hold the sheet material together well in the beginning, **__________will soon see the collapse of the carcase.** So, such manufacture is often reinforced with the application of screws to the joint. The type of screw most likely to be used in these cases is the countersunk Pozidriv® screw, due to the efficiency with which it can be applied.

![Fig 7.3 Screws](image)

Wedges

‘Wedging’ is the process of applying some pressure to a mortise and tenon joint in order to permanently lock the mortise into the tenon. It is worth noting that outside the range of mortise and tenon joints, wedges have very little place in joint construction.
Section 8 – Case study

Once you have read the scenario below, explain in detail what Jonno needs to do to complete the task assigned to him before the end of the day.

Consider carefully the number of cramps available, the length of time that each chair needs to remain in cramps and strategies that can be adopted to make the cramps available for the next chair as soon as is practicable.

Jonno is a first-year apprentice working in a mass-production furniture factory. He is given the task of assembling chairs for six dining suites. Each suite has six chairs, so he needs to assemble a total of 36 chairs before the end of the day.

Each chair will require three cramps during its assembly, and there are 13 cramps available for use at the factory. QA fittings are applied to the top rail only, thereby allowing the removal of one cramp on completion of assembly. What strategies can Jonno adopt in order to have all of the chairs assembled by the end of the day?

How much time can Jonno spend on each chair if he starts work at 7 am and finishes at 4.30 pm (his lunch break is 45 minutes and his tea break is 10 minutes)?
Hand Make Timber Joints
Learner’s Guide

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. It contains information and activities that cover the types of joints, properties and characteristics of adhesives; capabilities and limitations of tools; choice of adhesives; and workflow in the workplace.

EDITION
Second edition

CATEGORY
Building and Construction

RELATED PRODUCTS
BC2012 Work Safely in the Furniture-Making Industry
BC2013 Join Solid Timber
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