Trade of Toolmaking

Module 5:	Press Tools, Jigs & Fixtures, Mouldmaking
Unit 6:	Jig Components
	Phase 2

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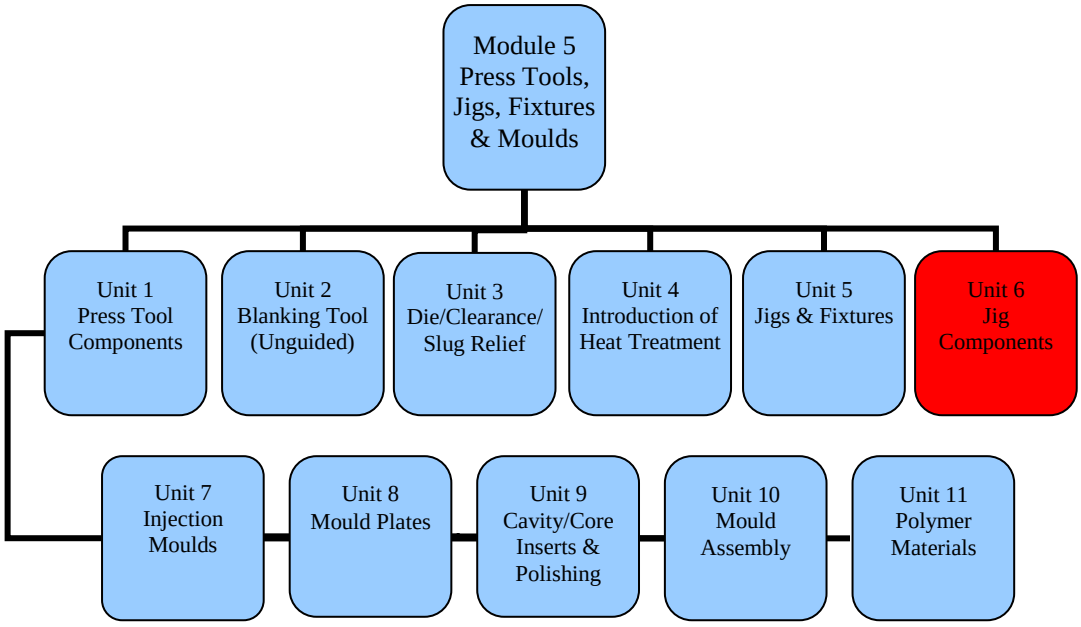
Unit Objective

On completion of this unit you will be able to build a sample jig utilising standard component and safely use the jig to hold and drill the workpiece.

Introduction

Module five of this course covers Press Tools, Jigs & Fixtures, Mouldmaking. This is the sixth unit in module five and explains the manufacture, assembly and use of jigs. When manufacturing the mating parts of the jig, the use of the limits and fits is important, where some parts need to be press-fitted together and other parts require a close sliding fit. This unit also explains that standard parts such as clamps, screws, handles etc., should be used where possible.



By the end of this unit you will be able to:

- Build a sample jig utilising standard component parts where appropriate.
- Position and clamp components to jig as per drawing specification.
- Drill work piece while using a jig to safety hold a workpiece.

1.0 Building A Sample Jig Utilising Standard Components

Key Learning Points

Process planning: utilisation of standard components and available resources from standard catalogue parts. Limits and fits: use of clearance, interference and transition fits. Use of datum edges for location. Safe use of jig boring machine, lathe and milling machine.

1.1 Process Planning: Utilisation Of Standard Components And Available Resources From Standard Catalogue Parts

Drawings should be read carefully prior to manufacturing the jig and it is important to plan the sequence of operations. The main body of the jig is machined using the milling machine or lathe, use the raw material as specified on the drawing and assembled together with screws and dowels. Locators and bushes are manufactured separately from tool steel and are hardened in order to reduce wear and are then assembled with the main assembly. Use standard components where possible such as toggle clamps, screws, handles etc., which can be sourced from catalogues.

1.2 Limits And Fits: Use Of Clearance, Interference And Transition Fits

In order for the jig to function correctly it is important that all the parts fit together as designed. In the *limits and fits system* there are three classes of fit (i) clearance, (ii) transition and (iii) interference fits. For a clearance fit the shaft is always smaller than the hole. For an interference fit the shaft is always bigger than the hole. For a transition fit the shaft can be bigger or smaller than the hole. To achieve the required fit, the *limits and fits system* is used and required fit is chosen from the data sheet (Ref.: BSI data sheet 4500A).

The locators for example can be assembled to the main body of the jig by using an *interference fit* between the parts, where the hole is reamed to size and the locator body is turned to a diameter larger then the hole. It is then pressed into the jig body.

For parts, such as the bushings, that are designed to be removable will require a close sliding fit between parts, therefore a *clearance fit* is used. Again the tolerance bands are taken from the data sheet.

Ref: Simmons, Colin H & Maguire, Dennis E 2004, *Manual of engineering drawing*, 2nd edn, Elsevier Science & Technology, chapter 19, *Limits and fits*, p. 154.
ISBN-13: 9780750651202

1.3 Use Of Datum Edges For Location

The *datum* is a reference edge from which measurements are made. Prior to milling or drilling the component of the jig, the plates are marked out using the same datum edges as those specified on the drawing. All features are marked out and measured from one end of the plate. Normally there are two datum edges, which are at right angles to each other.

1.4 Safe Use Of Jig Boring Machine, Lathe And Milling Machine

When using the jig boring machine, lathe or the milling machine, safe working procedures need to be applied. Wear safety glasses at all times. Keep hands away from swarf and use a long handed rake to remove swarf, only after the machine has been stopped. Wear suitable protective clothing. Loose clothing, long sleeves, ties and long hair are a source of danger and therefore should be securely contained. When using the lathe, remove the chuck key immediately after use. Keep the area around machine clean and tidy and free from wet or oily patches.

2.0 Positioning And Clamping Components In Jig As Per Drawing

Key Learning Points

Assembly procedures and organisation of surrounding work areas. Machining and assembly of components parts. Application of clamping forces: workholding forces to be greater than applied cutting forces.

2.1 Assembly Procedures And Organisation Of Surrounding Work Areas

Prior to assembling the jig or fixture, it is important to carefully study the Assembly Drawings and to plan the sequence of operations. Tools and material should be laid out and organised in a neat and logical order. If you have any questions or not sure about something ask your Instructor.

2.2 Machining And Assembly Of Components Parts

Drawings should be read carefully prior to carrying out any task and it is important to plan the sequence of operations. The main body of the jig or fixture can be machined from mild steel or aluminium and assembled together with screws and dowels. Locators and bushes are manufactured separately from tool steel and are hardened in order to reduce wear and are then assembled with the main assembly. Clamps, screws, handles etc., can be sourced from catalogues.

2.3 Application Of Clamping Forces: Workholding Forces To Be Greater Than Applied Cutting Forces

The clamp needs to hold the workpiece in place while it is being machined, but should not damage, break it or distort the workpiece. The work holding forces need to be greater than the applied cutting forces. In a milling fixture for example the clamp holds the workpiece in place, but it is important to position a positive restraint at one end of the workpiece, as this will resist the cutting forces and prevent movement when the cutter is being fed in the direction of the restraint.

Ref: Manufacturing Timings, R.L. 1998, *Manufacturing technology*, vol. 1, 3rd edn, Pearson Education Limited, chapter 3, *Toolholding and workholding*, sec. 3.3, *Practical clamping*, p. 98.
ISBN-13: 9780582356931

3.0 Drilling A Work Piece Using A Jig To Safely Hold A Workpiece

Key Learning Points

Materials handling, machine shop safety. Machine operation, hand skills.

3.1 Materials Handling, Machine Shop Safety

When using machines such as the jig boring machine, lathe and milling machine it is important to wear eye protection, suitable clothing, use a brush to remove swarf and keep the machine and surrounding area tidy. Switch off the machine when not in use and in the case of an emergency press the red stop button to stop the machine.

3.2 Machine Operation, Hand Skills

When the component has been drilled using the jig, ensure that the drill has retracted fully prior to unclamping the workpiece. Remove the workpiece and be careful of burrs and sharp corners. These are later removed with appropriate files and deburring tools.

When the components have been machined to size, all burrs and sharp edges need to be removed with a file. It is important to keep the work area and the workshop clean and tidy. All tools and equipment must be returned to their respective toolbox or storage area when not in use. Ensure that the floor is kept free of debris, oil and coolant spills. Clean up spills immediately. When using machines always wear safety glasses and tie back long hair or loose clothing.

Summary

Building a sample jig utilising standard components: Drawings should be read carefully prior to manufacturing the jig and it is important to plan the sequence of operations. The main body of the jig is machined using the milling machine or lathe, use the raw material as specified on the drawing and assembled together with screws and dowels. Locators and bushes are manufactured separately from tool steel and are hardened in order to reduce wear and are then assembled with the main assembly. Use standard components where possible such as toggle clamps, screws, handles etc., which can be sourced from catalogues.

In order for the jig to function correctly it is important that all the parts fit together as designed. In the *limits and fits system* there are three classes of fit (i) clearance, (ii) transition and (iii) interference fits. For a clearance fit the shaft is always smaller than the hole. For an interference fit the shaft is always bigger than the hole. For a transition fit the shaft can be bigger or smaller than the hole. To achieve the required fit, the *limits and fits system* is used and required fit is chosen from the data sheet (Ref.: BSI data sheet 4500A).

Positioning and clamping components in jig as per drawing: The clamp needs to hold the workpiece in place while it is being machined, but should damage, break it or should not distort the workpiece. The work holding forces need to be greater than the applied cutting forces. In a milling fixture for example the clamp holds the workpiece in place, but it is important to position a positive restraint at one end of the workpiece, as this will resist the cutting forces and prevent movement when the cutter is being fed in the direction of the restraint.

Drilling a work piece using a jig to safely hold a workpiece: When the components have been machined to size, all burrs and sharp edges need to be removed with a file. It is important to keep the work area and the workshop clean and tidy. All tools and equipment must be returned to their respective toolbox or storage area when not in use. Ensure that the floor is kept free of debris, oil and coolant spills. Clean up spills immediately. When using machines always wear safety glasses and tie back long hair or loose clothing.

When the component has been drilled using the jig, ensure that the drill has retracted fully prior to unclamping the workpiece. Remove the workpiece and be careful of burrs and sharp corners. These are later removed with appropriate files and deburring tools.

Materials handling, machine shop safety. Machine operation, hand skills. Safe use of jig boring machine, lathe and milling machine

Suggested Exercises

1. Obtain a toggle clamp and sketch it in open and closed positions.
2. In the hole and shaft based systems, what are the three classes of fits?
3. When designing a clamp for a jig, what considerations do you need to take?
4. What safety precautions should you take when using a drilling a workpiece in a jig and when removing it.

Questions

1. Give an example of interference fit when assembling the Jig parts.
2. Give an example of clearance fit when assembling the Jig parts.
3. What is the definition of a datum?
4. What safety precautions should you take when using a milling machine of a lathe?
5. What are the main functions of a clamp?

Answers

1. The locators for example can be assembled to the main body of the jig by using an interference fit between the parts, where the hole is reamed to size and the locator body is turned to a diameter larger then the hole. It is then pressed into the jig body.
2. For parts, such as the bushings, that are designed to be removable will require a close sliding fit between parts, therefore a clearance fit is used.
3. The Datum is a reference edge from which measurements are made. Prior to milling or drilling the component of the jig, the plates are marked out using the same datum edges as those specified on the drawing.
4. Wear safety glasses at all times. Keep hands away from swarf and use a long handed rake to remove swarf, only after the machine has been stopped. Wear suitable protective clothing. Loose clothing, long sleeves, ties and long hair are a source of danger and therefore should be securely contained. When using the lathe, remove the chuck key immediately after use. Keep the area around machine clean and tidy and free from wet or oily patches.
   The Clamp should be quick and easy to operate in order to reduce setup time. It should hold the workpiece against the cutting forces without damaging the workpiece.

Recommended Additional Resources

Reference Books

Black, Bruce J 2004, *Workshop processes, practices and materials*, 3rd edn, Elsevier Science & Technology.

ISBN-13: 9780750660730

Simmons, Colin H & Maguire, Dennis E 2004, *Manual of engineering drawing*, 2nd edn, Elsevier Science & Technology.

ISBN-13: 9780750651202

Timings, R.L. 1998, *Manufacturing technology*, vol. 1, 3rd edn, Pearson Education Limited.

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