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Traditional Craft Heritage Training , Design & Marketing in Jordan and Syria
(HANDS)

Project Number: 610238-EPP-1-2019-1-JO-EPPKA2-CBHE-JP

Engineering Workshops

Course Offered By: : ZUJ,ABU,TU

Module 5

Responsible partner(s):

Training and Technical Group (TTG)

Scientific and Supervising Committee (SC)

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ENGINEERING WORKSHOPS

Training Program

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HANDS

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Objectives

to provide students with hands-on experience in using tools and equipment to create physical objects. This helps bridge the gap between theoretical engineering knowledge and practical application.

1. Accurately select, use, and interpret readings from measuring instruments
2. Safely operate welding equipment and produce quality welds on various materials
3. Effectively use woodworking tools and machinery to create basic carpentry projects
4. Identify and troubleshoot common machining problems, such as chatter and tool wear
5. Utilize CAM software to create CNC programs for the production of complex parts

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Program Details

Target Audience

School and university students

Program Duration

Four weeks, two days a week with three hours per day.

Delivery Method

- Presentations
- Training activities
- Brainstorming
- Discussion and dialogue

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MEASUREMENTS

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Measurements

How do we measure the world?

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7 Basic SI units

Quantity	Name	Symbol
Length	meter	m
Mass	kilogram	kg
Time	second	s
Electric Current	ampere	A
Thermodynamic Temperature	kelvin	K
Amount of Substance	mole	mol
Luminous Intensity	candela	cd

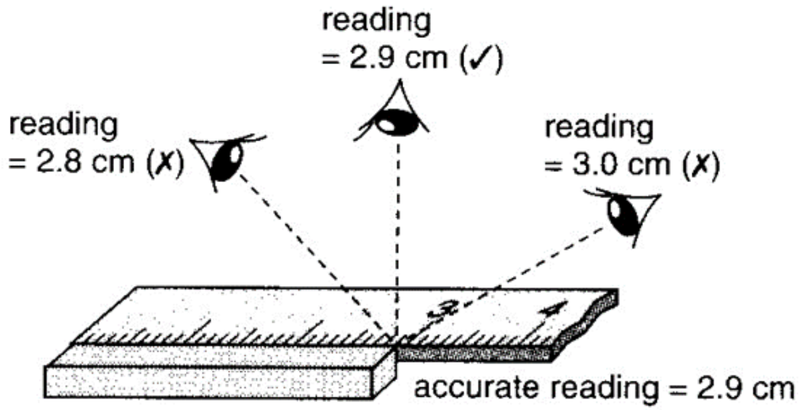
Measurements

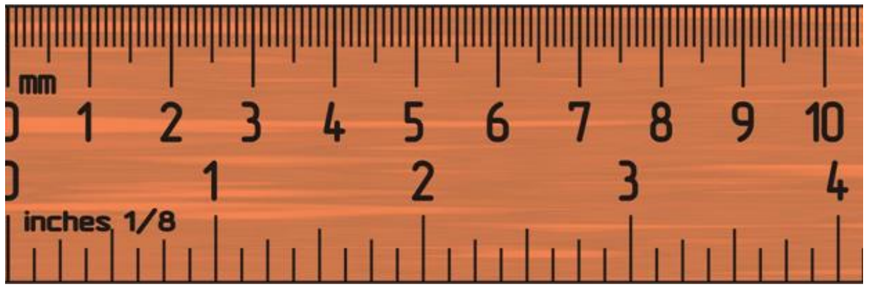
Hand's project

Measuring Instruments

Ruler

- A ruler is used to measure lengths from a few cm up to 1 m. A metre rule has an accuracy of 0.1 cm (i.e. 1 mm).
- 2 Precautions to be taken when using a ruler:
  - (a) Ensure that the object is in contact with the ruler to avoid inaccurate readings.
  - (b) Avoid parallax errors. Parallax errors in measurement arise as a result of taking a reading, with the eye of the observer in the wrong position with respect to the scale of the ruler. Figure shows the correct position of the eye when reading the scale





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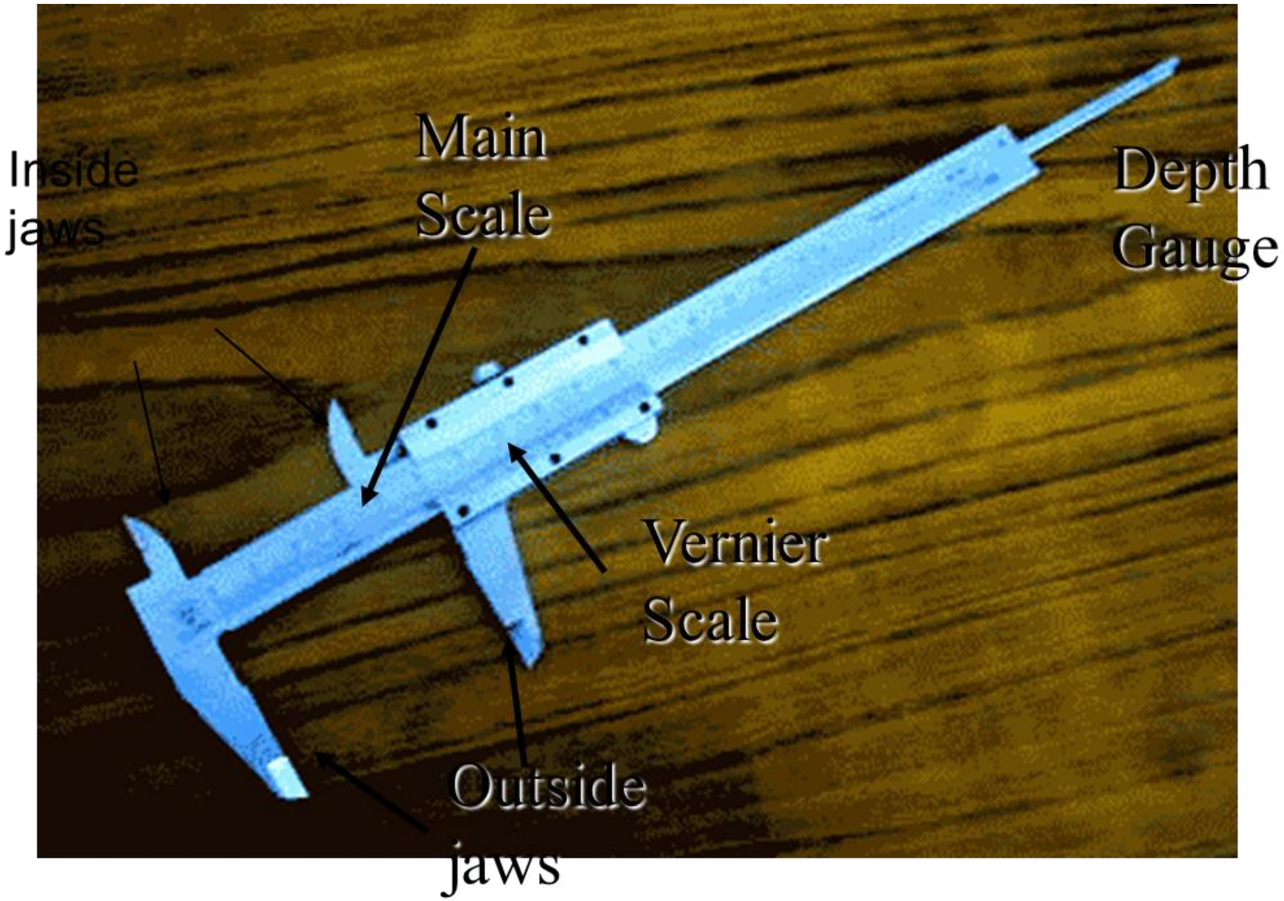
Measurements

Use of Vernier Caliper

Vernier Caliper can be used to measure diameter, thickness very accurately.



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Measurements

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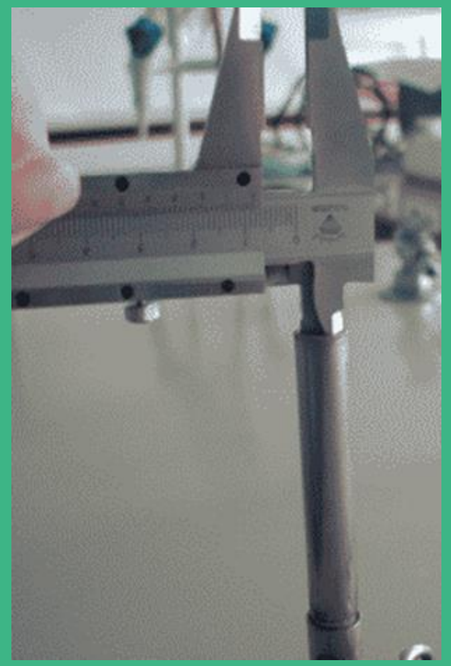
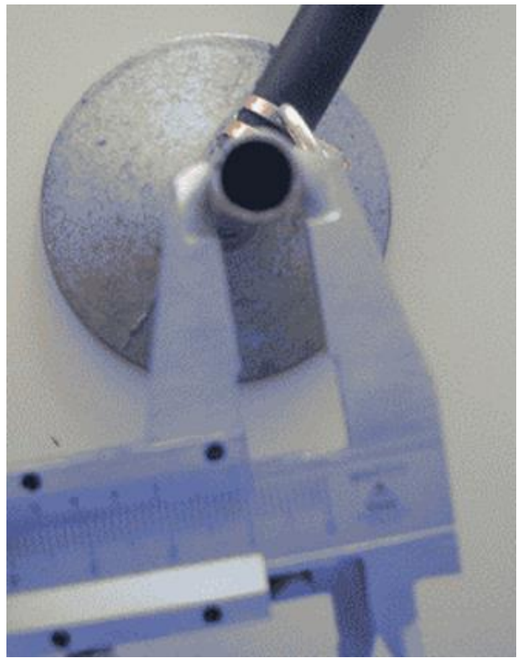
Measuring Internal Diameter



Use the inside jaws of the caliper as shown



Use the outside jaws of the caliper as shown

Use the depth gauge of the caliper as shown

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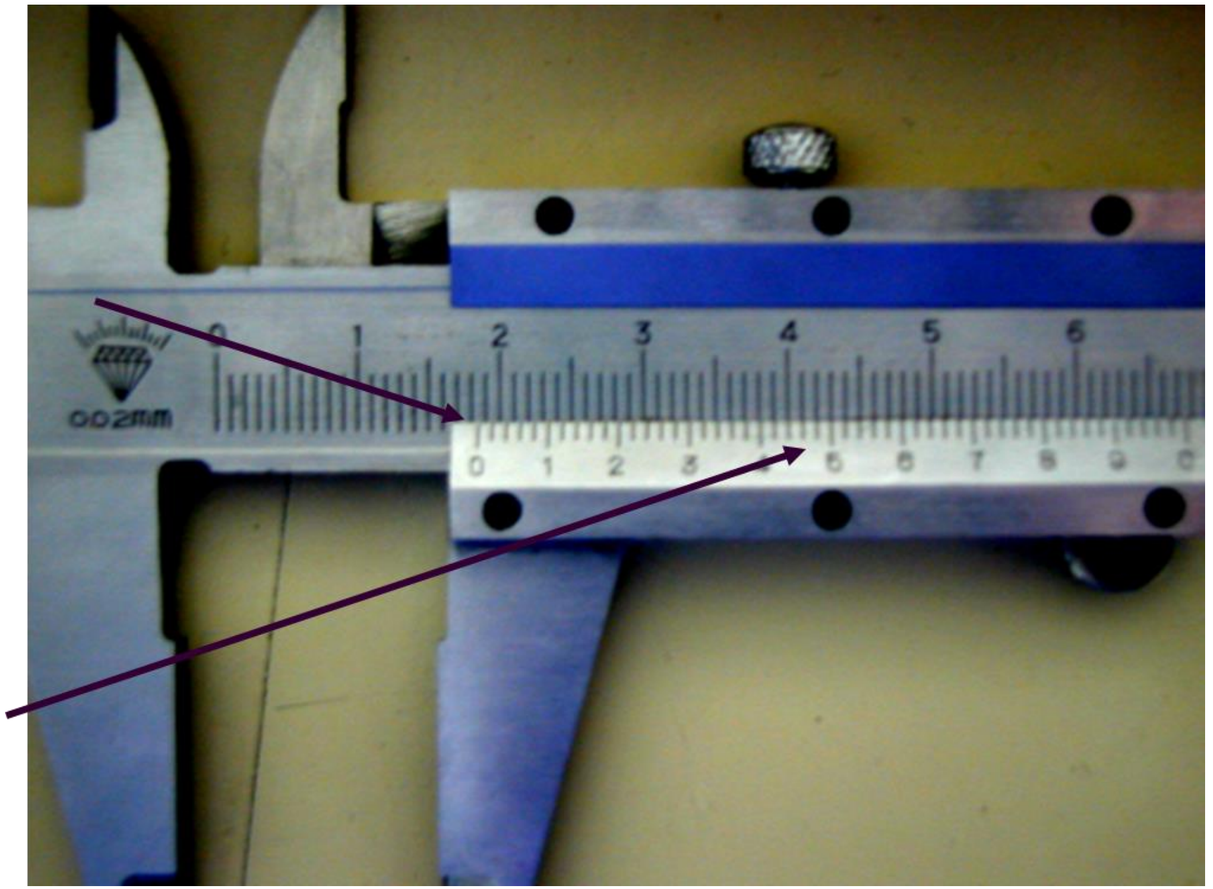
Measurements

Use of Vernier Caliper

- Read the “0” position of the vernier scale on the main scale to get a rough reading.
- Rough reading = 18mm
- Look along the vernier scale until one of the vernier division coincides with the main scale
- Accurate reading = 18.46mm±0.01 mm



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Measurements

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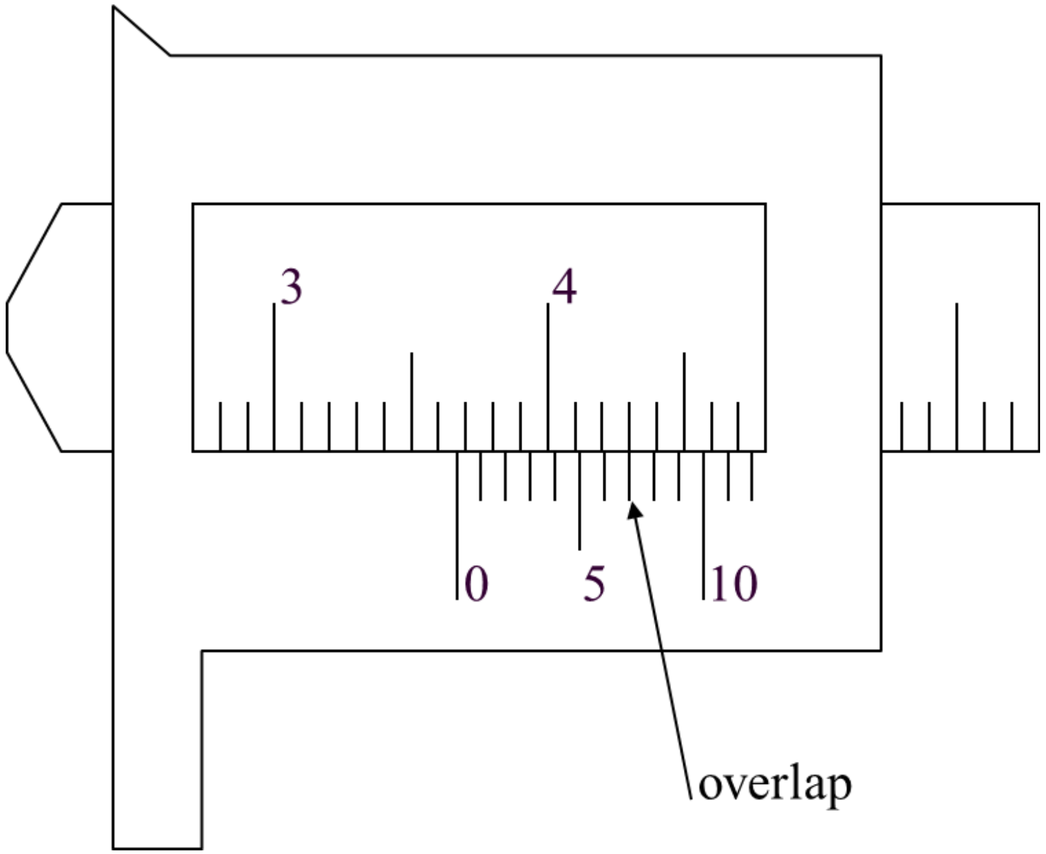
Exercise

What is the reading in the caliper shown?

A. 3.51cm
B. 3.57cm
C. 3.62cm
D. 3.642cm
E. 3.67cm



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Measurements

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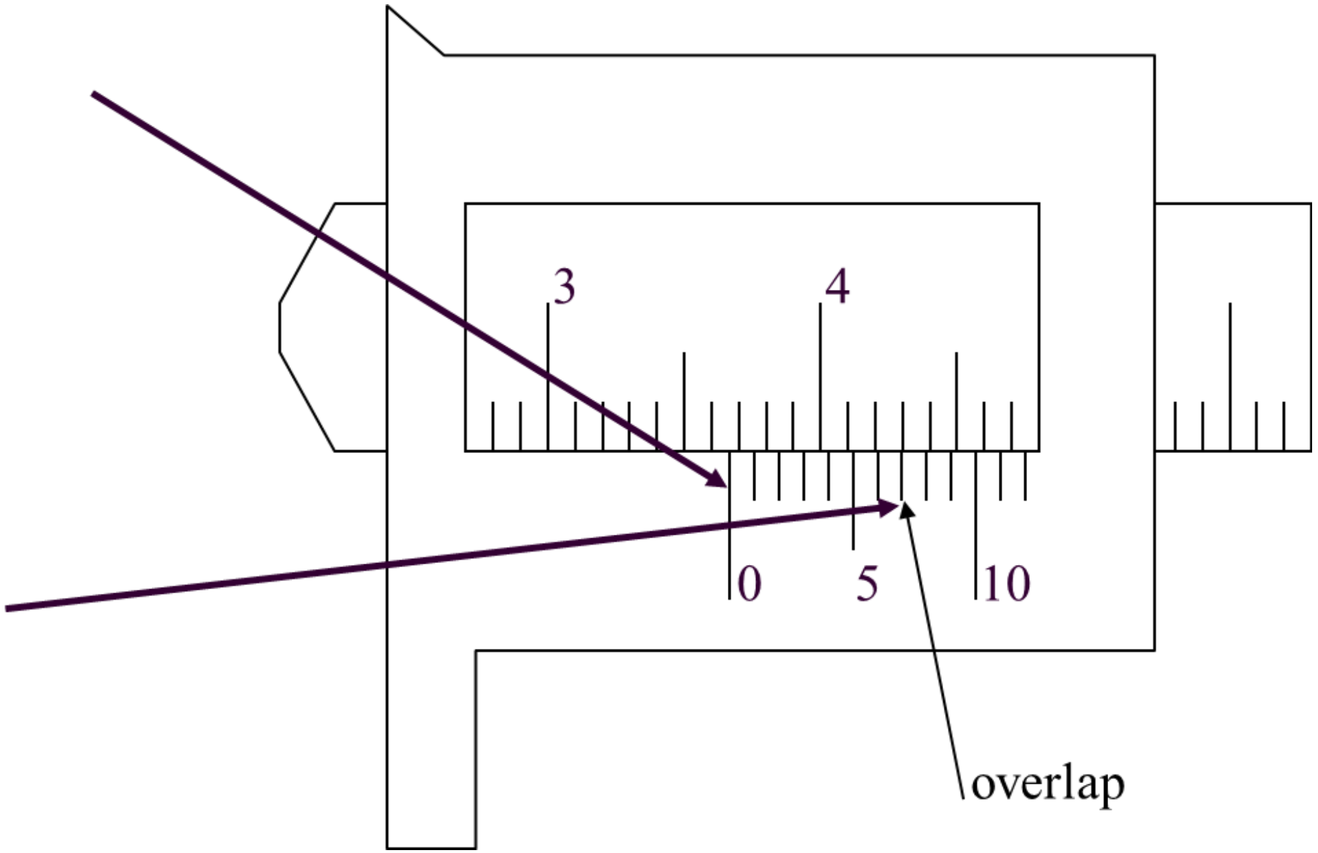
Solution

Read the "0" position of the vernier scale on the main scale to get a rough reading.

Rough reading = 3.6cm

Look along the vernier scale until one of the vernier division coincides with the main scale

Accurate reading = 3.67cm±0.005cm



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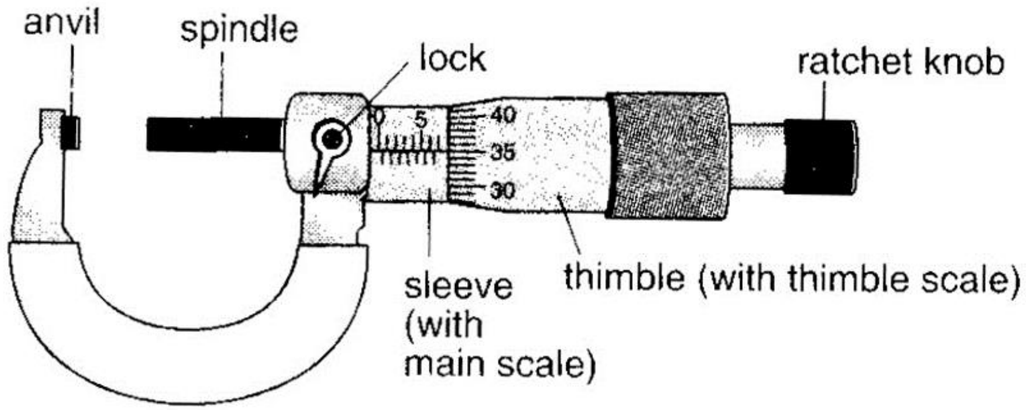
Measurements

Micrometer Screw Gauge

A micrometer screw gauge is used to measure small lengths ranging between 0.10 mm and 25.00 mm.



Hand's project

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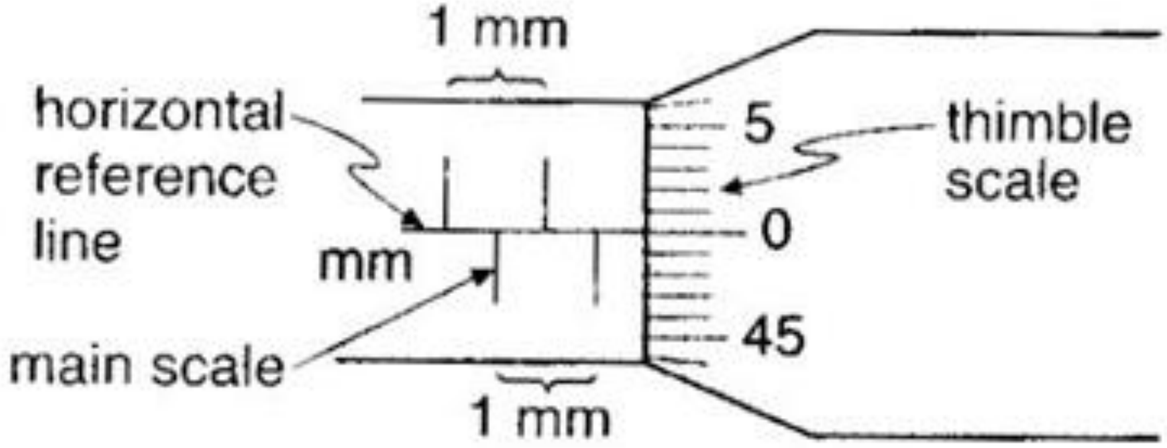
Measurements

Micrometer Screw Gauge

- This instrument can be used to measure diameters of wires and thicknesses of steel plates to an accuracy of 0.01 mm.
- The micrometer scale comprises a main scale marked on the sleeve and a scale marked on the thimble called the thimble scale.



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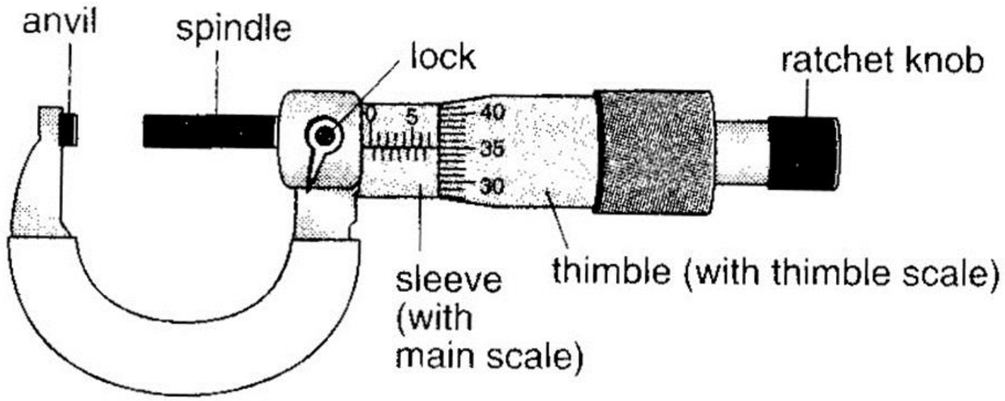
Measurements

Micrometer Screw Gauge

- The difference between one division on the upper scale and one division on the lower scale is 0.5 mm.
- The thimble scale is subdivided into 50 equal divisions. When the thimble is rotated through one complete turn, i.e. 360°, the gap between the anvil and the spindle increases by 0.50 mm.
- This means that one division on the thimble scale is = 0.01 mm.
- When taking a reading, the thimble is turned until the object is gripped very gently between the anvil and the spindle.
- The ratchet knob is used to prevent the user from exerting undue pressure.
- The grip on the object must not be excessive as this will affect the accuracy of the reading.



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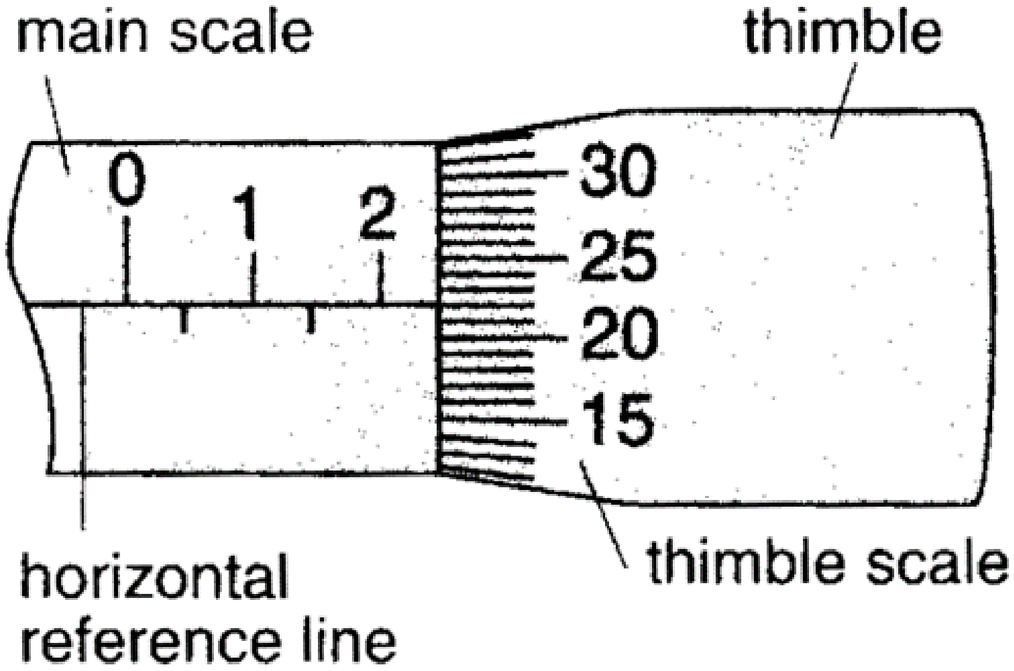
Measurements

Micrometer Screw Gauge

- Readings on the micrometer are taken as follows.
  - (a) The last graduation showing on the main scale indicates position between 2.0 mm and 2.5 mm. Thus the reading on the main scale is read as 2.0 mm.
  - The reading of the micrometer screw gauge is the sun of the main scale reading and the thimble scale reading which is: 2.0 + 0.22 =2.22 mm



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WELDING

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Welding

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Introduction

Welding joins two pieces of metal by the use of heat, pressure, or both.

Use of Welding:

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Welding

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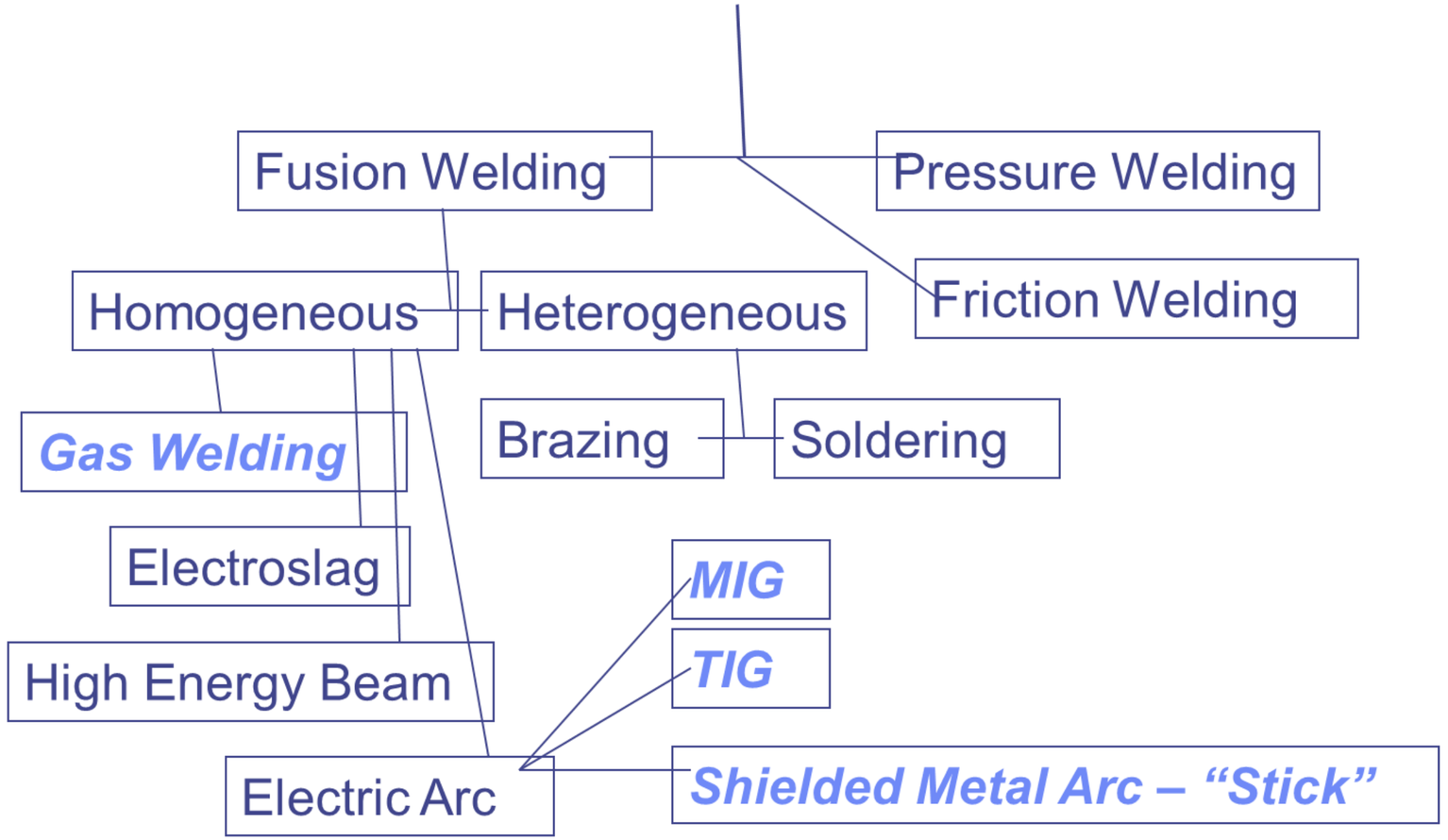
Types of Welding



Welding

MIG Welding

Metal Inert Gas Welding

An arc is struck between an electrode and the sheet metal to be welded. The electrode used in the machine shop is Copper wire and is in the form of continuous filler metal. The weld is shielded by an inert gas, CO2, to prevent oxidation.

Uses

- Carbon steels, low alloy steels, stainless steels, most aluminum alloys, and zinc based copper alloys can be welded with the MIG Welder.
- Can weld very thin sections and metals that can not be easily welded with other types of welding.

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Welding

TIG Welding

Tungsten Inert Gas Welding (TIG)

- Produced by an electric arc maintain between non consumable tungsten electrode and the part to be welded.
- Excellent for welding thin metals, pipeline welding and exotic metals
- Highly skilled labor needed for this process

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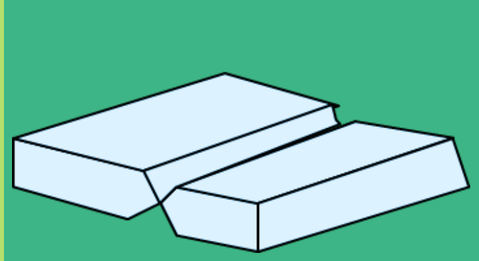
Welding

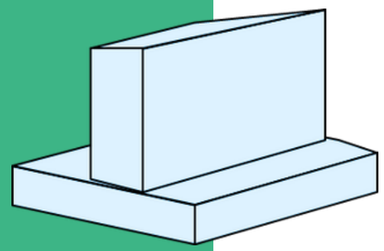
Selection of Joining Process

What determines what equipment to use for a job:

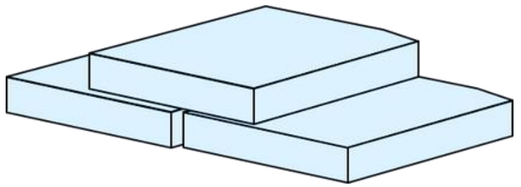
- Availability equipment
- Repetitiveness of the operation (how many passes)
- Quality requirements (pipeline)
- Location of the weld
- Materials to be joined
- Appearance of the finished products
- Size of the parts
- Time Available



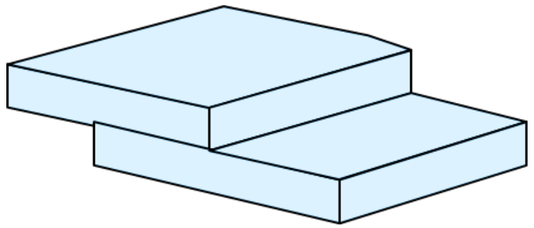
BUTT JOINT



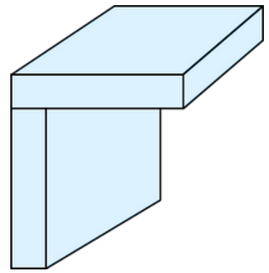
FILLET JOINT



STRAP JOINT



LAP JOINT



CORNER JOINT

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Welding

Types of ARC Welding Machines

DC Welding Machines

- Often generator type machines
- Diesel or gasoline engine driven
- Portable
- Expensive

AC/DC Welders

- Can weld in AC or DC polarity
- Less expensive than DC machine
- Quieter than DC machine

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CARPENTRY

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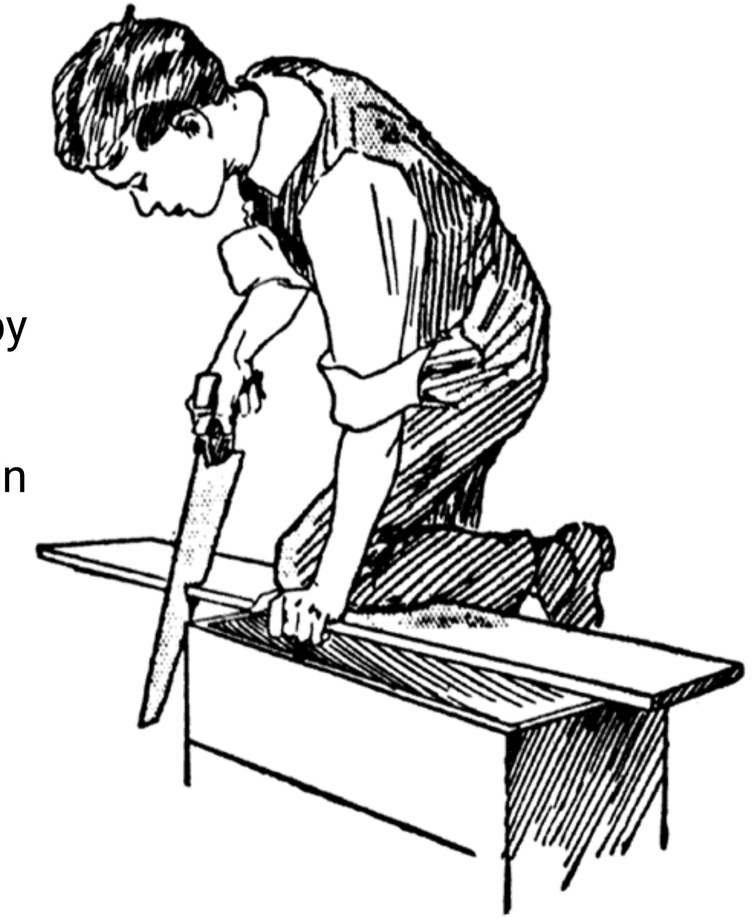
Carpentry

Introduction

- Carpentry is an assemblage of pieces of timber connected by being framed together, as the pieces of a roof, floor, etc.
- Carpenters work with wood to construct, install and maintain buildings, furniture, and other objects.



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Carpentry

Measuring and Marking out Tools

- Knife : is more accurate than the pencil; it has a fine tip and will cut through the fibres of the wood allowing saw or chisel to produce a finer finish.
- Steel rule
- Combination Square: they accurately mark out right angles and bevels and it can also double up as a try square for measuring internal angles.
- Marking Gauge: is used for marking a depth on wood.
- Spirit Levels: is used them when fitting furniture, stud walls or anything that you need to be level.

Figure 5.1: 1-Marking Knife 2-Stanley knife 3-Retractable Tape 4- Steel Rule5- Combination Square 6- Marking Gauge 7- Spirit Level

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Carpentry

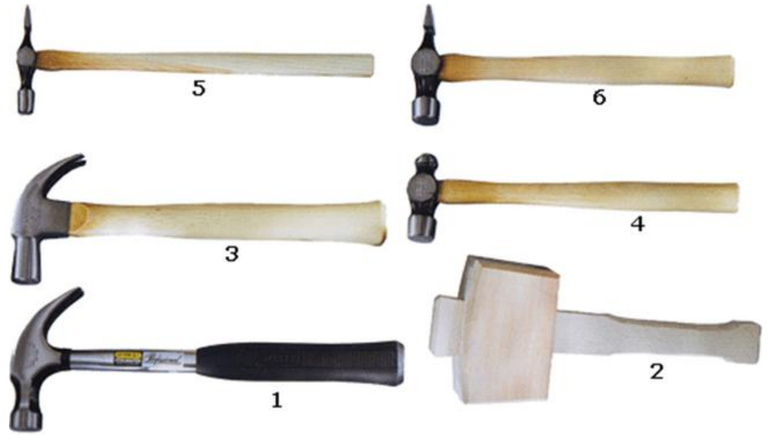
Measuring and Marking out Tools

Saws are used to cut the wood

Figure 6.2: 1 Hand Saw - 2 Tenon Saw - 3 Dovetail Saw - 4 Coping Saw - 5 Fret Saw

Planes are used to smooth wood

Figure 6.3: 1 - Jointer or Try Plane 2 - Fore Plane 3 - Jack Plane 4 - Smoothing Plane 5 - Block Plane



Hammers and Mallets

Figure 5.4: 1 - Steel Handled Claw Hammer 2 - Beach Mallet 3 - Wooden Handled Claw Hammer 4 - Ball-Pen Hammer 5 - Pin Hammer 6 - Cross-Pen (Warrington) Hammer.

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Carpentry

Chisels are used for carving or cutting

Figure 5.6: 1 - Bevel Edge Paring Chisel 2 - Firmer Chisel 3 - Bevel Edge Chisel 4 - Polypropylene Handled Chisel 5 - Carver Handel.

Measuring and Marking out Tools

Screwdrivers are used for the tightening of screws

Figure 5.6: 1 - Stubby Screwdriver 2 - Standard Screwdriver 3 - Long Reach Screwdriver 4 - Slotted Tip 5 - Pozidrive Tip 6 - Phillips Tip.

Drills are used for drilling holes in various materials

Figure 6.7: 1 - Hand Drill 2 - Twist Drill Set 3 - Centre Bit 4 - Auger Bit 5 - Adjustable Expansive Bit 6 - Ratchet Brace.

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Carpentry

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Measuring and Marking out Tools

Tools for Holding

- **G Clamp**: is a fastening device to hold or secure objects tightly together to prevent movement or separation through the application of inward pressure.
- **Vices**: The vice is designed to hold timber while it is being worked, so you can cut and mark, NOT hitting with a hammer.

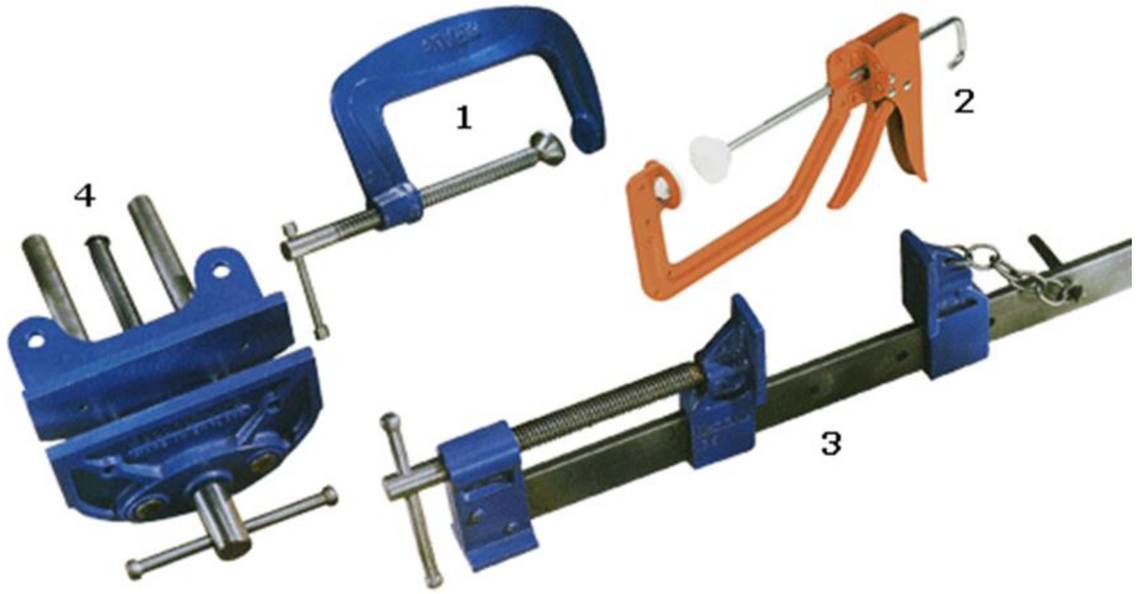

Figure 6.8: 1 - G-Clamp 2 - Speed Clamp/Quick Release
3 - Sash Clamp 4 - Woodworker's Bench Vice

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Carpentry

Joint Types

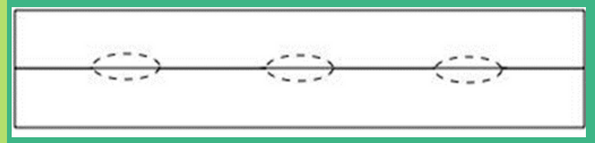

Figure 6.9:
Biscuit Joints

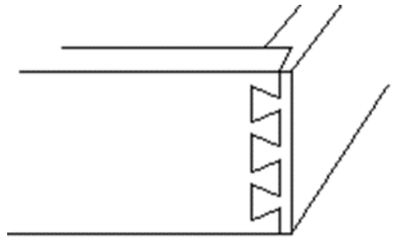

Figure 6.10:
Dovetail Joints

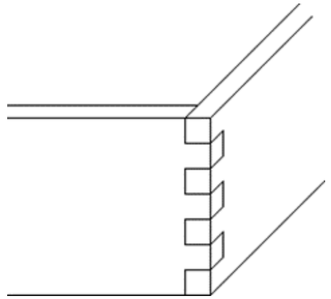

Figure 6.11:
Box Joints

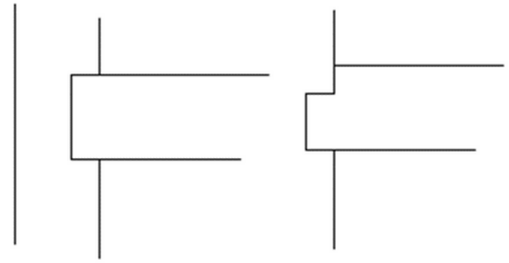

Figure 6.12:
Dado Joints

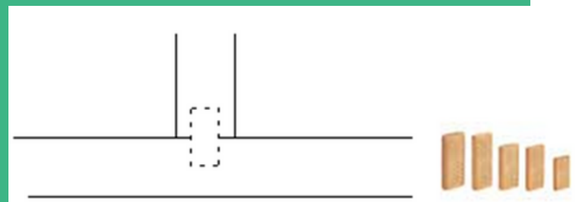

Figure 6.13:
Dominos Joints.

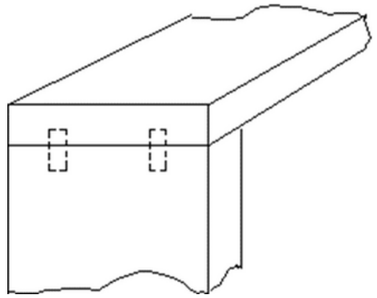

Figure 6.14: Dowel butt Joints.

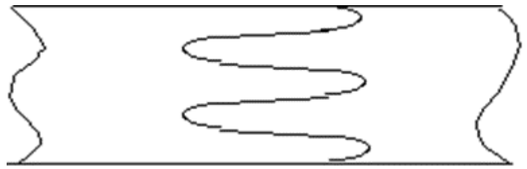

Figure 6.15:
Finger Joints.

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Carpentry

Hand's project

Joint Types

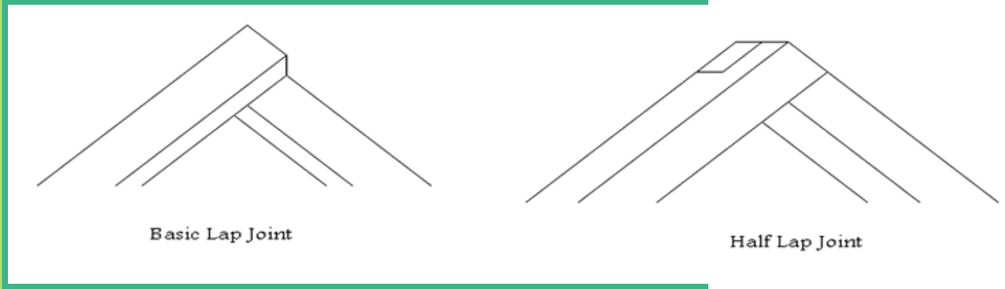

Figure 6.16: Lap Joints.

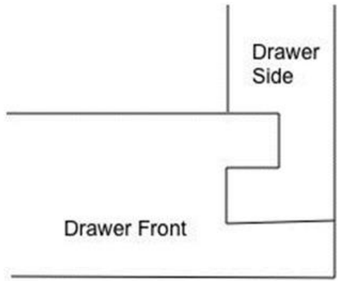

Figure 6.17: Locked Rabbet Drawer Joint

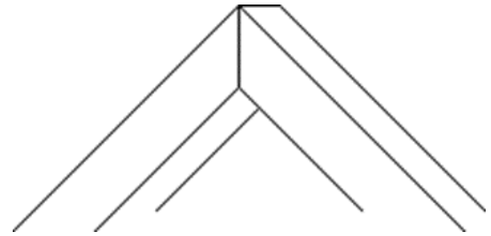

Figure 6.17: Miter joints

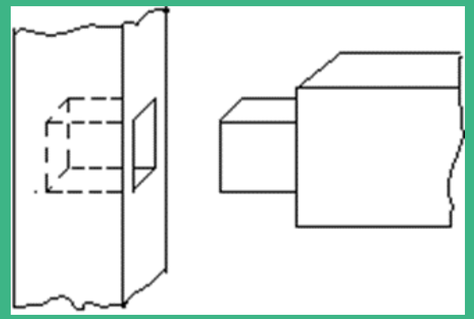

Figure 6.18: Mortise and Tenon joints

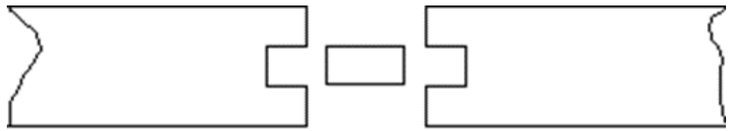

Figure 6.19: Spline joints

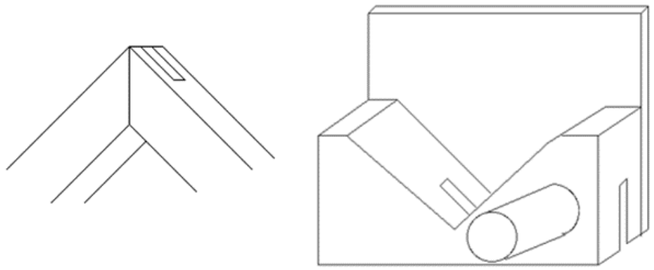

Figure 6.20: Picture Frame Spline Jig Joints

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HANDS

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Machines & Machining Issues

Hand's project

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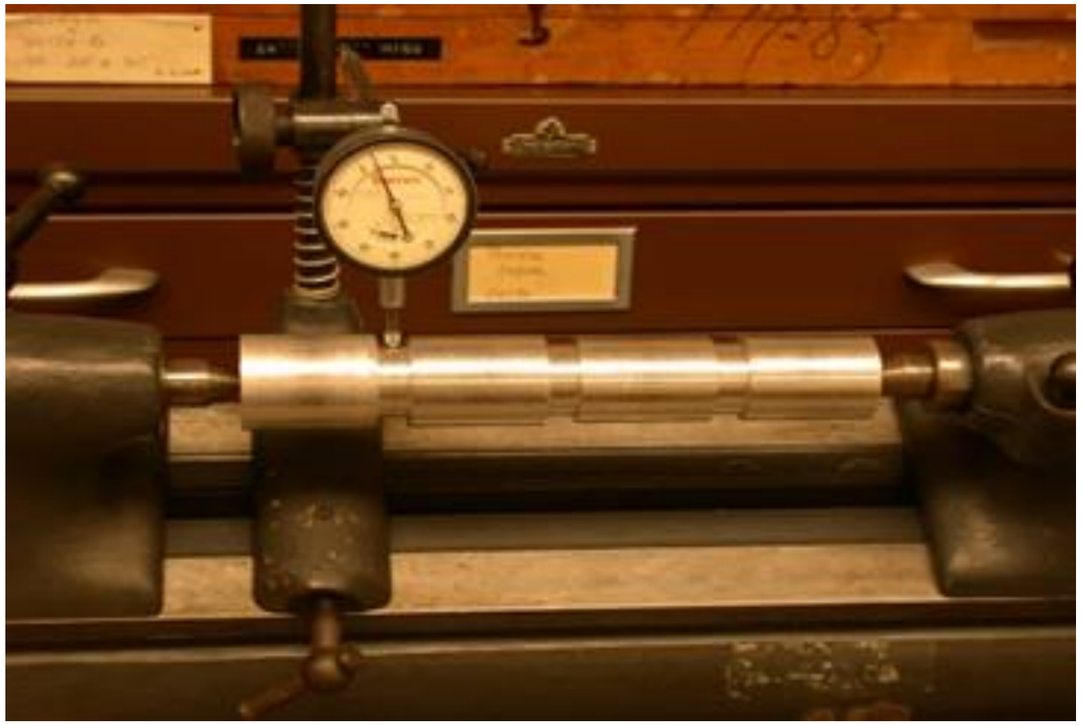
Machines & Machining Issues

Turning Operations

- Turning (Performed on lathe)
- Part is moving and tool is stationary.
- Used to make parts of round cross section
- Screws, shafts, pistons....
- Number of various lathe operations
- Turning, facing, boring, drilling, parting, threading



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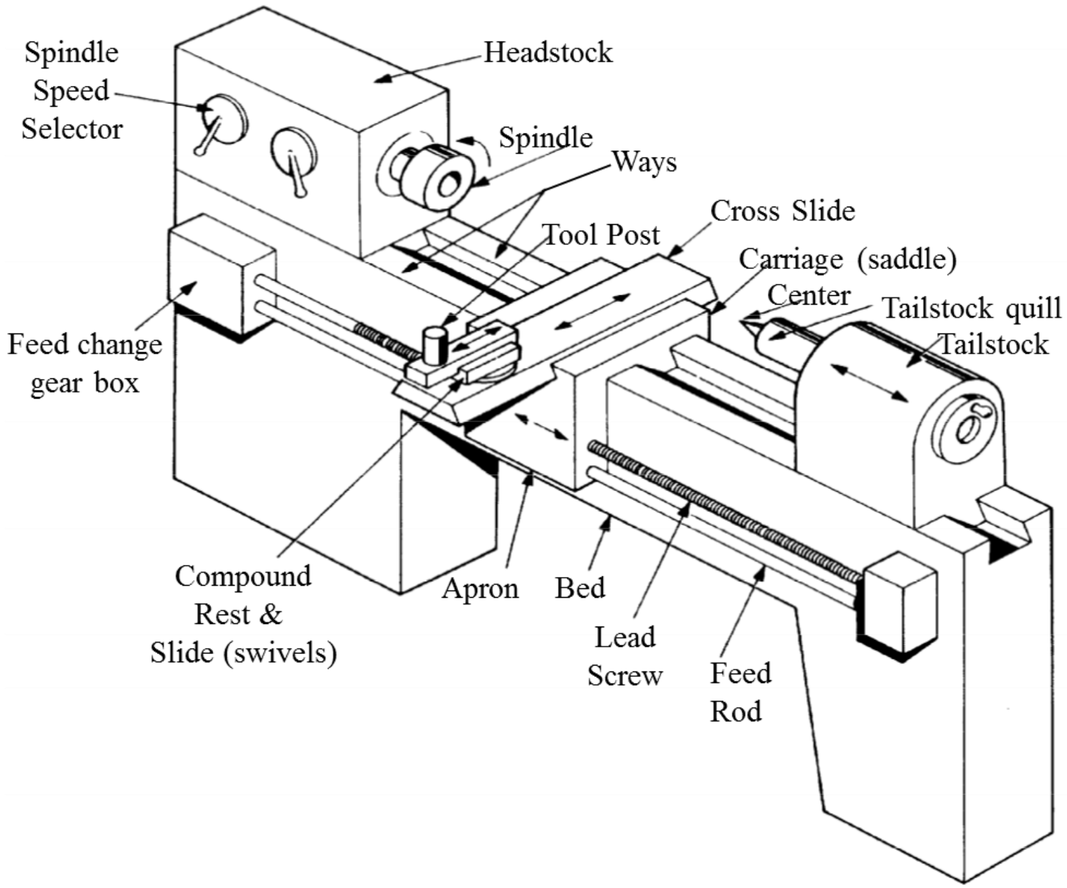
Machines & Machining Issues

Lathe Components

Machine Components (Main items)

- Bed: Supports all other machine parts
- Carriage: Slides along the machine ways
- Head stock: Power train of system (spindle included)
- Tail Stock: Fixes piece at end opposite to the head stock
- Swing: Maximum diameter of the machinable piece
- Lead screw: controls the feed per revolution with a great deal of precision



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Machines & Machining Issues

Hand's project

Lathe Tools

Lathe tools

- Left handed
- Right handed
- Threading
- Boring
- Groove
- Parting (Cut-Off)

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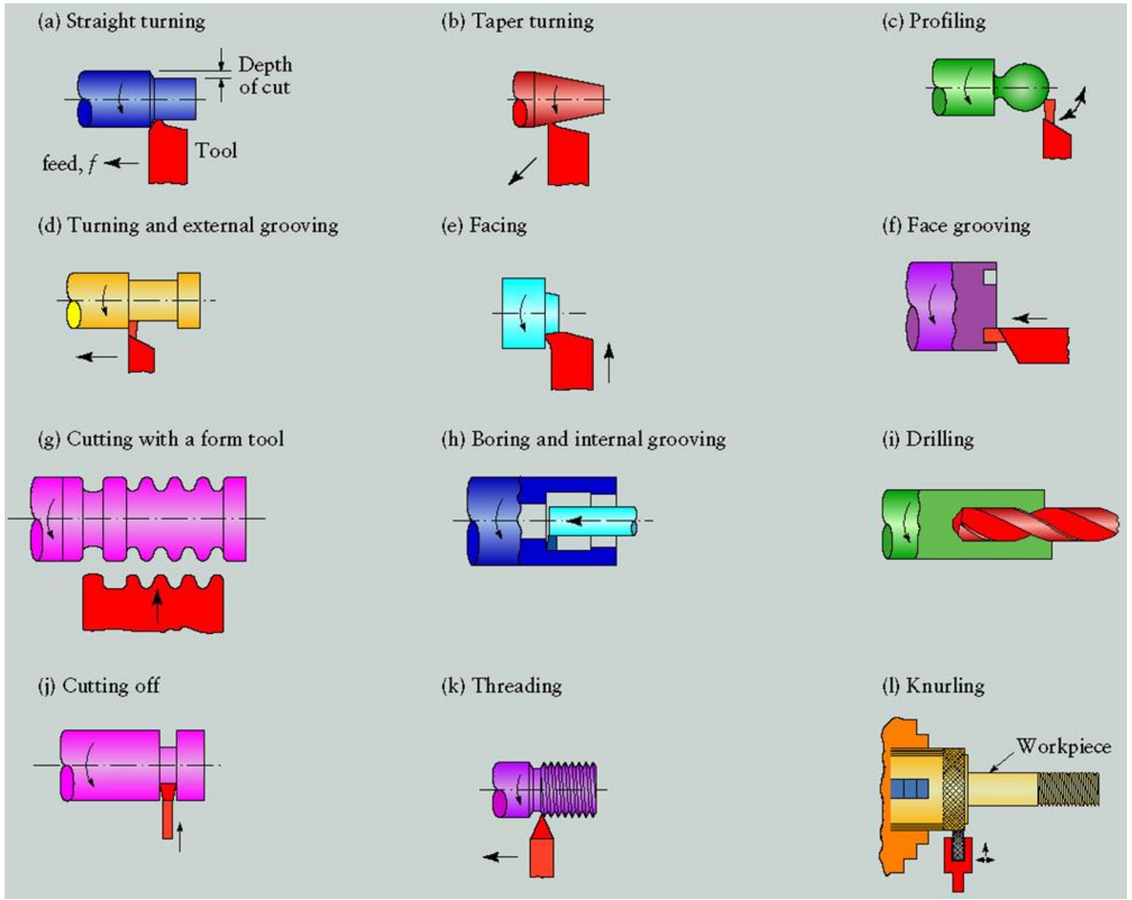
Machines & Machining Issues

Hand's project

Lathe Operations



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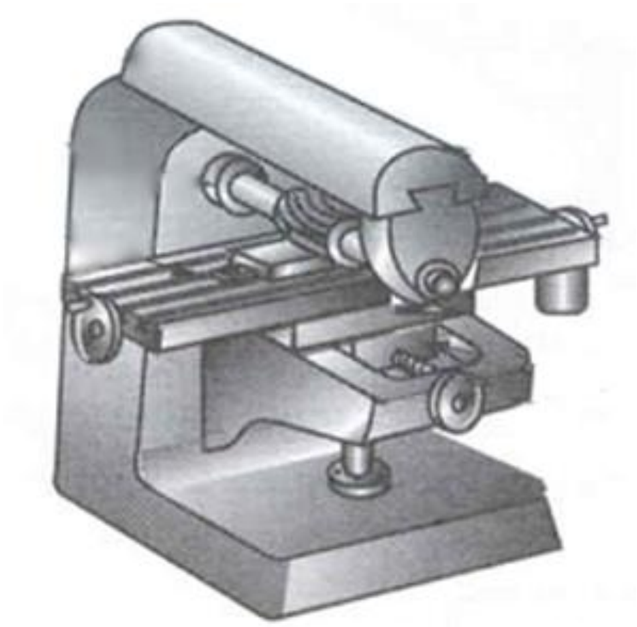
Machines & Machining Issues

Hand's project

Milling

Types of Milling Machines

- Horizontal Milling Machine
- Vertical Milling Machine



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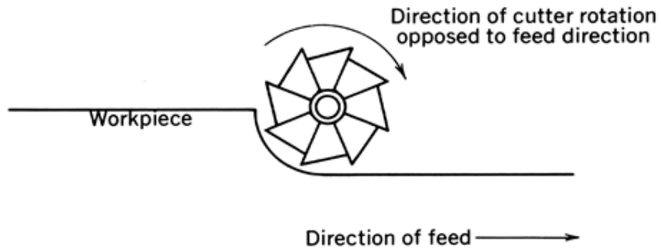
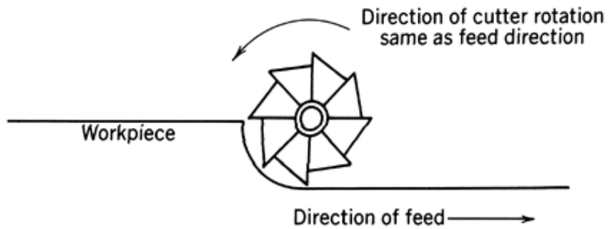
Machines & Machining Issues

Mill Cutting Direction

- ***Conventional (Up) Milling***- Maximum thickness of chip at end of cut



- ***Climb (Down) Milling***- Maximum thickness of chip at start of cut.



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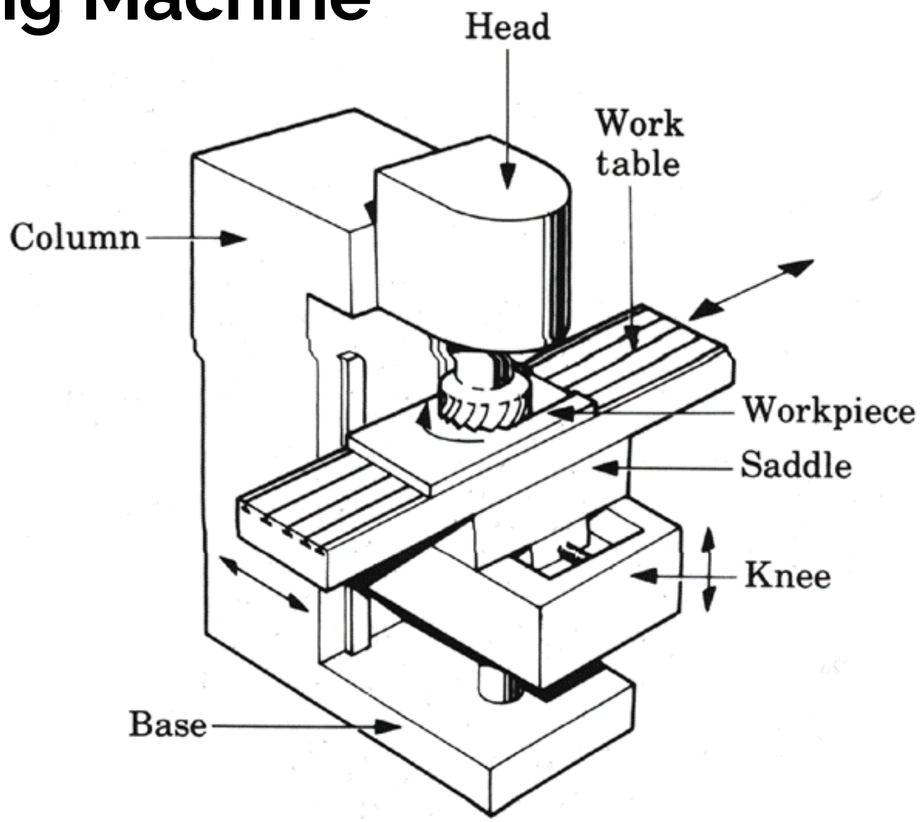
Machines & Machining Issues

Vertical Knee Milling Machine

- Base and Column- support structure
- Knee-Connected to slide on column- can move up and down
- Saddle-Engages slide on top of knee- can be moved in and out.
- Table-Engages slide atop of saddle- moved lengthwise. Holds workpiece.
- Ram-Engages swiveling slide atop column.
- Toolhead-Attached to end of ram, contains motor and quill.
- Quill-Non rotating, but contains rotating spindle. Can be moved up and down.



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Machines & Machining Issues

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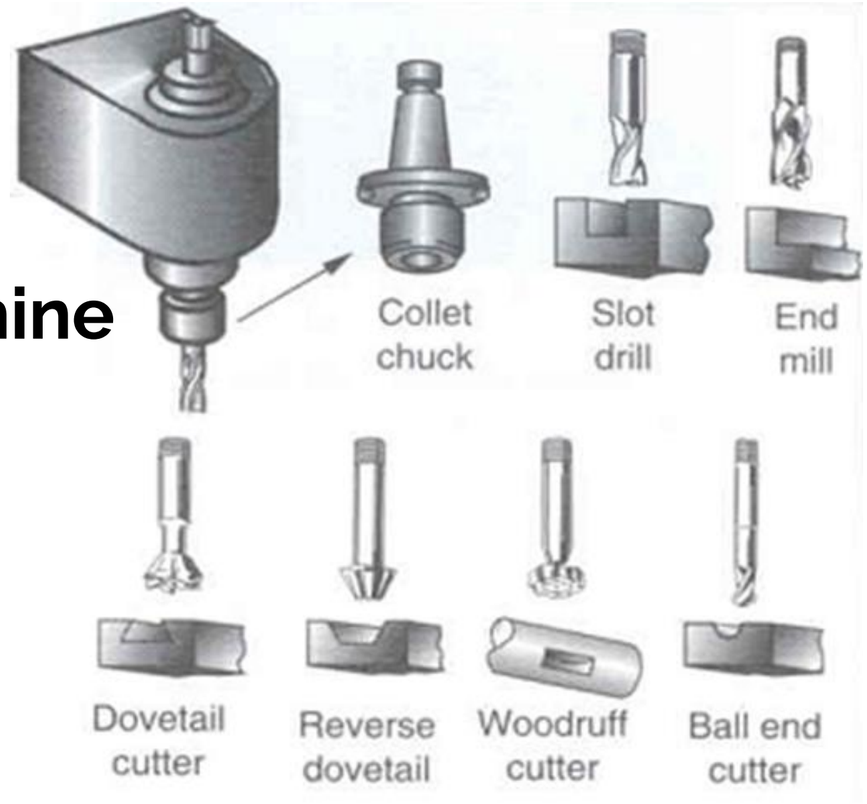
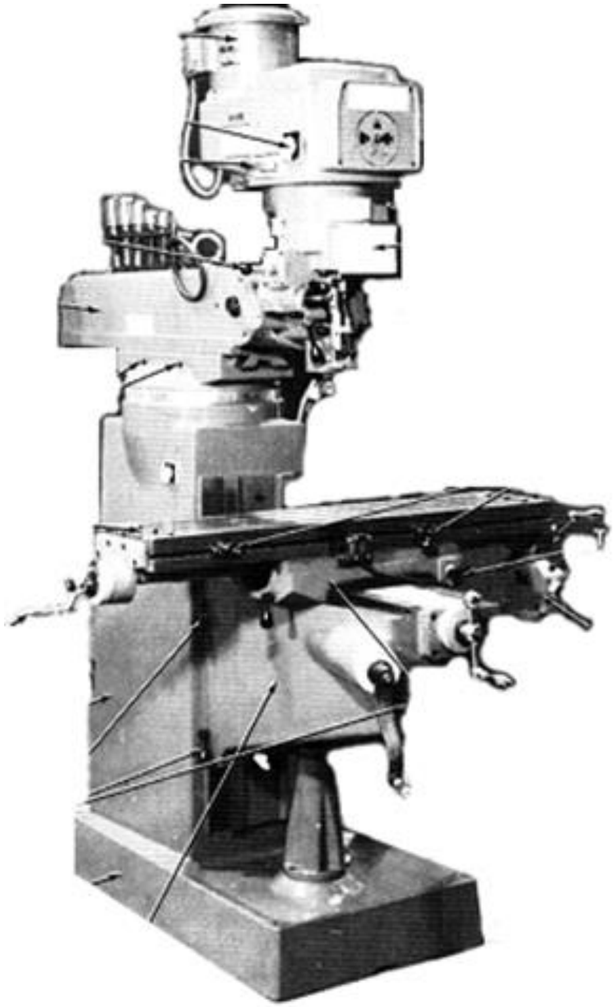
Vertical Milling Machine

- Flexible
- Versatile
- Newer machines – more DOF





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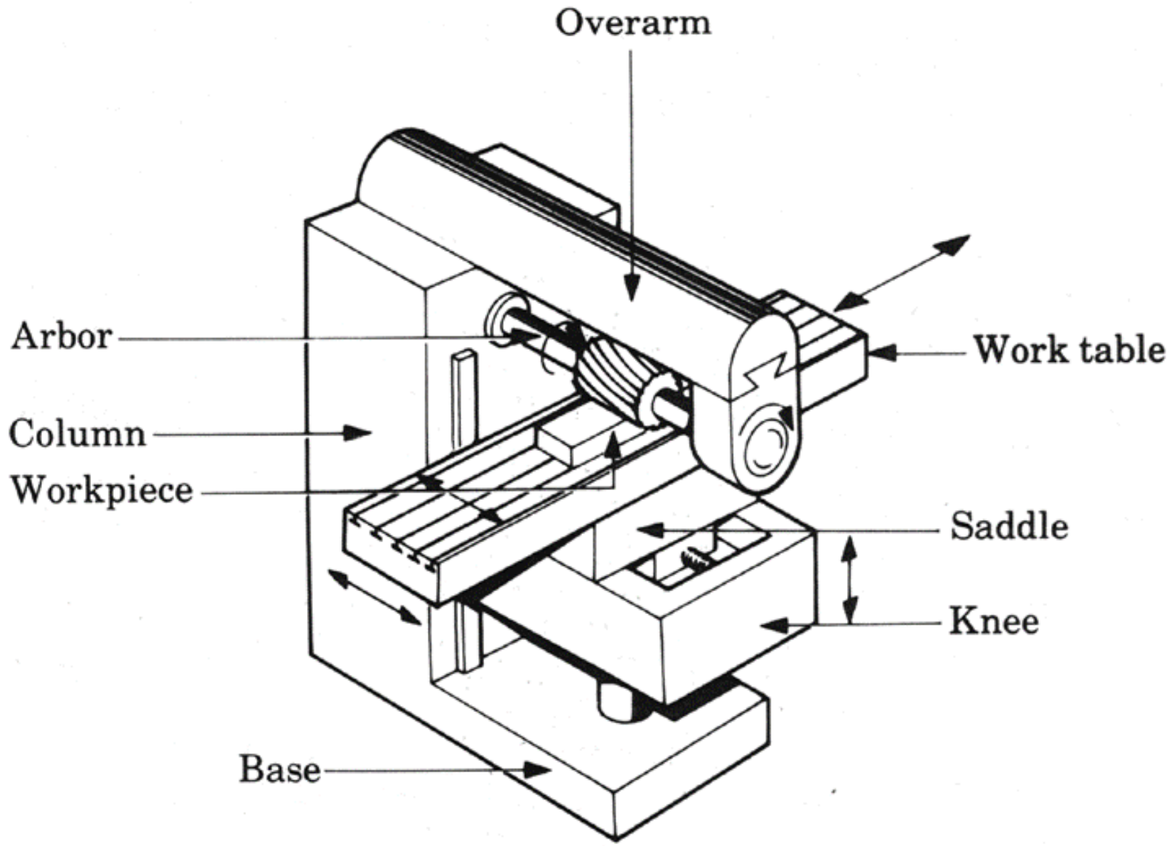
Machines & Machining Issues

Horizontal Milling Machine

COMPONENTS

- Base & Column
- Knee
- Saddle
- Table
- Spindle
- Overarm & Arbor Support



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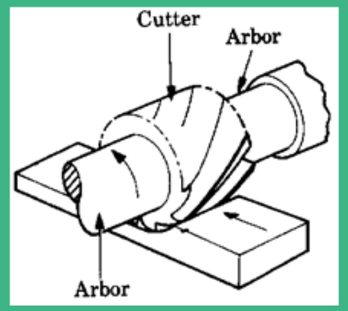
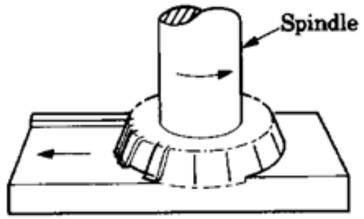
Machines & Machining Issues

Types Horizontal Milling Operations

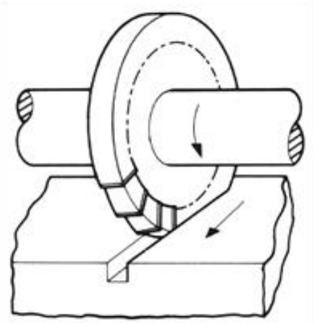
Slab- Axis of cutter // to workpiece surface



Face- Axis of rotation to workpiece surface



Side- Axis of cutter // to workpiece surface



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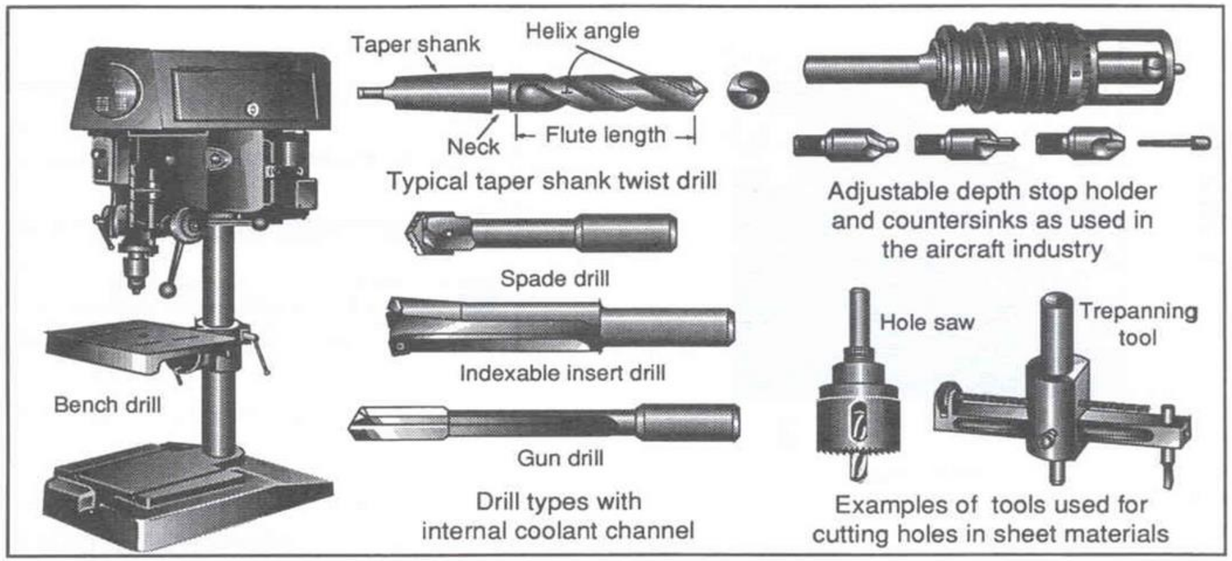
Machines & Machining Issues

Drilling

- Drilling is the operation of producing circular hole in the work-piece by using a rotating cutter called DRILL.
- The machine used for drilling is called drilling machine.
- The drilling operation can also be accomplished in lathe, in which the drill is held in tailstock and the work is held by the chuck.
- The most common drill used is the twist drill.



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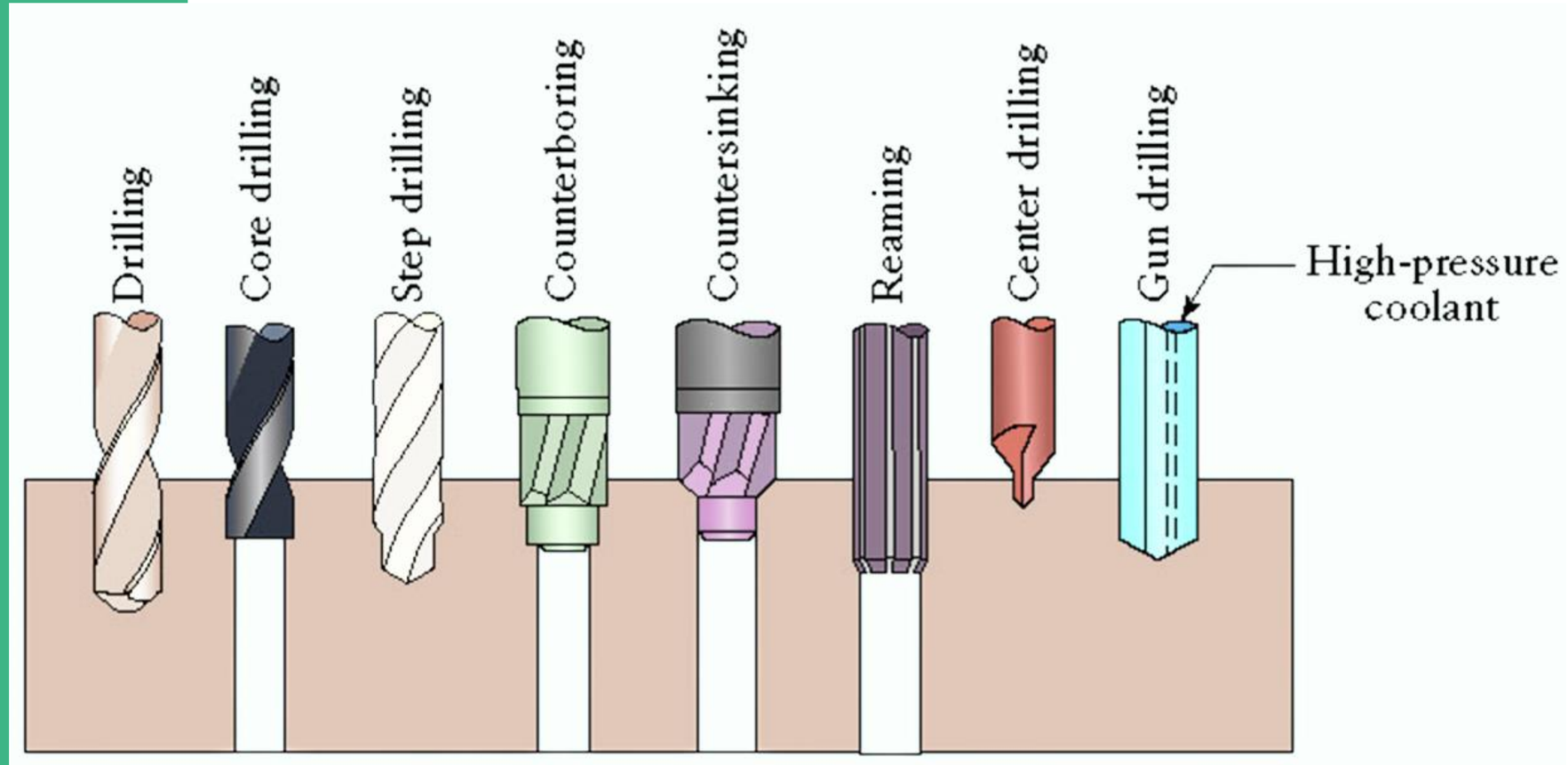
Machines & Machining Issues

Drills and Drilling Operations



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CNC MACHINES

Hand's project

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CNC Machines

What is a CNC Machine?

CNC : Computer and Numeric Control

Conventionally, an operator decides and adjusts various machines parameters like feed , depth of cut etc. depending on type of job , and controls the slide movements by hand. In a CNC Machine functions and slide movements are controlled by motors using computer programs.

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CNC Machines

Types of Machine

Lathes for metal and plastics

- Used to produce 3D product shapes and moulds for plastic products.
- Automated version of a manual lathe.
- Programmed to change tools automatically.
- Used for turning and boring wood, metal and plastic.

Milling machine for mould making and surface milling.

- Used to produce dies for die cutting printed products.
- Has 3 to 5 axes.
- Used for wood, metal and plastic.
- Used to make 3D prototypes, moulds, cutting dies, printing plates and signs.

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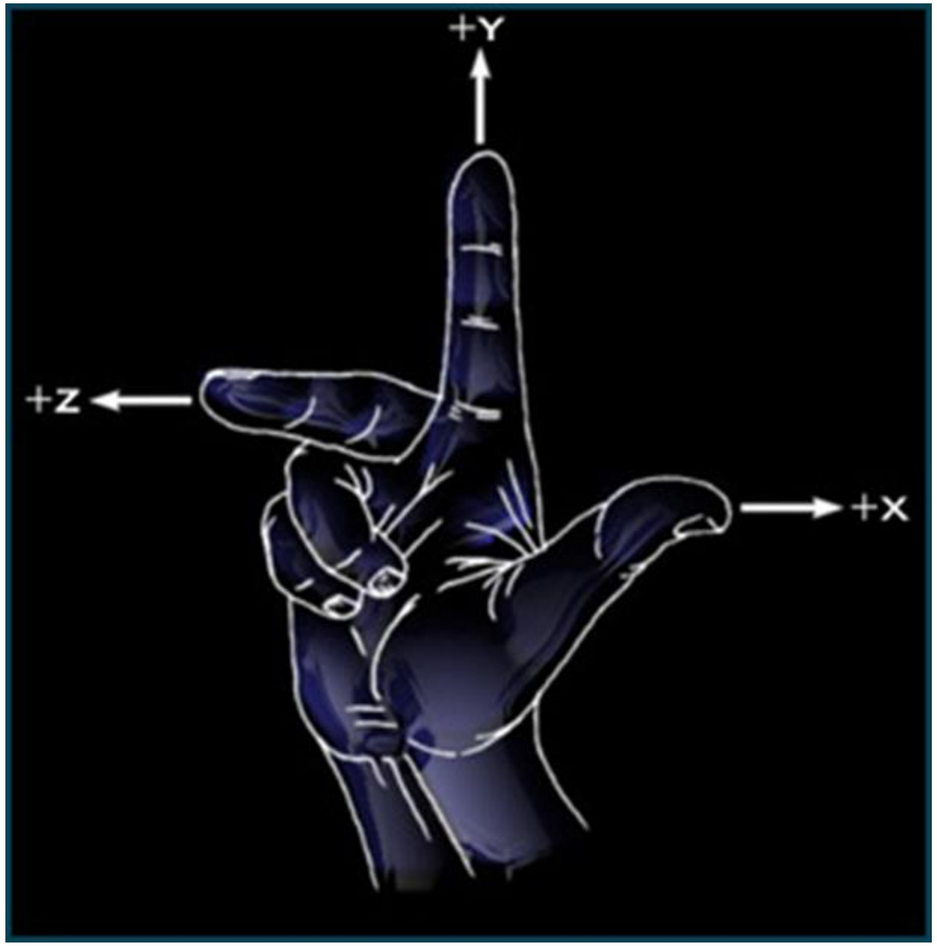
CNC Machines

Machine coordinate system

- The direction of each finger represents the positive direction of motion.
- The axis of the main spindle is always Z, and the positive direction is into the spindle.
- On a mill the longest travel slide is designated the X axis and is always perpendicular to the Z axis.
- If you rotate your hand looking into your middle finger, the forefinger represents the Y axis.
- The base of your fingers is the start point or (X0, Y0, Z0).



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CNC Machines

Axis and motion nomenclature – Rotary motion designation

- The right-hand rule for determining the correct axis on a CNC machine may also be used to determine the clockwise rotary motion about X, Y, and Z.
- To determine the positive, or clockwise, direction about an axis, close your hand with the thumb pointing out.
- The thumb may represent the X, Y, or Z direction and the curl of the fingers may represent the clockwise, or positive, rotation about each axis.
- These are known as A, B, and C and represent the rotary motions about X, Y, and Z, respectively.

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CNC Machines

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How CNC Works

- Controlled by G and M codes.
- These are number values and co-ordinates.
- Each number or code is assigned to a particular operation.
- Typed in manually to CAD by machine operators.
- G&M codes are automatically generated by the computer software.

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CNC Machines

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Features of CNC Machinery

- The tool or material moves.
- Tools can operate in 1-5 axes.
- Larger machines have a machine control unit (MCU) which manages operations.
- Movement is controlled by a motors (actuators).
- Feedback is provided by sensors (transducers)
- Tool magazines are used to change tools automatically.

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CNC Machines

CNC Programming Basics

- CNC instructions are called part program commands.
- When running, a part program is interpreted one command line at a time until all lines are completed.
- Commands, which are also referred to as blocks, are made up of words which each begin with a letter address and end with a numerical value.
- Each letter address relates to a specific machine function. “G” and “M” letter addresses are two of the most common. A “G” letter specifies certain machine preparations such as inch or metric modes, or absolutes versus incremental modes.
- A “M” letter specifies miscellaneous machine functions and work like on/off switches for coolant flow, tool changing, or spindle rotation. Other letter addresses are used to direct a wide variety of other machine commands.

CNC Machines

CAD/CAM

- Two computer-based systems which impact the use of CNC technology are computer aided design and computer aided manufacturing.
- A computer aided design, or CAD, system uses computers to graphically create product designs and models. These designs can be reviewed, revised, and refined for optimum end use and application. Once finalized, the CAD design is then exported to a computer aided manufacturing, or CAM, system.
- CAM systems assist in all phases of manufacturing a product, including process planning, production planning, machining, scheduling, management and quality control.

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CNC Machines

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CNC Machines- Advantages/Disadvantages

Advantages:

- High Repeatability and Precision e.g. Aircraft parts
- Volume of production is very high
- Complex contours/surfaces need to be machined. E.g. Turbines
- Flexibility in job change, automatic tool settings, less scrap
- More safe, higher productivity, better quality
- Less paper work, faster prototype production, reduction in lead times

Disadvantages:

- Costly setup, skilled operators
- Computers, programming knowledge required
- Maintenance is difficult

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Hand's project

Woodworking Projects:

Using CNC techniques.
Using equipment at HANDS workshops

Building a simple wooden furniture piece such as a stool, bench, or side table using joinery techniques like mortise and Tenon, dovetail, or box joints.

Project follow up

Analyzing case studies,
Build 3D model, Composition, Sequence of Experiences, construction of 3D object

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Hand's project

Woodworking Projects:

Using CNC techniques.
Using equipment at HANDS workshops

Carving a decorative relief panel or sculpture from a block of wood, exploring different carving tools and techniques.

Project follow up

Analyzing case studies,
Build 3D model, Composition, Sequence of Experiences, construction of 3D object

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Hand's project

Wood Projects

Wood carving and Inlay

description

In this workshop, you will learn several different ways to embellish and enhance your woodworking projects using wood inlay. We will teach the basics of string inlaying and cutting recesses for inlay. You will learn to cut and inlay a 5-point geometric star. If time allows, we may also look at sand shading techniques. If you have a favorite block plane, feel free to bring it.
This course will introduce you to veneer and show you how to decorate wooden objects with it.

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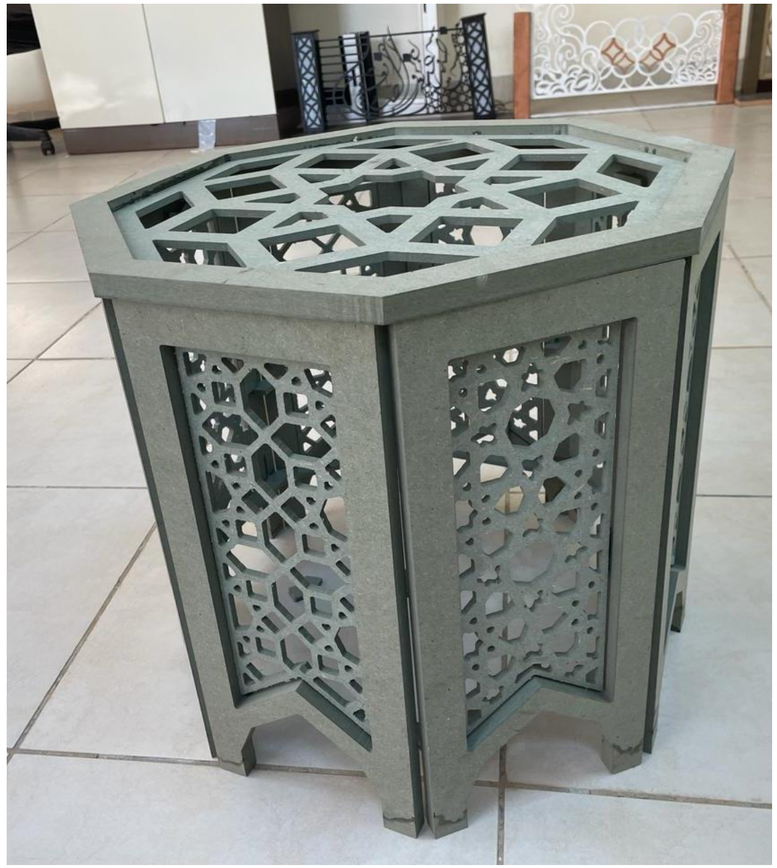

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Hand's project

Woodworking Projects:

Using CNC techniques.
Using equipment at HANDS workshops

Joinery Box: Design and construct a small box using different joinery techniques such as dovetail, finger joints, or box joints. Students will learn precision cutting, assembly, and finishing techniques.
Project follow up

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Hand's project

Metal Forming Projects:

Using Laser Cutter and Saw's techniques.
Using equipment at HANDS workshops

Geometric Metal pattern : Design and construct a small geometric metal shape using different cutting techniques.
Students will learn precision cutting, assembly, and finishing techniques.

Project follow up

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Hand's project

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