Relevant Knowledge

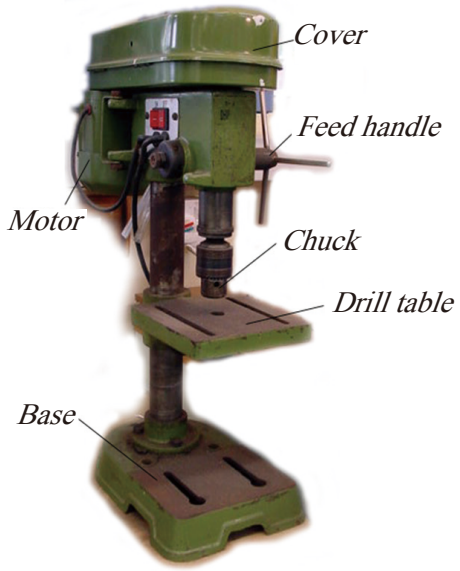
I. Safe Use of Tools and Equipment

In secondary one teaching materials, we have discussed the safe use of hand tools and introduced a few types of machinery for cutting materials quickly and effectively. In secondary two, teachers will demonstrate the safe use of drilling machines and jigsaws. When possible, students may try to use these machines.

1. Drilling machines

The main function of drilling machines is to drill holes of different diameters on workpieces with drill bits. One of the commonly used drilling machines is bench type.

Drill bits



Part names of a bench type drilling machine

To ensure safety, the following safety precautions must be followed when using a drilling machine.

a. Permission must be granted from teachers before using a drilling machine. The machine must be used under the instructions of teachers.
b. Before using the machine, a protective shield must be installed on the machine and users must put on goggles.
c. Before turning on the machine, ensure there is sufficient illumination at the work area.
d. When using the machine, never put your fingers or body close to the rotating or operating parts.
e. To prevent the tool from breaking accidentally, do not press with excessive pressure.
f. Workpieces should be firmly mounted.
g. Before moving the workpieces or clearing up the worktable, turn off the power and wait for the machine to stop operating completely.
h. Choose the appropriate drill bits.

2. Jigsaws

The main function of jigsaws is to cut thin plywood or plastic workpieces using thin wire saw blades. The saw teeth must point downwards during operation. Jigsaws are often used to cut curves. When using a jigsaw:

a. Permission must be granted from teachers before using a jigsaw. The machine must be used under the instructions of teachers.
b. Before using the machine, a protective shield must be installed on the machine and users must put on goggles.
c. Before turning on the machine, ensure there is sufficient illumination at the work area.
d. Ensure that the wire saw blade is firmly clamped.
e. When using the machine, both hands should press on the workpiece on its left and right sides respectively. Then follow the line drawn beforehand, slowly push the workpiece forwards. Never let the fingers get too close to the vertically moving part.
f. To prevent the tool from breaking accidentally, do not push too quickly.
g. Before moving the workpieces or clearing up the worktable, turn off the power and wait for the machine to stop operating completely.

A bench jigsaw

II. Selection, Operation, Maintenance and Disposal of Technological Equipment

The best way to process a material is usually a method that can be used to make a product with the lowest cost, while at the same time meeting the various requirements of the product, for example, appropriate size, precision and surface finishing, time limit and quantity.

In the following, we will take the selection of cutting methods as an example to discuss the various considerations when choosing a method. Other material processing methods can be analysed using a similar approach.

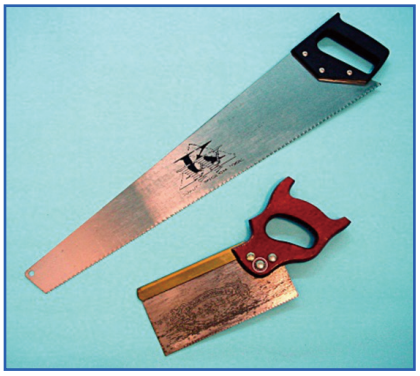
1. Choosing a Cutting Method

Considerations when choosing a cutting method:

a. Limitations of resources
b. Sizes and shapes of workpieces
c. Materials used to make the workpieces
d. Surface quality and precision
e. Quantity of production

(a) Resources Constraints

There are various constraints concerning resources, including manpower, technology, equipment, venue, energy and time. For instance, a goldsmith workshop usually has hand tools or small machinery only. The technology and equipment available in such a workshop is not able to cut large workpieces such as steel beams used for construction. Thus, we should realise the resources we can make use of before choosing a cutting method. For example, we should know whether handsaws, electric saws or sawing machines are available in a workshop, such that an appropriate method can be chosen for cutting aluminium bars according to the needs and available equipment.



Handsaws

Large machinery

(b) Sizes and Shapes of Workpieces

Each type of cutting tool or machinery has its own constraints in the sizes and shapes of workpieces it can handle. For example, regarding cutting machinery, the chucks of lathes can usually hold small- or medium-sized cylinders only, while the length, width and height of the workpiece that a milling machine can handle are limited. However, cutting machinery usually have better strengths, speeds and power, and thus can cut workpieces quickly and remove a lot of materials. When operated by computer programmes, it can cut workpieces with more complex shapes automatically and precisely.

A lathe chuck

Casting workpieces

A hand-held grinder

On the contrary, cutting hand tools, operated directly with hands and driven by small motors, often have weaker strengths, speeds and power. Therefore they are not suitable for cutting hard materials. However, they can be moved by hands flexibly and thus can handle large and irregular workpieces, for example, cutting the excess portions of casting workpieces.

(c) Materials of Workpieces

We often need different cutting tools to handle different materials. For example, wood surfaces are usually flattened by planes but surfaces of metal workpieces are usually made smooth by milling machines or grinding machines. We need to consider the mechanical and working properties of materials, e.g. hardness, toughness and cutting properties, when choosing a proper cutting method and cutting tool. To drill holes on an aluminium sheet, which has a lower hardness, we can select among a hand drill, an electric hand drill and a drilling machine; to drill holes on a much harder steel sheet, we should consider using a drilling machine or some other special cutting methods such as laser cutting.

(d) Surface Quality and Precision

Different products have different requirements for their surface quality and precision, e.g. surfaces of household appliances must be smooth and their components must be tightly joined to each other. Hence, when choosing a cutting method for manufacturing a product, we must consider the surface quality and precision that the method will bring about.

Smooth surface of a household appliance (a blender)

Tight joining interfaces

Different surface quality will result through the use of different cutting tools, e.g. the resulting notches are not the same when a metal rod is cut by a sawing machine or by a lathe. The one caused by sawing is usually uneven while the one made by a lathe tool is smoother.

A rough metal surface

A smooth metal surface

With the advancement of technology, the precision of cutting machines keeps on improving. In contrast, the precision of cutting using hand tools is usually lower and the quality of the products always depends on the operating skills of the tools. However, hand tools are easier to control so that, under certain circumstances, materials can be cut more accurately. For instance, it may be more accurate to use a portable jigsaw, rather than an electric one, to cut wood joints.

(e) Quantity of Production

The quantity and required rate of production of workpieces are important factors to consider in choosing the right cutting method and cutting tool. For example, if we are mass-producing delicate chess pieces from metal rods, we may use large machinery such as computer numerically controlled lathes or automated machine tool centres. On the contrary, if we are only producing a single piece of metal product, we may use tools such as hand tools, drilling machines, lathes and milling machines.

A chessboard

An automated machine tool centre

2. Maintenance of Tools and Equipment

Maintenance can be categorised into regular maintenance and periodic maintenance. Students can participate in regular maintenance also.

a. Before using the tools and equipment, take a look at their outer appearance and check if there is anything unusual. Report it to the teachers if there is any.
b. If the equipment gives unusual sound or smell, or jitters abnormally during use, stop using them and notify the teachers.
c. After using the equipment, clean them and then turn off the power.

Periodic maintenance is usually performed by more experienced people or professionals. Processes carried out in periodic maintenance include:

a. greasing the equipment;
b. applying lubricant to the moving parts;
c. examining the equipment according to the maintenance manuals; and
d. replacing components when their service lives end.

3. Disposal of Tools and Equipment

When disposing of a tool or a piece of equipment, we should consider the following.

a. Is there any way to extend its life?
b. Can it be used in another way?
c. Will other people or organisations need it? If so, we may consider giving it to them.
d. Can recyclers handle it, so that part of its materials can be reused?
e. If improper disposing of some of the materials of the equipment, such as asbestos and waste oils, they may cause impact to the environment. In such cases, we need to refer them to specialised recyclers.
f. Some countries, e.g. European Union, have strict regulations regarding the disposal of electronic devices, ranging from large household appliances, computer equipment to small devices such as computer mice and wrist watches. (Refer to 2002/96/EU and 2012/19/EU)

Relevant Knowledge

III Glossary of Terms

Drilling machine	鑽床		Drill Table	鑽枱
Jigsaw	線鋸床		Base	底座
Chuck	夾頭		Drill bit	鑽咀
Motor	電動機		Accuracy	精確度

IV Relevant Information

http://resources.hkedcity.net/resource_detail.php?rid=1127540799
http://cd1.edb.hkedcity.net/cd/tech_edu/computer_design/video/video.htm

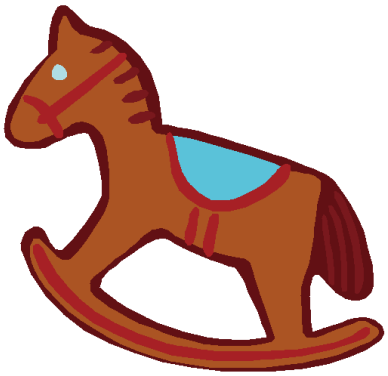
Video: Introduction to Electric Power Tools

Scope	Video names
Safety regulation in workshop	Safety regulation in workshop
Tools and drawings	Plastic cutter Tenon saw Woodwork coping saw Hacksaw Metalwork file Using a marker
Machinery and equipment	Folding acrylic sheet Drilling machine Sander Jigsaw Bandsaw Making conceptual model Operation of vacuum forming
Principles of design and machinery	Four kinds of mechanical motions Hydraulic robotic arm Principle of vacuum forming Conceptual model and real model Exercise on robotic arm
Computer control	LEGO machinery Soldering and connection of cable

Relevant Knowledge

Exercise

1. Make a wooden rocking horse, like the one shown on the right, for children aged two to six. The horse part should be mounted on a curved rocker made of wood.



   (a) What should be considered when making a wooden rocking horse?

   (b) Suggest a method for making the horse part of the toy.

   (c) Suggest and briefly describe two methods that can be used to make a curved rocker.

   (d) Compare the two methods suggested in (c) for wood bending. Which do you think is more suitable?

2. Metals can be cut using either of the following processes.

   (a) Sawing

   (b) Drilling

   Give an application of each of the above metal cutting methods.

4. (a) Write down three material processing methods for producing circular cross-sections.

   (b) Give an application of each of the above processing methods.

5. (a) Write down three methods for producing flat surfaces on materials.

   (b) Give an application of each of the above processing methods.

Project Activity – Tools and Equipment
(Nameplate with Personal Style)

Project Activity Guidelines

1. Objectives

Designing through major design processes and using coping saws and drilling machines, students are going to make a nameplate possessing their personal style.

2. On completion of the design project, students should be able to

1.choose and use appropriate tools for drawing lines.
2.operate coping saws and drilling machines safely.

3. Situation

The chance of having two students sharing the same name in a class is quite rare; students will highlight a nameplate possessing their personal style, characteristics and personality. A nameplate affixing, placing or hanging on their own room doors may be appealing to everyone.

4. Design Brief

Students are going to make use of main design procedures and simple materials to produce a nameplate for affixing, placing or hanging on their room doors, bedheads, desktops, clothes or locker doors, highlighting their personal characteristics and personality.

5. Recommended Time

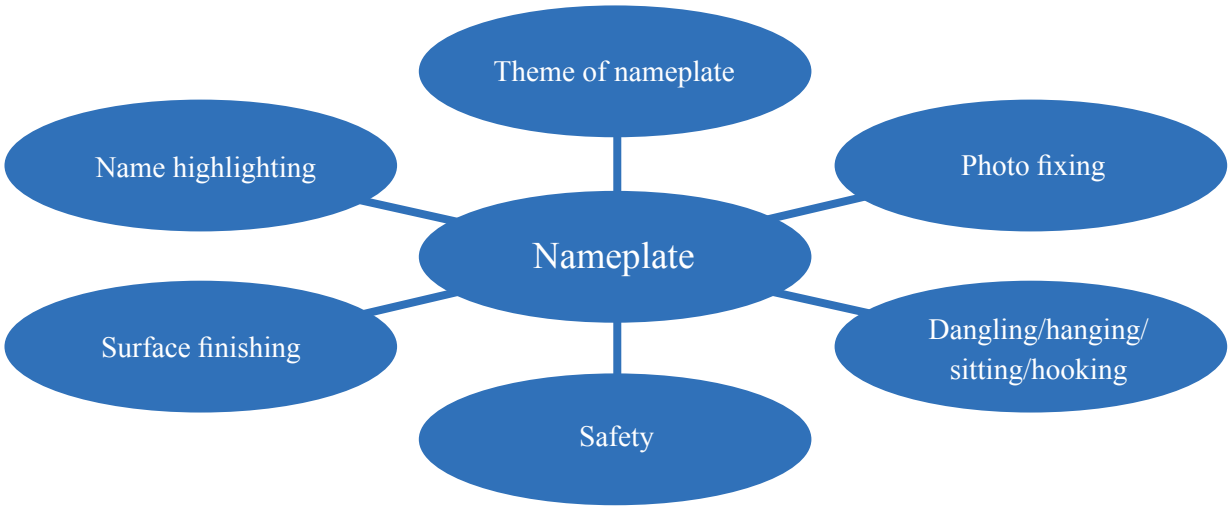
5 teaching periods × 40 minutes (total 200 minutes)

6. Required Materials

1. A piece of plywood (75mm × 125mm × 5mm)
2. A coloured plastic board (75mm × 125mm × 2.5mm)
3. A few other materials

7. Activity Content

(a) Considerations



The following issues should be considered when designing and making a nameplate.

(i) What is the theme of the nameplate?
(ii) What are the characteristics of the nameplate?
(iii) How to highlight the name?
(iv) How can the nameplate sit on a table or be hung on a vertical/slanted surface?
(v) What is the method to be used for surface finishing?
(vi) Safety considerations

(b) Production procedures

(i) Choose a theme.
(ii) Design the appearance.
(iii) Design the style of the name.
(iv) Choose a suitable material for each part.
(v) Choose suitable production methods and tools.
(vi) Make each component.
(vii) Assemble the components.
(viii) Perform surface finishing on the nameplate.

Safety tip: When carrying out this activity, you will use coping saws and drilling machines. When possible, teachers will let you use jigsaws as well. Be careful when using them.

(c) Design folio

The design folio may include the following items in order to record the design process.

(i) Cover
(ii) Table of contents
(iii) Situation
(iv) Design brief
(v) Design specifications
(vi) Data collection
(vii) Proposed solutions
(viii) Realisation (pictures can be used to record part of the production process)
(ix) Testing
(x) Evaluation

Basic Design Drawing

Draw your design in the following area on a 1:1 scale and colour it.

Design Characteristics

Describe your design characteristics with no less than 30 words.

_____

_____

_____

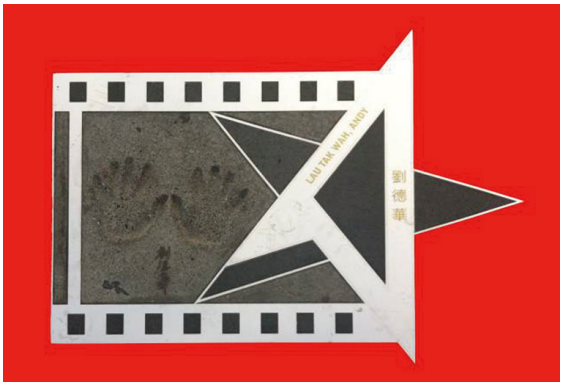
_____

Tools and Equipment used

Part of nameplate	Tools used

References:

A nameplate of a photographer

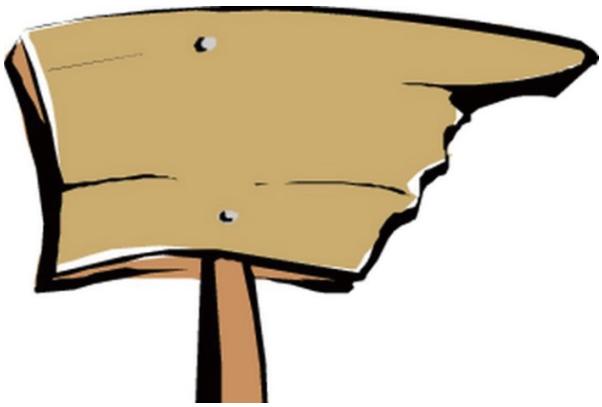


With the autograph and hand imprint of a star

A special license plate

Cartoon characters with a geometric shape

A metal road sign



A wooden sign