FACTFILE:

GCSE Technology and Design

UNIT: TECHNOLOGY AND DESIGN CORE CONTENT

Rewarding Learning

1.4 Appropriate methods of joining

Learning Outcomes

You should be able to:

- demonstrate understanding of the main features and applications of the following permanent joining methods:
  - soft soldering, brazing and welding;
- demonstrate understanding of the main features and applications of the following semi-permanent joining methods:
  - knock-down fittings.

Course Content

There are many ways in which materials can be joined. The joining method will depend on the type of material and whether or not the joint needs to be permanent or semi-permanent.

- permanent: a joint which cannot be reversed without causing damage to the material (the joint is intended to stay put for the life cycle of the product).
- semi-permanent: a joint which can be reversed without causing damage to the material (the joint can be disassembled perhaps for repair, maintenance or transportation purposes).

Permanent joining methods

Soft soldering, brazing and welding are permanent methods of joining metal parts using intense heat. In simple terms, soldering and brazing cannot melt the metal parts together but the joint can be heated and filled with a 'filler metal' ensuring a strong and permanent bond.

Welding is a much higher temperature method of joining metals than soldering and brazing which actually melts (fuses) the metal parts together.

Welded joints are also permanent and the strongest way of joining metal.

Soft Soldering

Soft soldering is the process of permanently joining metal parts which are generally small or which may become damaged using very high temperature joining methods. Soft soldering uses a filler metal (solder) which melts at temperatures below 450°C, this is commonly done in two ways:

1. Using a soldering iron (to join electronic components).
2. Using a gas or electric torch (to join metals objects e.g. jewellery, copper pipes etc.).

Applying high levels of heat to metal will cause a vapour oxide to form on the surface and prevent the solder from adhering to it. A type of paste known as flux should be applied to the joint beforehand to prevent oxidisation and help ensure that the solder adheres to the metal.

Soldering electronic components

Soldering is widely used for joining electronics components and wires as shown in Figure 1. A soldering iron is required rather than a naked flame from a gas torch as this would obviously burn the components and the Printed Circuit Board (PCB). Flux is not normally necessary as most manufacturers produce solder with flux contained inside. Components which could be easily damaged by heat should be protected with a heat sink, for example, by attaching a crocodile clip or using long nosed pliers to draw the heat away from the component (but not the joint).

Soldering process:

1. Ensure copper tracks/pads on the PCB are free from grease and fingerprints.
2. Insert electronic components / wires into the PCB.

3. Heat the joint evenly with the tip of the soldering iron.
4. Apply solder to the joint.
5. Remove soldering iron and solder and allow the joint to cool.

Figure 1

Soldering metal objects

Soft soldering is an excellent joining method for joining metal objects which are not subject to mechanical stress. It is widely used by jewellery makers and plumbers. The bond is achieved by using a gas torch to melt the filler metal (solder) which flows into the joint as shown in Figure 2. Using flux is vital.

Figure 2

Soldering process

1. Clean the joint ensuring it is free from grease and fingerprints (use wire wool if necessary).
2. Secure metal parts closely together with minimal gaps.
3. Apply flux to the joint (to prevent oxidisation).
4. Heat the joint evenly and apply solder.
5. Allow to cool.

Brazing

Brazing uses a filler metal which melts at temperatures above 450°C. It is a similar process to soft soldering but is much stronger because a brass alloy is used as the filler as shown in Figure 3. Although brazing it is not as strong as welding, it is much more precise and dissimilar metals can be joined.

Figure 3

Welding

Welding uses extremely high heat to join metal by fusing (melting) the parts together. Welding is the strongest joining method and is usually associated with gas and high current electric (arc welding), however, laser, friction or ultrasonic energy can also be used to join plastics and other dissimilar materials. The following industrial methods are widely used for joining metal and can be used in school workshops.

Oxy-acetylene

This type of welding makes use of acetylene gas and oxygen to create a flame of around 3000°C which melts metal parts together (a filler metal can be added). Oxy-acetylene is used less frequently than arc welding (see MIG and TIG below) but does have the advantage of being portable since an electric power source is not required as illustrated in Figure 4.

Figure 4

MIG and TIG welding
MIG and TIG welding make use of an electric arc and gas to join metal as illustrated in Figure 5. MIG (Metal Inert Gas) and TIG (Tungsten Inert Gas) fuse metal parts together at temperatures of up to 20000°C. In TIG welding a filler metal (rod) can be used as an option but in MIG welding it is fed into the joint semi-automatically (through a spool). MIG and TIG welding are by far the strongest joining methods for joining metal and can even be fully automated using robot technology.

Figure 5

Semi-permanent joining methods

Knock-down fittings
Knock-down fittings are a type of mechanical joining method used to assemble products such as flat pack furniture, kitchen units, beds etc.

There are many different types of knock-down fitting but they generally use some type of screw fixing, dowel, bracket or block to pull the joint together. Typical Knock-down fittings include:

- cabinet screws
- cam lock fittings
- cross dowels
- shelf supports

Advantages of Knock-down fittings
Knock-down fittings can be used by anyone who has access to screw-drivers or allen keys. There is no need for the 'assembler' to mark out, cut or drill. A cam lock fitting cleverly pulls the man made panels together giving a precise finish. The cam lock is hidden so as not to impact on the aesthetic look of the product.

Knock down fittings provide companies with the option for flat-pack assembly which makes large products easy to store and transport thereby saving money. Knock-down fittings can also be cost effective as a joining method as they do not require expensive equipment or skilled labour. Another perceived advantage of knock down fittings is that the product can disassembled again if required.

Revision questions

1. Identify the most appropriate joining method for each of the following:

   a. joining a transistor to a copper track on a PCB.

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   b. joining two pieces of steel when manufacturing a jack for a car.

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2. Explain the key differences between soldering and brazing as a method of permanently joining metal.

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3. Give **one** advantage of oxy-acetylene welding over MIG and TIG welding.

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Student Task

Using a sketch, clearly illustrate how **two** pieces of manmade board could be semi-permanently joined using a knock-down fitting of your choice. Use the following link as a starting point:

http://wiki.dtonline.org/index.php/Knock_Down_Fittings,_Brackets_and_Plates

http://www.technologystudent.com/joints/kdown2.htm