INDMS401 PRODUCING MODELS ON SCALE

Introduction

Making Model is a very important stage in the design and construction of any manufactured piece. **Model is a physical representation of a structure and provides a visual representation of how a finished piece will look**, and, often more importantly, demonstrates how a finished piece will function. For the model maker, it is important that the selection of materials and construction techniques is appropriate for the finished piece. For example, if the model is being used to test strength as well as visual appearance, then it is likely that the materials and construction techniques used will replicate those of the finished piece. If, however, a visual representation is all that is needed, then it is likely that a model will be constructed of cheaper materials than the finished piece.

Learning Unit 1. **Select suitable model materials**

Learning Outcome 1.1: Identify materials, tools and equipment according to the drawing.

- Types of materials and their functions

a) Cardboard: is a generic term for heavy-duty paper-based products having greater thickness and superior durability or other specific mechanical attributes to paper; such as foldability, rigidity and impact resistance.
b) Chipboard may refer to: A type of paperboard generally made from reclaimed paper stock
c) Plywood: Is a material manufactured from thin layers or "plies" of wood veneer that are glued together with adjacent layers having their wood grain rotated up to 90 degrees to one another
d) Medium-density fiberboard (MDF): Is an engineered wood product made by breaking down hardwood or softwood residuals into wood fibers, often in a defibrator, combining it with wax and a resin binder, and forming panels by applying high temperature and pressure. MDF is generally denser than plywood.

Chipboard, plywood and MDF: these are useful for making a rigid base for your model. The base should not warp or bend. MDF can be used to make large models of buildings where you want to show the rooms inside. Chipboard has the coarsest finish. MDF has a very fine finish and needs no sanding. Sheets measure 2400 x 1200 mm and come in various thicknesses. Many DIY (Do It Yourself) shops sell small, pre-cut sheets.

Thicknesses for full sheets are given below.

Chipboard 12 mm, 18 mm A 12 mm thick sheet.

MDF 3 mm, 6 mm, 12mm, 15mm, 18mm A 12 mm thick sheet

Plywood 3 mm, 6 mm, 12 mm, 18 mm A 12 mm thick sheet

e) Kappaboard: (two sheets of thin card with a layer of foam between them) is useful for making large-scale models of buildings on which you want to show the interior walls and rooms. It comes in two sheet sizes (see below) and two thicknesses, 3 mm and 5 mm. It looks good, is easy to cut with a blade and is thick enough to represent the thickness of a wall at scales from 1: 100 to 1:50. It is available from some artists' and drawing supply shops, but is expensive. (MDF can do the same job much more cheaply, but it has to be cut and shaped with a saw.)

Sheets 200 x 300 mm. 3 mm thick and 5 mm thick

Sheets 400 x 400 mm. 3 mm thick and 5 mm thick

f) Timber: a timber is used to make timber dowel Useful for making columns or pillars. Available in diameters of 6 mm, 9 mm, 12 mm, 15 mm, 18 mm, 21 mm and 25 mm

g) Cork: Cork flooring tiles are available in packs from DIY stores. They are easy to cut with a fine blade and have a "natural" feel. They are good for modeling landscapes and can be built up in layers to model hilly sites.

h) Balsa wood: Balsa wood is available from hobby shops. It is available in thin sheets and in sections from 1 x 1 mm to 50 x 50 mm. It comes in 1 meter lengths. Balsa wood looks well. It is light, easy to cut and sand, and can be used to make very detailed models. It is the best material for structural models in which you want to show only the "skeleton" of the building. However, it is expensive.

i) Other materials
   - ✓ Bamboo
   - ✓ Maize/sorghum
   - ✓ Saw dust and

All sorts of scrap materials such sheets of metal, small machine parts, foam rubber, flower arranging foam, plastic tubing, paper, wire cables, nylon tights, fabric, wood-shavings, bits of dried shrubs and weeds , can be put to good use in model making, particularly for making landscapes or for forming buildings of unusual shapes. However, make sure the materials are sturdy enough for the job so that all your hard work is not wasted. Cornflake packets do not make good models.

j) Adhesives:
   - ✓ PVA adhesives Use for paper, cardboard, wood. Sets in 20-30 minutes. Wood must be clamped while drying.
   - ✓ Contact adhesive Use for plastic, metal, wood. Sets on contact.
   - ✓ Balsa cement Use for wood, cardboard, metal, glass. Fast drying.
   - ✓ Polystyrene cement Use for hard plastic materials. Fast-drying.

k) Glue: Glues such as UHU POR or POLY ZAP are amongst the most suitable for foam-based boards although balsa glue can be used for balsa wood.
Glue is carefully applied to join all the parts permanently together.

- **Types of tools and their functions**

1) **Steel ruler:** Steel ruler is used to measure and make cutting lines on boards
2) **Pencil:** Used to draw lines on boards
3) **Welding file:** used to refine the cut edge of wooden, metal and plastic pieces for model making.
4) **A craft knife and cutting mat**: are essential model making tools. They can be used to cut model making foam boards as well as paper and card. A craft knife should always be used with a steel ruler when cutting straight lines, ensuring that hands and fingers are kept behind the cutting edge.
5) **Scissors**: A model maker will inevitably need a selection of scissors to cut shapes. Scissors have the relative advantage of being comparatively safe compared to craft knives.
6) **Clamp**: clamp is a tool used to hold pieces together like piece of wood or metal.
7) **Gripper vice**: Versatile modeler's vise to hold irregular shaped objects securely. Piece is held in place by four metal pegs you **insert into each half of the vise.**
8) **Strip cutting tool**: Ideal for cutting your own strips of balsa, card or thin plastics
9) **Razor:** slim blade used to cut cardboard, thin plastic, papers
10) **Screw driver:** A screwdriver is a tool, manual or powered, for screwing and unscrewing (inserting and removing) screws
11) **Saw:** This tool is used in model making to cut wood, MDF, Plywood, Chipboard.
12) **Model Hammer:** hammer is used to fix nails
13) **Fretsaw:** is a bow saw used for intricate cutting work which often incorporates tight curves. Are used when cutting lightweight materials such as MDF, plywood, plastic materials and model making materials such as depron and zepron.
14) **Coping saw:** a saw with a very narrow blade stretched across a D-shaped frame, used for cutting curves in wood.
15) **Sander:** A sander is a power tool used to smooth surfaces by abrasion with sandpaper.

- **Types of equipment and their functions**

1) **Jigsaw:** is a powered handsaw with narrow blade which moves up and down (reciprocates) to enable the tool to make curved and intricate cuts.
2) **staple gun:** A staple gun or powered stapler is a hand-held machine used to drive heavy metal staples into wood, plastic

3) **Glue gun**: can be used to quickly fix materials together. However, the glue can be very hot and so care should be taken when using the gun. Foams tend to melt if glued with a hot glue gun. Test a scrap piece of material first. This type of glue is best used with harder materials.
4) **Hot wire cutter:** can be used to shape a variety of model making foams including Styrofoam. This is a specialist model making material easily cut and shaped by a hot wire. Styrofoam can also be cut and shaped with hand tools although less accurately. Most hot wire cutters have a central wire fixed between two points and a hand held wire cutter. This is useful for free had styling and shaping.
5) **A solid board.** Plywood or MDF where you will work on your model. Do not work directly on a table top or on a drawing board - you will damage them.

Learning Outcome 1.2: Identify finishes according to materials' requirement

- **Types of materials and their functions**
  1) **Paint:** the paint is used to provide a good look to the model
  2) **Varnish:** the varnish is used to give a shine and smooth surface to the model, especial the model mad with MDF, plywood, chipboard.
  3) **Printed paper:** this is a kind of finishing using the paper containing the picture, paint, color or other pleased images that can be printed and applied to the model as finishes.
  4) **Saw dust:** saw dust mixed with glue can be used as finishing materials by applying them to the model as plastering purpose.
  5) **Fine sand:** the fine sand can be also applied to the model by means of glue to provide a rough surface.
- **Types of tools used in model finishing and their functions**
  - ✓ Brush: application of paint on the model components
  - ✓ Sand paper: polishing or refining the model components
  - ✓ Small roller: this is used to apply paint on model
  - ✓ Scissors; this is a tool used to cut the printed paper or other model components which can be used as finishing material
  - ✓ Razor: have the same function as scissor
  - ✓ Glue gun: is tool used to apply glue on a model either for joining or sticking model finishes.
- Types of equipment used in finishing of model and their functions
  - ✓ Painting spray gun: used to spread paint on model components
  - ✓ PPEs (gloves, overall) for body protection

Learning Outcome 1.3: Assess materials' availability according to their affordability.

- Sources of materials

Cardboard, MDF, Chipboard, balsa board, and other materials used to make models are available from any builders' suppliers, hobby shops, artists' and drawing shops and most DIY shops. But there are others which can be found naturally such as maize and sorghum stalks, bamboo, saw dust.

- Prices of materials

Some of these materials used to make models are not affordable where their price is high compared to others especially for those found in DIY shops.

Here is the price of some materials:

- ✓ Chipboard 12 mm, 18 mm

  A 12 mm thick sheet costs £ 1 1.50.
- ✓ MDF 3 mm, 6 mm, 12mm, 15mm, 18mm

  A 12 mm thick sheet costs £ 18.00
- ✓ Plywood 3 mm, 6 mm, 12 mm, 18 mm

  A 12 mm thick sheet costs £ 26.00
- ✓ Balsa wood

  A 1 mm x 75 mm length will cost about £ 3.00.

  A 1 mm x 1 mm length will cost 50p.

  A 50 mm x 50 mm length will cost £5.00.
- ✓ Timber dowel

  6 mm diameter dowel costs about £1 for a 2400 mm length.

  12 mm diameter dowel costs about £2 for a 2400 mm length.
- ✓ Mounting board

Depending on thickness, the price ranges from £ l.25-£2.OO for an A1 sheet (840 x 595 mm).

- ✓ Pulp board is cheaper, at about 35p for a sheet which is somewhat smaller than A1.
- ✓ Kappa board: is expensive and is available in the following sizes and thickness

Sheets 200 x 300 mm. 3 mm thick, £2.90. 5 mm thick, £4.50

Sheets 400 x 400 mm. 3 mm thick, £5.75 5 mm thick, £8.50

Learning Unit 2: Make model components on scale

Learning Outcome 2.1: Select scales according to the project size.

- Principles of scaling

- ✓ Scale is referred to the real object either to enlarge or to reduce
- ✓ Scale respect the law of proportionality

- ✓ Scale refers to overall size of the real object or image
- ✓ Large scale objects create obvious visual weight
- ✓ If an object is out-of-scale or oddly proportioned, then it will create a point of emphasis.

- Techniques of scaling

- ✓ Start by measuring the width and height of the object you'll be scaling.
- ✓ Choose appropriate scale to reduce the size of your image or object, such as 1:10, 1:20, 1:50, and 1:100 depending on the sizes of your paper.
- ✓ Choose a ratio to resize your drawing, such as 2 to 1 to double the image in size then, multiply your measurements by the first number in your ratio to increase the size.
- ✓ Make conversion of scale of the real measurement or sizes of object or image.

Examples on how to make scale conversion

1) Room scale size at scale 1:100

A room of 5.2 meters by 4.8 meters, what is the scale size for the building plan at scale 1:100 ?

First, we can convert the unit from meter to centimeter.

5.2 m = 5.2 × 100 = 520 cm

4.8 m = 4.8 × 100 = 480 cm

then, convert by scaling

520 cm × 1 ÷ 100 = 5.2 cm

480 cm × 1 ÷ 100 = 4.8 cm

So we have to draw a room of 5.2 x 4.8 cm

2) To calculate the real length, use scale length multiply the scale factor of it, then divide the scale factor of real length, for example

Scale ratio 1:200

Scale length: 5 cm

Real length: 5 cm × 200 ÷ 1 = 1000 cm

3) Door actual width at scale 1:50

On the building plan the width of the front door is 18.6 mm.

and the scale of the plan is 1:50,

what is the actual width of that door?

Solution:

First, we convert the unit from millimeter to centimeter.

18.6 mm = 18.8 ÷ 10 = 1.86 cm

then, convert by scaling

1.86 cm × 50 ÷ 1 = 93 cm

so the actual width of door is 93 cm

NB: A scale factor greater than 1 enlarges the object. ... A scale factor between 0 and 1 shrinks the objects. You can also drag the cursor to make the object larger or smaller.

Learning Outcome 2.2: Print the blue print according to the scale

A **blueprint** is a reproduction of a technical drawing using a contact print process on light-sensitive sheets. the process allowed rapid, and accurate, production of an unlimited number of copies. It was widely used for over a century for the reproduction of specification drawings used in construction and industry. The blueprint process was characterized by white lines on a blue background.

- Scaling the document in CAD

Scaling the document in CAD means reduce or increase the sizes of working drawings so that working drawings can fit to the required sizes of page format.

Scaling can be done by adjusting scale, resizing paper or adjusting drawing layout.

Layout Adjustment consists of:

- ✓ Align objects to page edges.
- ✓ Align objects to page margins.
- ✓ Centering the drawings
- ✓ Align objects to ruler guides.

- **Saving the blue print in the right format**

There is different format you can save in during blueprinting depending on the types of CAD you are using.

You can save as:

1. **JPG:** A JPG file is an image saved in a compressed image format standardized by the Joint Photographic Experts Group (JPEG). It is commonly used for storing digital photos and used by most digital cameras to save images. JPG files are among the most common image files along with .PNG, .TIF, and .GIF.
2. **PDF:** PDF stands for "portable document format". It was introduced to ease the sharing of documents between computers and across operating system platforms when you need to save files that cannot be modified but still need to be easily shared and printed.
3. **DWF:** A DWF file is a 2D/3D drawing saved in the Design Web Format (DWF) developed by Autodesk. It contains design data, which includes graphics and text.

4. **DWG:** DWG files contain designs, photos, maps, and geometric data
5. **DXF:** DXF is a file extension for a graphic image format typically used with AutoCAD
6. **PNG:** A PNG file is an image file stored in the Portable Network Graphic (PNG) format. It contains a bitmap of indexed colors and uses lossless compression, similar to a .GIF file but without copyright limitations. PNG files are commonly used to store graphics for web images.
7. **GIF:** GIF. Stands for "Graphics Interchange Format." GIF is an image file format commonly used for images on the web and sprites in software programs. Unlike the JPEG image format, GIFs use lossless compression that does not degrade the quality of the image.
8. **TIF:** TIF is an image format file for high-quality graphics. TIF files are also called .TIFF, which stands for "Tagged Image Format File."

- **Printing the blue print in the defined size**

  While printing, you have to define the sizes of the paper depending on the size of the project.

  The following are the sizes of the paper you have to print in:

  A0, A1, A2, A3, A4 …

Learning Outcome 2.3: Cut model components on scale according to the precise dimension

- Types of cutting tools
  - ✓ Cutting blade
  - ✓ Scissors
  - ✓ Cutting board
  - ✓ Metallic ruler
  - ✓ French curve
- Precision cutting

Precision cutting means to cut model components exactly to the required sizes and measurement of the model components. Precision cutting need to use appropriate cutting blade such as cutting mat, craft knife, razor, scissor and precise cutting equipment such as hot wire cutter.

You have to check also if the cutting tools and equipment are sharpened because unsharpened tool or equipment does not cut precisely.

- **Cutting techniques**

There are two techniques which can be used to cut model components

1) Cutting model components using hand cutting blades such as cutting knife, cutting matt, scissors, razors
2) Cutting model components using equipment such as fretsaw, hot wire cuter

Steps of cutting model components

- ✓ Select suitable model materials and cutting tools
- ✓ Choose a right scale
- ✓ Scaling and Measure the model components
- ✓ Trace line with pencil where you are going to cut
- ✓ Select right cutting techniques
- ✓ Using cutting tools follow the traced line to cut desired components.

LU 3 Assembling model components

Learning Outcome 3.1: Apply glue according to type of materials and component arrangement plan

Types of glue and their uses

- ✓ PVA glue (Wood glue)
- ✓ Hide glue
- ✓ Epoxy
- ✓ Cyanoacrylate glue
- ✓ Polyurethane glue

Poly (vinyl acetate) known as wood **glue**, white **glue**, carpenter's **glue**, and is emulsion, soluble in water, it is particularly useful for gluing porous materials, particularly for wood, paper and cloth

Hide glue is **used in** woodworking. It may be supplied as granules, or flat sheets, which have an indefinite shelf life if kept dry. It is dissolved in water, heated and applied warm, typically around 60°C (140°F). Warmer temperatures quickly destroy the strength of **hide glue**.

Epoxy glue can also be **used as** a secondary **adhesive** to reinforce the wood **glue**. **Epoxy adhesives** are **used to** laminate plywood with fiberglass. This increases the strength and durability of the construction. **Epoxy** resin is an excellent choice for coating bar tops and other frequently wet wooden surfaces.

cyanoacrylate glue has application in woodworking. It can be used as a fast-drying and creates a strong bond between materials

Polyurethane glue is known also as gorilla. It is used and is able to bond many types of substrates, including glass, plastic, wood and concrete.

- **Dos and Don'ts of glue application**

Dos of glue application

- ❖ **Use sufficient protection.**

Some of the most common injuries people experience when using glue and adhesives are skin burns, and eye injuries. Having sufficient protection can help prevent these injuries.

- **Choose a right glue for any application**
  Chen joining components you have to choose right glue or adhesive to provide adequate bond
- Apply glue straightly to the joining pieces
  Application of glue require attention because, you have to apply glue straightly to the joining pieces to avoid access of the glue to the surface because it may not be easy to remove for the quicker dry glue.
- Avoid access of glue application
  Access of glue create stains and dirties on the surface of model
- Use right tool to apply glue like glue gun
  Glue gun is the right tool you have to choose when applying glue because avoid application of too much and access of glue.
- Remove immediately the access of glue if there are any.
  When the glue exceeds the edges of joining pieces, you have to remove it immediately, otherwise it will be difficult to remove it.

Don'ts of glue application

- **Not choosing a right glue**
  Before you purchase silicone adhesive or sealant for your project, you must check the materials you are working with. There are adhesives made especially for certain materials.
- **Not checking expiration date**
  Before purchasing any glue or adhesives, make sure it is not out of date.
- **Not cleaning the surface**
  If there is any grime, oil, grease, or other residues on the surfaces which you are working with, you will have a difficult time forming a solid and good bond. Make sure you clean surfaces thoroughly and let them dry before proceeding with application of glue.
- **Not following the instructions**
  There are various types of glue and adhesives, and they come with slightly different instructions for how they are to be used, particularly in terms of how long it takes for the glue to dry. Therefore, always read the instructions and follow them to the letter.
- **Not applying pressure**
  Gluing two pieces of metal or other hard materials together is different from using glue with paper and waiting for it to dry on its own. Pressure has to be applied to ensure the bond formed is as strong as possible. A vise or clamp can hold the pieces together with a firm pressure so that the adhesive or glue can bond to the metal surfaces. Wait as long as possible before removing the clamp, and allow the adhesive or glue enough time to dry.

Learning Outcome 3.2: Join elements according to the component orientation plan

- Methods of joining elements
  - ✓ Riveting
  - ✓ Nailing
  - ✓ Gluing
  - ✓ Welding
- Guidelines to proper joining
  - ✓ Measure and mark pieces to join
  - ✓ Cut with precision the pieces to join
  - ✓ Use straight steel ruler and right-angle steel square to measure right angles
  - ✓ Avoid cutting with zig zag
  - ✓ Using sharpened cutter to have straight cutting edge which allow a proper edge joining
  - ✓ Cleaning the surface before any application of glue or adhesive for better bond.

Learning Outcome 3.3: Apply texture according to the visualization plan

- Types of textures.
  The textures applied to model may be in the following type.
  - ✓ **Rough**

  This is a kind of texture created on model using rough materials like sand, saw dust, or other rough materials
  - ✓ **Smooth**

  You can create a smooth finish on model by applying varnish, paint or printed paper depending on the model construction materials.
  - ✓ **Wavy**

  This is another type of finish which consist of creating wave lines on model using brush or other tool.
  - ✓ Course

  This finish consists of creating horizontal lines on model either using paint or printed photos having course line like bricks or other shapes
  - ✓ Shinny

  The shinny texture is created by using shinning materials like varnish, sealers, primers.

- Techniques of reproducing textures using different media.
  - ✓ Create texture using paint with brush and roller
  - ✓ Create texture using paint spreading gun.
  - ✓ Create texture by sponge stamp with paint.
  - ✓ With glue applied on surface, you can create rough textures by spreading sand or saw dust on the surface of model.
  - ✓ Create texture by using stickers

- Matching textures to the visualization plan
  Matching textures to the visualization plan mean, to create textures as it was attended to be on the provided plan. The textures to be applied to the model will look like the one provided by architect while developing architectural plan.

Learning Outcome 3.4: Label model referring to the concept design plan

- **Labelling calligraphy**
  Labelling or using a label is describing someone or something in a word or short phrase
  A label helps to provide complete information regarding the product. It mainly includes ingredients of the product, its usage, and caution in use, cares to be taken while using it, date of manufacturing, batch number, etc.
  Calligraphy
  Definition. Calligraphy is a visual art related to writing. It is the design and execution of lettering with a broad tip instrument, brush, or other writing instruments.
  So, labeling calligraph on model means to write on model some word for identification.
- Methods and tips of labelling
  Methods of labelling
  1. **Hold your pen diagonally at a 30 to 60-degree angle.** A calligraphy pen isn't used quite the same way as a regular pen. The tip, or nib, of the pen should point diagonally away from you, to the left, as you write

2. **Don’t twist the nib as you write.** The tip of writing tool used to do calligraphy is called a nib. Regardless of the letters you are forming, the orientation of the nib should remain consistent. The tip of the nib should always point in the same direction
3. **Lead the nib backwards or sideways across the paper.** The nib should move backwards or sideways from the direction it’s pointing in. Pushing it forward away from your hand leads to blotting and uneven letter formation
4. **Apply light pressure.** Using too much pressure can make for messy letters or scratches in your paper. Pressing too hard can also damage the nib, so do your best to apply the pen to the paper with a light, consistent pressure.
5. **Keep your lines parallel.** Vertical, horizontal, and diagonal lines in various letters should be parallel to corresponding lines in other letters. This will make your writing look more consistent and professional

Tips of labelling

1. **Keep it Simple and Clean.**

   Keep your designs, images, and fonts simple and clean for maximum user experience.

2. **Use color wisely.**

   Keep your colors consistent. If you’re communicating flavors, stick with the colors that are associated with the model

3. **Select the Right Font.**

   Don’t use too many fonts, to keep your label consistent and easy to read.

4. **Use high quality labelling tools like ink pen.**
5. **Keep it consistent with your model**

   One of the most important things you need to do is to use the label as the tool of conveying the message.

6. **Consider the label size for the model**

   Label should respect the raw of proportionality based on the size of your model. This means that, the label sizes have to be related to the sizes of model