

#### 4.4.4.4 Section D: Developing design ideas (20 marks)

Students will develop and refine design ideas. This may include, formal and informal 2D/3D drawing including CAD, systems and schematic diagrams, models and schedules. Students will develop at least one model, however marks will be awarded for the suitability of the model(s) and not the quantity produced.

Students will also select suitable materials and components communicating their decisions throughout the development process. Students are encouraged to reflect on their developed ideas by looking at their requirements; including how their designs meet the design specification. Part of this work will then feed into the development of a manufacturing specification providing sufficient accurate information for third party manufacture, using a range of appropriate methods, such as measured drawings, control programs, circuit diagrams, patterns, cutting or parts lists.

Mark band	Description
16–20	<p>Very detailed development work is evident, using a wide range of 2D/3D techniques (including CAD where appropriate) in order to develop a prototype.</p> <p>Excellent modelling, using a wide variety of methods to test their design ideas, fully meeting all requirements.</p> <p>Fully appropriate materials/components selected with extensive research into their working properties and availability.</p> <p>Fully detailed manufacturing specification is produced with comprehensive justification to inform manufacture.</p>

#### 4.4.4.5 Section E: Realising design ideas (20 marks)

Students will work with a range of appropriate materials/components to produce prototypes that are accurate and within close tolerances. This will involve using specialist tools and equipment, which may include hand tools, machines or CAM/CNC. The prototypes will be constructed through a range of techniques, which may involve shaping, fabrication, construction and assembly. The prototypes will have suitable finish with functional and aesthetic qualities, where appropriate. Students will be awarded marks for the quality of their prototype(s) and how it addresses the design brief and design specification based on a contextual challenge.

Mark band	Description
16–20	<p data-bbox="703 635 2112 778">The correct tools, materials and equipment (including CAM where appropriate) have been consistently used or operated safely with an exceptionally high level of skill.</p> <p data-bbox="703 806 2112 906">A high level of quality control is evident to ensure the prototype is accurate by consistently applying very close tolerances.</p> <p data-bbox="703 935 2112 1035">Prototype shows an exceptionally high level of making/finishing skills that are fully consistent and appropriate to the desired outcome.</p> <p data-bbox="703 1063 2112 1206">An exceptionally high quality prototype that has the potential to be commercially viable has been produced and fully meets the needs of the client/user.</p>

# Student Guide – Manufacturing Specification

## Introduction- Have you:

Explained why you will need to complete a plan of manufacture before starting the manufacture of your final prototype.

## Plan of manufacture– have you:

- Written out every step in the manufacture of your final product? These should be small detailed steps.
- Split up drawing in CAD into small detailed stages e.g. page set up, drawing different components, and saving multiple pages for different materials?
- Used specific tool, material and equipment names?
- Given measurements of all materials using millimetres (mm)?
- Given specific information e.g. line/fill colours in 2D Design, laser cutter settings and drying/curing times for paint/adhesives?
- Included photo evidence for all stages, with a description to explain the image? These should focus on demonstrating quality control and quality assurance wherever possible.
- If you are completing a flow chart – have you use the correct shapes and layout (see page 6 and 7)?

## Possible extra ideas for inclusion:

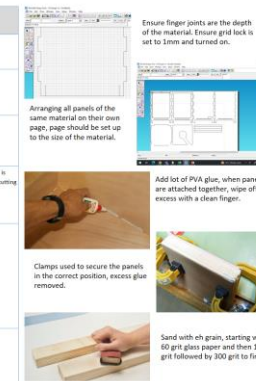
- Add in information about modifications or changes you have made throughout manufacture.

## Summary - Have you:

- Explained what you plan to do next (*begin to manufacture the final prototype*).

### Table format

Step no.	Instruction	Equipment & Materials	QA/QC	H&S
1	Open 2D Design, set grid spacing to 1mm, turn on grid lock. Use line tool to draw the basic panels using a black line.	Computer	Set grid spacing to 1mm, check all dimensions using dimension tool.	N/A
2	Add finger joint to the basic panels. Each finger measures 10mm in height and 4mm in depth.	Computer	Align all panels to adjoining panel to check finger joints match. Check all dimensions using dimension tool.	N/A
3	Copy image for engraving from Google Images. Paste it on to 2D design. Set to black and white silhouette and vectorize. Change outline to red and fill to red. Add to the canvas panels.	Computer	Check location of engraving detail using dimension tool.	N/A
4	Place four 1mm plywood into the laser cutter. Upload 2D design file to laser cutter, selecting setting for 4mm plywood (black lines 100% power and 5% speed, red lines and areas 100% power and 40% speed).	Computer 2D Design 4mm plywood sheet Laser cutter	Ensure plywood sheet is placed into tray with hand corner of the laser cutter. Ensure plywood sheet is not warped.	Ensure extraction is activated during control and engraving.
5	Remove plywood panels from the laser cutter, check they fit together. Apply PVA glue to all contact areas of the finger joints. Clamp the canvas together at right angles using corner clamps and masking tape to secure. Leave to dry for 24 hours.	Canvas panels PVA glue Paint brush Masking tape Corner clamps Til square	Check angle of canvas using a til square. Wipe excess PVA away from joints. Use masking tape to secure joints. Use corner clamps to achieve right angles. Check joints are dry before removing clamps.	N/A
6	Use 2 grades of sand paper, grade 40 to start, when most roughness and excess PVA has been removed, move to grade 120, continue until smooth, finish with the grain using a sand block.	Sand paper Sanding block	Hand check of all surfaces and joints.	N/A



Ensure finger joints are the depth of the material. Ensure grid lock is set to 1mm and turned on.

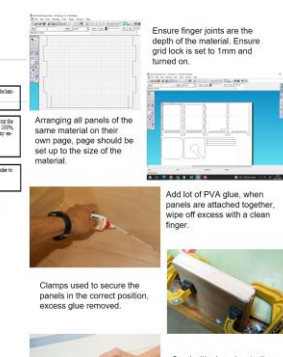
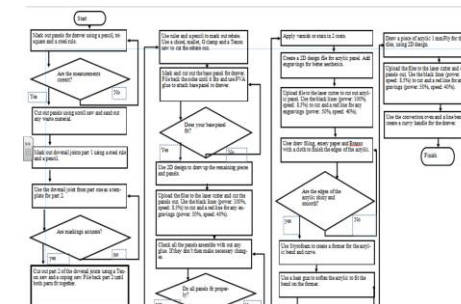
Arranging all panels of the same material on their own page, page should be set up to the size of the material.

Add lot of PVA glue, when panels are attached together, wipe off excess with a clean finger.

Clamps used to secure the panels in the correct position, excess glue removed.

Sand with eh grain, starting with 60 grit glass paper and then 120 grit followed by 300 grit to finish.

### Flow chart format



Ensure finger joints are the depth of the material. Ensure grid lock is set to 1mm and turned on.

Arranging all panels of the same material on their own page, page should be set up to the size of the material.

Add lot of PVA glue, when panels are attached together, wipe off excess with a clean finger.

Clamps used to secure the panels in the correct position, excess glue removed.

Sand with eh grain, starting with 60 grit glass paper and then 120 grit followed by 300 grit to finish.

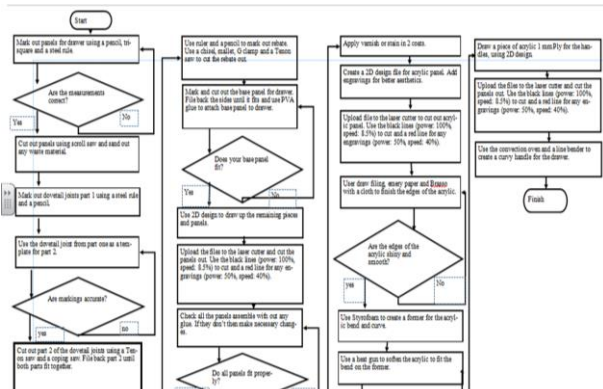
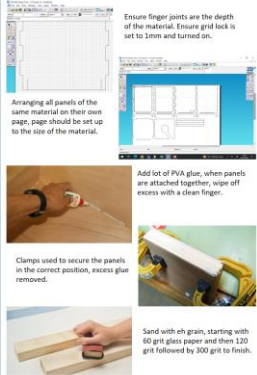
# Parent guide – Plan of manufacture

## Introduction to this page

Students have already completed their material and process choices, cutting list and costings which is one aspect of their Manufacturing Specification. However this information would not be enough to manufacture a prototype and so students need to use this page to fully explain how the prototype would be manufactured. This should consider what would take place at each stage of manufacture and what materials/equipment will be needed for each of these stages. Students also need to demonstrate an awareness of Health and Safety and Quality Control and should use this page as an opportunity to demonstrate their understanding of how both will be considered throughout manufacture.

Again, page is much more informative rather than evaluative like previous pages in their NEA and gives an opportunity for students to demonstrate their manufacturing knowledge.

Step no.	Instruction	Equipment & Materials	QA/QC	H&S
1	Open 2D Design, set grid spacing to 5mm, turn on grid lock. Use line tool to draw the basic panels using a black line.	Computer 2D Design	Set grid spacing to 5mm, check all dimensions using dimension tool	N/A
2	Add finger joint to the basic panels. Each finger measures 10mm in height and 4mm in depth.	Computer 2D Design	Align all panels to adjoining panel to check finger joints match. Check all dimensions using dimension tool.	N/A
3	Copy image for engraving from Google Images. Paste it on to 2D design. Set to black and white (Invert) and Vectorize. Change outline to red and fill to red. Add to the canvas panels.	Computer 2D Design	Check location of engraving detail using dimension tool.	N/A
4	Place items back plywood into the laser cutter. Upload 2D design file to laser cutter, selecting setting for 4mm plywood (black line 100% power and 90 speed) red lines and areas 100% power and 40% speed).	Computer 2D Design 4mm plywood sheet Laser cutter	Ensure plywood sheet is placed into top left hand corner of the laser cutter. Ensure plywood sheet is not warped.	Ensure extraction is activated during cutting and engraving.
5	Remove plywood panels from the laser cutter, check they fit together. Apply PVA glue to all contact areas of the finger joints. Clamp the corners together at right angles using corner clamps and masking tape to secure. Leave to dry for 24 hours.	Corner panels PVA glue Masking tape Corner clamps Til square	Check angle of corners using a 90 degree square. Wipe excess PVA away from joints. Use masking tape to secure joints. Use corner clamps to achieve right angles.	N/A
6	Use 2 grades of sand paper, grade 40 to start, when most roughness and excess PVA has been removed, move to grade 150 continue until smooth, sand with the grain using a sand block.	Sand paper Sanding block	Hand check all of surfaces and joints.	N/A



## How can you support your child at home?

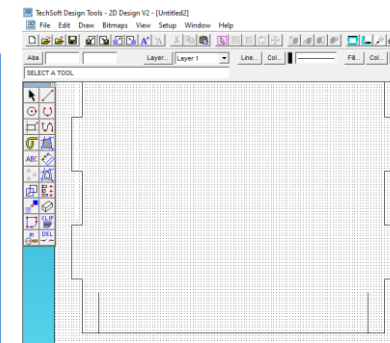
Look over your child's page:

- Have they written each stage of manufacture in enough detail that it could be followed by a third party.
- Have they named specific tools, materials and equipment that will be used at each stage?
- Have they explained how they will consider Health and Safety at each stage of manufacture?
- Have they demonstrated an understanding of Quality Control (QC) and Quality Assurance (QA) (how to plan to ensure work is accurate and then techniques to check this) for each stage of manufacture?
- Does their use of photos demonstrate consistent use of the QC and QA techniques throughout the manufacture of their products?

Could you ask your child to talk through the stages of how their prototype will be manufactured? They should be able to talk about this in detail and the same level of detail should be mirrored in their work for this page. Could you encourage them to add in the extra ideas for inclusion (in green) to help them gain more marks.

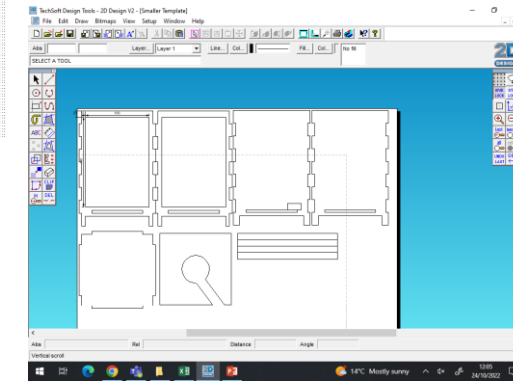
# Exemplar pages – using a table

Step no.	Instruction	Equipment & Materials	QA/QC	H&S
1	Open 2D Design, set grid spacing to 1mm, turn on grid lock. Use line tool to draw the basic panels using a black line.	Computer 2D Design	Set grid spacing to 1mm, check all dimensions using dimension tool.	N/a
2	Add finger joint to the basic panels. Each finger measures 10mm in height and 4mm in depth.	Computer 2D Design	Align all panels to adjoining panel to check finger joints match. Check all dimensions using dimension tool.	N/A
3	Copy image for engraving from Google images. Paste it on to 2D design. Set to a black and white silhouette and vectorise. Change outline to red and fill to red. Add to the carcass panels.	Computer 2D Design	Check location of engraving detail using dimension tool.	N/a
4	Place 4mm birch plywood into the laser cutter. Upload 2D design file to laser cutter, selecting setting for 4mm plywood (black lines 100% power and 5% speed, red lines and areas 100% power and 40% speed).	Computer 2D Design 4mm plywood sheet Laser cutter	Ensure plywood sheet is placed into top left hand corner of the laser cutter. Ensure plywood sheet is not warped.	Ensure extraction is activated during cutting and engraving.
5	Remove plywood panels from the laser cutter, check they fit together. Apply PVA glue to all contact areas of the finger joints. Clamp the carcass together at right angles using corner clamps and masking tape to secure. Leave to dry for 24 hours.	Carcass panels PVA glue Paint brush Masking tape Corner clamps Tri square	Check angle of carcass using a tri square Wipe excess PVA away from joints. Use masking tape to secure joints Use corner clamps to achieve right angles. Check joints are dry before removing clamps	Wear an apron when assembling the product.
6	Use 2 grades of sand paper, grade 40 to start, when most roughness and excess PVA has been removed, move to grade 120 and continue until smooth. Sand with the grain using a sand block.	Sand paper Sanding block	Hand check of all surfaces and joints.	Wear an apron when sanding materials.



Arranging all panels of the same material on their own page, page should be set up to the size of the material.

Ensure finger joints are the depth of the material. Ensure grid lock is set to 1mm and turned on.



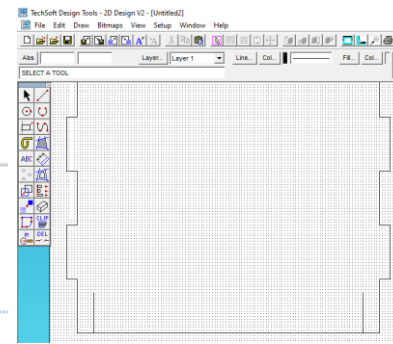
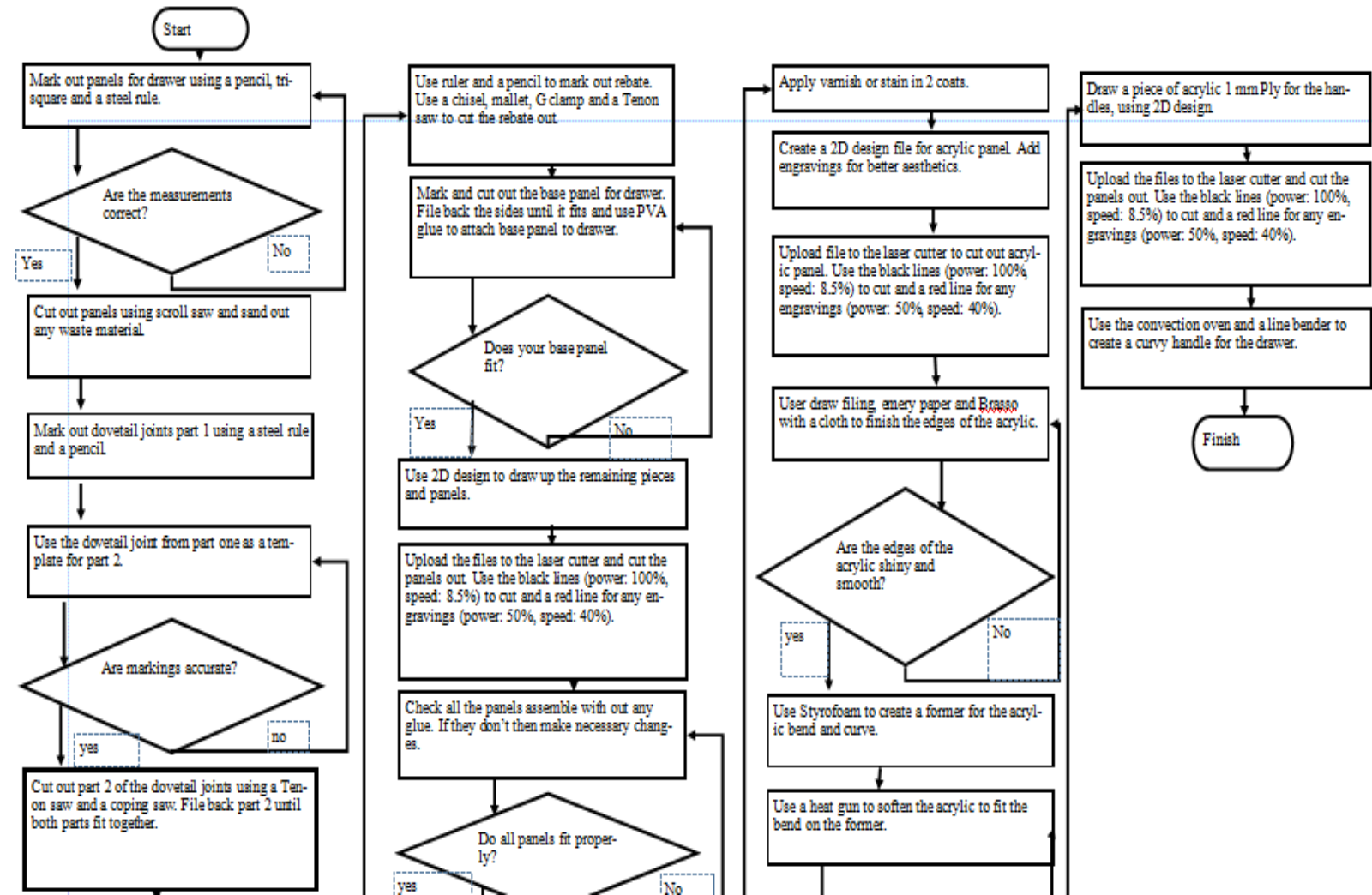
Add lot of PVA glue, when panels are attached together, wipe off excess with a clean finger.

Clamps used to secure the panels in the correct position, excess glue removed.



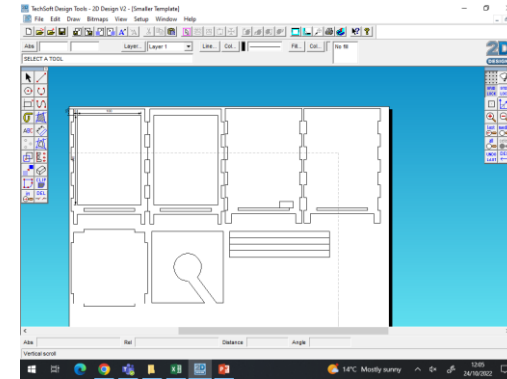
Sand with eh grain, starting with 60 grit glass paper and then 120 grit followed by 300 grit to finish.

# Exemplar pages – using a flow chart



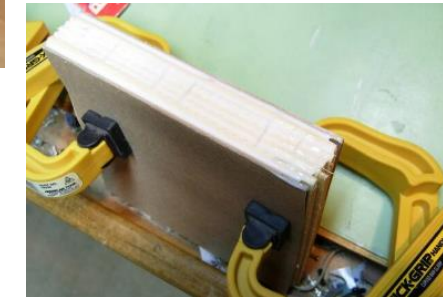
Arranging all panels of the same material on their own page, page should be set up to the size of the material.

Ensure finger joints are the depth of the material. Ensure grid lock is set to 1mm and turned on.



Add lot of PVA glue, when panels are attached together, wipe off excess with a clean finger.

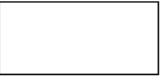
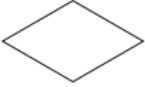


Clamps used to secure the panels in the correct position, excess glue removed.



Sand with eh grain, starting with 60 grit glass paper and then 120 grit followed by 300 grit to finish.

# Additional information

## Flowchart format

Flow Chart Symbol	Meaning	Example
	Action / Task	Draw main carcass panels on 2D Design Sand down surfaces with glass paper
	Decision / Question	Have they cut correctly? Do they fit? Are they smooth?
	Start / Stop	Used to show beginning and ending of flowchart
	Shows direction	To move between tasks To create feedback loop
Yes    No	Responses to decision / question	Allows flow to continue Starts feedback loop

Remember you will need to add photo evidence next to your flow chart.

## Table format

Possible Columns:

- Step
- Component / part
- Instruction / task
- Equipment / tools
- Materials
- Quality control / quality assurance
- Health & Safety
- Photo evidence

Material	Stock Dimensions / size
4mm laser plywood	500mm x 350mm
3mm laser MDF	500mm x 350mm
6mm birch plywood	1220mm x 2440mm
9mm birch plywood	1220mm x 2440mm
Styrofoam	600mm x 600mm x 50mm
HDPE foam	150mm x 150mm 75mm
Foam board	420mm x 297mm x 3mm
3mm Acrylic	600mm x 400mm
3mm dowel	2400mm length
6mm dowel	2400mm length
9mm dowel	2400mm length
12mm dowel	2400mm length
0.7mm Aluminium	250mm x 250mm

## Laser cutter settings:

- 4mm laser plywood  
Black = 4% speed, 100% power  
Red = 100% speed, 50% power
- 3mm acrylic  
Black = 4% speed, 100% power  
Red = 100% speed, 40% power

## Process Options –

- Line bending
- Convection oven
- Laser cutting
- Laser engraving
- Pillar drilling
- Disc sanding
- Aluminium cutting and forming
  - Aluminium beating
  - File forming
- Foam Coating – PVA wash
  - Spray painting
  - Living hinge
- Plywood lamination
- Pewter casting
- Vacuum forming

## Joining Options –

- Living hinge
- Finger joints – laser cut
  - Butt joint
  - Dowel joint
  - Mitre joint
- PVA glue – Wood to wood
- Contact adhesive – 2 different materials
- Tensol cement – plastic to plastic

## Finishing Options –

- Wood – stain, polyurethane varnish, Danish oil, bees wax
- Foam – PVA wash and stray paint