A-LEVEL

DESIGN AND TECHNOLOGY: PRODUCT DESIGN 3D

PROD3 : Design and Manufacture

Mark scheme

1551/2551

June 2014

Version: 1.0 Final

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this Mark Scheme are available from aqa.org.uk

Question 1

01 Although the question refers to colour, texture and images the mark scheme does not require candidates to refer to all three equally to gain full marks. However if only one is mentioned then marks should be limited to 10 max.

Use of Colour:
1. Green for go: Used on mobile phones, traffic lights etc.
2. Red for stop/hot: Used for safety on emergency switches etc./hot taps etc.
3. Blue for cold: Used on taps etc.
4. Use of Blue and white on motorway signs for ease of reading
5. Use of Yellow and Black for hazards poisons etc.

Use of texture:
1. Texture on pavements for the blind (crossings)
2. Texture on mobile phones for ease of grip and also to identify parts of product in pocket or dark.

Use of images:
1. Standardised pictograms used so all ages can use products: e.g. on symbol or play/pause etc.
2. Use of images makes a product usable in all countries regardless of language.

1 mark allowed for each relevant point.
A second mark may be awarded if a candidate has added sufficient detail to clarify the point further, an example of this is shown below:
Texture is often used on pavements near to pedestrian crossings to **alert the blind and partially sighted.**
Dyson use pictograms on the base of their vacuum cleaners to show **where to push with your foot if you want to tilt the main body from an upright position.**

02 Below are two examples, although this is not an exhaustive list and other relevant developments should be accepted.

Injection moulding:
- Improved range of colours and ease of large scale production due to limited energy needed for production.
- Complexity of 3D forms available
- Reduction of number of parts required due to integral fixings
- Electrical insulation ideal for electronic products

Development of transistor:
- Miniaturisation in comparison to thermionic valves
- VLSI (Very Large Scale Integration)
- Reliability of products
- Reduction in heat loss
- Reduction in cost of electronic products

Use of example products and facts to back up statements would warrant extra credit.

Question 2

03 1 mark allowed for each relevant point.
A second mark may be awarded if a candidate has added sufficient detail to clarify the point further up to a maximum of 7 per section.
If candidates refer to the limitations of 3D CAD for initial concept generation credit should be given as this shows understanding of appropriate use.

Concept development:

- Allows easy manipulation of central model (all angles can be viewed)
- Wireframe views allow internal components to be visualised
- Sectional views can be easily generated
- Once the central model has been constructed materials and textures can be changed to show a variety of possible finishes.
- A central parts library may allow designers to use standardised components without having to re-draw from scratch.
- If parts are updated parametrically linked assemblies will update automatically.

Communication within the design team:

- Orthographic projection drawings can be created rapidly from the central model for manufacturing engineers
- Mass properties can be set for different materials to assess volumes and costs of materials for individual parts.
- Using online conferencing designers and engineers can discuss designs and alterations concurrently on different continents with the central model being updated in real time.

Pre-production testing:

- The use of Finite Element Analysis allows companies to test products using:
    - Virtual wind tunnels
    - Simulations of a rolling road to check stresses on a cars suspension
    - Analyse the flow of polymer in a possible injection mould tool
- All parts can be assembled on screen to check tolerances and fits.

Prototype production:

- 3D printing such as FDM (Fused Deposition Modelling) can be used directly from an STL (Stereolithography) file to generate a physical model of the object

If candidates go into detail about specific Rapid prototyping procedures credit should be given with a maximum of 3 marks for correct detail of the process and a clear annotated diagram.

Question 3

04 The term Quality Assurance within product manufacture refers to procedures that have been put in place to ensure that all products produced are to the correct standard 'right first time'

Quality Control refers to the checking procedures that companies use on products after production and before delivery to the customer.

Examples of Quality Assurance procedures:

- CAD simulations prior to manufacture
- Use of Jigs to insure accurate cutting of components
- Checking the setup of automated machinery against specific job cards
- setting suitable tolerances for the specific job.
- Tolerances checked through statistics by computer, to prevent critical faults.
  -This could lead to adjustments in tooling based on wear etc.

Examples of Quality Control checks

- Using measuring gauges on critical dimensions
- Checking sample products at regular intervals

Maximum 2 marks per accurate definition of QA and QC

Expect students to refer to QA and QC procedures used in their own coursework as the one off situation.

1 mark should be awarded for a relevant check,
1 mark may be awarded for **appropriate** reference to equipment used for checking, such as vernier calliper, micrometer for critical dimensions.
1 mark for stating how failure was dealt with, was the part re-used or disposed of etc.

For the large scale production expect reference to:

- the use of go-no go gauges, Laser scanners/probes for measurement checks.
- Use of feedback to stop production if issues are found.
- Greater use of automated checks (less labour intensive).

Question 4

05

Mark Banding:

0-2 marks: Very few basic points without explanation
3-4 marks: a range of points with no explanation/or a few points with explanation
5-6 marks: a range of points made with some explanation
6-8 marks: a range of points, all explained with relevant detail.

Example points with possible detailed explanations:

- Chemical resistance: as the bucket is designed to hold floor cleaners, which can be corrosive the material selected must be resistant to degradation caused by these specific chemicals.
- Non-porous: the bucket must not leak and so the material used must be impervious to water/liquids.
- Fair degree of toughness: as the bucket is likely to be kicked and pushed around it must be able to withstand impact.
- Ability to be formed or deformed into hollow shapes: as the bucket will be holding a large quantity of liquid the weight of the material must be kept to a minimum and so a thin, hollow section would be most suitable.
- Available in a range of colours to match with the décor of the kitchen or house.
- Hard wearing: as the bucket may be cleaned with a coarse scouring pad the material must be resistant to abrasion.

06 1 mark for accurate naming of material: PP or HDPE for polymer bucket,
Galvanised mild steel for metal bucket accept stainless steel due to photograph.
1 mark for stating injection moulding is the method for production of the polymer bucket.
1 mark for stating that rolling would be used to produce the sides of the metal bucket
1 mark for stating that the 'mop holder' would be blanked and press formed
Up to 3 marks per product for diagrams showing manufacturing processes related to the bucket i.e injection moulding diagram with annotation, cross sectional drawings of joints etc.
The metal bucket has been joined using seam joints to seal the edges
The rolled edge around the top of the bucket increases rigidity and hides the raw edge of the metal from view.

The handle has been attached with rivets, candidates identifying this should be rewarded
Assembly:

- Injection moulding means assembly is simple with integral fixings and no extra components are required
- The galvanised bucket has been joined using rivets and also spot welds (to attach the mop squeezer to the top plate after forming into a cone) which require extra machinery and set up time as well as meaning the product cannot be dis-assembled.
- As with all questions a relevant point is worth 1 mark and explanation of that point is worth a further mark.
- Bending the handle into shape is not sufficient for a mark unless reference is made to a former to bend round.
- Candidates describing the benefits of manufacturing with polymers versus the disadvantages of manufacturing with metals should be credited accordingly.

Question 5

07 1 mark for reference to specific patented technology, but not the product as a whole
i.e. The bagless cyclone technology used by Dyson

Patents allow designers to:

1. Protect exclusivity of sale of products in a market determined by the patent itself
2. The patent runs for a number of years determined by the fee paid
3. The patent allows a company to build up a market share and establish a 'name' before other companies can release similar products into that market.

Expect students to use examples such as the Dyson vacuum cleaner to support their answer.

08 Marks should be awarded for making a relevant point, with further credit being given explaining the relevance of the point. Diagrams should be credited if the help to explain the point made.

It is hoped that students will recognise the reference to Japanese production systems, such as Just In Time and the comparison with older methods of stock piling goods.

Students may make reference to:

Kaizen, Kanban, Pokeyoke, Muda, Quality Circles, Heijunka and other relevant systems employed by companies to increase efficiency

The definition of these terms should be worthy of a mark, with specific explanations

Some example points are shown below:

Just in Time (JIT) Manufacture

- No need to store components prior to production, as the arrive from suppliers Just In time.
- This reduces
  - Storage rental costs,
  - Security costs to protect the storage facilities,
  - Energy and maintenance costs involved with the storage facilities and also the risk of damage to components prior to production (waste components)
- There is no chance that the product will go out of fashion while it is being stored ready to be sold as they are made to demand. This then means companies are less likely to need to sell last year's products at discounted rates.
- Production lines are streamlined and versatile as they must be able to produce many different products. This means FMS (Flexible Manufacturing Systems) such as SMED (Single Minute Exchange Dies) are essential these allow a manufacturer to quickly change their machines to produce different products, by changing formers/dies. The quicker this change can be done the more productive their production line becomes.
- **Kanban** and EPOS (Electronic Point Of Sale) systems are used to effectively manage JIT production. These refer to barcodes on products/components which are scanned and a central computerised stock control system can automatically order the correct level of stock at the correct time to make sure there is always enough for the order being processed.

- Every component once produced is given one of the barcodes mentioned above. This allows accurate QC (Quality Control), as the information on the Barcode tells the computer the batch of material used and the machine that it was produced on. This allows QC managers to monitor problems within components and thus track down other components made from the same faulty materials/machines.
- **Poke Yoke** is a Quality Assurance method used in product assembly, it is a form of quality control to ensure the product is inserted into the machine correctly. An example of this can be seen on a SD card which has a corner removed to ensure it can only be fully inserted the correct way round.

Problems with Just in Time

- For a successful JIT production line you must ensure that your suppliers conform to British quality Standards to avoid excessive customer complaints from faulty components.
- There will occasionally be problems with transporting components to and from the factory and thus delays ensue. (problems for retailers)
- Unavoidable problems such as the recent petrol crisis.
- You are at the mercy of your supplier and any increase in component price may have to be covered as the components are required quickly.
- You may not be able to cover excessive unpredicted demand for a product, thus loosing trade to a company who still stock pile goods
- If demand/orders for one product are low at certain times of a year you must make sure you have another product to produce in the □, this will keep your staff working and keep the production line running.
- This can however have a big impact on staff training budgets as they are expected to be able to work on many different products requiring training for each.
- There must be effective administration systems in place for JIT to work.

Question 6:

09 1 mark for each product named (max 2 per movement/period)
1 mark for a recognised design movement/period
1 mark for a specific designer, but only if linked with a specific product or type of product.

Maximum 3 marks for annotated sketch of each product
Further marks available for reference to design movement influences and views:
e.g. The Bauhaus believed in the statement '**form follows function'** this supported their aim to design **mass producible products** using **modern machine production techniques. Their minimalist functional designs are highly relevant and visible in society today,** due to their **clean lines and use of Chrome and Black leather, which are still used in furniture design.**
Students may refer to the influence of WW1 on mass production techniques

e.g. Philip Starck has worked with many companies, while designing in the late 1980s and 90s he was re-known for his Post-modern take on kitchen products, specifically the Juici Salif lemon juicer and Hot Berta kettle. In comparison to the products of the Bauhaus stated in 09 Starck followed a '**function follows form'** theme **designing beautiful object that were more about challenging our pre-conceived opinions of what a juicer or kettle should look like that how it worked**. The products would **look more at home in an art exhibition** than being used in a domestic kitchen.