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Engineering (Double Award) 48504

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Unit 4 Developing Design and Manufacturing Products

Report on the Examination

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The completion of Part A and B can take a variety of forms, as was evident from the work presented for assessment. Approximately half the centres taught the two sections separately with no link between the controlled tasks tackled. However in a number of centres the students designed the engineered product in their part A work and went onto make it for part B. Both approaches have advantages and disadvantages; it is for the centre to decide what is most appropriate for their circumstances. A variety of tasks were attempted for part A of the projects but a more limited number of the controlled tasks were attempted by students for part B with low voltage adjustable light being particularly popular.

When making assessments the three mark bands in the grid indicate that a candidate has shown:

- Increasing depth and breadth of understanding;
- Increasing coherence, comparison against the specification, drawing of valid conclusions, a greater consideration of industrial practices and more consideration of costs.
- Increasing independence and originality.

Through their work, students should be given opportunities to show these abilities.

When awarding marks in the higher mark bands, the following should be considered.

- Range of ideas
- Consideration of costs at the design stage and during use.
- Alternative solutions considered and reasons for choice explained.
- Alternative methods of making explored and reasons given for choice.
- Number of making processes considered with advantages and disadvantages given.
- Presentation of the portfolio in an increasing logical manner.
- Whether an outsider could follow the design choices and make the product from the information given.
- Comparison of the design solutions to the initial specification throughout the design process.
- Self-criticism and positive improvements suggested.
- Listening to the views of others particularly the client and modifying the design to make it more appropriate.

Unit 4 Part A: Designing, communicating, testing and presenting the design solution to a chosen controlled assessment task.

Students must be given the opportunity to:

- Analyse client design briefs;
- Develop design specifications, generate ideas and select the most appropriate solution;
- Apply scientific principles;
- Produce and read engineering drawings;
- Select appropriate drawing techniques;
- Communicate a design solution to a mixed audience.

The design activity must be based around one of the controlled assessment tasks from the AQA website. All of the controlled tasks for Unit 4 will involve the students designing in and working in a range of technologies. This will be considered by moderators.
It is important that candidates consider more than aesthetic properties. The solutions should include the use of some scientific principles and, possibly, calculations.

It should also be considered that the students are expected to present their chosen designs using a range of suitable techniques.

When designing

Analysis of the design brief (5 marks)

Candidates need to carry out an analysis of a given design brief to identify the key features, including: size, shape, function, limiting features, functional requirements. Students will also have considered and investigated the likely energy demands of the product during its use and manufacture. The key features should then be developed into a design specification. Students were generally able to list the client's needs and the key features of the product. However many students did not achieve the degree of analysis required to meet mark band 3. In many cases well-written lists of the main features were presented or a diagram was presented that showed some of the key features together with a lot of irrelevant ones. Most students undertook some research into existing products which proved useful.
The better candidates were able to independently identify most of the key features for a given design brief and then go on to explain the key features in detail with reference to the client's requirements for the product and to justify their importance within the design brief.

Generation and evaluation of design ideas (9 marks)

Candidates should make use of the key features they have identified and go on to produce a range of design ideas including solutions for technical aspects of the product. Detailed evidence of testing using objective methods together with suggested modifications should be shown.
The majority students produced imaginative design solutions and most to some extent considered engineering features in their solutions.
Mark Band Three candidates should independently produce a range of possible design ideas from a design specification. The design ideas must then be developed into suitable detailed design solution. The candidates must be able to carry out structured tests to evaluate the suitability of the design solutions with reference to the customer requirements in order to produce a final design solution. It is not necessary to model the entire product; it is often sufficient to prototype a moving part, circuit or structure. In those centres that produced a model they were used well to assess the suitability of the design.

When communicating (12 marks)

Candidates should have used a wide range of engineering drawings to sector specific standards including: sketching, orthographic, isometric, CAD (2D and 3D) including rendered presentation drawings, assembly or exploded drawings, circuit diagrams, system diagrams and flow charts. Students should have used scale. Information should be clear and logical, with legible text, a good grasp of grammar, punctuation and spelling.
Candidates will need to explain their chosen design solution in sufficient detail that it may be produced.
Drawings and diagrams must be appropriate for both the information being portrayed and the audience and they should be to recognised standards.
Most candidates were able to sketch, although the level of annotation was variable. A variety of 3D drawing methods was chosen including isometric and oblique and good use was made of 3D drawing packages with an increasing number of centres presenting their work using one of the 3D drawing packages. The better candidates were able to independently produce a range of sector specific drawings and diagrams that explained the design solution in detail.

In this section teachers should make an assessment of how clearly, logically and organized the folder has been presented. They should consider whether the text is legible, easily

understood and does the student's work show good grasp of grammar, punctuation and spelling. Of 12 marks in this section, a maximum of 3 are awarded for this.

When testing and evaluating (max 6 marks)

Selecting and testing the final design idea against the design brief and specification (6 Marks)

Throughout the design folder candidates should include evidence that they have tested, modified, and developed their ideas to produce the final design. Candidates will need to have carried out a formal selection of the final design idea and show evidence that they have tested their proposed solution against the requirements of the client design brief and design specification. Again at this stage it is vital that candidates have written a full and detailed specification against which tests can be made. Basic scientific principles should be applied to the proposed solution to ensure that it will be able to perform the tasks as described in the customer design brief. This could take the form of calculations of force when using levers, the testing of different value electronic components or materials testing investigating hardness or strength.
Although testing can be evidenced throughout the portfolio it would be useful if candidates included a separate testing section in their folders. This would not only make moderation easier but would focus the students on the need to carry out specific tests.

Presentation of the final design idea (5 marks)

Candidates should produce a final conclusion for their design project. This should include a final detailed explanation of their preferred design solution and explain why the other design solutions have not been adopted. They should present their work to a third party. Modifications should be made in response to feedback and detailed within the folder. Students should be encouraged to refer to the client/s throughout the design process.

Part B: Engineered Product

Centres are reminded that photographic evidence of the final product/products must be included with the student's portfolio.

In this section students were engaged in making an engineered product. Some centres had clearly given the choice of project much thought and in all cases the choice of product had a major impact on success in this unit. In all cases the product must be based on one of the controlled tasks described on the AQA website. Centres can interpret the task and based on equipment and materials available, generate a series of drawings to be given to the students. Both drawings and the product specification can be given to the students by the teacher.

For the benefit of the moderators it would be most useful if the product drawings and specification could be included at the front of the folder and one set of drawings included with the students' portfolios. As described earlier these drawings could be provided by the centre or when a student has decided to make what they have designed the folder will naturally flow from part A into part B.

Centres should remember that during part B candidates should:

- Use product specifications;
- Read and interpret engineering drawings and diagrams;
- Show that they can select and use suitable materials, parts and components for a product;
- Create a production plan;
- Use processes, tools and equipment, including Computer Aided Manufacture (CAM), required to make an engineered product;
- Check that the quality of their work conforms to the standards required;
- Apply health and safety procedures.

Produce a production plan (5 marks)

Candidates should analyse the specification, and show that they can make informed decisions regarding the manufacture of the product and produce a production plan.
They should study the specification and engineering drawings, listing the exact requirements of the product, including details regarding size, shape, materials, parts, components, processing methods etc.
Students should have produced a comprehensive production plan for the component parts of their product. They will have shown an understanding of both batch and continuous production methods. They show that they are clear about the stages, sequences and timings of operations.
Candidates must produce a production plan **for the majority of parts of the product**, planning the materials, resources and process requirements to make it.

The plan should give information about: *(Taken from the specification)*

- Materials, parts and components to be used;
- Processes to be used;
- Tools, equipment and machinery to be used;
- The sequence of production, including critical production and quality control points;
- Production scheduling, including realistic deadlines;
- How quality will be checked and inspected;
- Health and safety factors.

The most successful plans contained all this information within a pro forma sheet that the candidates completed either by hand or using ICT. In some centres, a separate production plan was completed for each component part. This seemed to be a sensible approach that allowed the candidates to break down the making into manageable parts. Some plans included a space for modifications or alterations that occurred during manufacture and a space for candidates to write about alternative production methods (both mark band three requirements).

A comprehensive production plan is at the heart of a well-planned and produced engineered product and time spent at this early stage will be well rewarded.

Following a production plan (5 marks)

It is useful at this stage that candidates have made on-going notes on their production plan of problems encountered and how they were overcome. This shows that the plan is an interactive document that has been referred to throughout the making process. Moderators will refer to the teacher's annotation and expect to see comments about the amount of help individuals asked for. The teacher's comments should be backed up by photographic evidence.
Mark band three candidates will have followed virtually all aspects of their plan, which will have itemized a sound selection of materials, resources and equipment.

Selecting materials, parts and components (5 marks)

Moderators will expect to see a product that involves the candidates using a range of materials.
Candidates should provide evidence about how they selected materials. This could either be as a section within the production plan or some candidates submitted separate sheets about material selection. Moderators referred to teacher comments about the candidate's ability to use the materials. For example annotation would indicate that a student can identify a specific material from a range of materials and choose the most suitable cross section to minimize waste.

Selecting processes, tools and equipment (18 marks)

Moderators will expect to see a product that shows that the students have worked in a number of technologies.
Candidates should provide evidence about how they selected appropriate processes, tools and equipment. For some candidates this appeared in their production plan where the students had included an additional section entitled "Reasons for Choice of materials and production methods".
The mark band three candidates had suggested a number of production methods, suggesting why the one chosen was considered the most appropriate. The evidence was in the form of a written justification with complementary evidence in the quality of the product itself. Centres are reminded that **photographic evidence of the final product** must be included with the portfolio.

Teachers are asked to comment on the ability of individual candidates to select processes, tools and equipment.

The annotated candidate record sheet should state:

- What the student did;
- The degree of skill and accuracy demonstrated;
- How they worked safely;
- What safety equipment was used;
- The degree of independence and confidence demonstrated.

Mark band three candidates should independently select and use appropriate processes, tools and equipment, to safely and competently make a product, which exhibits a high level of skill and accuracy.

Testing the product in relation to the specification (5 marks)

It is expected that candidates will have undertaken a number of objective tests comparing the final product to the specification. This appeared more successful in those centres where the students made the product they had designed. The students should be encouraged to use the product and comment on how well it works.

Mark band three candidates will have used and provided evidence of a variety of relevant tests against all of the specification points. Quality control checks suitable for quantity production will have been used during manufacture and have been used to ensure compliance to all aspects of the specification. The product will comply with the specification and will be of a high quality.

Part C: When applying new technologies.

Marks for this final section are to be drawn from parts A and B of the student's folder. It is therefore assumed that while designing students will have:

- Considered and investigated the impact of new technologies in manufacturing and control systems.
- Described the use of CIM or CIE.
- Had the opportunity to investigate or use smart materials.
- Described and carried out automated / robotic operations.

Investigate engineered products and describe new technologies. (6 marks)

Several centres included additional pages in the folders to show how products had been investigated. This seemed at odds with the fact that the evidence should be a part of the students' designing. While designing an adjustable light, for instance, a number of products could be disassembled and the manufacturing processes and materials described. All up to date products will include elements of new technology in both their manufacture and the materials used. It would therefore make sense for candidates to investigate engineered products at the analysis stage of their designing. Products could also be investigated when alternative materials and manufacturing methods are being suggested in part B.

Candidates should also be encouraged to think about and show how

- CIM or CIE could be used in a plant suitable for manufacturing their product.
- Investigate and apply a smart material in their product.

Describe and carry out several automated/robotic operations. (9 marks)

Centres should give their students a number of opportunities to describe and use automated operations while working through parts A and B of the project. This could be using a three axis CNC machine or describing how a robot could be used within the production process. Work submitted in this section should be associated with the students' designing (part A) or making (part B).

For candidates to be awarded the maximum marks they should be able to describe and demonstrate the use of at least two different three axis CNC machines or use a modeling system such as Lego or Fischertechnik to demonstrate how robot might be used within a production line.

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