GCSE

Rewarding Learning

Chief Examiner's Report

Technology and Design

Summer Series 2019

Foreword

This booklet outlines the performance of candidates in all aspects of this specification for the Summer 2019 series.

CCEA hopes that the Chief Examiner's and/or Principal Moderator's report(s) will be viewed as a helpful and constructive medium to further support teachers and the learning process.

This booklet forms part of the suite of support materials for the specification. Further materials are available from the specification's section on our website at www.ccea.org.uk.

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GCSE Technology and Design

Chief Examiner's Report

Subject Overview

Poor writing skills caused readability problems in some scripts. Candidates should be made aware of the importance of clear legible handwriting when answering questions.

Some candidates would benefit by taking more care when reading questions in order to have a clear focus on what a particular question is asking.

When producing flowcharts candidates must use the correct cell symbols containing clear and correct statements.

Some 3859 candidates were entered for the core module. Option C: Product Design was the most popular option with an entry of 1700 candidates; this was followed by Option A: Electronic and Microelectronic Control Systems which had an entry of 802 candidates and Option B: Mechanical and Pneumatic Control Systems which had an entry of 570 candidate.

Assessment Unit 1 Technology & Design Core Content

Unit Overview

This paper is compulsory for all candidates and catered for the whole range of abilities. It enabled almost all candidates to attempt all questions. Only a very small number of candidates did not attempt all questions, this included a small number of candidates who left many answers blank.

Questions ranged from one mark answers to more substantial questions that required reasoning and discussion of processes.

Marks for this paper ranged from low to very high.

There was no evidence to suggest that candidates had insufficient time to complete the paper.

The level of language and readability of questions was deemed appropriate.

Unit 1 Questions

Q1 Part (a) was generally well answered but a number of students were careless with some responses. Common errors included stating mechanism/s instead of mechanical and switch instead of single pole single throw switch. Some candidates were unable to sketch the diode symbol. Part (b) was generally well answered. In Part (c) the majority of candidates were able to identify the shuttle valve and many identified its OR function but did not focus on its purpose in a pneumatic circuit.

Q2 In Part (a)(i) the majority of candidates could name at least one metal but only the more able were able to name both metals. A range of acceptable answers ensured that Part (a)(ii) was well answered. Part (b) was also generally well answered but only a minority of candidates were able to identify the lathe processes.

In Part (d) a majority of candidates were able to correctly summarise all or some of the four bullet points but in a number of cases the complete bullet point or most of it was crammed into the response box with little attempt to summarise. Some candidates had the stages in the wrong order.

Q3 Part (a)(i) & (ii) and Part (b)(i) & (ii) were generally well answered by the majority of candidates although some candidates demonstrated a clear lack of knowledge in this area. Calculating the distance moved by the follower in Part (b)(iii) proved a little difficult for a number of candidates who added the 20 mm rather than subtracting it. Some candidates spent time drawing diagrams similar to Fig.4.

Q4 Part (a) & (b)(i) & (ii) were generally well answered but some candidates were unable to label the main air supply or indicate the correct method of return for the valve. The more able candidates were able to respond well to Part (c) giving a full description of how the circuit worked but a common error for some was the omission of the instroke of the cylinders when A was released. Most candidates were able to achieve some marks here but less able candidates struggled with the description and in some cases answers were very poor.

Q5 In general good marks were achieved in Part (a) by all candidates with a majority scoring very well. In Part (b) a majority recognised the correct category of plastic but many candidates provided a limited explanation as to why this type of plastic is used for vacuum forming. A number of candidates were able to name the calipers correctly and identify their use, but only a minority of candidates achieved full marks in response to Part (c). Some confused the calipers for spring dividers or a compass. Many candidates provided incorrect answers here.

Q6 Although a large number of candidates answered Part (a)(i) correctly it was surprising to see that many others did not know what the letters PCB stood for. For Part (a)(ii) many candidates were able to state at least one acceptable process with the more able candidates able to provide two acceptable processes required for Part (a)(ii) but many others struggled with this question and the follow on in Part (a)(iii). Candidates who responded correctly to Part (a)(ii) were generally able to follow through to describe the purpose of the process in Part (a)(iii). In Part (b)(i) a large number of candidates correctly named the electronic components but it was surprising to see a large number of candidates who struggled here. The vast majority of candidates were able to name soldering as the process for Part (b)(ii).

Q7 The flow chart was well understood by many candidates who produced clear logical diagrams with many achieving high or full marks. Candidates should be reminded that only generic flowcharts should be produced using the symbols that appear in Appendix 3 of the specification. This is stated quite clearly in Section 1.39 of the specification. Many candidates produced poor unacceptable cell symbols and in some cases did not bother with symbols at all. Feedback loops were not always clear with incorrect exit and entry points. In a number of cases output and waits were grouped together in one box and some candidates did not state if a LED was on or off or omitted the unit of time. Statements need to be clear and precise.

Q8 Part (a) was generally well answered but a number of candidates were only able to name one system and some candidates were unable to provide correct answers for either transmission system. Parts (b)(i) and (ii) were well answered by the majority of candidates. In Part (b)(iii) many candidates were able to calculate the gear ratio and present it correctly but a number of other candidates had the ratio inverted and some others simply presented a fraction as the answer, weaker candidates struggled with this part of the question. Most candidates were able to respond positively to Part (c)(i) by producing either one or two acceptable ways to reduce the speed of the lorry. Candidates who understood that the focus of Part (c)(i) and (ii) was on the gear train were able to recognize the need for additional an additional gear/s and followed this through to the influence on the lorry. Many other candidates suggested unsuitable answers such as fitting a chain or using a pulley and belt.

Q9 Part (a)(i) was well answered. In response to Part (a)(ii) many candidates recognised that the lever had to be activated to switch on a circuit or valve but only the more able candidates recognised that the lever had to be switched off, as well as on, when used to control the operation of a circuit or valve. A number of candidates struggled to provide an acceptable answer here. In response to Part (b)(i) almost all candidates were able to achieve some marks. Many showed an excellent understanding of the pneumatic circuit shown in Fig 14 by their ability to provide a clear description of how it worked. Some candidates did not recognize the AND circuit at A and B and others made no reference to the function of C in slowing down the output speed of D. A common error was to ignore the return stroke of the SAC. Part (b)(iii) was well answered by a majority of candidates.

Q10 Only those candidates with a good understanding of the procedures scored well in this question. The process of pop riveting was not well answered by many who could only provide brief details although many candidates were able to explain aspects of the marking out process, the drilling process and the preparation prior to pop riveting. Some did this better than others. A number of candidates went off on a tangent and described how to make the aluminium frame and cut out the acrylic sheet. A numbers of others simply repeated statements from the stem of the question and made no attempt to indicate measurements to show the positions of the holes for the rivets. Some indicated that the holes were in the corners of the frame. Candidates should integrate appropriate safety precautions and use of tools into the body of text rather than giving isolated lists of general safety precautions and tools to be used. Careful reading of the question is required in order to achieve good marks.

Assessment Unit 2 Option A Electronic and Microelectronic Control Systems

Unit Overview

The examiners reported that this paper was well received by most candidates and they were able to respond positively to both questions.

Examiners reported that the language used in the paper was appropriate for the candidates. It did require specialist knowledge of the subject to answer these questions, but the paper was accessible to all.

It was reported by the examiners, that the answers indicated a large spread of marks catering for a full range of abilities. Most candidates were able to attempt nearly all parts of each section of the two questions. Progression in both questions and a gradual degree of difficulty seemed to enable all abilities to provide answers and clearly will assist with differentiation within the paper.

There seemed to be better clarity in schools in the use of generic flow charts symbols and this reflected in the candidates' answers, however, the candidates need to present these symbols neatly and correctly. There was a good balance in the questions in terms of calculations, symbols and circuit designs.

In a minority of cases candidates hand writing was illegible making awarding marks difficult.

The majority of candidates attempted both questions fully and this seemed to indicate the appropriateness of the one hour and thirty minutes for the paper to be sufficient.

In Question 1 the following parts of the question were more testing, Part (b)(iii); (iv); (vi); (c) (i); (ii); (iii); and (d).

In Question 2 the candidates should take more care drawing the correct flowchart symbols and use the correct appropriate macros boxes. Two different commands are not acceptable in one box. The following parts of the question were more testing, Part (c) and (d).

Q1 **(a) (i)** & **(ii)** Well answered, the majority of candidates completed this question correctly.

(b) **(i)** Most candidates were able to identify SPST, however, a number of candidates called it 'pull'.

(ii) LED almost 100% correct.

(iv) Some candidates only mentioned the capacitor discharging.

(vi) A number of candidates forgot to subtract 9 – 2 volts.

(v) Well understood question on resistors and LEDs.

(vi) This calculation question caused some problems and was a good differentiating question. Some candidates omitted the unit's kΩ or Ω.

(c) **(i)** The majority of candidates were able to complete some parts of this question on Astable and Monostable circuits.

(ii) Generally answered well, some candidate's failed to give ms but gave seconds.

(iii) Poorly answered calculation. If the correct formula was selected then the answer was straight forward.

(d) Satisfactory answers with a lot of candidates able to discuss and describe some applications for resistors. Good challenging question for the more able candidates to gain full marks for the completion of the circuit.

Q2 **(a)** Many correct and varied answers for the reasons of the use of robotics in industry.

(b) Some candidates didn't always compare the two types of mowers.

(c) Many correct answers for the focus on the Microcontrollers (PIC). Some candidates gave vague answers.

(d) Generally the candidates knew the symbol for a relay coil but not the contact switch. The diode was also a problem being inverted in its location.

(e) **(i)** Good answers but a small number of candidates used incorrect boxes.

(ii) A mixed range of answers, a lot of candidates left out the decision box at the start of the flowchart.

(iii) A good question for differentiation. Some candidates did not include the count routine correctly or insert the correct boxes for the macros.

Assessment Unit 2 Option B Mechanical and Pneumatic Control Systems

Unit Overview

This paper allowed the full range of abilities to gain the full range of marks.

Candidates of differing abilities were able to attempt questions in all sections of the paper and again scored slightly better on questions on pneumatics compared to those on mechanisms. Calculations again proved difficult but most candidates were able to score reasonable marks. Appropriate units were generally stated.

Students struggled with some mechanism symbols within the first question.

It was found that most of the candidates answered questions with full sentences and succinct answers which fulfilled the marking criteria.

The final answer was answered well by some candidates, however, it appeared others chose to answer with shortened bullet points and some did not answer fully at all.

It was evident from the responses there were a wide range of abilities and that all questions were attempted by the majority of candidates.

Q1 **(a)** Was well answered by most candidates. Many candidates were unable to identify the wheel and axle or single pulley mechanical symbols.

(b) **(i)** & **(ii)** Were answered well. Almost all candidates named the mechanism and specified the input and output correctly.

(iii) Common errors included inverting the driven and driver and therefore gaining no marks. Candidates should note that the units are required to gain full marks.

(c) **(i)** Was generally well answered were most candidates named the mechanism correctly although some candidates identified these incorrectly as 'meshed gears' as opposed to a Simple Gear Train.

(ii) Most candidates outlined appropriate advantages and disadvantages of the Simple Gear Train compared to the Pulley System.

(iii) This question was correctly answered by a majority of candidates and differentiated candidates by mathematical ability. The most common mistake by some candidates was to invert the driven and driver and gain no method marks.

(iv) & **(v)** Were well answered with most candidates being able to specify an idler gear and recognize that it had no effect on the speed.

(vi) This differentiated by candidates of different ability. A common error by a large number of candidates was to suggest increasing the size of gear A or B. Some candidates suggested a compound gear train. Candidates did not read the question correctly as it was asking for another method of transmitting power between two shafts apart from the two already discussed in Part (b) and Part (c).

(vii) This question again differentiated candidates of different abilities. Only a few candidates recognized the significance of a LARGE reduction in speed and the appropriate mechanical system to achieve this requirement. Some candidates did mention the Worm and Worm wheel but this answer transferred power and motion through 90º which is incorrect.

(d) **(i)** Was well answered with a majority identifying the Class of Lever as Class 2.

(ii) Generally answered well by the majority of candidates. Candidates suggested a large number of answers. Candidates should note that they need to be specific as metal or wood is not enough for this question. The type of metal and reason should be appropriate to the specific application.

(iii) This question differentiated candidates of different abilities. Some candidates did not use distances from the pivot when taking moments. Common errors included using the force from effort not the fulcrum although candidates gained some method marks. A large number of candidates attempted to use force, pressure, area formula. Candidates should also note that units are required to gain full marks.

(e) **(i)** & **(ii)** Were generally well answered.

(iii) Was very well answered with nearly all candidates gaining full marks for this question.

(iv), (v) & **(vi)** Most candidates made a successful attempt at these questions. These questions successfully differentiated candidates of different ability. Some responses were not generally well presented to show steps in the calculations. Common errors included using the radius instead of calculating the diameter although this gained some method marks. Candidates should note that units are required to gain full marks. Most candidates used the formula correctly for their answers to Part (iv) and (v). Quite a limited number of candidates gave their answer as a ratio.

(vii) This question differentiated candidates of different abilities.

(viii) Most candidates were able to show some form of an appropriate method of joining the plastic ball to the handle. A range of possible design solutions gained the range of marks. Candidates should note that annotation is required to gain full marks in this question.

Q2 **(a)** **(i)** was generally well answered. Most candidates scored well in this question. Candidates should note that answers should be from the table provided.

(ii) again was generally well answered. Candidates should note that answers should be from the table provided. Common errors included candidates attempting to use the full contents of the table across Part (a)(i) and (a)(ii).

(b) **(i) & (ii)** Generally well answered although a large number of candidates achieved 3 of the 4 marks as they suggested adjust the FCV but not specifically tighten the FCV.

(c) **(i)** Candidates achieved the full range of marks in this question. It effectively differentiated candidates of different abilities. Common errors included not indicating a switch of B, stating that the air went 'just through B', also, not recognising the speed control of the outstroke, just stating 'outstroke of the DAC hitting the roller 3/2 valve'. Most candidates recognised the time delay and that C then instrokes after the time delay. A number of candidates stated that the DAC instroke was slow due to the Flow Control Valve E which was incorrect.

(ii) Was poorly answered. Many candidates suggested including a FCV but few recognised there was one already there and all they had to do was 'adjust Valve E'.

(c) **(iii)** This question was attempted by the majority of candidates. Many achieved full marks. Common errors included omitting the shuttle valve and in a limited number of papers the piping to the shuttle valve. The more able candidates were able to show the required circuit using all the additional valves required drawn very accurately.

(d) **(i)** Was well answered with most candidates able to show the additional valves and connections required. A limited number of candidates did not attempt this question. A large number of candidates achieved the top mark band in this question with many achieving full marks. Common errors included the position of the 3/2 valves at the instroke and outstroke positions.

(ii) This question differentiated candidates of different abilities. Many candidates found this challenging with a small number achieving top marks. The majority of candidates recognised the need to insert a 3/2 valve at A+. A small number recognised the need to connect this in AND logic through port 1 of the 3/2 valve at B+.

(e) Most candidates were able to discuss a number of safety factors involved in the building and operating of pneumatic circuits. A limited number of candidates seemed unprepared for this question. The majority of candidates made a reasonably good attempt to identify safety issues when using/building pneumatic circuits. Approximately 60% made attempts to discuss why these safety issues are necessary. Candidates should note that their spelling punctuation and grammar are assessed in this question. This question was answered by the majority of candidates, however, there were some who chose to only utilise less than half of the given space for the answer.

Assessment Unit 2 Option C Product Design

Unit Overview

The Examiners reported, this paper was generally well attempted by nearly all candidates and they produced a variety of solutions to most questions making the paper accessible to all abilities. There was no evidence that the candidates were unable to attempt all the questions within the set time.

There seemed to be a certain amount of misinterpretation of some questions. Understanding and reading of the questions and giving the appropriate answers seemed to a problem for some candidates.

The paper was a solid test of knowledge and one where some candidates, those well prepared, were able to score well and present articulate, correct answers.

Questions 1(b), (c)(ii), Question 2 (ii) Question 4 (a)(iii), (b), Question 5(e) and (d)(i), Question 7(a), (b)(i) and (ii), (c)(ii) and Question 8 offered the most difficulty within the paper. It appeared a lot of candidates rushed the final question and this was evident in the quality of work and marks. In a number of cases poor handwriting caused difficulty when marking and the quality of sketches in Question 8 ranges from poor to good, lacking detailed notes and not ensuring all parts of the question were answered.

Q1 **(a)** Understanding of safety of using a lathe caused problems to some candidates. There were too many general safety answers, however, most candidates scored 2 marks.

(b) Some very vague answers about recycling old tools and equipment.

(c) **(i)** & **(ii)** A lot of candidates obtained the mark for the mobile phone, but struggled with the word and meaning of obsolescence.

Q2 **(i)** Well answered question by most candidates but a lot struggled to name all four stages.

(ii) A good discriminating question candidates were able to identify at least some responses, with a much lesser group supplying full responses for the growth stage.

Q3 **(a)** A lot of candidates were able to identify advantages for using robots but struggled to give enough detail why. Candidates should be aware of the need of more detailed answers for two marks per example and not just shot/limited answers.

(b) Well answered by most candidates, a wide range of alternative acceptable answers for uses of robots.

Q4 **(a)** **(i)** A wide ranges of acceptable answers for the squeezer. It appeared some candidates were unsure of the requirements of this question.

(ii) Well answered.

(b) Not well answered by most candidates. This question was a good discriminating question.

Q5 **(a)** Most candidates seemed to name either the legs or rails of the table. The explanations were in many parts vague.

(b) Well answered.

(c) Mostly a good range of answers for the properties of the named wood, however, some candidates gave very limited answers such as cheap and easy to work.

(d) **(i)** This calculation question was poorly answered. Candidates and teachers must be aware of the inclusion of mathematical questions.

(ii) This calculation question was well answered.

(e) Quite well answered, however, sketches and notes could have been better detailed.

Q6 **(a)** **(i)** Well answered.

(ii) Mostly very good responses, with only a few obtaining full marks.

(iii) Very well answered by most candidates.

(iv) A range of different, but correct, answers to the selling price due the factor of multiplying by 1800 and the number of decimal points candidates used

Q7 **(a)** Poorly answered by a lot of candidates who considered more of a general customer's specification and not a manufactures specification.

(b) **(i)** & **(ii)** Surprisingly poor responses, generally disappointing, with many candidates unable to identify a Gantt chart and its key factors.

(c) **(i)** The majority of candidates were able to identify three features of the scooter.

(ii) Poorly answered by a large number of candidates who seemed unsure of the term anthropometrics.

Q8 This question was attempted by nearly all candidates and the stool seemed a popular design with most candidates. A range of answers were provided by the candidates. A number of candidates designed a chair and not a stool. Most candidates failed to describe or sketch the details of their designs and the manufacturing processes including justification required to make the stool. The purpose of dimensions was to give scale to the size of the stool. A few candidates achieved highly in this question.

It is important that the candidates address all the listed specification points and give as much detail as possible with suitable materials, suitable joining processes and finish all with justification.

Detailed annotated sketches are vital to explain the key aspects of their design and proportion.

Assessment Unit 3 Design and Manufacturing Project

Unit Overview

'The design portfolio should be a maximum of ten A3 sheets on one side only or equivalent. All text must be size 12. All titles should not exceed size 16. See page (39) and (47) of the revised specification;

NB. Moderators will only assess the first (10) A3, pages of the portfolio.

All centres produced the required documentation for the 2019 moderation series. The eCRSs seemed to be a successful initiative. This provides the opportunity for centres to report on how the candidates had responded to the controlled assessment task throughout. However, some centres did not provide comments on their candidates' record sheets.

It is pleasing to report that all centres have embraced unit 3 of the revised specification and that many candidates have produced quality outcomes which meet the requirements of the set design themes. Of the two themes the museum activity centre appeared to be the most popular. The eco-friendly theme was also favoured by many and a wide variety of innovative products that enhanced children's play in a nursery school environment were evident. Overall, the quality of work presented reflected the demands and breadth of coursework parameters with the use of a wide range of materials and processes employed for the completion of the practical prototype.

The two themes are released annually every January for this specification and are posted on the CCEA micro site; http://ccea.org.uk/technology/

The design process will continue to challenge the wide array of capabilities, to analysis, think creatively, conceptualise, model/manufacture and evaluate a working functional prototype. This final project outcome may or may not include a system; depending upon the design intent/design brief but the core skills necessary for designing should be evident throughout. Candidates' knowledge, skills and capabilities are measured against the mark descriptors in each of the bands in the five elements of the specification in Appendix 2 pages 58-64.

A number of teachers were unable to attend the support events last autumn and some may have missed important guidance given by the senior moderating team. It is considered important by CCEA to attend the annual agreement trials to gain further clarification of the mark descriptors and avail of the opportunity to apply these to numerous exemplar portfolios/projects. Applying the standard set by the senior moderating team will help provide for more accurate centre marking.

1. Design Thinking, Analysis and Specification

In all centres candidates explored design possibilities. However, in some instances there was a lack of creativity and depth in knowledge and understanding in relation to exploring the theme for the marks awarded. The criterion in Appendix 2 challenges the candidates to brainstorm the potential design opportunities of the chosen theme. A spider diagram or who, what, why, where, when model are both appropriate strategies, but evidence of in-depth thinking and exploring the theme will gain higher marks. Often candidates' design briefs are not clear of the design intent. See Appendix 2 mark bands: - Relevant material is succinct, well organised and presented with a good/high degree of clarity and coherence. As the design process is not linear candidates may revisit their brief after research to clarify thinking.

The ability to analyse existing products still continues to challenge many candidates. Students must understand the key design factors such as functionality, ergonomics, aesthetics, product safety in use; materials etc. and justify their views and opinions when comparing products. The ability to discriminate and articulate what is and is not good design demonstrates a higher level of capability; these qualities will gain higher marks. Repetitive examples of design analysis are not considered good practice and descriptive accounts of existing products will not gain high marks. Generic information on parts and components, materials and manufacturing processes are often used in research without connections to the problem. Justification and sound reasons why materials, fittings, components etc. have been considered will be rewarded.

Candidates that identify key design features and quantitative measurable data demonstrating knowledge sufficient for the development of an appropriate solution in their specification will gain higher marks. Candidates who carry out research prior to writing their specification usually understand better the requirements of the product and assist in developing a more in-depth specification.

Note: (JCQ Guidance Page 9); Candidates must include their reference materials source/s where appropriate i.e., Books, websites, audio/visual resources etc. where appropriate.

The following are observations noted by the moderating team in relation to outcomes in this element:-

Some candidates used a smaller font size than (12) as prescribed in the specification (Page 39) this is not permitted;

A small number of centres followed the legacy portfolio format. This does not address criteria for the revised specification;

- Some design brief were lacking in clarity;
- Many candidates misunderstand and even omitted 'ergonomics' in their specification;
- Quantifiable facts and figures are often omitted in many specifications;
- Too much generic electronic component information is being presented. Some of this information was descriptive with little connection to the design opportunity.

2. Concepts and Analysis

Overall, this element was well addressed by the majority of candidates. Many produced quality freehand sketches with some showing design and fabrication details using exploded views. A range of quality graphical techniques will gain higher marks. Design concepts must be illustrated using freehand graphics. A few centres used SketchUp which is CAD driven software and does not meet the marking criteria in this element. Candidates should be encouraged to generate a good range of initial freehand concepts/ideas which demonstrate

creativity, thinking and analysis on their first design sheet. There is an opportunity to illustrate and justify some development of the chosen concept/s on the second design sheet. If the product includes an electronic system the candidate is expected to demonstrate knowledge and understanding of the inputs, control and outputs; I/C/O's and include a sketchmatic circuit diagram of the proposed circuit/system on the second design sheet. 2D CAD may be used to draw circuit diagrams. There is an opportunity in this element to reduce text by illustrating concepts using a range of graphical skills and techniques. Note: Page (41) of the revised specification - 'Include clear and succinct annotation'. Reference to the amplification is important for further guidance, this is available on the CCEA website.

3. Development of Proposed Concept: Modelling and Testing

The highest marks in the portfolio may be gained in this element. In the majority of centres candidates allocated four A3 pages to this section as suggested in the guidance in the amplification. Overall, the majority of candidates made a good attempt to develop their project/prototype that included/excluded a system. The development should include further illustrations of design and fabrication details that may have been influenced from physical modelling. The majority of candidates had models presented but quite a number closely resembled their final project. Modelling is an important stage of the manufacturing process and informs the candidates' thinking. For higher marks candidates should include evidence in their portfolios of how the scaled model/s provided feedback and inspired the necessary changes i.e. size, proportion, features, ergonomics, parts, controls etc. Many candidates included photographs of testing their physical models in situ with annotation as part of their manufacturing development. This is excellent practice and is likely to gain higher marks.

- Note: A physical model/s must be presented for candidates to score marks in the excellent band category.

Physical models may be realised using card, foam, wood, plastic etc. and should be made to scale. Candidates should avoid using miniature 3D printed models as these are generally too small to inform quality thinking.

The opportunity exists to include an electronic system to demonstrate understanding of the programme development using flowcharts and PCB artwork. Including an operating system provides an additional opportunity to demonstrate virtual modelling, testing and analysis. The majority of candidates demonstrated a high level of competence in this area. The functionality and ergonomics should not be ignored when testing projects as part of the development process. The majority of centres are to be commended on the quality of working drawings. Many of these are now realised using 3D solid modelling software such as SolidWorks. A number of candidates missed the opportunity to present their part files showing manufacturing development i.e. exploded and sectional views of assembly details. Working drawings should be drawn in BSI 3rd angle projection and include key dimensions, a parts table, balloon referencing, title etc.

There are also opportunities to demonstrate knowledge and understanding of 'testing' using virtual models using 3D CAD. This aspect of modelling may be explored.

4. Development of Proposed Concept: Manufacture

All moderators reported a high standard of manufacturing outcomes in many centres with candidates demonstrating a wide range of making skills and creativity. Computer numerically controlled (CNC) manufacturing using laser cutters, CNC routers and more recently 3D printers are now more commonly used in the majority of school workshops. This technology provides for greater precision and accuracy. Generally higher level computer aided design (CAD) skills are required for CNC manufacture. Where this is used

candidates must show evidence of virtual modelling in their portfolios. The use of this manufacturing technology meets the requirements of the revised specification and is to be encouraged where appropriate. The use of laser cutting technology continues to challenge many candidates to produce creative outcomes. Some candidates incorporating a system into their project tended to have unimaginative acrylic box shapes with limited thought given to ergonomics. The efficient functionality of the final project is paramount and as ergonomics and aesthetics are key factors these must be evident in outcome to achieve higher marks. Some 3D printing outcomes were presented for moderation and this is an acceptable form of CNC manufacturing where appropriate.

Moderators reported that it was pleasing to see moulds, jigs and models presented in many centres to support manufacturing. Candidates who demonstrate higher order manufacturing skills, attention to detail and quality finishing will be rewarded. Some centres are generously rewarding basic manufacturing techniques such as butt joints.

Including a vectorising jpeg image/s downloaded from the internet can enhance project outcomes but this is not designing from first principles and should be considered only a part of an innovative solution.

5. Evaluation

Many centres continue to mark this element leniently. For high marks candidates are expected to produce a detailed evaluation of the prototype that demonstrates an excellent level of reflective thought, which includes fitness for purpose; testing against the specification and making evaluative comments; and suggesting valid modifications, using sketches, photographs where appropriate.

Candidates will gain marks by justifying with sound reasoning as to why the prototype performs well including the features or aspects of the product/project that may require changing. This is an opportunity to address aspects of the specification that could be improved.

Evidence of intelligent testing of the prototype in many centres is excellent. However, with some candidates this element is poorly addressed. The ability to discriminate and justify demonstrating knowledge of a good design outcome will be rewarded.

The following were generally underdeveloped:-

- Functionality, ergonomics and reliability;
- Testing systems performance including the outcome of results/calculations etc.
- Measurement with justification against the key specification points;
- Suggestions for improvement and the effects of these;
- Modifications and suggestions for improvements.

Using video evidence of candidates' operating systems may be useful for the moderating process.

Centres need to consider that the final prototype in this revised specification is a project with or without an operating system. There will be some differences in some aspects of the portfolio outcomes but ultimately the candidates are designing and manufacturing a project. The key requirements of the design process dictate similar challenges and experiences for all.

NB. Each of the A3 pages in the portfolio should include the title of the elements, candidate number and centre number. This makes for easy of assessment by the moderator.

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