Contents

WJEC GCSE in DESIGN & TECHNOLOGY (SYSTEMS AND CONTROL)

For Teaching from 2009
For Award from 2011

This is a unitised specification: candidates may be entered for separate units at stages during the course.

For subject awards from summer 2014, this specification will not be available to centres in England: centres in England will be required to follow the linear version of this specification.

DESIGN AND TECHNOLOGY (SYSTEMS AND CONTROL)

SUMMARY OF ASSESSMENT

Unit 1: SYSTEMS AND CONTROL WRITTEN PAPER (40%) **Written Paper: 2 hours** **120 marks (80 UMS)** **This will consist of one paper for each focus area.**
Section A 20% (60 marks)
Four compulsory questions related to the world of Design and Technology and focus area specific.
Section B 20% (60 marks)
Four compulsory questions based on the specification content. These questions share a common structure across all focus areas.
Unit 2: SYSTEMS AND CONTROL TASK (60%) **Controlled Assessment** **180 marks (120 UMS)**
Part A Carry out an analysis of the problem, write a design specification, generate a range of ideas, develop a solution and produce the details of the final solution. (10 guided hours). **Part B** Plan the making process, carry out the making and evaluate project. (20 guided hours). Both parts of the task have to comply with the controlled assessment rules.
Focus Areas Provided
Food Technology Graphic Products Resistant Materials Technology Systems and Control Technology Textiles Technology Product Design

AVAILABILITY OF ASSESSMENT AND CERTIFICATION

	Entry Code		June 2010	Jan 2011 and each year thereafter	June 2011 and each year thereafter
	Subject	Option*			
Unit 1	4121	01 or W1	✓		✓
Unit 2	4122	01 or W1			✓
Subject Award	4120	SA or GU			✓

*** Option Codes**
English Medium 01, Welsh Medium W1 - for units
English Medium SA, Welsh Medium GU - for subject award

Qualification Accreditation Numbers
500/8151/2 until 2013
600/5562/5 from 2014

DESIGN & TECHNOLOGY (SYSTEMS AND CONTROL)

1 INTRODUCTION

1.1 Rationale

A course in Design and Technology offers a unique opportunity in the curriculum for candidates to identify and solve real problems by designing and making products or systems in a wide range of contexts relating to their personal interests. Design and Technology develops candidates' interdisciplinary skills, all six Key Skills and their capacity for imaginative, innovative thinking, creativity and independence.

The specification is based upon the view that design and technology is essentially a practical activity involving the combination of skills with knowledge and understanding in order to design and make quality products. It is intended to develop candidates' design and technological capability through a flexible and broad-based approach. The specification is planned to be sufficiently broad, balanced and relevant to interest all candidates.

Candidates should have the opportunity to analyse and evaluate situations, design and make products, and then appraise their performance. They should be provided with the opportunity to work with a range of materials and ICT.

Candidates should be presented with the subject matter in a stimulating and interesting way to promote discussion and research. They should be given the opportunity to experience the variety of roles involved in design and technology; client, designer, maker, manager, user etc. Candidates should be encouraged to consider the relationship between technology and society.

As a fundamental part of their course, candidates should design and make products. They should carry out activities related to industrial practices and the application of systems and control within their designing and making of these products.

The specification allows candidates to work in one or more of the following focus areas:

- Food Technology
- Graphic Products
- Resistant Materials Technology
- Systems and Control Technology
- Textiles Technology
- Product Design

1.2 Aims and Learning Outcomes

GCSE specifications in design and technology should encourage learners to be inspired, moved and changed by following a broad, coherent, satisfying and worthwhile course of study and gain an insight into related sectors, such as manufacturing and engineering. They should prepare learners to make informed decisions about further learning opportunities and career choices.

GCSE specifications in design and technology must enable learners to:

- actively engage in the processes of design and technology to develop as effective and independent learners;
- make decisions, consider sustainability and combine skills with knowledge and understanding in order to design and make quality products;
- explore ways in which aesthetic, technical, economic, environmental, ethical and social dimensions interact to shape designing and making;
- analyse existing products and produce practical solutions to needs, wants and opportunities, recognising their impact on quality of life;
- develop decision-making skills through individual and collaborative working;
- understand that designing and making reflect and influence cultures and societies, and that products have an impact on lifestyle;
- develop skills of creativity and critical analysis through making links between the principles of good design, existing solutions and technological knowledge.

1.3 Prior Learning and Progression

Although there is no specific requirement for prior learning, this specification builds upon the Programmes of Study for Design and Technology in Key Stages 1-3.

This specification may be followed by any candidate, irrespective of their gender, ethnic, religious or cultural background. This specification is not age specific and, as such, provides opportunities for candidates to extend their life-long learning.

This specification builds upon the Programmes of study for Design and Technology in Key Stages 1, 2 and 3 and allows candidates to fully address the knowledge, skills and understanding required by the National Curriculum Order for Design and Technology. The specification allows candidates to work in the following focus areas: Food Technology; Graphic Products; Resistant Materials Technology; Systems and Control Technology; Textiles Technology and Product Design promoting progression to a deeper level of knowledge, skill and understanding in one of the areas studied at Key Stage 3.

Whilst there is no specific requirement for prior learning in the WJEC Advanced Subsidiary / Advanced GCE specification in Design and Technology, there is a clear progression route from this GCSE specification. Candidates following the Graphic Products; Resistant Materials Technology; Textiles Technology or Product Design focus areas have an opportunity to extend their experience into the Product Design focus area at AS/Advanced level. Food Technology and Systems and Control Technology candidates have a clear progression route into focus areas with the same titles at AS/Advanced.

1.4 Equality and Fair Assessment

GCSEs often require assessment of a broad range of competences. This is because they are general qualifications and, as such, prepare candidates for a wide range of occupations and higher level courses.

The revised GCSE qualification and subject criteria have been reviewed to identify whether any of the competences required by the subject presented a potential barrier to any disabled candidates. If this was the case, the situation was reviewed again to ensure that such competences were included only where essential to the subject. The findings of this process were discussed with disability groups and with disabled people.

This review did not identify any potential barriers to disabled candidates within the criteria and no potential barriers have been added within the specification. It should be noted that candidates may use CAD/CAM for the making process and practical assistants may be used to support students with physical disabilities in this process.

Reasonable adjustments are made for disabled candidates in order to enable them to access the assessments. For this reason, very few candidates will have a complete barrier to any part of the assessment. Information on reasonable adjustments is found in the Joint Council for Qualifications document *Regulations and Guidance: Access Arrangements, Reasonable Adjustments and Special Consideration.* This document is available on the JCQ website (www.jcq.org.uk).

Candidates who are still unable to access a significant part of the assessment, even after exploring all possibilities through reasonable adjustments, may still be able to receive an award. They would be given a grade on the parts of the assessment they have taken and there would be an indication on their certificate that not all of the competences have been addressed. This will be kept under review and may be amended in future.

1.5 Classification Codes

Every specification is assigned a national classification code indicating the subject area to which it belongs. The classification code for this specification is 9060.

Centres should be aware that candidates who enter for more than one GCSE qualification with the same classification code will have only one grade (the highest) counted for the purpose of the School and College Performance Tables.

Centres may wish to advise candidates that, if they take two specifications with the same classification code, schools and colleges are very likely to take the view that they have achieved only one of the two GCSEs. The same view may be taken if candidates take two GCSE specifications that have different classification codes but have significant overlap of content. Candidates who have any doubts about their subject combinations should check with the institution to which they wish to progress before embarking on their programmes.

2 CONTENT

DEVELOPING, PLANNING AND COMMUNICATING IDEAS

This part of the specification is concerned with the process of designing. This will start with an initial problem and conclude with a proposed solution giving due consideration to the issues that can and should influence the outcome.

Candidates should be taught to:

(a) develop and use design briefs and detailed specifications;

Understand the difference between design brief and design specification.
Analyse and clarify a design brief.
Identify essential criteria for inclusion in a design specification.
Use a specification to help develop a design.
Use a design brief and design specification for evaluation.
Use existing products as a source of ideas.

(b) consider issues that affect their research, designing and planning;

Use different research strategies to find information.
Consider the needs and values of a range of users.
Appreciate the economic costs involved.
Consider issues of sustainability.
Consider moral, social, environmental and cultural influences.
Take into account relevant safety legislation.
Prioritise and summarise research material.
Recognise the potential of new technologies.
Consider marketing and advertising.

(c) be flexible and adaptable in responding to changing circumstances and new opportunities;

Recognise that there is a range of possible ways forward when designing and making.

(d) generate, develop, model and communicate design proposals;

Use a variety of graphic techniques to communicate ideas clearly.
Use ICT to communicate ideas clearly.
Use appropriate modelling techniques to develop their proposals.
Develop designs in a progressive way.
Communicate final design proposals in an appropriate form and level of detail.

(e) design for manufacturing in quantity;

Consider how products are designed to facilitate manufacturing in quantity.

(f) plan work schedules effectively;

Produce a realistic schedule of work.
Recognise critical points and constraints.

(g) match materials and components with tools, equipment and processes, taking account of critical dimensions and tolerances when deciding how to manufacture the product.

Select and justify the materials, components, tools, equipment and processes needed for successful manufacture.

PRODUCT ANALYSIS

This part of the specification is about knowing how to analyse a product.

This specification provides the opportunity for candidates, through Systems and Control to develop a wider understanding of how products are designed and made.

Candidates should be taught to carry out a detailed analysis of a product addressing the following aspects:

(a) the probable specification for the product;
(b) the aesthetic appeal of the product;
(c) the function and/or purpose of the product;
(d) quality issues relating to the product;
(e) the size data of the product;
(f) the safety considerations of the product with reference to the end user;
(g) the materials used in the manufacture of the product;
(h) the scale of manufacture used to make the product;
(i) the commercial processes used to make and assemble the product;
(j) safety considerations for making the product;
(k) sustainability and environmental issues.

SUSTAINABILITY and LEGISLATIVE ISSUES

This part of the specification is about knowing that sustainability and environmental issues, legislation and standards affect and influence designing and manufacturing choices and decisions and use this information in their own designing and making.

Sustainability in Design and Technology

The specification requires candidates to develop a understanding of sustainability and environmental issues and to be able to use their understanding to guide and assist their decision making during designing in their focus area.

Candidates will have to be taught to look at the world we live in and to consider the needs of future generations and will need to consider how, as designers and manufacturers, they can minimise their environmental impact and also to show in their work how we can have a more sustainable future.

Candidates should be taught to:

(a) recognise why sustainability issues and environmental issues are important;

(b) consider sustainability issues and environmental issues when designing and manufacturing;

(c) recognise and take account of social, economic and environmental responsibility in designing and making products.

(d) understand and use of SIX R's of sustainability, that is:

rethink
reuse
recycle
repair
reduce
refuse.

(e) understand that sustainable designing is more than using recycled or recyclable materials to manufacture their products. It is about the total impact that the process of designing and making has on the environment.

(f) carry out a "Life Cycle Analysis" to determine the environmental impact of a product.

Legislative Issues in Design and Technology

This specification requires candidates to develop an understanding of legislative issues and standards as they affect their designing and making in their chosen focus area and to be able to use the understanding they have gained to guide and assist their decision making during designing.

Candidates should be taught to:

(a) know about the work of the British Standards Institution (BSI) and how it is related to the Committee for European Standardisation (CEN) and the International Standards Organisation (ISO);

(b) know how standards are produced, what they are for and how products that reach the standards are marked;

(c) British Standards on Electronic Symbols.

OTHER DESIGNERS / PRACTITIONERS

This part of the specification is about knowing about and understanding the work of professional designers and/or professional practitioners within the world of Design and Technology.

Candidates should be taught to recognise the influence of two Designers/ Practitioners in the world of Design and Technology with respect to:

(a) the range of work that each of the Designers/Practitioners have produced over time;
(b) how to identify the work of each of the Designers/Practitioners;
(c) the innovations and/or new ideas that the two Designers/Practitioners have introduced over time;
(d) the influence that each of the two Designers/Practitioners has had on the world of Design and Technology.

Each Focus Area will specify two Designers/Practitioners for each examination year and the awarding body will review the two Designers/Practitioners each year. Centres will be informed of the details of each of the Designers/Practitioners two years before the examination to be taken.

COMMERCIAL MANUFACTURING PRACTICES

This section relates to candidates' understanding methods of production used in commercial practice, and showing an appreciation of this in the work undertaken during the course.

Candidates should be taught to:

(a) Commercial Practice

- Appreciate how designs are developed and modelled in commercial practice.
- Appreciate the role of CAD in commercial situations.
- Appreciate techniques of rapid prototyping.
- Appreciate how products are manufactured in quantity.
- Appreciate issues related to production on a larger or continuous scale.
- Appreciate purchasing materials in bulk.
- Appreciate CAM and hand processes.
- Understand the scale of production and the need for parameters and tolerances.
- Have experience of using a CNC machine.
- Understand a commercial production line and its features.
- Understand the techniques used to manufacture electronic circuit boards in bulk.
- Understand the techniques used to produce PCB's.
- Understand automated component placing and surface mount technology.
- Compare SMT with through hole methods and understand the benefits.
- Understand flow, reflow and wave soldering techniques.
- Appreciate the principles related to integrated circuit manufacture.
- Understand the trend of Moore's Law .
- Understand the concept of miniaturisation of control systems and the effect this has on products.
- Understand how adding features to products or control systems enhances products.

(b) Commercial Production

- Understand a typical manufacturing and assembly line.
- Appreciate the control systems operating on such lines.
- Appreciate microprocessor and PLC control used in such lines.
- Simulate a simple automatic machine control system found in such scenarios including drilling, conveyor belts, selection and rejection.
- Model commercial systems using input, process and output commands.
- Analyse typical products that include control systems and understand their manufacture.
- Show an understanding of jigs and devices to control repeat activities.
- Consider how quality is controlled in commercial situations.

MATERIALS AND COMPONENTS

Systems and Control candidates are expected to develop an understanding of the range of materials and components available for manufacturing control systems. Candidates should develop an understanding of individual materials and components and how they can be combined to from a system or sub-system. Candidates should be encouraged to consider the range of materials and components available and make reasoned selections and exclusions for given tasks.

Candidates should be taught to:

(a) Electronics

- Understand the terms Voltage, Resistance and Current and their relationship in an electronic circuit.
- Understand and apply Ohm's Law. *V=I*R*
- Understand the function of resistors and their colour code system.
- Consider electronic circuits / systems under INPUT, PROCESS and OUTPUT blocks.

Use Input Devices

- Understand components as INPUT devices.
- Use switches, SPST, SPDT, DPDT, push to make, push to break.
- Reed, and tilt.
- Sensors for light, heat and moisture.
- Understand and apply potential dividers.
- Understand $V\,out = \frac{R\,bottom}{R\,bottom + R\,top} * \mathrm{V}\,in$
- Understand that arranging an LDR in a potential divider can be used as a light / dark sensor.
- Understand that arranging a Thermistor in a potential divider can be used as a hot / cold sensor.

Use Switches for Control

- SPST toggle switches for simple on / off control.
- SPDT for controlling two options.
- SPDT for reversing systems.
- Understand applications for magnetic reed switches.
- Understand applications for tilt switches.
- Understand applications where a relay switch can be used.
- Use a relay to connect low voltage circuits to higher voltage circuits.

Use Process Components

- Use a transistor to control a switching or sensing circuit.
- Understand that a transistor functions as a switch and amplifier.
- Understand that a transistor conducts through the collector - emitter junction when 0.6v is present at the base.
- Understand the use of a transistor as a transducer driver.
- Understand the Darlington Pair transistor arrangement.
- Understand a dual transistor multivibrator system.
- Select transistors for appropriate functions.
- Understand and apply the formula *Ie=Ic+Ib*.
- Understand and apply the formula *Current Gain* = $\frac{lc}{lb}$.
- Understand the term ASICs – Application Specific Integrated Circuits.
- Use application specific IC's to control monostable time delays.
- Use application specific IC's to control astable pulse generators and multivibrators.
- Understand how a time delay and pulse frequency can be controlled.
- Understand the capacitor and its role in timing circuits.
- Understand and apply formula *T=1.1*R*C*.
- Understand and apply formula *f* = $\frac{1.44}{(R1+2R2)*C}$.
- Understand the principle of an electronic latch and its uses.
- Understand the function of a thyristor or silicon controlled rectifier as a latching device.
- Understand how a latch can be reset.
- Use and understand operational amplifiers and the term gain.
- Understand the principle of an inverting amplifier.
- Understand and apply formula *Gain (AV)* = $\frac{-R2}{R1}$.
- Understand the principle of a non inverting amplifier.
- Understand and apply formula *Gain (AV)* = $1+\frac{+R2}{R1}$.
- Use an application specific IC as a voltage comparator.
- Understand the use of a comparator in sensing circuits.
- Understand the function of AND, OR, EOR, NOT, and NAND logic gates.
- Understand the truth tables associated with logic gates.
- Combine logic gates to form control systems.

Use Output Components

- Understand that certain components are classed as output devices.
- Understand and use output components including lamps, LEDs, buzzers, loudspeakers, sirens, motors and solenoids.

Use Modern Electronic Materials and Components

- Understand that developments in technology can generate new and modern electronic components or materials.
- Understand Quantum Tunnelling Composite (QTC) and how its resistance changes under compression.
- Understand and use photovoltaic cells and solar energy.
- Understand electroluminescent film or wire and appreciate uses for this material.
- Understand that 'super capacitors' (2.5v 10Farad) can be used to store larger amounts of electricity.
- Use 'super capacitors' as renewable / rechargeable power supply components in systems.

Nano Electronic Devices and Materials

- Development of thin film transistors for electronic displays and imaging system.

- Investigation of nanoscale transistors (65nm and below) for analog/digital signal processing.

- Study of organic materials for nano junctions, transistor and light emitting devices. Development of nano devices by e-beam writing.

- Understand solar cells are attractive for clean and renewable power; with miniaturization, they might also serve as integrated power sources for nanoelectronic systems.

- Understand microelectronics, is related to the study and manufacture of electronic components which are very small (usually micron-scale or smaller, but not always). These devices are made from semiconductors using a process known as photolithography.

(b) Mechanisms

- Understand the different types of motion and identify linear, rotary, reciprocating and oscillating.
- Understand that mechanical systems transmit motion and convert types of motion.
- Consider mechanical systems under INPUT, PROCESS and OUTPUT blocks.

Pulley Systems

- Use pulley and belt systems to increase and decrease rotational velocity.
- Use simple and compound pulley and belt systems.
- Understand the term revolutions per minute RPM.
- Use pulley and belt systems to change direction.
- Understand and calculate velocity ratio.
- Understand and apply formula.
- *RV of driver*dia of driver= RV of driven*dia of driven*
- Use pulley systems for lifting.
- Understand and apply formula $VR = \frac{Distance\,moved\ by\ effort}{Distance\,moved\ by\ load}$

Gear Systems

- Use gear systems to increase and decrease rotational velocity.
- Use simple and compound gear systems.
- Understand the term revolutions per minute RPM.
- Use gear systems to change direction.
- Understand and calculate velocity ratio.
- Understand and apply formula.
- *RV of driver*teeth on driver= RV of driven*teeth on driven.*
- Understand Torque=Force*Radius.
- Understand worm drive systems.
- Understand bevel gear systems.

Levers and Linkages

- Understand the function of lever systems in everyday products.
- Understand the classification of levers.
- Understand and apply the formula $\text{MA} = \frac{\text{Load}}{\text{Effort}}$.
- Use levers and linkage systems to create specific motion.
- Calculate forces acting in lever systems using the principle of moments.

Rack and Pinion

- Understand the function of rack and pinion systems in everyday products.
- Understand that rotary motion is converted to linear or vice versa.
- Use rack and pinions in control applications.

Pawl and Ratchet

- Understand the function of a pawl and ratchet system.
- Understand applications for pawl and ratchet systems.

Crank and Slider

- Understand the function of a crank and slider.
- Understand that rotary motion is converted to linear or oscillating motion.
- Use crank and slider systems to generate required motions.

Cams

- Understand the function of a cam.
- Understand that cams can provide a *lift, fall and dwell*.
- Understand that cam systems may feature followers to convert rotary motion to linear motion.
- Use cam systems to generate required motions.

(c) Computer Control

- Understand that computers can be used to control a range of systems.
- Understand that the computer can interface with other devices.
- Consider computer control systems under INPUT, PROCESS and OUTPUT blocks.

Flowcharts

- Understand the principle of flowcharts and the symbols used.
- Understand how feedback is used in a flowchart.
- Design flowcharts to control everyday situations.
- Design flowcharts for a specific purpose.
- Understand that complex flowcharts can be managed as sub-routines or macros.

Controlling devices with a PC

- Use a PC based systems to control a variety of devices.
- Use an interface / buffer box to connect to a PC.
- Control devices that include counting, switching, and timing.
- Use analogue and digital sensors as input components.
- Use sub routines or macros in control systems.
- Use logical and mathematical principles in control systems.

(d) PIC and Programmable controllers

- Understand that programmable microcontrollers can be used to control a range of systems.
- Understand that the programmable microcontroller can interface with other devices.
- Understand that programmable microcontrollers can be reprogrammed repeatedly.
- Understand the benefits and limitations of programmable microcontrollers.

PIC

- Understand the term Programmable Interface controllers (PIC).
- Understand how a PIC could be used to control everyday products or systems.
- Be able to run and test PIC systems using dedicated software.
- Be able to program a PIC using a computer based system.
- Understand the process of programming a PIC.
- Be able to control devices using a PIC.

TOOLS, EQUIPMENT AND MAKING

This section is about candidates having the ability to safely and correctly select appropriate tools, equipment and methods for manufacturing systems and control products. Candidates studying systems and control technology are required to manufacture whole products and not the control system in isolation. Thus, candidates must have the relevant knowledge and skills to use constructional and resistant materials with accuracy.

Candidates should be taught to:

- Consider the options available in terms of components, materials and methods of manufacturing.
- Understand that products may be manufactured in one off, batch or continuous production systems.
- Use templates and jigs to assist and control the accuracy in making tasks.
- Use CAD/CAM techniques where appropriate.
- Choose materials, components and manufacturing processes that are appropriate to the scale on production.

Safety

- Use hand and machine processes safely.
- Appreciate and apply relevant Health and Safety measures.
- Conduct appropriate Risk Assessments.
- Review safety procedures.
- Understand safety issues involved with common hand working tools and processes.
- Understand safety issues involved with common machine processes including drilling, milling and turning.
- Understand and apply safety issues in the setting up of CAM and CNC equipment.

Selection of Tools and Equipment

- Select and justify selection of components and materials appropriate to the task.
- Select and use components appropriate to the systems outline in this specification.
- Understand the basic working properties of common materials including softwoods, manufactured boards, thermoplastics for moulding and fabricating, and readily available ferrous and non ferrous metals.
- Select methods of manufacture most appropriate to the task.
- Understand and apply processes used for wasting, deforming, fabricating and finishing.

Planning for Making

- Develop and apply a manufacturing specification for a system or product.
- Develop a manufacturing plan to show sensible and realistic procedures.
- Plan logically the stages of manufacturing including an appreciation of time.
- Anticipate potential problems and plan possible solution.
- Apply quality control strategies during preparation and manufacture.
- Use test equipment to ensure accuracy of manufacture and function.
- Use a range of marking out and testing equipment including, a PSU and digital multimeter.
- Test and Measure completed product against the original specification.
- Appreciate issues involved in repetitive manufacture.
- Appreciate that CAM may benefit manufacturing.

Manufacturing Skills

- Use a range of hand tools appropriate to the manufacture of systems and control products.
- Use a range of machine tools appropriate to the manufacture of systems and control products.
- Use CAD CAM equipment to produce parts or components of products.
- Understand that combining materials can enhance or change their properties.
- Understand that materials can be laminated to improve strength and appearance.
- Understand and use modern materials for appropriate purposes.
- Cut and prepare resistant materials from stock sizes.
- Select and use a range of electronic and mechanical stock components.
- Finish products by selecting appropriate methods.
- Understand common finishing methods for typical resistant materials.
- Understand common finishes to metals and woods.
- Select materials and components on the basis of aesthetic, physical, economic and performance factors.

ICT, CAD AND CAM

Systems and Control candidates are expected to use computer systems with appropriate software and hardware to support their designing and manufacturing. They need to be able to use ICT systems to assist research for problem solving. They need to be able to use CAD design and develop a range of control systems, model, test, evaluate and modify control systems for given applications. CAM may be used where appropriate to manufacture parts or components for products or control systems, particularly where quality control is required. Outcomes may contain elements of CAM, this may be encouraged but this is not mandatory. Wholly CAM products should not be produced.

Candidates should be taught to:

Use word processing software to create text.

- Edit text using word processing software.
- Check spelling and grammar using word processing software.

Use spreadsheet software to collate numerical data.

- Create graphs and charts using spreadsheet software.

Access the internet and world wide web.

- Use search engines to find information to aid the design process.
- Access relevant resources.
- Download information and resources for use.

Use dedicated CAD software to design electronic control systems.

- Model parts and whole electronic circuits .
- Test circuits, adapt and modify as required.
- Design and develop Printed Circuit Board (PCB) layouts.

Use dedicated CAD software to design mechanical control systems.

- Model simple and compound mechanical systems.
- Interconnect mechanical systems and subsystems.

Use dedicated CAD software to design computer control systems.

- Model simple flowcharts for typical everyday applications.
- Model flowcharts that include 'macro's' or sub routines for more complex systems.
- Control models connected to computers via a buffer box or interface.

Use dedicated CAD software to design microprocessor control systems.

- Model simple flowcharts or systems for use in microprocessor control systems.
- Model complex flowcharts or systems for use in microprocessor control systems.
- Programme a Programmable Interface Controller (PIC).

Use CAD to communicate the physical form of components, control systems and products.

- Model individual component show parts to show appropriate details.
- Model control systems to communicate specific details.
- Model overall form of products that include control systems.

CAD *(Computer Aided Design)*

- Recognise the advantages and disadvantages of the use of CAD.
- Use of appropriate CAD software.
- Recognise the limitations of CAD for the modelling and developing control Systems.

CAM *(Computer Aided Manufacture)*

- Recognise advantages and disadvantages of the use of CAM.
- Select and prepare appropriate CAM machinery.
- Plan and set up CAM machinery.
- Use of appropriate CAM machinery.
- Use of CAM for manufacturing components or parts of control systems.

SYSTEMS AND PROCESSES

Systems and Control candidates must develop a detailed knowledge and understanding of the range of systems and processes required to analyse, design, develop, construct and evaluate typical products that include control systems. Through practical activity, candidates should develop the associated skills to allow the production of high quality products.

Candidates should be taught to:

Design Control Systems

- Understand and use the correct graphical conventions for communicating systems and control concepts including circuit diagrams, block diagrams, flowcharts and mechanical details, illustrate systems as input, process and output.

Analyse Products with Control Systems

- Analyse and understand everyday items in term of their control system; Input, process and output.
- Understand the importance of feedback within the system.
- Understand the methods of providing feedback in different systems.
- Analyse and appreciate products with a range of systems or sub systems.
- Analyse the performance of a variety of common systems in terms of efficiency.
- Understand efficiency as: $\frac{\text{Useful energy transferred by the device}}{\text{Total energy supplied to the device}}$.
- Understand and calculate mechanical efficiency using MA/VR*100/1%.

Model Electronic Control Systems

- Model, test and develop electronic systems using appropriate kits.
- Use CAD to model, test and develop electronic control systems.
- Use a breadboard to prototype electronic circuitry.
- Construct circuits on strip board.
- Construct circuits on Printed Circuit Boards.
- Diagnose faults in electronic systems, including using a digital multimeter.

Model Mechanical Control Systems

- Model, test and develop mechanical control systems using kits and / or software.
- Model test and evaluate mechanical systems using discrete components.
- Understand how loose and fixed pivots are formed in mechanical systems.
- Understand the term locus and plan the locus for parts moving in mechanical system.
- Understand and apply the range of stock components available to construct mechanical systems.
- Generate diagrams of mechanical systems using the correct conventions.

Model Computer Control Systems

- Model, test and develop computer control systems using flowcharts.
- Use CAD to model, test and develop computer control systems.
- Use sub routines or macros for more complex flowchart systems.
- Use models to interface with PC to control given scenarios.

Model Microprocessor Control Systems

- Model, test and develop microprocessor control systems using flowcharts and /or programs.
- Use CAD to model, test and develop microprocessor systems.
- Use sub routines or macros for more complex flowchart systems.
- Program a PIC using specific hardware / programmer.

3 ASSESSMENT

3.1 Scheme of Assessment

Assessment for GCSE **Systems and Control** is untiered, i.e. all components/units cater for the full range of ability and allow access to grades A*-G for the subject award.

The scheme of assessment will consist of:

UNIT 1: SYSTEMS AND CONTROL WRITTEN PAPER

Written Paper 2 hours (40 %)

Candidates will be required to sit an examination of two hours' duration (split into two sections), set and marked by the WJEC. Specific papers will be set for each of the six focus areas.

The papers for all focus areas follow a similar structure. Section 1 is designed to be answered in 60 minutes and consists of four questions. These questions are set so as to be accessible to candidates from all focus areas and will relate to Product Analysis, Overarching Principles, Designers and Practitioners and The Design Process. The quality of written communication will be integrated into question 3 and will necessitate paragraphs or essay style responses. Section 2 consists of four questions: these are focus area specific, and designed to take 60 minutes to answer.

Differentiation will be achieved by using a variety of styles of questioning to ensure that specification content is tested in such a way as to provide a meaningful examination to candidates of different levels of ability. The principle of incline of difficulty will be built into questions so that the examination will provide an adequate test across the targeted ability range.

UNIT 2: SYSTEMS AND CONTROL TASK

Controlled Assessment 30 hours (60%)

The WJEC is responsible for 'task setting' and details of the controlled assessment tasks for Design and Technology will be forwarded to all centres in September each year.

Candidates are required to complete one 30 hour design, make and evaluate task. The task is divided into two sections. Section A is concerned with designing the product and Section B is concerned with planning, making and evaluating the product. The task is time limited and teachers are required to monitor and verify this time limit. Candidates will not gain additional credit by exceeding the time limit. Further details of the assessment process can be found in section 5.

3.2 Assessment Objectives

Candidates will be required to demonstrate their ability to:

AO1 Recall, select and communicate their knowledge and understanding in design and technology including its wider effects.

AO2 Apply knowledge, understanding and skills in a variety of contexts and in designing and making products.

AO3 Analyse and evaluate products, including their design and making.

3.3 Weighting of Assessment Objectives

Assessment objectives are weighted as follows across the two units:

	Unit 1 (Written Paper) %	Unit 2 (Controlled Assessment %	Total %
AO1	26.66	3.33	30
AO2	6.66	48.33	55
AO3	6.66	8.33	15
Total	40	60	100

3.4 Quality of Written Communication

For components involving extended writing (Written paper) candidates will be assessed on the quality of their written communication within the overall assessment of that component.

Mark schemes for these components include the following specific criteria for the assessment of written communication:

- legibility of text; accuracy of spelling, punctuation and grammar; clarity of meaning;
- selection of a form and style of writing appropriate to purpose and to complexity of subject matter;
- organisation of information clearly and coherently; use of specialist vocabulary where appropriate.

4 AWARDING, REPORTING AND RE-SITTING

GCSE qualifications are reported on an eight point scale from A* to G, where A* is the highest grade. The attainment of pupils who do not succeed in reaching the lowest possible standard to achieve a grade is recorded as U (unclassified) and they do not receive a certificate.

This is a unitised specification which allows for an element of staged assessment. At least 40% of the assessment must be taken at the end of the course, to satisfy the requirement for terminal assessment. Units may be re-taken once only (with the better result counting) before aggregation for the subject award.

Results for a unit have a shelf-life limited only by the shelf-life of the specification. A candidate may retake the whole qualification more than once.

Individual unit results are reported on a uniform mark scale (UMS) with the following grade equivalences:

GRADE	MAX.	A*	A	B	C	D	E	F	G
Unit 1	80	72	64	56	48	40	32	24	16
Unit 2	120	108	96	84	72	60	48	36	24
Subject Award	200	180	160	140	120	100	80	60	40

5 ADMINISTRATION OF CONTROLLED ASSESSMENT

The WJEC GCSE Design and Technology specification meets all regulations for controlled assessment as laid down by the regulatory authorities.

The controlled assessment task is worth 60% of the total marks available for the specification.

The controlled assessment tests all the assessment objectives for GCSE Design and Technology, within the weightings stipulated by the regulatory authorities.

Candidates will be required to demonstrate their ability to:

AO1 Recall, select and communicate their knowledge and understanding in design and technology including its wider effects.

AO2 Apply knowledge, understanding and skills in a variety of contexts and in designing and making products.

AO3 Analyse and evaluate products, including their design and making.

The weighting of assessment objectives across examination components is as follows:

	AO1	AO2	AO3	Total
Controlled Assessment (Marks and Percentages)	**10 (3.3%)**	**145 (48.3%)**	**25 (8.33%)**	**180 (60%)**

Rationale for Controlled Assessment

The controlled assessment is a compulsory component of GCSE Design and Technology. It complements the external examination by offering a distinct means of assessment. It is important for a number of reasons.

It enables candidates to:

- design creatively by generating, developing, planning and communicating ideas;
- make products by working safely with tools, equipment, components, materials and ingredients;
- apply systems and control. CAD/CAM, digital media and new technologies appropriate to the focus area;
- analyse and evaluate processes and products.

Levels of Control

The regulation of controlled assessment in GCSE Design and Technology is split into three stages:

- task setting
- task taking
- task marking

For each stage, the regulatory authorities have specified a certain level of control to ensure authenticity and reliability.

A. Task setting (High level of control)

The WJEC is responsible for **task setting** and details of the controlled assessment tasks for Design and Technology will be forwarded to all centres in September each year. Three tasks will be offered for each focus area. Candidates will choose one of these tasks. These tasks will be reviewed on a one-year cycle. The tasks will be open to interpretation and contextualisation by the centre/candidate.

B. Task taking (Medium level of control)

Candidates are required to complete one 30 hour design, make and evaluate task. The task is divided into two sections. Section A is concerned with designing the product and Section B is concerned with planning, making and evaluating the product. The task is time limited and teachers are required to monitor and verify this time limit. Candidates will not gain additional credit by exceeding the time limit. **Section A** of the task is to be completed in **10 hours** supervised time and **Section B** of the task is to be completed in the remaining **20 hours** of supervised time.

Supervision

The task must be supervised in such a way as to ensue that the contributions of individual candidates are recorded accurately and that plagiarism does not take place.

The task can be carried out in the normal classroom/workshop environment. Candidates are allowed supervised access to resources that may include information gathered outside the 30 hours of controlled assessment time.

Candidates may gather research/inspirational material prior to or during the assessment period and this can be referred to during the task but this material is not to be included in the material to be assessed**. Graphical work which has been prepared in advance by the candidate as part of an ongoing workbook or research cannot be included as part of the material assessed for the control assessment task.**

Candidates may collaborate/confer with others in relation to the task but all assessed material must be the candidates' work only.

The supervising teacher can give candidates limited guidance during the task in order to clarify what is to be done and to ensure that safe working practices are adhered to.

It is the responsibility of the centre to ensure the reliability and authenticity of all work presented for this controlled assessment. Teachers and students will be required to sign a declaration that all work presented is the work of the candidate alone. Failure to authenticate the work may result in grades being delayed or refused.

Presentation
All graphical and written work entered for this controlled assessment must be submitted on the pre-printed pages which are available for download from the WJEC website. Candidates are free to use ICT applications where they are appropriate. The assessment criteria for the task are detailed in section 3.

C. Task marking

The Task is to be assessed as follows.

Section A Designing
10 hours (60 marks) (Weighting 20%)

	Marks	**Assessment objective**
Analysis of the task	5	AO3
Design specification	5	AO2
Generation of ideas	10	AO2
Development and modelling Form/style/function (5) Materials/components (5) Construction/making (5) Size/quantity (5) Finish/quality (5)	25	AO2
Final solution – graphical presentation	5	AO1
Final solution – technical details	5	AO2
Creative thinking	5	AO2
Total marks	60	

Section B Planning, Making and Evaluating
(20 hours) (120 marks) (Weighting 40%)

	Marks	**Assessment objective**
Plan the make	10	AO1(5) AO2(5)
Making Range and difficulty of processes (10) Quality of construction (25) Dimensional accuracy (15) Quality of finish/appearance (15) Function (10 marks) Independent working (15)	90	AO2
Evaluation	10	AO3
Improvements	10	AO3
Total marks	120	

Internal Moderation
Teachers are responsible for marking the controlled assessment by applying the criteria provided. In centres where more than one teacher is involved in a focus area and/or in centres where there is more than one focus area being taught it will be beneficial if the marking criteria are discussed before marking takes place so that some agreement on the application of the criteria can be arrived at. It is essential also that a system of cross moderation between teachers is applied before final marks are submitted to the WJEC.

Annotation
There is an opportunity on each page of the task for teachers to make some notes that support the marks being awarded and to record any information that may have some bearing on the candidates' performance. A note of the time taken is also recorded on each sheet.

External Moderation
All candidates' marks are recorded on the appropriate form and those marks are submitted in the summer term. The WJEC will select a sample of work that will be moderated externally. A visiting moderator will moderate this sample of work. This external moderation will take place **at the centre**.

WJEC's *Internal Assessment Manual* gives instructions about selecting and despatching samples of work to the moderator.

As a result of the moderation, the marks of candidates may be adjusted to bring the centre's marks into line with the national standard.

It assists the moderation process considerably if the final marks of all the candidates are submitted to the moderator in rank order. It is only if this is done that the moderator can be fully aware of the full impact of any scaling.

In the event of concern over the awarding procedures, the normal appeals process will apply.

Authentication
Candidates will be required to confirm in writing, with any exceptions stated, that the work has been completed unaided. This will be achieved by signing the Controlled Assessment box on the pre-printed sheet.

Teachers will be required to confirm in writing that, to the best of their knowledge, all the work submitted for moderation, with any exceptions stated, is the candidate's own unaided work. This will be achieved by signing the composite mark sheet and the Controlled Assessment sheet.

Malpractice discovered prior to the candidate signing the declaration of authentication need not be reported to WJEC but must be dealt with in accordance with the centre’s internal procedures.

Before any work towards the Controlled Assessment is undertaken, the attention of candidates should be drawn to the relevant JCQ Notice to Candidates. This is available on the JCQ website (www.jcq.org.uk) and included in *Instructions for Conducting Coursework/Portfolios.* More detailed guidance on the prevention of plagiarism is given in *Plagiarism in Examinations; Guidance for Teachers/Assessors* also available on the JCQ website.

Material that candidates may have acquired in their research such as multiple copies of questionnaires and pre-printed material should not be submitted.

Retention of Controlled Assessment
Centres need to retain the Controlled Assessments until the end of November following the Summer Examination.

Details of assessment criteria

The assessment criteria provided should be applied to each controlled assessment task and are applicable to all focus areas in Design and Technology. The mark descriptors provide a general indication of the performance of candidates in each mark range.

Section A Designing

Analysis of the task (5 marks)
This is an opportunity for candidates to define and contextualise the task in their own terms and to formulate an appropriate initial design brief. Candidates are free to carry out any research they consider necessary but the work presented for assessment will be confined to a summary of how their product sits in the market place together with an evaluation of a similar or competitor's product.

Mark	Description of Attainment
0	No analysis presented.
1	There is a very basic analysis of where the product fits in the market place together with a limited evaluation of a similar product. The work presented shows little evidence of prior research and preparation. A simple brief may be evident.
2	There is a basic but appropriate analysis of where the product fits in the market place together with a basic evaluation of a similar product. The work presented shows limited evidence of prior research and preparation. A simple brief is evident.
3	There is a good analysis of where the product fits in the market place together with an evaluation of a similar product. The work presented shows some evidence of prior research and preparation. A clear brief is evident.
4	There is a very good analysis of where the product fits in the market place together with a detailed evaluation of a similar product. The work presented shows good evidence of prior research and preparation. A well-worded brief is evident.
5	There is a comprehensive analysis of where the product fits in the market place together with a very detailed evaluation of a similar product. The work presented shows clear evidence of detailed research and preparation. A clear and appropriate brief is evident.

Design Specification (5 marks)

This is an opportunity for candidates to present a detailed design specification of the intended product.

Mark	Description of Attainment
0	No specification presented.
1	A design specification comprising a list of basic attributes for the product. The specification shows little or no links with the analysis of the task. Information is poorly organised, little or no use of technical language/vocabulary. Written communication is limited in terms of organisation of material, with many errors of grammar, punctuation and spelling.
2	A basic design specification comprising a list of relevant attributes for the product. The specification shows superficial links with the analysis of the task. Information shows evidence of structure, limited use of technical language/vocabulary. Written communication is limited in terms of organisation of material with some errors of grammar, punctuation and spelling.
3	A good design specification comprising a prioritised list of attributes for the product presented under appropriate headings. The specification illustrates clear links with the analysis of the task. Information is organised, basic use of technical language/vocabulary. Written communication is adequate in terms of organisation of material, with some errors of grammar, punctuation and spelling.
4	A comprehensive design specification comprising a prioritised list of attributes for the product presented under appropriate headings. The specification demonstrates strong links with the analysis of the task. Information is well organised, good use of technical language/vocabulary. Written communication is good, presenting mainly appropriate material in a coherent manner, with few errors of grammar, punctuation and spelling.
5	An excellent design specification comprising a prioritised list of attributes for the product presented under appropriate headings. The specification is well founded in the analysis of the task. Information is well organised, presented in a highly appropriate manner, very good use of technical language/vocabulary. Written communication is good, presenting appropriate material in a coherent manner, and largely error-free.

Generation of ideas (10 marks)

This is an opportunity for candidates to present up to four initial design ideas for the product. Ideas are to be clearly sketched and annotated.

Mark	Description of Attainment
0	No ideas presented. No evidence of written communication.
1 - 2	A small range of barely appropriate ideas that are poorly annotated. The ideas and annotation show little attention to the specification. Information is poorly organised, little or no use of technical language/vocabulary. Written communication is limited in terms of organisation of material, with many errors of grammar, punctuation and spelling.
3 - 4	A range of appropriate ideas that are annotated. The ideas and annotation show some attention to the specification. Information shows evidence of structure, limited use of technical language/vocabulary. Written communication in terms of organisation of material with some errors of grammar, punctuation and spelling.
5 - 6	A range of clear ideas that are appropriately annotated. The ideas and annotation show some attention to the specification. Information is organised, basic use of technical language/vocabulary. Written communication is adequate in terms of organisation of material, with some errors of grammar, punctuation and spelling.
7 - 8	A range of good initial ideas that are well annotated. The ideas and annotation show good attention to the specification. Information is well organised, good use of technical language/vocabulary. Written communication is good, presenting mainly appropriate material in a coherent manner, with few errors of grammar, punctuation and spelling.
9 - 10	A range of excellent initial ideas that are very well annotated. The ideas and annotation show close attention to the specification. Information is well organised, presented in a highly appropriate manner, very good use of technical language/vocabulary. Written communication is good, presenting material in a coherent manner and largely error-free.

Development and modelling (25 marks)

This is an opportunity for candidates to choose their best idea and to develop it into its final form. This section is an opportunity for candidates to use appropriate ICT. Marks are awarded for evidence of development under the headings shown. Candidates must offer options and make reasoned decisions under each heading. Evidence of these areas may be presented in integrated form across the 5 pages available.

Form/Style/Function

Mark	Description of Attainment
0	No development of form presented.
1	Limited evidence of the form/style being developed or modelled. An alternative shape or style may be evident. There is no evidence of decision-making.
2	Some evidence of the form/style being developed or modelled. Several options are presented. There is evidence of decision-making but with little reasoning offered.
3	Clear evidence of the form/style being developed or modelled. Several options have been offered. There is evidence of reasoned decision-making.
4	Good evidence of the form/style being developed and modelled. Several appropriate options have been offered. There is clear evidence of informed decision making.
5	A variety of forms/styles have been presented and the shape and form of the product have been developed and modelled in a progressive way. A final decision based on sound reasoning has been made.

Materials/Components

Mark	Description of Attainment
0	No development of materials/components presented.
1	Limited evidence of the selection of appropriate materials/ components. Materials/components have been stated. There is no evidence of decision-making.
2	Some evidence of the selection of appropriate materials/components. Alternatives have been offered. There is some evidence of decision-making.
3	Clear evidence of the selection of appropriate materials/components. Alternatives have been offered. There is evidence of reasoned decision-making.
4	Clear evidence of the selection of appropriate materials/components. Appropriate alternatives have been offered. There is clear evidence of reasoned decision-making.
5	Full and clear evidence of the selection of appropriate materials/ components. Appropriate alternatives have been offered. There is evidence of well-reasoned decision-making.

Construction/Making

Mark	Description of Attainment
0	No development of the construction/making presented.
1	Limited evidence of the construction/making being developed. A construction/making method has been offered. There is no evidence of decision-making.
2	Some evidence of the construction being developed. A small variety of construction/making methods have been offered. There is some evidence of decision-making.
3	Clear evidence of the construction/making being developed. A variety of construction/making methods have been offered. There is evidence of reasoned decision-making.
4	Clear evidence of the construction/making being developed. A variety of appropriate construction/making methods have been considered. There is evidence of well-reasoned decision-making.
5	Full and clear evidence of the construction/making being developed. A range of appropriate construction/making methods has been considered. There is evidence of well-reasoned decision-making.

Size/Quantity

Mark	Description of Attainment
0	No development of size/quantity presented.
1	Limited evidence of sizes and or quantities being developed. Sizes or quantities may be evident. There is no evidence of decision-making.
2	Some evidence of sizes and or quantities being developed. Alternative sizes and or quantities will be evident. There is some evidence of decision-making.
3	Clear evidence of sizes and or quantities being developed. Alternative sizes and or quantities will be evident. There is evidence of reasoned decision-making.
4	Clear evidence of sizes and or quantities being developed. Sizes and or quantities have been developed in a progressive way. There is evidence of reasoned decision-making.
5	Full and clear evidence of sizes and or quantities being developed. Alternative sizes and or quantities have been systematically evaluated. There is clear evidence of well-reasoned decision-making.

Finish/Quality

Mark	Description of Attainment
0	No development of finish/quality presented.
1	Limited evidence of the development of finish/quality. A suitable finish may be offered. There is no reference to quality control. There is no evidence of decision-making.
2	Some evidence of the development of finish/quality. An alternative finish is offered. There is brief reference to quality control. There is evidence of decision-making.
3	Some evidence of the development of finish/quality. Alternative finishes are offered. There is reference to aspects or quality control. There is evidence of decision-making.
4	Clear evidence of the development of finish/quality. Alternative finishes are offered. There is reference to aspects of quality control. There is evidence of reasoned decision-making.
5	Full and clear evidence of the development of finish/quality. A range of alternative finishes is offered. There is reference to a variety of quality control issues. There is evidence of well-reasoned decision-making.

Final solution

This is an opportunity for candidates to give full details of their final design using presentation techniques appropriate to the chosen focus area. Details of the form, dimensions, construction, components, materials and finish will be included as appropriate. This section is an opportunity for candidates to use appropriate ICT. Marks are awarded for (a) a graphical presentation of the final design and (b) The technical details that support manufacture.

(a) Graphical presentation (5 marks)

This is an opportunity for the candidate to present a clear and expressive graphical presentation of their final design. Any appropriate method of communication may be used.

Mark	Description of Attainment
0	No graphical presentation presented.
1	A basic illustration of the final product. It is recognisable but lacks proper form. It offers little evidence of shading or colour rendering.
2	An illustration of the final product. It is recognisable and shows reasonable form. It offers evidence of shading and/or colour rendering.

3	A clear illustration of the final product. It is recognisable and shows good form. It offers evidence of good shading and/or colour rendering.
4	A very good graphical presentation of the final product. It uses a recognised graphical technique, is accurate in its structure and It shows effective shading and or colour rendering.
5	A very high quality graphical presentation of the final product. It uses a recognised graphical technique, is accurate in its structure and shows expressive shading and/or colour rendering.

(b) Technical details (5 marks)

This is an opportunity for candidates to present the final technical details of their design. These could include dimensions, materials/components, construction and finish as appropriate to each focus area.

Mark	**Description of Attainment**
0	No technical details presented.
1	Limited evidence of technical detail.
2	Evidence of some technical detail.
3	Evidence of many technical details.
4	Evidence of most technical detail.
5	Evidence of virtually all technical details.

Creative thinking (5 marks) (Throughout)

This is an opportunity for candidates to show a measure of flair, imagination and creativity in their designing. It can be evident at any stage through the design process.

Mark	**Description of Attainment**
0	No creative thinking presented.
1	Evidence of limited creative thinking.
2	Evidence of some creative thinking.
3	Evidence of creative thinking in several areas.
4	Evidence of much creative thinking. Some ideas show imagination and flair. Creative thinking is evident throughout the development of the product and imaginative presentational techniques are evident.
5	A high level of creative thinking. Very imaginative ideas are evident. A highly creative development of the product is evident. Presentational techniques show much flair.

Section B Planning, making and evaluating

Planning the make (10 Marks)

This is an opportunity for the candidate to plan the stages and processes necessary to manufacture the product. It must be done before the candidates begins making.

Mark	Description of Attainment
0	No plan for making presented. No evidence of written communication.
1 - 2	A list of manufacturing steps is evident but shows little appreciation of the work involved or the time needed. Information is poorly organised, little or no use of technical language/vocabulary. Written communication is limited in terms of organisation of material, with many errors of grammar, punctuation and spelling.
3 - 4	A list of basic manufacturing steps is evident. The steps contain some detail of the processes required. There is little attempt to quantify the time needed. Information is organised, basic use of technical language/vocabulary. Written communication is limited in terms of organisation of material with some errors of grammar, punctuation and spelling.
5 - 6	A list of realistic manufacturing steps is evident. The steps contain some detail of the processes required. There is an attempt to quantify the time needed. Information is organised, with basic use of technical language/vocabulary. Written communication is adequate in terms of organisation of material with some errors of grammar, punctuation and spelling.
7 - 8	A list of realistic manufacturing steps is evident. The steps contain some detail of the processes required and note any constraints. There is a realistic estimate of the time needed to manufacture the outcome. Information is well organised, with good use of technical language/vocabulary. Written communication is good, presenting mainly appropriate material in a coherent manner, with few errors of grammar, punctuation and spelling.
9 - 10	A clear, appropriate and detailed list of manufacturing steps is evident. Constraints have been recognised. There is a realistic estimate of the time needed to manufacture the outcome. Information is well organised, presented in a highly appropriate manner, with very good use of technical language/vocabulary. Written communication is good, presenting appropriate material in a coherent manner, and largely error-free.

Making the product (90 marks)

This is an opportunity for candidates to demonstrate the range and quality of their manufacturing skills. The 90 marks available for making are apportioned under the following headings.

Range and difficulty of practical processes (10 marks)

Mark	**Attainment**
0	No practical processes evident.
1 - 2	One straightforward practical processes are evident.
3 - 4	One or two more demanding practical processes are evident.
5 - 6	A range of fairly demanding practical processes are evident.
7 - 8	A range of demanding practical processes are evident.
9 - 10	A range of challenging practical processes are evident.

Quality of construction/making (25 marks)

Mark	**Attainment**
0	No practical processes evident.
1 - 5	Little acceptable accuracy is evident in the construction/making.
6 - 10	An adequate level of accuracy is evident in only a few aspects of the construction/making.
11 - 15	An adequate level of accuracy is evident in some aspects of the construction/making.
16 - 20	A good level of accuracy is evident in all aspects of the construction/ making.
21 - 25	A high level of accuracy is evident in all aspects of the construction/ making.

Dimensional accuracy (15 marks)

Mark	**Attainment**
0	No practical processes evident.
1 - 3	The finished product bears little resemblance to the final design proposal.
4 - 6	The finished product matches some details, both visual and technical, of the final design proposal.
7 - 9	The finished product matches many details, both visual and technical, of the final design proposal.
10 - 12	The finished product matches most details, both visual and technical, of the final design proposal.
13 - 15	The finished product matches virtually all details, both visual and technical, of the final design proposal.

Quality of finish/appearance (15 marks)

Mark	Attainment
0	No practical processes evident.
1 - 3	No elements of the product displays an adequate finish.
4 - 6	Some elements of the product display an adequate finish.
7 - 9	Most elements of the product display an adequate finish.
10 - 12	Most elements of the product display a good finish.
13 - 15	Great care is taken to achieve a very high quality finish on all elements of the product.

Function (10 marks)

Mark	Attainment
0	The product does not function on any level.
1 - 2	The product functions in a very limited or partially finished way.
3 - 4	The product functions to a limited extent.
5 - 6	The product functions fairly well.
7 - 8	The product functions well.
9 - 10	The product functions perfectly.

Independent working (15 marks)

Mark	Attainment
0	The candidate cannot work without constant support and advice.
1 - 3	The candidate has required considerable support and advice during the making of the product.
4 - 6	The candidate has required fairly frequent support and advice during the making of the product.
7 - 9	The candidate has required some support and advice during the making of the product.
10 - 12	The candidate has required only minor support and advice during the making of the product.
13 - 15	The candidate has worked almost entirely unaided whilst making the product.

Evaluation (10 marks)

This is an opportunity for the candidate to evaluate the final product and to suggest any improvements that could be made. Evaluations must compare the final outcome with the initial intention.

Evaluation of practical outcome (10 marks)

Mark	Attainment
0	No evaluation presented. No evidence of written communication.
1 - 2	A basic evaluation of the outcome is evident. Comments are general and do not relate back to the initial specification. Information is poorly organised, little or no use of technical language/vocabulary. Written communication is limited in terms of organisation of material, with many errors of grammar, punctuation and spelling.
3 - 4	An evaluation of the outcome is evident. Comments offer some detail and relate in part back to the initial specification. Information shows evidence of structure, limited use of technical language/vocabulary. Written communication is limited in terms of organisation of material, with some errors of grammar, punctuation and spelling.
5 - 6	A critical evaluation of the outcome is evident. Comments offer some detail and relate in part back to the initial specification. Information is organised, with basic use of technical language/vocabulary. Written communication is adequate in terms of organisation of material, with some errors of grammar, punctuation and spelling.
7 - 8	A critical evaluation of the outcome is evident. The comments are perceptive and detailed and relate back to the initial specification. Information is well organised, with good use of technical language/vocabulary. Written communication is good, presenting mainly appropriate material in a coherent manner, with few errors of grammar, punctuation and spelling.
9 - 10	A critical evaluation of the outcome is evident. The comments are perceptive and detailed and relate in full back to the initial specification. Information is well organised, presented in a highly appropriate manner, very good use of technical language/vocabulary. Written communication is good, presenting appropriate material in a coherent manner, and largely error-free.

Suggested improvements (10 marks)

This is an opportunity for candidates to put forward suggestions for improving the design and/or suggesting any improvement of techniques to ensure better quality of manufacture.

Mark	Attainment
0	No improvements presented. No evidence of written communication.
1 - 2	An improvement to the design and/or manufacturing process has been suggested. Written communication is limited in terms of organisation of material, with many errors of grammar, punctuation and spelling.
3 - 4	Several suggestions for improvements to the design together with a suggestion of how quality of manufacture could be improved. Written communication is limited in terms of organisation of material, with some errors of grammar, punctuation and spelling.
5 - 6	Several relevant suggestions for improvements to the design together with suggestions of how quality of manufacture could be improved. Quality of written communication is basic, some errors of grammar, punctuation and spelling.
7 - 8	Well-founded suggestions for improvements to the design together with suggestions of how quality of manufacture could be improved. Information is well organised, with good use of technical language/vocabulary. Written communication is good, presenting mainly appropriate material in a coherent manner, few errors of grammar, punctuation and spelling.
9 - 10	Well-founded suggestions for improvements to the design together with detailed suggestions of how quality of manufacture could be improved. Information is well organised, with very good use of technical language/vocabulary. Quality of written communication is good, presenting appropriate material in a coherent manner, and largely error-free.

6 GRADE DESCRIPTIONS

Grade descriptions are provided to give a general indication of the standards of achievement likely to have been shown by candidates awarded particular grades. The descriptions must be interpreted in relation to the content specified by the specification; they are not designed to define that content. The grade awarded will depend in practice upon the extent to which the candidate has met the assessment objectives overall. Shortcomings in some aspects of candidates' performance in the assessment may be balanced by better performances in others.

Grade A

Candidates recall, select and communicate detailed knowledge and thorough understanding of design and technology, including its wider effects.

They apply relevant knowledge, understanding and skills in a range of situations to plan and carry out investigations and tasks effectively. They test their solutions, working safely and with a high degree of precision.

They analyse and evaluate the evidence available, reviewing and adapting their methods when necessary. They present information clearly and accurately, making reasoned judgements and presenting substantiated conclusions.

Grade C

Candidates recall, select and communicate sound knowledge and understanding of design and technology, including its wider effects.

They apply knowledge, understanding and skills in a range of situations to plan and carry out investigations and tasks. They test their solutions, working safely and with precision.

They review the evidence available, analysing and evaluating some information clearly, and with some accuracy. They make judgements and draw appropriate conclusions.

Grade F

Candidates recall, select and communicate knowledge and understanding of basic aspects of design and technology, including its wider effects.

They apply limited knowledge, understanding and skills to plan and carry out simple investigations and tasks, with an awareness of the need for safety and precision. They modify their approach in the light of progress.

They review their evidence and draw basic conclusions.

7 THE WIDER CURRICULUM

Key Skills

Key Skills are integral to the study of GCSE Design and Technology and may be assessed through the course content and the related scheme of assessment as defined in the specification. The following key skills can be developed through this specification at levels 1 and 2:

- Communication
- Problem Solving
- Information and Communication Technology
- Working with Others
- Improving Own Learning and Performance
- Application of Number

Mapping of opportunities for the development of these skills against Key Skills evidence requirement is provided in 'Exemplification of Key Skills for Design and Technology', which are available on the WJEC website.

Opportunities for use of Technology

This specification gives candidates the opportunity to use their ICT skills for practical purposes, especially in the production of their design folios and associated products. These opportunities will apply particularly to the generation of information together with its processing and presentation though, depending on resources and the specific project in question, may include CAD and/or CAM work.

Spiritual, Moral, Ethical, Social and Cultural Issues

This specification provides opportunities for candidates, through the study of their chosen focus area, to develop an understanding of spiritual, moral, ethical, social and cultural issues as they relate to the designer, manufacturer or user. The specification provides a framework and includes specific content through which individual courses may address these issues

Project work may serve to extend understanding of these issues in order that a balanced appreciation of the conflicts and dilemmas involved in the design and manufacture of products or systems may be encouraged.

Design and Technology also provides opportunities to promote enterprise and entrepreneurial skills through the process of identifying an opportunity to design a product or system to meet a specific need, investigating the work of professional designers, the manufacturing industry, developing their own product or system and finally evaluating the whole process. Tasks linked to the project provide opportunities to develop independent thinking skills, through candidates identifying relevant sources of information and developing specific performance criteria for their designs to guide their thinking.

Citizenship

In this context citizenship is taken to include the development of social and moral responsibility, participation in community activity and development of political literacy. This specification is designed to make a contribution to the development of the knowledge, skills and understanding of citizenship. In particular, the coursework element will encourage pupils to take an effective part in school-based and community-based activities, showing a willingness and commitment to evaluate such activities critically. Aspects of the project, for example, could be directly related to the needs of the school or local community, which would provide candidates with the opportunity to tackle problems which are real and meaningful to themselves. In doing so, they will be encouraged to demonstrate personal and group responsibility in their attitudes to themselves and others: they would also need to consider critically and constructively the views of others when developing and evaluating possible solutions.

Environmental Issues

This specification supports all aspects of environmental education. Candidates are expected to develop and appreciate a deeper understanding of the environment. The specification has been developed to consider environmental issues and candidates will be examined on their knowledge and understanding in section A of the written paper.

Health and Safety Consideration

This part of the specification is about ensuring the safety of everyone working in the school Design and Technology rooms.

Health and safety is vital and centres must take into account all relevant safety legislation and observe all appropriate safety procedures in the working environment.

It is essential for centres to ensure that health and safety and related issues are applied and consideration of these issues must therefore be an integral part of all teaching in Design and Technology.

The specification provides candidates with the opportunity to learn about Health and Safety as it applies to them in the Design and Technology rooms and to become familiar with the processes of ensuring that safe working practices are always employed.

Candidates are should know:

(a) the safety procedures that apply in the Focus Area that they are studying;
(b) how to carry out a risk assessment for the tools and equipment they use;
(c) how to carry out a risk assessment for the machines they use;
(d) how to carry out a risk assessment for the manufacturing processes they use;
(e) how to carry out a risk assessment for the materials that they use;
(f) how to set up, adjust and use tools and equipment safely;
(g) how to set up, adjust and use machines safely;
(h) how to carry out manufacturing processes safely;
(i) how to minimise the risk to themselves and others in the working environment.

The European Dimension

This specification supports environmental education, the European dimension and health education, consistent with EC agreements.

The approach used in constructing the specification lends itself to the establishment of links with other areas of study, particularly those involving problem solving or the use of ICT skills, knowledge and understanding, for example in the completion of tasks and assignments for other GCSE specifications.

The above approach conforms with the aspirations expressed in the 1998 Resolutions of the European Community and the Ministers of Education meeting within the Council, concerning the European dimension in education and environmental education, particularly those intended at the level of member states.