OCR ADVANCED SUBSIDIARY GCE IN DESIGN AND TECHNOLOGY: PRODUCT DESIGN (3822) IN DESIGN AND TECHNOLOGY: SYSTEMS AND CONTROL TECHNOLOGY (3823)

OCR ADVANCED GCE IN DESIGN AND TECHNOLOGY: PRODUCT DESIGN (7822) IN DESIGN AND TECHNOLOGY: SYSTEMS AND CONTROL TECHNOLOGY (7823)

Foreword to Third Edition

This specification was revised and updated in November 2003 following feedback from teachers attending INSET courses, refinements from examination and moderation teams and discussions with QCA.

The first year of certification of the revised OCR Advanced Subsidiary GCE in Design and Technology is June 2005.

The first year of certification of the revised OCR Advanced GCE in Design and Technology is Jan 2006.

The main changes for Centres to note for teaching from September 2004 are:

AS UNITS

Unit 2518

- Assessment criteria combined and reduced.
- Clear statement provided of what is required.

Unit 2519

- Re-allocation of marks to give a larger allocation to generation of initial ideas to reward creativity and innovation.

Unit 2520

- **Section A** – (common to both 2520 and 2521) revised content to reflect recent advances in technology and applications.
- Specification is now in a new clearer format, which separates content from teaching opportunities.
- **Section B** – content revised and a clear statement of how material areas are to be assessed.
- Textiles content revised.

Unit 2521

- **Section A** – (common to both 2520 and 2521) – revised content to reflect advances in technology and applications.
- Specification is now in a new clearer format, which separates content from teaching opportunities.
- **Section B** – candidates no longer have to study all three focus areas.
- It is now possible to answer questions from **one** focus area from:
  – electrical and electronic systems;
  – mechanical systems;
  – pneumatic systems.

A2 UNITS

Units 2522 and 2523

- Assessment criteria have been re-ordered and reduced to ensure a more natural flow of ideas.
- Working drawings are now presented in 2522.

Unit 2524

- **Section A** – clear statement of how material areas are to be assessed.
- Specification is now in a new clearer format, which separates content from teaching opportunities.
- Textiles content revised.
- **Section B** – minor alterations made to textiles content.

Unit 2525

- **Section A** – candidates no longer have to study all **three** focus areas.
- Specification is now in a new clearer format, which separates content from teaching opportunities.
- It is now possible to answer questions from **one** focus area from:
  – electrical and electronic systems;
  – mechanical systems;
  – pneumatic systems.
- **Section B** – provides candidates with **three** questions – **one** question based upon each of the following focus areas:
  – electrical and electronic systems;
  – mechanical systems;
  – pneumatic systems.

  Candidates answer **one** question.

This booklet contains OCR's Advanced Subsidiary (AS) and Advanced GCE (A Level) Design and Technology specifications – Product Design, and Systems and Control Technology – for teaching from September 2004.

Advanced Subsidiary GCE is assessed at a standard appropriate for candidates who have completed the first year of study of a two year Advanced GCE course, i.e. between GCSE and Advanced GCE. It forms the first half of the Advanced GCE course in terms of teaching time and content. When combined with the second half of the Advanced GCE course, known as 'A2', the Advanced Subsidiary GCE forms 50% of the assessment of the total Advanced GCE. However, the Advanced Subsidiary GCE can be taken as a 'stand-alone' qualification. The A2 is weighted at 50% of the total assessment of the Advanced GCE.

In these specifications the term **module** is used to describe teaching and learning requirements. The term **unit** describes a unit of assessment.

Each teaching and learning module in assessed through its associated unit of assessment.

These specifications meet the requirements of the *Common Criteria* (Qualifications and Curriculum Authority, 1999), the *GCE Advanced Subsidiary and Advanced Level Qualification-Specific Criteria* (QCA, 1999) and the relevant Subject Criteria (QCA, 1999)

Contents

OCR ADVANCED SUBSIDIARY GCE IN DESIGN AND TECHNOLOGY: PRODUCT DESIGN (3822) IN DESIGN AND TECHNOLOGY: SYSTEMS AND CONTROL TECHNOLOGY (3823)

OCR ADVANCED GCE IN DESIGN AND TECHNOLOGY: PRODUCT DESIGN (7822) IN DESIGN AND TECHNOLOGY: SYSTEMS AND CONTROL TECHNOLOGY (7823)

Specification Summary

Outline

The suite of Design and Technology specifications, which is offered at Advanced Subsidiary GCE and Advanced GCE, is designed to offer candidates opportunities to study, propose and realise prototype solutions to designing and making opportunities closely linked to the real world of product/system manufacture. Recognising the routes pursued at GCSE, the OCR suite provides candidates with opportunities to pursue their studies following two distinct routes; these are:

Design and Technology: Product Design;
Design and Technology: Systems and Control Technology.

Each route enjoys a common examining pattern and for Advanced Subsidiary GCE, wherever possible, a common knowledge framework stemming from the Subject Criteria. The content is chosen to provide a balanced and coherent study of all elements of Design and Technology, providing Centres and candidates with a variety of teaching and learning routes which encourage flexible approaches such as co-teachability of knowledge and understanding whilst retaining discrete material integrity.

Each route offers candidates opportunities to acquire and demonstrate knowledge and understanding of the world of designing and making. Candidates are offered opportunities to demonstrate their own technological capabilities through the design and making of quality outcomes whether conceived as products or systems within products. Candidates should be aware of the responsibilities that designers and technologists have to mankind through an understanding of the potentials and hazards inherent in technological advance, change and decision making.

These specifications are designed to enable candidates to study the following:

- identification of opportunities for design and technological activity;
- the design and making of artefacts/products and/or systems;
- materials technology as appropriate to the production of products or systems;
- components, as appropriate, within systems – electrical, electronic, pneumatic, mechanical and interfaces;
- a range of manufacturing methods, and their systems of control;
- social, moral, cultural and ethnic dimensions that relate to technological decisions;
- constraints that economic and ergonomic factors place on designing and making products and systems.

These specifications are designed to enable candidates to:

- demonstrate knowledge and understanding of technological processes/systems and their implications for designing and making activities;
- analyse design situations and requirements;
- propose ideas through a variety of media solutions/prototypes capable of being realised within the internally assessed project work;
- design, make, test, evaluate and, where appropriate, modify, quality solutions/prototypes to satisfy design needs and examine the implications of industrial production from realised prototypes;
- demonstrate a sound knowledge of manufacturing technologies and the implications for product/system design and production;
- demonstrate understanding of those mathematical and scientific concepts that underpin the application of technological design decisions;
- acquire interest in and enthusiasm for the process of meeting designing and making challenges by producing quality solutions;
- provide a sound basis for further study in design and technology.

Specification Content

All modules draw as appropriate on the QCA Subject Criteria for Design and Technology: Product Design and Systems and Control (1999). The content is chosen to provide a balanced and coherent study of all elements of Design and Technology, providing Centres and candidates with a variety of teaching and learning routes which encourage flexible approaches such as co-teachability of knowledge and understanding whilst retaining discrete material integrity.

Scheme of Assessment

The Advanced Subsidiary GCE forms 50% of the assessment weighting of the full Advanced GCE. Advanced Subsidiary GCE is assessed at a standard between GCSE and Advanced GCE and can be taken as a 'stand-alone' specification or as part of the full Advanced GCE course.

Candidates must take one of the following combinations of units:

Advanced Subsidiary: Product Design	Units 2518, 2519 and 2520
Advanced Subsidiary: Systems and Control Technology	Units 2518, 2519 and 2521
Advanced GCE: Product Design	Units 2518, 2519, 2520, 2522, 2523 and 2524
Advanced GCE: Systems and Control Technology	Units 2518, 2519, 2521, 2522, 2523 and 2525

Units of Assessment

Unit	Level	Name	Duration	Mode of Assessment	Weighting	
					AS	Advanced GCE
2518	AS	System Case Study	20 hours	OCR-marked Coursework	30	15
2519	AS	Product Study: Analysis and Development	30 hours	Centre-marked Coursework	40	20
2520	AS	Product Design 1	2 hours	Written Examination	30	15
2521	AS	Systems and Control Technology 1	2 hours	Written Examination	30	15
2522	A2	Designing	40 hours	Centre-marked Coursework	–	15
2523	A2	Making and Evaluating	40 hours	Centre-marked Coursework	–	15
2524	A2	Product Design 2	2 hours 30 mins	Written Examination	–	20
2525	A2	Systems and Control Technology 2	2 hours 30 mins	Written Examination	–	20

Question Paper Requirements

Advanced Subsidiary

The question papers for Units 2520 and 2521 have **two** sections:

Section A: Generic design based questions;
Section B: Questions requiring knowledge and understanding of product materials, system components and their applications within products.

A2

The question papers for Units 2524 and 2525 have **two** sections:

Section A: Requires further in-depth knowledge of products materials, components and systems across the whole specification;
Section B: Designing and Thinking, tests a candidate's ability to make proposals to address a design problem. Unit 2524 and Unit 2525 papers will include synoptic assessment.

The quality of written communication is assessed in Unit 2518, which is externally marked by OCR.

Coursework Requirements

Advanced Subsidiary

Unit 2518 is intended to encourage candidates to consider broadly the opportunities, implications and responsibilities of the use of design and technology within society. Candidates produce a case study based on the investigation of a system.
Unit 2519 provides an emphasis on product analysis and product development. Candidates produce a project based on the study of a product.

Unit 2518 is marked by OCR.
Unit 2519 is marked by the teacher, internally standardised within the Centre and externally moderated by OCR.

A2

Units 2522 and 2523 provide opportunities for open-ended tasks with candidates choosing the nature of the task for designing and making.

The outcome of **Unit 2522** is a project based on the identification by the candidate of a problem or opportunity involving a product need, developing a design with relevant research and analysis up to the production of working drawings.
The outcome of **Unit 2523** is the making, testing and evaluating of the solution designed in Unit 2522.

Units 2522 and 2523 are marked by the teacher, internally standardised within the Centre and externally moderated by OCR. Unit 2523 contains some synoptic assessment.

Key Skills

Key Skills signposting appears in **three** sections of OCR specifications:

- *Key Skills Coverage* – the matrix aids curriculum managers in mapping the potential Key Skills coverage within each OCR Advanced Subsidiary/Advanced GCE specification.
- *Specification Content* (Section 5) – the specific evidence references enable subject teachers to identify opportunities for meeting specific Key Skills evidence requirements within the modules they are delivering.
- *Appendix A* – provides guidance to teachers in trying to identify those parts of their normal teaching programme which might most appropriately be used to develop or provide evidence for the Key Skills signposted.

The specifications provide opportunities for the development of the Key Skills of *Communication, Application of Number, Information Technology, Working With Others, Improving Own Learning and Performance* and *Problem Solving* as required by QCA's subject criteria for Design and Technology.

Through classwork, coursework and preparation for external assessment, candidates may produce evidence for assessing Key Skills at Level 3. However, the extent to which this evidence fulfils the requirements of the QCA at this level will be dependent on the style of teaching and learning adopted for each module. In some cases, the work produced may meet the evidence requirements of the Key Skills specifications at a higher or lower level.

Throughout Section 5 the symbol  is used in the margin to highlight where Key Skills development opportunities are signposted. The following abbreviations are used to represent the above Key Skills:

C = Communication
N = Application of Number
IT = Information Technology
WO = Working with Others
LP = Improving Own Learning and Performance
PS = Problem Solving

These abbreviations are taken from the QCA Key Skills specifications for use in programmes starting from September 2000. References in Section 5 and Appendix A, for example IT3.1, show the Key Skill (IT), the level (3) and subsection (1).

Centres are encouraged to consider the OCR Key Skills scheme to provide certification of Key Skills for their candidates.

Key Skills Coverage

For each module, the following matrix indicates those Key Skills for which opportunities for at least some coverage of the relevant Key Skills unit *at Level 3* exists.

Unit	Communication	Application of Number	Information Technology	Working with Others	Improving own Learning and Performance	Problem Solving
2518	✓		✓		✓	
2519	✓		✓		✓	✓
2520	✓		✓	✓		
2521	✓	✓	✓	✓		
2522	✓		✓		✓	✓
2523	✓		✓		✓	✓
2524	✓		✓	✓		
2525	✓	✓	✓	✓		

1 INTRODUCTION

These OCR specifications lead to qualifications at Advanced Subsidiary GCE and Advanced GCE in Design and Technology. Candidates take three units for Advanced Subsidiary and a further three for A2. Advanced Subsidiary and A2 combined constitute the full Advanced GCE specification. There is coursework in both Advanced Subsidiary GCE and A2.

Candidates wishing to study Design and Technology: Product Design or Design and Technology: Systems and Control Technology should have studied a GCSE course in **either** Resistant Materials, Graphic Products, Textiles **or** Systems and Control, Electronic Products or TEP Industrial Production. From their study it will be assumed that candidates have an elementary knowledge of most of the following:

- designing and making skills needed to produce end-products;
- materials – common forms of paper/card, modelling materials, fibres and fabrics, plastics, woods, light weight metals and composites;
- components and processes as used in products;
- systems and control functions as applied to the planning and manufacture of products, or as components within products;
- products and their applications;
- Health and Safety issues and a range of experience drawn from the wider study of graphical and textile materials-based products, or systems and control within products.

The specifications are designed to make available to candidates opportunities to tackle technological problems that impinge upon their lives and human activities whether in advanced or developing societies and, in so doing, provide opportunities to study, propose and realise quality solutions to satisfy designing and making needs. Their solutions or prototypes will be the outcome of rigorous research, application of knowledge and understanding acquired in the respective material or component area.

Design and making skills are delivered through the Advanced Subsidiary and A2 internally assessed coursework. It is not expected that each section of the 'knowledge and understanding' identified in the Subject Criteria for Design and Technology will be covered in isolation, but rather that topic areas might be taught in parallel or in conjunction with the needs of schemes of work and within designing and making activities.

The specifications offer candidates opportunities to acquire and demonstrate:

- knowledge and understanding of the world of designing and making;
- flair and technological capabilities through the making of quality outcomes;
- an awareness of industrial processes and manufacturing techniques that underpin the manufacture of products and systems within products;
- an awareness of the responsibilities of designers and technologists to mankind through an increasing knowledge of the potentials and hazards inherent in technological advance, change and decision making.

In all written examinations candidates are encouraged to draw upon practical experience derived from teaching and learning opportunities contained within these specifications in order to demonstrate a breadth of technological understanding.

The assessment objectives are:

AO1: Designing and its application;
AO2: Making and its application.

Although AO1 and AO2 are expressed separately, it should be noted that in practice they cannot always be treated as discrete.

1.1 Certification Title

These qualifications are shown on a certificate as:

- OCR Advanced Subsidiary GCE in Design and Technology: Product Design.
- OCR Advanced GCE in Design and Technology: Product Design.
- OCR Advanced Subsidiary GCE in Design and Technology: Systems and Control Technology.
- OCR Advanced GCE in Design and Technology: Systems and Control Technology.

1.2 Language

These specifications and associated assessment materials are in English only.

1.3 Exclusions

Candidates who enter for one of these Advanced Subsidiary GCE specifications may **not** also enter for any other Advanced Subsidiary GCE specification with the certification title Design and Technology in the same examination series.

Candidates who enter for one of these Advanced GCE specifications may **not** also enter for any other Advanced GCE specification with the certification title Design and Technology in the same examination series.

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

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

The classification codes for these specifications are:

Design & Technology: Product Design	9080
Design & Technology: Systems and Control Technology	9060

1.4 Code of Practice Requirements

These specifications will comply in all respects with the revised Code of Practice requirements for courses starting in September 2004.

2 SPECIFICATION AIMS

The aims of these Design and Technology Advanced Subsidiary GCE and Advanced GCE specifications are to:

- develop and sustain candidates' own innovation, creativity and design and technology capability, to recognise and produce high quality products;
- build upon the knowledge, understanding and skills acquired in GCSE studies;
- promote a progression through Advanced Subsidiary and Advanced GCE and provide a suitable foundation for the study of related aspects in further and higher education;
- develop a critical understanding of the influences on processes and products of design and technological activity from a historical perspective and in current practice;
- apply essential knowledge, understanding and skills of design production processes to a range of technological activities and develop an understanding of industrial practices;
- use information and communication technology (ICT) to enhance candidates' design and technological capability;
- use ideas and concepts across related design areas and in so doing, achieve an understanding of the relevant ideas, facts, concepts, laws and theories;
- develop appropriate skills in communication, application of number and ICT;
- identify the importance of, and apply mathematical and scientific principles in design and technological activities;
- recognise the social, moral, spiritual and cultural values inherent in design and technological activity, and develop critical evaluation skills in technical, aesthetic, ethical, economic, environmental, social and cultural contexts;
- encourage candidates to develop as discerning consumers who are able to make informed choices;
- develop positive attitudes of co-operation and citizenship, and encourage candidates to work collaboratively.

2.1 Spiritual, Moral, Ethical, Social and Cultural Issues

These specifications provide an opportunity for candidates to appreciate the following aspects in the designed and technological world:

- the relationship between shape, form, function and the tactile senses within organised human making activities (Modules 2519, 2522 and 2523);
- the scale and impact of technology upon natural processes and resources (all modules);
- the impact of design and technological activities upon advanced and developing societies (Modules 2519 and 2522);
- the human dimension – value issues and value systems (Module 2518);
- the moral implications of some applications of technological activities (Module 2518).

2.2 Environmental Education, the European Dimension and Health and Safety Issues

Design and Technology activities are global and not solely restricted to the European sub-continent or its associated culture. Design and making responses are multicultural and arise from identifiable needs and opportunities. The specifications do not make specific reference to the European Dimension, however, it may be drawn into the course of study in many ways, for example, European Safety Standards (Modules 2520, 2521, 2523, 2524 and 2525).

Health and Safety is referred to in Modules 2520, 2521, 2523, 2524 and 2525.

2.3 Avoidance of Bias

OCR has taken great care in the preparation of these specifications and associated assessment materials to avoid bias of any kind.

3 ASSESSMENT OBJECTIVES

Design, make and evaluate processes are not necessarily linear, but may be cyclic or at any stage revert back to different elements within the whole process.

Candidates should be able to:

Designing

- identify and draw on relevant knowledge, understanding and skills related to materials and components, systems and control, quality processes, products and applications, and health and safety issues at appropriate times during their designing and making;
- identify, devise and apply evaluation techniques to information, ideas, design proposals, models and products, be they the outcomes of others' or their own work, to enable decisions to be made and appropriate actions to be taken;
- manage the use of resources and time;
- identify and use appropriate means to communicate ideas, design proposals and evaluations to a range of audiences;
- develop and use inter-personal skills including working with others and developing contacts with users;
- analyse design situations, including identifying appropriate research materials, routes and methods – being encouraged to draw on the work of others to inform their analysis and proposed solutions;
- develop and use specifications, including those prepared by others;
- use appropriate design methodology to generate and develop ideas in creative and practical ways;
- use an awareness of industrial methods and approaches to design, manufacture and quality control in different volumes of production;

Making

- select and use materials and components, processes and equipment to produce models, prototypes, products and systems, considering suitability, availability and the scale of proposed production;
- implement a proposal to the point where it can be fully evaluated against the original specification;
- apply safety principles and safe working practices, including identifying hazards, making risk assessments, deciding how to minimise risks;
- use and apply hand and machine manufacturing methods;

Specific Knowledge and Understanding

- recognise and use specific knowledge and understanding in relation to the designing and making of products/systems;
- recognise and use the differing characteristics and properties of materials, components, equipment and processes;
- recognise systems and their control and application;

- use and apply mathematical and scientific knowledge, as appropriate, to designing and making;
- analyse existing products/systems and their applications, and apply the results to their own designing and making;
- apply ICT – including its use as an aid to designing and modelling, as a tool for assessing, manipulating and presenting information, in control systems and computer aided design (CAD) and computer aided manufacture – CAD/CAM systems, and its use by industry and commerce;
- use resources appropriately and become aware of any economic or environmental implications of technological decisions;
- demonstrate an awareness of aesthetic and relevant moral, social, cultural issues;
- develop and use specifications which suit the requirements of potential clients in terms of price and quality;
- develop an understanding of current industrial and commercial practice in respect of product/systems studies and in their own designing and making;
- demonstrate an understanding of the relevant legal requirements, British and International Standards and technical guidance in their designing and making;
- apply quality procedures in terms of products/systems, for example
  – fitness for purpose
  – meeting criteria of a product/system specification
  – accuracy in production
  – appropriate use of technology.

The assessment objectives set out in the subject criteria for Design and Technology (QCA, 1999) are as follows:

AO1 Candidates should be able to apply their knowledge and understanding in combination with skills to design products to suitable specifications.

AO2 Candidates should be able to apply skills, knowledge and understanding of relevant materials, processes and techniques and use materials, tools and other equipment to produce work to suitable specifications.

The assessment objectives are weighted as follows:

	Advanced Subsidiary GCE	A2	Advanced GCE
AO1	66%	54%	60%
AO2	34%	46%	40%

3.1 Specification Grid

The relationship between assessment objectives and units of assessment is shown in the specification grid below.

Unit of Assessment	Level	Percentage of Advanced GCE		
		AO1 Designing	AO2 Making	Total
2518	AS	13	2	15
2519	AS	12	8	20
2520 or 2521	AS	8	7	15
2522	A2	13	2	15
2523	A2	2	13	15
2524 or 2525	A2	12	8	20
Total		60	40	100

3.2 Quality of Written Communication

Quality of Written Communication is assessed in Unit 2518: System Case Study.

4 SCHEME OF ASSESSMENT

Candidates take three units, 2518, 2519 and either 2520 or 2521 for Advanced Subsidiary GCE, followed by three further units, 2522, 2523 and either 2524 or 2525 at A2 if they are seeking an Advanced GCE award.

Units of Assessment

Unit	Level	Name	Duration	Mode of Assessment	Weighting	
					AS	Advanced GCE
2518	AS	System Case Study	20 hours	OCR-marked Coursework	30	15
2519	AS	Product Study: Analysis and Development	30 hours	Centre-marked Coursework	40	20
2520	AS	Product Design 1	2 hours	Written Examination	30	15
2521	AS	Systems and Control Technology 1	2 hours	Written Examination	30	15
2522	A2	Designing	40 hours	Centre-marked Coursework	–	15
2523	A2	Making and Evaluating	40 hours	Centre-marked Coursework	–	15
2524	A2	Product Design 2	2 hours 30 mins	Written Examination	–	20
2525	A2	Systems and Control Technology 2	2 hours 30 mins	Written Examination	–	20

Rules of Combination

Candidates must take **one** of the following combinations of units:

Advanced Subsidiary: Product Design:	Units 2518, 2519 and 2520
Advanced Subsidiary: Systems and Control Technology:	Units 2518, 2519 and 2521
Advanced GCE: Product Design:	Units 2518, 2519, 2520, 2522, 2523 and 2524
Advanced GCE: Systems and Control Technology:	Units 2518, 2519, 2521, 2522, 2523 and 2525

Unit Availability

There are two assessment sessions each year, in January and June.

The availability of units is shown below.

Unit	Unit Title	Jan 2005	June 2005	Jan 2006	June 2006
2518	System Case Study		✓		✓
2519	Product Study: Analysis and Development		✓	✓	✓
2520	Product Design 1		✓	✓	✓
2521	Systems and Control Technology 1		✓	✓	✓
2522	Designing			✓	✓
2523	Making and Evaluating			✓	✓
2524	Product Design 2			✓	✓
2525	Systems and Control Technology 2			✓	✓

In 2005 only the Advanced Subsidiary (AS) units will be available as shown in the table above.
The availability shown for 2006 will be the same for subsequent years.
Examinations in 2004 and A2 in 2005 will be based on the second edition of the specification.

Sequence of Units

The normal sequence in which the units could be taken is Units 2518, 2519 and either 2520 or 2521 in the first year of study leading to an Advanced Subsidiary GCE award, then Units 2522, 2523 and either 2524 or 2525 in the second year, together leading to an Advanced GCE award. However, units may be taken in other sequences.

Alternatively, candidates may take all units at the end of their Advanced Subsidiary GCE or Advanced GCE course in a 'linear' fashion.

Synoptic Assessment

At least 20% of the total assessment is synoptic with a minimum of 17% in Unit 2524 or Unit 2525, where questions assess the candidates' understanding of the connection between the different elements of the designing and making process. The remaining 3% is in the Evaluation section of Unit 2523.

For Advanced GCE, either Units 2523 and 2524 or Units 2523 and 2525 should normally be taken at the end of a candidate's course of study but this is not a requirement.

Aggregation

Candidates may enter for:

- Advanced Subsidiary GCE aggregation;
- Advanced Subsidiary GCE aggregation, bank the result, and complete the A2 assessment at a later date;
- Advanced GCE aggregation.

Candidates must enter the appropriate Advanced Subsidiary and A2 units to qualify for the full Advanced GCE award.

Individual unit results, prior to the certification of the qualification, have a shelf-life limited only by the shelf-life of the specification.

Re-sits of Units

Candidates are permitted to re-sit units once only before seeking an Advanced Subsidiary or Advanced GCE award, and the better result will count.

Re-sits of Advanced Subsidiary and Advanced GCE

Candidates may retake the whole qualification more than once.

4.1 Question Papers

Note: CHANGES TO THE EXAMINATION REQUIREMENTS FOR UNITS 2521 AND 2525.

4.1.1 Advanced Subsidiary

Unit 2520 and Unit 2521

Unit 2520 (Product Design 1) and Unit 2521 (Systems and Control Technology 1) are timed written papers of 2 hours duration. Each question paper contains **two** sections.

Unit 2520 Section A and Unit 2521 Section A

Section A questions are common to both Unit 2520 and Unit 2521 and presents candidates with **five** generic context based questions. These questions test candidates' understanding of:

- the effects of design decisions upon the environment;
- the pressures put on the designers of products by such issues as:
  – energy;
  – the environment;
  – the human interface;
  – aesthetics;
  – scale of production;
  – production technologies;
  – fashion;
  – product life;
  – commercial issues.

Candidates are required to answer **three** questions.

The questions have a common structure and style, containing an incline of difficulty within each question and a common mark weighting.

Unit 2520 Section B

Section B presents candidates with **seven** questions which are product context based. These are set within the specific material areas of graphics (paper/boards), textiles, plastics, wood and metals and focus on materials processes and components. Questions have a common structure and style, containing an incline of difficulty within each question and a common mark weighting.

The seven questions will be:

- one wood;
- one metal;
- one plastics;
- two graphics (paper/boards);
- two textiles.

Candidates are required to answer any **two** questions.

Unit 2521 Section B

Section B presents candidates with **six** questions which are systems context based.

The six questions will be:

- two electrical and electronic systems;
- two mechanical systems;
- two pneumatic systems.

Candidates are required to answer **two** questions.

4.1.2 A2

Units 2524 (Product Design 2) and 2525 (Systems and Control Technology 2) are timed written papers of 2 hours 30 minutes duration. Each question paper contains **two** sections.

Unit 2524 Section A

Section A presents candidates with **seven** questions which are product context based. These are set within the specific material bases of graphics (paper/boards), textile, plastics, wood and metals and focus on materials, processes and components.

The seven questions will be:

- one wood;
- one metal;
- one plastics;
- two graphics (paper/boards);
- two textiles.

Candidates should spend about one hour on Section A and are required to answer any **two** questions.

Unit 2525 Section A

Sections A presents candidates with **six** questions which are systems context based.

The six questions will be:

- two electrical and electronic systems;
- two mechanical systems;
- two pneumatic systems.

Candidates should spend about one hour on Section A and are required to answer any **two** questions.

Unit 2524 Section B and Unit 2525 Section B

Section B assesses the abilities of candidates to make immediate design responses to a given situation. It is intended to be a discriminator in identifying those candidates who can effectively use their experiences and knowledge gained through the course in designing and making to 'self start' successfully on a design task.

Candidates are required to:

- identify the criteria that a successful solution must satisfy;
- present initial ideas that will address the given problem;
- justify a proposed route for development.

Candidates are **not** required to produce a fully developed final solution ready for prototype production.

Candidates are required to respond to **one** given situation. The situations posed have a common mark structure and guidance is printed on the question paper indicating the allocation of marks.

Discrete questions are prepared for both Product Design and Systems and Control Technology related question papers. Up to **five** questions are set for Unit 2524. Up to **three** questions are set for Unit 2525.

Outlines of each given situation are sent to Centres approximately one month in advance of the examination date. Candidates should make themselves aware of the given situations by exploring the background and nature of each. Outlines will also be posted on the OCR website: (www.ocr.org.uk).

Candidates **may not** take into the examination room any prepared material. The preparation for the examination should be carried out by the candidate. It is **not** intended that the preparatory work should be formally taught.

4.2 Coursework

Unit 2518 is marked by OCR.

Units 2519, 2522 and 2523 are marked by the teacher, internally standardised within the Centre and externally moderated by OCR.

Unit 2519 in AS and Units 2522 and 2523 in A2 provide opportunities to deliver the core designing and making skills, and knowledge and understanding of product and system analysis.

4.2.1 Advanced Subsidiary

Unit 2518: System Case Study (Examined Coursework)

Although a Centre-controlled activity, resulting in candidates producing a written report, the System Case Study is externally marked by OCR. The System Case Study is based on the investigation of a specific system identified within the system context set by OCR. A new context is set for each examination session.

The specific system selected by the candidate must be outside their normal domestic experience and must be set in the context of industrial and/or commercial practices and should refer to materials, components and their uses appropriate within the selected system. As a guide 20 hours should be spent on the compilation of the examined report.

The unit has **five** elements:

1	System Choice, Objectives and Research Plan	18 marks
2	Research and Recording of Information	27 marks
3	Analysis of Information and Conclusions	24 marks
4	Proposals and Case Study Evaluation	15 marks
5	Quality of Written and Graphical Communication	6 marks

Full details of the marking criteria are given in Section 5.2.

Unit 2519: Product Study: Analysis and Development

Unit 2519 assesses aspects of product analysis and product development. Full details of the marking criteria are given in Section 5.4.

4.2.2 A2

At A2, Units 2522: Designing and 2523: Making and Evaluating provide opportunities for assessing open-ended tasks focused on designing and making respectively. Full details of the marking criteria are given for (Unit 2522) in Section 5.8 and for (Unit 2523) in Section 5.10.

4.2.3 Assessment and Moderation

All internally assessed coursework is marked by the teacher and internally standardised by the Centre. Marks must be submitted to OCR by the agreed date, after which moderation takes place in accordance with OCR procedures. For AS Unit 2519, moderation is by post; for A2 Units 2522 and 2523, moderation is initially by post with additional selective visits.

The purpose of moderation is to ensure that the standard for the award of marks in internally assessed coursework is the same for each Centre, and that each teacher has applied the standards appropriately across the range of candidates within the Centre.

The sample of work which is submitted to the Moderator for moderation must show how the marks have been awarded in relation to the marking criteria.

4.2.4 Minimum Coursework Requirements

If a candidate submits no work for a Centre-marked coursework unit, then the candidate should be indicated as being absent from that unit on the internal assessment coursework mark sheets submitted to OCR. If a candidate completes any work at all for that coursework unit then the work should be assessed according to the criteria and marking instructions and the appropriate mark awarded, which may be 0 (zero).

4.2.5 Authentication

As with all coursework, the teachers must be able to verify that the work submitted for assessment is the candidate's own work. Sufficient work must be carried out under direct supervision to allow the teacher to authenticate the coursework marks with confidence.

4.3 Special Arrangements

For candidates who are unable to complete the full assessment or whose performance may be adversely affected through no fault of their own, teachers should consult the *Inter-Board Regulations and Guidance Booklet for Special Arrangements and Consideration*. In such cases advice should be sought from OCR as early as possible during the course.

4.4 Differentiation

In the question papers, differentiation is achieved by setting questions which are designed to assess candidates at their appropriate levels of ability and which are intended to allow candidates to demonstrate what they know, understand and can do.

In coursework, differentiation is by task and by outcome. Candidates undertake assignments which enable them to display positive achievement.

4.5 Awarding of Grades

The Advanced Subsidiary has a weighting of 50% when used in an Advanced GCE award. An Advanced GCE award is based on the aggregation of the weighted Advanced Subsidiary (50%) and A2 (50%) marks.

Both Advanced Subsidiary GCE and Advanced GCE qualifications are awarded on the scale A-E, or U (unclassified).

4.6 Grade Descriptions

The following grade descriptions indicate the level of attainment characteristic of the given grade at Advanced GCE. They give a general indication of the required learning outcomes at each specified grade. The descriptions should be interpreted in relation to the content outlined in 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 the examination may be balanced by better performances in others.

Grade A

Combining their designing and making skills with knowledge and understanding, candidates:

(a) when generating ideas and clarifying the task, use an imaginative range of appropriate primary research methods, analyse and record information and demonstrate a high degree of selectivity;

(b) when developing and communicating ideas, take into account functionality, aesthetics, ergonomics, maintainability, quality and user preferences, then work to a specification which could be developed in conjunction with an external partner or client. Take account of commercial manufacturing requirements in terms of scale of production, time and resource management. Demonstrate an understanding of product life cycles. Initiate and develop a wide range of imaginative and feasible alternative ideas, showing that they effectively and completely satisfy all of the specification criteria. Demonstrate high level communication skills through a wide variety of appropriate and effective methods and techniques, including information technology, graphical, numerical and linguistic;

(c) when planning and evaluating, demonstrate good management of time and resources in the development of design proposals and appropriately test and evaluate final outcomes, as well as the various stages of development, discriminating between aspects which performed well and others which could be further improved. Evaluate the effect of the design proposal upon the wider society, taking into account, spiritual, moral, social, economical and environmental implications;

(d) when making, demonstrate demanding and high level skills which include, shaping, forming, assembly and finishing, and show imaginative use of materials. Take into account quality assurance procedures and precise and appropriate levels of tolerance in the realisation of design proposals. Select, use and demonstrate understanding of a range of materials/components and production processes appropriate to the specification and the scale of production. Demonstrate high levels of safety awareness both in the working environment and beyond.

Grade C

Combining their designing and making skills with knowledge and understanding, candidates:

(a) when generating ideas use a wide range of appropriate research methods, analyse and record information and demonstrate a degree of selectivity;

(b) when developing and communicating ideas, take into account functionality, aesthetics, ergonomics, maintainability, quality and user preferences. Take account of commercial manufacturing requirements in terms of scale of production, time and resource management;

(c) initiate and develop a range of feasible alternative ideas and show that they satisfy all of the specification criteria. Demonstrate a good level of communication skills through a variety of appropriate and effective methods and techniques, including information technology, graphical, numerical and linguistic;

(d) when planning and evaluating, demonstrate management of time and resources in the development of the design proposal and test and evaluate both final outcomes and the various stages of development. Evaluate the effect of design proposals upon the wider society, taking into account, spiritual, moral, social, economical and environmental implications;

(e) when making, demonstrate high level skills which include, shaping, forming, assembly and finishing. Take into account quality assurance procedures and appropriate levels of tolerance in the realisation of their design proposals. Select, use and demonstrate understanding of a range of materials/components and production processes appropriate to the specification and the scale of production. Demonstrate safety awareness both in their working environment and beyond.

Grade E

Combining their designing and making skills with knowledge and understanding, candidates:

(a) when generating ideas, use a range of research methods, analyse and record information appropriately;

(b) when developing and communicating ideas, take into account functionality, aesthetics, ergonomics, quality and user preferences. Take some account of commercial manufacturing requirements in terms of scale of production, time and resource management, although this may be superficial. Initiate and develop a limited range of feasible alternative ideas and show that they satisfy most of the specification criteria. Demonstrate a range of communication methods and techniques to a competent level, including information technology, graphical, numerical and linguistic;

(c) when planning and evaluating, demonstrate some management of time and resources in the development of the design proposal and test and evaluate both the final outcome and the various stages of development. Evaluate the effect of design proposals upon the wider society, possibly taking into account, spiritual, moral, social, economical and environmental implications;

(d) when making, demonstrate an adequate level of making/modelling skills which include, shaping, forming, assembly and finishing. Take into account quality assurance procedures and levels of tolerance in the realisation of their design proposals. Select, use and demonstrate understanding of a limited range of materials/components and production processes appropriate to the specification and the scale of production. Demonstrate safety awareness in their working environment.

5 SPECIFICATION CONTENT

Each teaching and learning module is assessed through its associated unit of assessment.

5.1 MODULE 2518: SYSTEM CASE STUDY

EXAMINED COURSEWORK

C3.2, C3.3; IT3.1 **LP3.1, LP3.2, LP3.3**

5.1.1 Introduction

This module, whose outcome is a Case Study Report, is a demanding intellectual learning experience which is intended to form a foundation for future modules. The module provides opportunities to address many aspects of systems and control in relation to the wider community and industrial and commercial practice and is intended to encourage candidates to consider broadly the opportunities, implications and responsibilities of the use of systems within Design and Technology.

The teaching and learning opportunities which will be assessed include:

- choosing and defining an appropriate task within the given context (a different context is set each year);
- identifying appropriate research methods;
- carrying out research and recording information;
- analysing information and reaching conclusions objectively;
- making justified proposals;
- evaluation of both the system and the case study methodology;
- effective and appropriate communication;
- furthering understanding related to systems, their usefulness, impact and control methods.

In addition, candidates should be able to identify and demonstrate:

- the fitness for purpose in the design of systems;
- appropriate use of technology within a system and its effect upon people and the environment;
- the forms of energy used in systems, their impact on design, manufacturing and the environment;
- the use and detailed design of systems and sub-systems (mechanical, electronic, interface systems – input, process, output) that underpin systems design and operation;
- the human use of systems being studied;
- an understanding of recent technological developments and capabilities on the design and production of systems;
- issues of safety, quality assurance, quality control, social and economic factors.

The Case Study Report is externally marked by OCR.

The Case Study is based on the investigation of a system.

The system context is set by OCR and is within industrial and/or commercial practices. A new context is set for each year and issued to Centres. Centres should ensure they are aware of the current context. This module is examined once a year, in the Summer session. Candidates who wish to resubmit this module will be required to follow the context set for that year, which will be different to the context set for their original case study. The context for each year will be published on the OCR website (www.ocr.org.uk). This module is not available in January.

Candidates must ensure that their case study is presented in a structured format which accurately follows the assessment criteria. To assist centres, OCR have produced an electronic template which is available on the OCR website (www.ocr.org.uk). This template contains a front cover sheet that **must** be attached to each case study.

The choice of a specific system within the set context is left to the candidate, with guidance from the teacher, but care should be taken to ensure that it will allow sufficient opportunities to meet the assessment criteria and that the report can be produced in the time available. It is essential that the candidate has access to primary and secondary information about the system being studied. The system selected by the candidate must be outside their normal domestic experience and should give the candidate sufficient opportunity to demonstrate their ability to Advanced Subsidiary level. OPF's (Outline Proposal Forms) are available from OCR to enable candidates to receive guidance on the suitability of their proposals.

The study should contain reference to materials, components and their uses as appropriate within the system.

Whilst this is a theoretical study leading to proposals, it is vital that candidates are able to access the system directly, as primary sources of research are a necessary part of the investigative process.

The module requires approximately 50 hours of work of which 30 hours should be allocated to the teaching and learning of appropriate skills and 20 hours to the production of the case study.

The Case Study Report is assessed via **five** criteria:

- **System Choice, Objectives and Research Plan** **18 marks**
- **Research and Recording of Information** **27 marks**
- **Analysis of Information and Conclusions** **24 marks**
- **Proposals and Case Study Evaluation** **15 marks**
- **Quality of Written and Graphical Communication** **6 marks**

The research, analysis and communication skills learnt in this module form the basis of work in later modules.

In previous years the system contexts have included, 'Visual Communication Systems,' 'The Needs of the Disabled,' and 'The Use of Systems for Protection.'

5.1.2 Examples of Teaching and Learning Opportunities

System Choice, Objectives and Research Plan

- System choice and nature of the system;

  teaching the nature of a system, including input, output, components, etc.;
  exercises in identifying systems in a variety of situations – industrial, environmental, agricultural, etc.;
  exercises in analysing the complexity of systems;
  exercises in identifying what the purpose is of sample systems;
  starting with a base system, e.g. the manufacture of uPVC window frames, identify the wider context, in this case, batch production and the use of standardised parts;

- Objectives and sources of information;

  simple exercises, starting with a sample system and analysing the possibilities that it provides for investigation, analysis and conclusions;
  exercises in identifying the main elements in sample systems;
  looking at sample systems to identify where information could best be obtained;
  analysing the range of information available for a sample system to identify which is likely to be of most value;
  teach what is meant by the terms primary and secondary information;
  exercises in obtaining specific limited pieces of information using a variety of sources;
  group visits with a pre-set agenda;

- Research plan;

  exercises in setting a realistic research and time plan, how to evaluate progress and how to adapt to the need for other sources of information.

Research and Recording of Information

- Range of information;

  look at sample systems to identify primary and secondary sources of information;
  exercises involving finding prescribed material from CD-ROMs or from the Internet;
  lesson on how to produce a detailed bibliography/sources of information page;

- Evaluation of progress;

  how to keep a diary of progress and identify successful progress;
  exercise involving an incomplete research plan to identify gaps in information and to plan modifications;

- Editing of information;

  exercise involving a batch of information on a topic which includes excessive material in need of editing;
  exercise involving presenting the description of a process in as concise a manner as possible;
  teaching how to reference, summarise and annotate information.

Analysis of Information and Conclusions

- Analysis of information;

  examine a system to identify management issues, quality assurance, quality control and organisation;
  exercise to demonstrate the difference between quality assurance and quality control and examples of management decisions and supervision, relative to systems;

- Analysis of system;

  examine a system to identify any sub-systems such as input, process and output;
  how to examine the effectiveness of a system/sub-system with reference to objectives;

- Conclusions;

  exercise which demonstrates the difference between objective and subjective evaluation;
  examine a system to identify what it does well and why this is;
  examine a system to identify a weakness and suggest how it can be improved.

Proposals and Case Study Evaluation

- Proposals;

  look at a system with identified weaknesses, suggest as a group several ways for improving the system, evaluate which would be the most effective;
  exercise which looks at a list of proposals for improving a system to identify what is realistic, and what is meant by the term realistic in a particular context;
  exercise which looks at a very successful system, perhaps by a group visit, and identifies the key elements which contribute to its success;

- Case Study Evaluation;

  exercise which follows on from one of the above exercises which looks at what aspects went well, which did not go so well, and attempts to discover why;
  practice summarising the making of a piece of practical work or a piece of research;
  exercise which demonstrates the difference between objective and subjective evaluation.

Quality of Written and Graphical Communication

- Quality of written and graphical communication;

  present the description of a process, e.g. injection moulding, using the minimum number of words and diagrams;
  candidates make a presentation to the group praising or criticising a product with clear justification for their views; use of technical phrases a series of exercises involving the teaching and learning of such communication techniques as word processing, graphs, annotated sketching, photography, referenced catalogue or brochure material, etc.;
  each candidate in a group produces a visual aid on a design topic which needs to be informative and eye catching.

The examples of teaching and learning opportunities (given in italics above) are not prescribed or a complete set but are intended only as a guide to the type of teaching and learning experiences that would enhance or develop those skills required by candidates to produce the assessed work in Unit 2518.

5.2 UNIT 2518: SYSTEM CASE STUDY

GUIDANCE AND MARKING CRITERIA

The System Case Study Report is marked out of 90.

It should be a balance of written and graphic information presented in an A4 format. The report should be produced using ICT and other appropriate communication techniques. As a guide, the report should be approximately 2000 words, together with graphical information. More is not better. A clear and concise style is needed. The use of diagrams, charts, photographs, annotation and other means of graphical communication is to be encouraged.

Assessment of the System Case Study focuses on the whole process pursued by the candidate, rather than on an outcome alone. The System Case Study is an investigation to determine the effectiveness of a system. It is not a study of a product, nor a design project. Use assessment headings from the marking criteria as headings in the study. Use phrases from the criteria as sub-headings.

Evidence is important. Examiners marking the studies need to be sure what the candidates have done themselves and what has been abstracted from other sources.

5.2.1 Written Communication

This unit is used for the assessment of the candidate's quality of written communication.

Candidates are required to:

- select and use a form and style of writing appropriate to differing sections of the Report and its related subject matter;
- organise relevant information clearly and coherently, using specialist vocabulary as appropriate;
- ensure that the text is legible; spelling, grammar and punctuation are accurate so that the meaning conveyed is clear.

5.2.2 The Report

The report is to be seen as the outcome of a demanding intellectual investigation that focuses candidates on the broader issues of systems within Design and Technology, and, where appropriate, having particular regard for:

- fitness for purpose;
- appropriate use of technology within a system and its effects upon people and the environment;
- energy resources and sources of materials;
- mechanical, electronic and interface systems that underpin system design and operation;
- human use of the system being studied;
- an understanding of recent technological developments and capabilities that directly underpin the development of the system studied;
- social and economic factors;
- issues of safety, quality assurance and quality control.

5.2.3 Marking Criteria

The Case Study Report is assessed as follows:

System Choice, Objectives and Research Plan **[18 marks]**

- System choice and nature of the system [6]
- Objectives and sources of information [9]
- Research plan [3]

Research and Recording of Information **[27 marks]**

- Range of information [12]
- Evaluation of progress [3]
- Editing of information [12]

Analysis of Information and Conclusions **[24 marks]**

- Analysis of information [9]
- Analysis of system [6]
- Conclusions [9]

Proposals and Case Study Evaluation **[15 marks]**

- Proposals [12]
- Case study evaluation [3]

Quality of Written and Graphical Communication **[6 marks]**

- Quality of written and graphical communication [6]

5.2.3.1 System Choice, Objectives and Research Plan [18 marks]

System choice and nature of the system **[max 6 marks]**

Candidates:

- select an appropriate and challenging system to study within the set context and time allowed. Outlines clearly the nature of the system and gives a clear indication of how it fits within the wider context. [5-6]
- select an appropriate system to study, within the set context and time allowed, which offers reasonable challenge; outline the more obvious elements of the system and give some indication of how it fits within the wider context; [3-4]
- select an appropriate system to study, within the set context and time allowed, which offers little challenge; present only a superficial outline of elements of the system and give little indication of how it fits within the wider context. [0-2]

a system in the candidate's 'school' context is not always a sensible choice if the candidate is to develop the investigative and interpersonal skills that this component of the examination intends; a specific focus is necessary if the investigation is to be in sufficient depth and detail (compare 'school' with 'changing rooms in the school sports hall'). Care is needed not to spread the study too thinly because the topic area is too broad;

the chosen system should offer sufficient challenge to the candidate, and be appropriate to his/her ability. There should ideally be some potential to develop or improve the chosen system;
this is a System Case Study and not the study of a product, although products form part of systems;
use visual material to set the scene and introduce the reader to the context and the system;
preliminary research/enquiries will in most cases be needed to establish the specific focus and aims for the study;
where Centres arrange a visit to a company for a group of candidates, it is essential that each candidate is able to select and undertake their own study and individually be able to address all the assessment criteria;
an INPUT > PROCESS > OUTPUT diagram of the system is a reasonable expectation in this section;
parts of the system – its sub-systems – must be clear;
context – the system as a sub-system of a larger system – possibly illustrated by photographs and diagrams;
similar systems may be mentioned.

Objectives and sources of information **[max 9 marks]**

Candidates:

- present detailed information about the objectives of the study with a detailed analysis of the main elements in the system and the criteria that it fulfils; identify clearly, several sources of primary and secondary information; why they are important to the objectives of the study and appropriate specific techniques for obtaining this information; [7-9]
- present some information about the objectives of the study with some analysis of the more obvious elements involved in the system with identification of the main criteria that it meets. Identifies the more obvious primary and secondary sources of information with some awareness of its importance to the objectives of the study and appropriate techniques for obtaining this information; [4-6]
- present little information about the objectives of the study with little analysis of the elements in the system and limited or superficial criteria that the system meets; identify few sources of information with little awareness of its importance to the objectives of the study and limited techniques for obtaining this information. [0-3]

list specific, measurable outcomes/targets. (These can be referred to in part 4.2 of the sheet on page 30-31);
objectives should be realistic, achievable, and specific to this system;
list the factors which will be used to assess the effectiveness of the system. (These can be referred to in part 3.2 of the sheet on page 30-31);
possibly lay out in a list/table format so that a candidate can clearly see the objectives of their study and refer back to them when required;
a list of specific, precise information required to achieve the stated objectives, with reasons why this information is important;
technical and legal data and detail is required at this level. (e.g. Anthropometrics, British Standards, legislation);
possibly present 'Information required' alongside 'Objectives' in a table;
Note 'primary and secondary sources and techniques';
where and how precise information can be gained, including technical data;
contact with a person/group closely involved with the actual system is required at this level (primary);
indicate exact technique intended, e.g. interviews may be structured or informal, telephone, or in person. State name of company/person/position held in company;
state details of publication, website, etc. (secondary);
for some useful guidelines on 'How and where to get the information you need', see Pages 37 & 38 of 'Advanced Manufacturing D&T' RCA Schools Technology Project. Hodder & Stoughton ISBN 0340705280.

Research Plan **[max 3 marks]**

Candidates:

- produce a detailed plan for obtaining relevant research information with an indication of timescales; [3]
- produce a reasonable plan for obtaining relevant research information with some indication of timescales; [2]
- show little evidence of a plan for obtaining relevant research information with little or no indication of timescales. [0-1]

planning for the research, for the gathering of the information for part 2 of the sheet on page 30-31; – not a plan for the study as a whole;
possibly a chart/table overviewing part 1.2 of the sheet on page 30-31;. This format acts as a checklist showing gaps that require filling;
possibly a flowchart format;
indication of time/details;
possible space for tick against each stage when completed;
possible space for evaluation of success (see part 2.2 of the sheet on page 30-31).

5.2.3.2 Research and Recording of Information [27 marks]

Range of information **[max 12 marks]**

Candidates:

- obtain a wide range of relevant information relating to the chosen system from primary and secondary sources and present detailed evidence of these sources in a bibliography; [9-12]
- obtain an adequate range of relevant information relating to the chosen system from primary and secondary sources and present reasonable evidence of these sources in a bibliography; [5-8]
- obtain only limited information relating to the chosen system from a few more obvious sources and presents some evidence of these sources in a bibliography. [0-4]

the obtaining of the information from Primary and Secondary sources;
first hand contact with the system and those involved with it is very important;
bibliography – a detailed list/indication of sources including websites;
evidence of sources and methods is important. This authenticates the candidate's own work;
possibly a photo of books/printed literature used etc.;
note 'a wide range' of relevant information;
think about the best method of presenting the data (see parts 2.3 and 5.1 of the sheet on page 30-31);
include only the information that is relevant (sorting information that is important is assessed in part 2.3 of the sheet on page 30-31);
several sources. The information in some cases may give a different viewpoint. A range of opinions should be sought – not just the candidate's;
information may include details of similar systems. Comparisons may highlight strengths and weaknesses of the chosen system, and confirm opinions gained from interviews and other sources;
keep on track – there will be many possible diversions – remember that the investigation is about 'the effectiveness of the chosen system.'

Evaluation of progress **[max 3 marks]**

Candidates:

- evaluate and record progress thoroughly, adapting the original plan if necessary to meet new challenges; [3]
- show some awareness of the need to evaluate and record progress, making changes to the original plan if necessary; [2]
- show little awareness of the need to evaluate and record progress or to make changes to the original plan if necessary. [0-1]

see part 1.3 of the sheet on page 30-31, possibly use a diary;
possibly a chart/table: 'What I planned' 'What I've done';
a record of progress;
show modifications/revisions to the original plan.

Editing of information **[max 12 marks]**

Candidates:

- provide evidence of creative editing, summarising, annotating and referencing of information, suitable for later analysis; [9-12]
- provide some evidence of editing, summarising, annotating and referencing of information, suitable for later analysis; [5-8]
- provide limited evidence of editing, summarising, annotating and referencing of information, suitable for later analysis. [0-4]

summary points guide the reader to important points. Highlight key points. Page numbers are required for referencing. References to other sections;
editing is the selecting, sorting, and recording of what is important; the removal of that which is not important;
clear annotation/labelling of photos and diagrams is crucial, giving clear details of what is shown; drawings and charts to show information visually. These only need be large enough to be read and understood;
a single pie chart on an A4 page is excessive;
think about who will be reading this study when it is completed. If it is a study on a system in a school context, it may be the Headteacher or Governors. Think about how they would want the information to be recorded for easy reading and reference in their busy schedules, e.g. clear points, with supporting notes and justification. Use of charts and diagrams (show more than one on a page);
use of an Appendix (if absolutely necessary) so that the main body of the study is not cluttered. Possibly list the data edited out and which is included in the Appendix. Sections of the Appendix or other pages of the study should be referred to by the candidate;
show the reasoning for the approach to the investigation, e.g. reasons for the questions in a questionnaire or interview;
possible overall 'reference map' of system with markings/pictures/references (e.g. a floor plan of a school showing positions of parts of the system being studied, possibly referring to a photograph or page number for further details).

5.2.3.3 Analysis of Information and Conclusions [24 marks]

Analysis of information [max 9 marks]

Candidates show:

- detailed and perceptive analysis of edited research material and key issues, such as management, quality assurance and control; [7-9]
- reasonable analysis of edited research material and key issues, such as management, quality assurance and control; [4-6]
- superficial analysis of edited research material and limited understanding of key issues, such as management, quality assurance and control. [0-3]

analysis = breaking down. For example, if the system was access to school buildings (doors/ramps, etc.), the following may be considered: management (instructions for use, school rules), materials, maintenance, electrical sub-systems, ergonomics, energy requirements and implications, social, environmental, economic – all the aspects of the system and sub-systems assessed (from the range of sources of information) as to their effectiveness and their contribution to the effectiveness of the system as a whole;
a survey/questionnaire may highlight quite differing opinions and viewpoints on an issue. Information from a book may contradict information gained from the Internet. The candidate should recognise and discuss such differences.

Analysis of system [max 6 marks]

Candidates:

- identify in detail the effectiveness of the system and any sub-systems with reference to the original objectives; [5-6]
- identify in some detail the effectiveness of the system and any sub-systems with some reference to the original objectives; [3-4]
- identify in a superficial way the effectiveness of the system and any sub-systems with little or no reference to the original objectives. [0-2]

an Input>process> output diagram may be useful to show the effectiveness of the system/sub-systems;
use of charts to show differences;
reference to technical aspects and specific details;
reference to the objectives stated in part 1.2 of the sheet on page 30-31.

Conclusions [max 9 marks]

Candidates:

- present clear and detailed conclusions and identify the strengths and weaknesses of the system studied; [7-9]
- present reasonably clear conclusions and identify the more obvious strengths and weaknesses of the system studied; [4-6]
- present only superficial conclusions. [0-3]

a 'clear and detailed' summary, arising from the research and analysis, of the strengths and weaknesses of the system;
a summary of key points;
presentation in chart/table/list format will show clearly the strengths and weaknesses of each

aspect of the system;
conclusions need to be relevant to the objectives stated in part 1.2 of the sheet on page 30-31.

5.2.3.4 Proposals and Case Study Evaluation [15 marks]

Proposals [max 12 marks]

Candidates:

- present creative and innovative proposals, based upon their research data, of realistic and detailed ways in which the system studied might be improved and demonstrate clearly how the system is already so effective; technical details and cost implications are included; [9-12]
- present some reasonable proposals, based upon their research, of realistic ways in which the system studied might be improved and show some understanding of how the system is already so effective; [5-8]
- present superficial proposals for improving the system studied, which lack support from their research, and show little or no understanding of why the system is already so effective. [0-4]

proposals should arise from the investigation and conclusions, and be realistic in terms of resources/funds available, technical details, suitability for purpose… in improving the effectiveness of the chosen system;
depth and detail is required at this level. It is preferable to propose one or two improvements with fuller detail than propose many improvements with little detail;
possibly include details of new products/systems/commercially available components which are being proposed. The Internet is a quick and easy resource bank for such details at this stage of the Case Study;
feedback from the system 'owner', or other external (qualified) opinion on the proposals, is helpful in confirming their feasibility. This is the right approach at the conclusion of an investigation of this nature;
if the system is effective and cannot be improved in any way, explain or show clearly how this was decided.

Case study evaluation [max 3 marks]

Candidates:

- present a detailed and objective evaluation of the case study and identify several aspects that could be improved in future work; [3]
- present a reasonable evaluation of the case study and show some awareness of how future work could be more effective; [2]
- present a superficial evaluation of the case study and show little awareness of how future work could be more effective. [0-1]

a summary of the effectiveness of the study, a summary of the effectiveness of candidate's approach to the study, and identify aspects that could be improved in future work;
comments should relate to the specific study, e.g. '…my question about <component name> to <name> of <company name> in the interview provided key information on the reliability of that part of the system';
when writing an evaluation it is helpful if it is broken down into sections.

5.2.3.5 Quality of Written and Graphical Communication [6 marks]

Quality of written and graphical communication [max 6 marks]

Candidates:

- present relevant information and arguments in a clear and concise manner, using appropriate technical phrases and high quality written communication skills; demonstrate a creative use of a variety of appropriate communication techniques, including ICT, to produce a visually interesting report; [5-6]
- present mostly relevant information and arguments in a reasonably clear and concise manner, with limited use of technical phrases and reasonable written communication skills; use a more limited range of communication techniques, including ICT, which results in a reasonably clear and visually interesting report; [3-4]
- present some relevant information and arguments in a manner that lacks a clear and concise approach, with little or no use of technical phrases and basic written communication skills; use few techniques, other than word processing, to produce a report with limited visual impact and clarity. [0-2]

note: 'presents...information and arguments..' The candidate is expected to discuss and argue a point of view;
presentation is a crucial factor if a study with real value is to be achieved within the 2000 word guide. How many words is a picture worth? Avoid detailed repetition between sections;
the layout of the study is important – with sections, titles/headings, numbered/bullet points, page numbers, contents page, etc.;
spelling, punctuation, grammar, and the use of correct terminology are also important;
look at Consumers' Association 'Which' reports as an example (look at the layout of the pages, the headings, the wording, the font type and size, the use of photographs, diagrams and charts, use of columns...);
candidates are likely to develop their own style of presentation. This should be followed throughout the document;
include plenty on each page. A page may well contain several photos plus diagrams and text;
this is a piece of Design Technology coursework. A reasonable expectation is that it is a 'designed' piece of work, with attention given to the right choices of communication techniques;
good communication is achieved by appropriate use of colour, and a consideration of proportion in respect of elements on each page (e.g. titles, font, photos, diagrams, text). Good quality/clear photographs are important;
a wide range of software is available to assist with word-processing, spreadsheets, databases, desktop publishing, internet, graphics, computer-aided drawing and design, project planning, flowcharts, photo/image scanning/manipulation, etc.

The guidance, explanations and suggestions (given on pages 23-29) are not prescribed or a complete set but are intended only as a guide to the techniques and strategies required by the candidate for successful completion of Unit 2518.

The following page contains a copy of the Assessment Criteria suitable for photocopying. This can be used for teachers to give feedback to their students, or for the students to use themselves.

2518 System Case Study – details provided for internal Centre use only.

1.1 SYSTEM CHOICE AND NATURE OF THE SYSTEM	**6**					
Selects an appropriate and challenging system to study within the set context and time allowed. Outlines clearly the nature of the system and gives a clear indication of how it fits within the wider context.	5-6					
Selects an appropriate system to study, within the set context and time allowed, which offers reasonable challenge. Outlines the more obvious elements of the system and gives some indication of how it fits within the wider context.	3-4					
Selects an appropriate system to study, within the set context and time allowed, which offers little challenge. Presents only a superficial outline of elements of the system and gives little indication of how it fits within the wider context.	0-2					
1.2 OBJECTIVES AND SOURCES OF INFORMATION	**9**					
Presents detailed information about the objectives of the study with a detailed analysis of the main elements in the system and the criteria that it fulfils. Identifies clearly, several sources of primary and secondary information; why they are important to the objectives of the study and appropriate specific techniques for obtaining this information.	7-9					
Presents some information about the objectives of the study with some analysis of the more obvious elements involved in the system with identification of the main criteria that it meets. Identifies the more obvious primary and secondary sources of information with some awareness of its importance to the objectives of the study and appropriate techniques for obtaining this information.	4-6					
Presents little information about the objectives of the study with little analysis of the elements in the system and limited or superficial criteria that the system meets. Identifies few sources of information with little awareness of its importance to the objectives of the study and limited techniques for obtaining this information.	0-3					
1.3 RESEARCH PLAN	**3**					
Produces a detailed plan for obtaining relevant research information with an indication of timescales.	3					
Produces a reasonable plan for obtaining relevant research information with some indication of timescales.	2					
Shows little evidence of a plan for obtaining relevant research information with little or no indication of timescales.	0-1					
1 SYSTEM CHOICE, OBJECTIVES AND RESEARCH PLAN	**18**					

2.1 RANGE OF INFORMATION	**12**					
Obtains a wide range of relevant information relating to the chosen system from primary and secondary sources and presents detailed evidence of these sources in a bibliography.	9-12					
Obtains an adequate range of relevant information relating to the chosen system from primary and secondary sources and presents reasonable evidence of these sources in a bibliography.	5-8					
Obtains only limited information relating to the chosen system from a few more obvious sources and presents some evidence of these sources in a bibliography.	0-4					
2.2 EVALUATION OF PROGRESS	**3**					
Evaluates and records progress thoroughly, adapting the original plan if necessary to meet new challenges.	3					
Shows some awareness of the need to evaluate and record progress, making changes to the original plan if necessary.	2					
Shows little awareness of the need to evaluate and record progress or to make changes to the original plan if necessary.	0-1					
2.3 EDITING OF INFORMATION	**12**					
Provides evidence of creative editing, summarising, annotating and referencing of information, suitable for later analysis.	9-12					
Provides some evidence of editing, summarising, annotating and referencing of information, suitable for later analysis.	5-8					
Provides limited evidence of editing, summarising, annotating and referencing of information, suitable for later analysis.	0-4					
2 RESEARCH AND RECORDING OF INFORMATION	**27**					

2518 System Case Study – details provided for internal Centre use only.

3.1 ANALYSIS OF INFORMATION	**9**					
Detailed and perceptive analysis of edited research material and key issues, such as management, quality assurance and control.	7-9					
Reasonable analysis of edited research material and key issues, such as management, quality assurance and control.	4-6					
Superficial analysis of edited research material and limited understanding of key issues, such as management, quality assurance and control.	0-3					
3.2 ANALYSIS OF SYSTEM	**6**					
Identifies in detail the effectiveness of the system and any sub-systems with reference to the original objectives.	5-6					
Identifies in some detail the effectiveness of the system and any sub-systems with some reference to the original objectives.	3-4					
Identifies in a superficial way the effectiveness of the system and any sub-systems with little or no reference to the original objectives.	0-2					
3.3 CONCLUSION	**9**					
Presents clear and detailed conclusions and identifies the strengths and weaknesses of the system studied.	7-9					
Presents reasonably clear conclusions and identifies the more obvious strengths and weaknesses of the system studied.	4-6					
Presents only superficial conclusions.	0-3					
3 ANALYSIS OF INFORMATION AND CONCLUSIONS	**24**					

4.1 PROPOSALS	**12**					
Presents creative and innovative proposals, based upon their research data, of realistic and detailed ways in which the system studied might be improved and demonstrates clearly how the system is already so effective. Technical details and cost implications are included.	9-12					
Presents some reasonable proposals, based upon their research, of realistic ways in which the system studied might be improved and shows some understanding of how the system is already so effective.	5-8					
Presents superficial proposals for improving the system studied, which lack support from their research, and shows little or no understanding of why the system is already so effective.	0-4					
4.2 CASE STUDY EVALUATION	**3**					
Presents a detailed and objective evaluation of the case study and identifies several aspects that could be improved in future work.	3					
Presents a reasonable evaluation of the case study and shows some awareness of how future work could be more effective.	2					
Presents a superficial evaluation of the case study and shows little awareness of how future work could be more effective.	0-1					
4 PROPOSALS AND CASE STUDY EVALUATION	**15**					

5.1 QUALITY OF WRITTEN AND GRAPHICAL COMMUNICATION	**6**					
Presents relevant information and arguments in a clear and concise manner, using appropriate technical phrases and high quality written communication skills. Demonstrates a creative use of a variety of appropriate communication techniques, including ICT, to produce a visually interesting report.	5-6					
Presents mostly relevant information and arguments in a reasonably clear and concise manner, with limited use of technical phrases and reasonable written communication skills. Uses a more limited range of communication techniques, including ICT, which results in a reasonably clear and visually interesting report.	3-4					
Presents some relevant information and arguments in a manner that lacks a clear and concise approach, with little or no use of technical phrases and basic written communication skills. Uses few techniques, other than word processing, to produce a report with limited visual impact and clarity.	0-2					
5 QUALITY OF WRITTEN AND GRAPHICAL COMMUNICATION	**6**					

TOTAL	**90**					

5.3 MODULE 2519: PRODUCT STUDY ANALYSIS AND DEVELOPMENT

COURSEWORK

C3.2, C3.3; IT3.1

LP3.1, LP3.2, LP3.3; PS3.1, PS3.2, PS3.3.

5.3.1 Introduction

Candidates are required to submit a project. The project is marked by the teacher, internally standardised within the Centre and externally moderated by OCR.

The project must be based on the study of an existing product. Choice of product is left to the candidate but it is recommended that the product chosen for study should have similar products available against which it can be compared and evaluated. Candidates should ensure that the chosen product is accessible and provides opportunities for research and analysis leading to conclusions about possible improvements, and proposals for some aspect of product development. The chosen product should be of an appropriate complexity to allow in-depth study within the time allocated, and be set within the context of:

- materials, components, and their uses;
- industrial and commercial practices;
- product development.

The module requires approximately 50 hours of work of which 20 hours should be allocated to the teaching and learning of appropriate skills, including the enhancement of making skills in a variety of materials, and 30 hours to the assessed piece of work.

The project is assessed in **two** sections:

Section A: Product Analysis and Design **[60 marks]**
Section B: Product Development, Modelling and Testing **[60 marks]**

The skills learnt in Module 2519 will form the basis of more advanced work in Modules 2522 and 2523.

5.3.2 Examples of Teaching and Learning Opportunities

5.3.2.1 Product Analysis and Design

Analysis of Chosen Product

Candidates should be able to:

- examine the intended purpose of the product and identify key criteria used in its design;

  examine a range of different products to determine which are suited to analysis and development within a prescribed time scale;
  learn from sample product analyses;
  analyse key factors in a good specification:
  identify the original criteria against which a selected product was developed by looking at the needs of the user, the environment and the manufacturer;
  group work on example products;
- analyse the strengths and weaknesses of the product in comparison to other similar products;

  for a selected product, find as much information as possible on other similar products;
  look at user issues for a type of product and analyse how successfully a range of similar products meet these issues;
  look at a range of similar products and develop criteria for comparing their individual success;
  examine how different manufacturers meet a particular need with a variety of products;
  for a selected product, analyse the strengths and weaknesses of the materials used in terms of product function;
  undertake a group exercise on the success of the workshop in ergonomic terms;
  undertake a cost analysis exercise on a selected product;
  examine various products to determine the relationship between form and function;
- identify and analyse the moral implications associated with environmental, social and economic issues in the design and use of a product;

  the Intermediate Technology Development Group (ITDG) (www.sda-uk.org) produce support material for this sub-section;
  look at the moral and social issues in, for example, products such as cigarettes, or advertisements for expensive toys;
  look at the environmental issues of, for example, products such as off-road vehicles or disposable drinking cups;
  look at how a type of product is designed to meet the needs of different social groups;

Initial Design of Improved Product

Candidates should be able to:

- write a detailed design brief for improving the product in some way;

  undertake group work to examine selected products to identify the main elements of a detailed design brief;
  produce *a detailed design brief for a selected product;*
- develop and justify an objective design specification;

  look at exemplar research material on selected products to draw out key factors relevant to a specification;
  look at selected products to determine the specific needs of the user, the manufacturer and

the environment as a means to develop a specification;
look at specimen specifications to analyse key elements;

- use annotated sketching to generate a wide range of initial ideas which explore possible improvements;

  exercises in identifying how different routes can be explored to develop different innovative/creative solutions to a problem;
  learn from examples of good and bad practice to understand the difference between a pre-conceived and an open-minded approach to developing ideas;
  exercises in presenting a range of initial ideas using freehand annotated sketching;
  further practise in the use of freehand annotated sketching to show product detail;

- evaluate ideas against the specification and justify the choice of one idea worthy of being taken forward;

  look at selected specimen products to develop ways to evaluate ideas objectively against a design specification;
  look at examples of good and bad practice;
  practise the use of annotated sketching as a means to present information on product detail or suitability;

- use a combination of text, graphical techniques and ICT, as appropriate, to present information;

- *undertake exercises in how to present information in a variety of appropriate and visually attractive styles such as photographs, written text, ICT, graphs etc.;*
  examine existing work to analyse the appropriateness of the communication techniques used.

5.3.2.2 Product Development, Modelling and Testing

Candidates should be able to:

- analyse the influence of relevant design constraints on the proposed idea, e.g., issues of materials choice, manufacturing issues, ergonomics, aesthetics, environment, etc;

  look at selected products to identify what design constraints have influenced the design of the product;
  examine school chairs to analyse how successfully they meet ergonomic criteria;
  examine selected products to determine how design has been constrained by the need for efficient manufacture;
  examine selected products to determine how design has been influenced by the need to use minimum materials;

- make sufficient first generation 2D & 3D experimental prototype models to establish the validity of the proposed idea in terms of:
  – physical requirements, e.g., construction, movement, stability, strength, etc;
  – aesthetic qualities;
  – suitable manufacturing processes;
  – suitability of materials or components;

  explore simple card modelling techniques suitable for demonstrating the validity of some mechanisms;
  practise simple 3D modelling techniques in such materials as card, timber products, foam, metal sheets and bar, plastic sheets and bar;
  practise using vacuum forming for modelling;

- make, using workshop tools, a self contained test rig to formally test either, an appropriate physical requirement, e.g. construction, movement, stability, strength etc. or the suitability of the proposed materials or components;

use standard test equipment to see how it works;
explore ways of testing for the effects of heat, or the effects of abrasions, etc.;

- produce a summary of the results of this modelling which includes analysis of information gained from the models, details and analysis of the results gained from the testing with suggestions for further improvement to the proposed idea;

  explore ways of writing up the results of some standard tests;
  explore ways of presenting results graphically;
  explore how to present details of improvements or modifications using annotated sketches.

The examples of teaching and learning opportunities (given in italics above) are not prescribed or a complete set but are intended only as a guide to the type of teaching and learning experiences that would enhance or develop those skills required by candidates to produce the assessed work in Unit 2519.

5.4 UNIT 2519: PRODUCT STUDY ANALYSIS AND DEVELOPMENT

GUIDANCE AND MARKING CRITERIA

The Product Study is marked out of 120 marks.

The Product Study consists of product analysis and product development, modelling and testing.

It is **not** envisaged that this task will involve the complete redesign of an existing product, but rather identify opportunities for its further development or enhancement.

5.4.1 Marking Criteria

Section A: Product Analysis and Design **[60 marks]**

Product Analysis and Design is assessed as follows:

Analysis of Chosen Product **[24 marks]**

- Purpose and criteria [9]
- Strengths and weaknesses comparison [9]
- Moral implications [6]

Initial Design of Improved Product **[36 marks]**

- Brief [3]
- Specification [6]
- Ideas and sketching [15]
- Evaluation and reasons for choice [6]
- Communication [6]

Section B: Product Development. Modelling and Testing **[60 marks]**

Product Development, Modelling and Testing is assessed as follows:

- Design constraints [6]
- Models [36]
- Test rig [12]
- Summary of results [6]

5.4.1.1 Section A: Product Analysis and Design [60 marks]

Analysis of Chosen Product [24 marks]

Purpose and criteria [max 9 marks]

Candidates should be able to examine the intended purpose of the product and identify the key criteria used in its design.

Candidates:

- give a detailed description of the intended purpose of the product, including the needs of both the manufacturer and the consumer and identify a wide list of criteria used in the designing of the original product; [8-9]
- give some detail of the intended purpose of the product, including some reference to the needs of both the manufacturer and the consumer and identify the more obvious criteria used in the design of the original product; [5-7]
- show only limited awareness of the intended purpose of the product, referring only to the more obvious aspects; show little or no awareness of the needs of the manufacturer; identify few or no criteria used in the design of the original product with little evidence of understanding. [0-4]

Strengths and weaknesses comparison [max 9 marks]

Candidates should be able to analyse the strengths and weaknesses of the product in comparison to other similar products.

Candidates:

- present a detailed analysis of the strengths and weaknesses of the product, in comparison to a range of similar products, in terms of function, suitability of materials and manufacturing processes used, ergonomic suitability, aesthetics and cost; show clear understanding; [8-9]
- present a reasonably detailed analysis of the strengths and weaknesses of the product, in comparison to a limited range of similar products, in terms of function, suitability of materials and manufacturing processes used, ergonomic suitability, aesthetics and cost; show reasonable understanding of the more obvious issues; [5-7]
- show only limited ability to analyse or identify the strengths and weaknesses of the product, with little or no comparison to other similar products, in terms of function, suitability of materials and manufacturing processes used, ergonomic suitability, aesthetics and cost; show only limited understanding of these factors. [0-4]

Moral implications [max 6 marks]

Candidates should be able to identify and analyse the moral implications associated with environmental, social and economic issues in the design and use of the product.

Candidates:

- demonstrate clear understanding of the influences of moral implications on the design and use of the product; [5-6]
- show some understanding of the more obvious moral implications and identify some of their influences on the design of the product; [3-4]
- show little or no understanding of moral implications and are unable to identify their influence on the design of the product. [0-2}

Initial Design of Improved Product **[36 marks]**

Brief **[max 3 marks]**

Candidates should be able to write a detailed design brief for improving the product in some way.

Candidates:

- present a detailed design brief for improving the product in some way; [3]
- present a clear design brief which shows reasonable awareness of possible improvements; [2]
- present only a simplistic brief with little depth concerning possible improvements. [0-1]

Specification **[max 6 marks]**

Candidates should be able to develop and justify an objective design specification.

Candidates:

- produce a detailed and justified specification from the objective analysis of the original product; [5-6]
- produce an adequate specification covering a range of issues; justification is fair and is based on some objective analysis of the original product; [3-4]
- produce only a basic or superficial specification; justification is minimal showing little evidence of objective analysis of the original product. [0-2]

Ideas and sketching **[max 15 marks]**

Candidates should be able to use annotated sketching to generate a wide range of initial ideas which explore possible improvements.

Candidates:

- present a wide range of innovative/creative initial ideas, which demonstrate a high level of development, using high quality annotated sketching; [12-15]
- present a good range of innovative/creative ideas, with varying levels of development, using reasonable quality annotated sketching; [8-11]
- present only a limited range of innovative/creative ideas, which are developed only to a simplistic level or not at all, using annotated sketching at a limited level. [0-7]

Evaluation and reasons for choice **[max 6 marks]**

Candidates should be able to evaluate ideas against the specification and justify the choice of one idea worthy of being taken forward.

Candidates:

- present a detailed and objective evaluation of ideas against the design specification and justify all decisions; [5-6]
- present an adequate and objective evaluation of ideas against the design specification and justify most decisions; [3-4]
- present only a limited and mainly subjective evaluation of ideas with little or no justification of decisions; little or no reference made to the design specification. [0-2]

Communication **[max 6 marks]**

Candidates should be able to use a combination of text, graphical techniques and ICT, as appropriate, to present information.

Candidates:

- use a wide range of high quality text, graphical techniques and ICT to present information; [5-6]
- use a good range of quality text, graphical techniques and ICT to present information; [3-4]
- show a limited range of quality text, graphical techniques and ICT to present information. [0-2]

5.4.1.2 Section B: Product Development, Modelling and Testing [60 marks]

Design constraints **[max 6 marks]**

Candidates should be able to analyse the influence of relevant design constraints on the proposed idea, e.g. issues of materials choice, manufacturing issues, ergonomics, aesthetics, environment, etc.

Candidates:

- show careful and perceptive consideration of the influence of the design constraints relevant to the product; [5-6]
- show adequate consideration of the influence of most of the design constraints relevant to the product; [3-4]
- show only a simplistic consideration of the more obvious relevant design constraints and little or no awareness of their influence on the product. [0-2]

Models **[max 36 marks]**

Candidates should be able to make sufficient first generation 2D & 3D experimental prototype models to establish the validity of the proposed idea in terms of: physical requirements, e.g. construction, movement, stability, strength, etc.; aesthetic qualities; suitable manufacturing processes and issues; suitability of materials or components.

Candidates:

- make a range of good quality first generation experimental 2D and 3D prototype models, suitable for establishing the validity of the chosen idea in terms of physical requirements, aesthetic qualities, suitability of manufacturing processes and suitability of materials or components; [26-36]
- make a range of competent first generation experimental 2D and 3D prototype models, suitable for establishing the validity of the chosen idea in terms of physical requirements, aesthetic qualities, suitability of manufacturing processes and suitability of materials or components; [16-25]
- make a more limited range of moderate first generation experimental 2D and 3D prototype models, suitable for establishing some aspects of the validity of the chosen idea in terms of physical requirements, aesthetic qualities, suitability of manufacturing processes and suitability of materials or components. [0-15]

Test rig **[max 12 marks]**

Candidates should be able to **make, using workshop tools,** a self contained **test rig** to formally test either, an appropriate physical requirement, e.g. construction, movement, stability, strength etc., or the suitability of the proposed materials or components.

Candidates:

- produce a well made simple test rig suitable for testing either, one of the above physical requirements, or the suitability of the proposed materials or components; [9-12]
- produce a competent simple test rig suitable for testing either, one of the above physical requirements, or the suitability of the proposed materials or components; [6-8]
- produce a limited simple test rig suitable for testing either, one of the above physical requirements, or the suitability of the proposed materials or components. [0-5]

Summary of results **[max 6 marks]**

Candidates should be able to produce a summary of the results of this modelling which includes analysis of information gained from the models, details and analysis of the results gained from the testing with suggestions for further improvement to the proposed idea.

Candidates:

- produce an objective summary of the results of this modelling with detailed analysis of how the models contributed to establishing the validity of the chosen idea; test results are presented in detail and their value analysed thoroughly; one further improvement is suggested and presented in detail; [5-6]
- produce an objective summary of the results of this modelling with reasonable analysis of how the models contributed to establishing the validity of the chosen idea; test results are presented carefully and their value analysed to a reasonable level; one further improvement is suggested and presented in limited detail; [3-4]
- produce a subjective summary of the results of this modelling with limited or no analysis of how the models contributed to establishing the validity of the chosen idea; test results are presented at a superficial level with little analysis; one further improvement is suggested but is presented with little or no detail. [0-2]

2519 Product Study: Analysis and Development – details provided for internal Centre use only

Section A: Product Analysis and Design (60 marks)

Analysis of Chosen Product (24 marks) Candidates should be able to:

- examine the intended purpose of the product and identify the key criteria used in its design; **[9]**
- analyse the strengths and weaknesses of the product in comparison to other similar products; **[9]**
- identify and analyse the moral implications associated with environmental, social and economic issues in the design and use of the product. **[6]**

PURPOSE and CRITERIA	**9**	
Gives a detailed description of the intended purpose of the product, including the needs of both the manufacturer and the consumer and identifies a wide list of criteria used in the designing of the original product.	8-9	
Gives some detail of the intended purpose of the product, including some reference to the needs of both the manufacturer and the consumer and identifies the more obvious criteria used in the design of the original product.	5-7	
Shows only limited awareness of the intended purpose of the product, referring only to the more obvious aspects. Little or no awareness of the needs of the manufacturer. Identifies few or no criteria used in the design of the original product with little evidence of understanding.	0-4	
STRENGTHS and WEAKNESSES COMPARISON	**9**	
Presents a detailed analysis of the strengths and weaknesses of the product, in comparison to a range of similar products, in terms of function, suitability of materials and manufacturing processes used, ergonomic suitability, aesthetics and cost. Shows clear understanding.	8-9	
Presents a reasonably detailed analysis of the strengths and weaknesses of the product, in comparison to a limited range of similar products, in terms of function, suitability of materials and manufacturing processes used, ergonomic suitability, aesthetics and cost. Shows reasonable understanding of the more obvious issues.	5-7	
Limited ability to analyse or identify the strengths and weaknesses of the product, with little or no comparison to other similar products, in terms of function, suitability of materials and manufacturing processes used, ergonomic suitability, aesthetics and cost. Shows only limited understanding of these factors.	0-4	
MORAL IMPLICATIONS	**6**	
Demonstrates clear understanding of the influences of moral implications on the design and use of the product.	5-6	
Shows some understanding of the more obvious moral implications and identifies some of their influences on the design of the product.	3-4	
Shows little or no understanding of relevant moral implications and is unable to identify their influence on the design of the product.	0-2	
ANALYSIS of CHOSEN PRODUCT	**24**	

Initial Design of Improved Product (36 marks)

Candidates should be able to:

- write a detailed design brief for improving the product in some way; **[3]**
- develop and justify an objective design specification; **[6]**
- use annotated sketching to generate a wide range of initial ideas which explore possible improvements; **[15]**
- evaluate ideas against the specification and justify the choice of one idea worthy of being taken forward; **[6]**
- use a combination of text, graphical techniques and ICT, as appropriate, to present information. **[6]**

BRIEF	**3**	
Presents a detailed design brief for improving the product in some way.	3	
Presents a clear design brief which shows reasonable awareness of possible improvements.	2	
Presents only a simplistic brief with little depth concerning possible improvements.	0-1	
SPECIFICATION	**6**	
Produces a detailed and justified specification from the objective analysis of the original product.	5-6	
Produces an adequate specification covering a range of issues. Justification is fair and is based on some objective analysis of the original product.	3-4	
Produces only a basic or superficial specification. Justification is minimal showing little evidence of objective analysis of the original product.	0-2	
IDEAS and SKETCHING	**15**	
Presents a wide range of innovative/creative initial ideas, which demonstrate a high level of development using high quality annotated sketching.	12-15	
Presents a good range of innovative/creative ideas with varying levels of development using reasonable quality annotated sketching.	8-11	
Presents only a limited range of innovative/creative ideas which are developed only to a simplistic level or not at all using annotated sketching at a limited level.	0-7	

EVALUATION and REASONS FOR CHOICE	6	
Presents a detailed and objective evaluation of ideas against the design specification and justifies all decisions.	5-6	
Presents an adequate and objective evaluation of ideas against the design specification and justifies most decisions.	3-4	
Presents only a limited and mainly subjective evaluation of ideas with little or no justification of decisions. Little or no reference made to the design specification.	0-2	
COMMUNICATION	**6**	
Uses a wide range of high quality text, graphical techniques and ICT to present information.	5-6	
Uses a good range of quality text, graphical techniques and ICT to present information.	3-4	
Shows a limited range of quality text, graphical techniques and ICT to present information.	0-2	
INITIAL DESIGN of IMPROVED PRODUCT	**36**	

Section B: Product Development, Modelling and Testing (60 marks)

Candidates should be able to:

- analyse the influence of relevant design constraints on the proposed idea, e.g. issues of materials choice, manufacturing issues, ergonomics, aesthetics, environment, etc.; **[6]**
- make sufficient first generation 2D & 3D experimental prototype models to establish the validity of the proposed idea in terms of: **physical** requirements, e.g. construction, movement, stability, strength, etc.; aesthetic qualities; suitable manufacturing processes and issues; suitability of materials or components; **[36]**
- **make, using workshop tools**, a self contained **test rig** to formally test either, an appropriate physical requirement, e.g. construction, movement, stability, strength etc., or the suitability of the proposed materials or components; **[12]**
- produce a summary of the results of this modelling which includes analysis of information gained from the models, details and analysis of the results gained from the testing with suggestions for further improvement to the proposed idea. **[6]**

DESIGN CONSTRAINTS	6	
Shows careful and perceptive consideration of the influence of the design constraints relevant to the product.	5-6	
Shows adequate consideration of the influence of most of the design constraints relevant to the product.	3-4	
Shows only a simplistic consideration of the more obvious relevant design constraints and little or no awareness of their influence on the product.	0-2	
MODELS	**36**	
Makes a range of good quality first generation experimental 2D and 3D prototype models, suitable for establishing the validity of the chosen idea in terms of physical requirements, aesthetic qualities, suitability of manufacturing processes and suitability of materials or components.	26-36	
Makes a range of competent first generation experimental 2D and 3D prototype models, suitable for establishing the validity of the chosen idea in terms of physical requirements, aesthetic qualities, suitability of manufacturing processes and suitability of materials or components.	16-25	
Makes a more limited range of moderate first generation experimental 2D and 3D prototype models, suitable for establishing some aspects of the validity of the chosen idea in terms of physical requirements, aesthetic qualities, suitability of manufacturing processes and suitability of materials or components.	0-15	
TEST RIG	**12**	
Produces a well made simple test rig suitable for testing *either*, one of the above **physical** requirements, *or* the suitability of the proposed materials or components.	9-12	
Produces a competent simple test rig suitable for testing *either*, one of the above **physical** requirements, *or* the suitability of the proposed materials or components.	6-8	
Produces a limited simple test rig suitable for testing *either*, one of the above **physical** requirements, *or* the suitability of the proposed materials or components.	0-5	
SUMMARY OF RESULTS	**6**	
Produces an objective summary of the results of this modelling with detailed analysis of how the models contributed to establishing the validity of the chosen idea. Test results are presented in detail and their value analysed thoroughly. **One** further improvement is suggested and presented in detail.	5-6	
Produces an objective summary of the results of this modelling with reasonable analysis of how the models contributed to establishing the validity of the chosen idea. Test results are presented carefully and their value analysed to a reasonable level. **One** further improvement is suggested and presented in limited detail.	3-4	
Produces a subjective summary of the results of this modelling with limited or no analysis of how the models contributed to establishing the validity of the chosen idea. Test results are presented at a superficial level with little analysis. **One** further improvement suggested but presented with little or no detail.	0-2	
PRODUCT DEVELOPMENT, MODELLING and TESTING	**60**	
TOTAL	**120**	

5.5 MODULE 2520: PRODUCT DESIGN 1

C3.1a, C3.1b, C3.2, C3.3; IT3.1, IT3.2, IT3.3 **WO3.1, WO3.2, WO3.3**

5.5.1 Introduction

The subject content of this module is focused towards products and applications and their analysis in respect of:

- materials, components and their uses;
- manufacturing processes;
- industrial and commercial practices.

It is essential that materials and components are studied from the perspective of analysing modern consumer products, their design and manufacture and taught within the context of:

- product development;
- industrial and commercial practices.

Candidates should be familiar with a range of materials from the pliable to the more resistant as used in the manufacture of commonly available products and be able to make critical comparisons between them.

The aim of the module is not to overburden candidates with large amounts of factual information, but rather to give them a framework for analysing existing products that enables them to make considered selections of appropriate materials and manufacturing processes when designing for making.

The module builds upon the work undertaken at GCSE in Design and Technology and brings together the knowledge, understanding and skills acquired in the study of Modules 2518 and 2519. The knowledge and understanding gained by candidates should also directly contribute to work undertaken in Modules 2522 and 2523.

5.5.2 Question Paper (Unit 2520)

Section A of the written paper presents candidates with **five** generic product design based questions. These questions test a candidate's understanding of:

- the effects of design decisions upon the environment;
- the pressures placed on the designers of products by such issues as:
  – energy;
  – the environment;
  – the human interface;
  – aesthetics;
  – scale of production;
  – production technologies;
  – fashion;
  – product life;
  – commercial issues.

Candidates are required to answer **three** questions.

Section B of the written paper presents candidates with **seven** questions, which are product context based. These are set within the specific material areas of wood, metals, plastics, graphics (paper/boards) and textiles and focused on materials, processes and components.

The seven questions will be:

- one wood;
- one metal;
- one plastics;
- two graphics (paper/boards);
- two textiles.

Candidates are required to answer any **two** questions.

5.5.3 Section A Content

Note: Section A in Modules 2520 and 2521 are common.

5.5.3.1 Industrial and Commercial Practice

Manufacturing Systems

Candidates should demonstrate an understanding of the application in system design of:

• one-off, batch, high volume and bought-in parts and components leading to an understanding of differing levels of production taking into account economic factors;	*the relative costs involved in the production of single printed circuit boards or volume batch production of the same design;* *consideration of the options available for producing a casing for a system, off-the-shelf bought-in cases or purpose designed, vacuum formed or injection moulded case;*
• modular production systems;	*research and record how industry uses modular systems in product production, e.g. textiles, automotive industry;*

• standardised parts;	*research and record principles of interchangeability, bulk production, waste elimination and automation;* *examine a range of systems' components and identify where these aspects have been used;* *examine a range of products and identify where these aspects have been used, e.g. 13 amp plug, children's constructional toys like Lego;* *identify how quality control can be improved by using bought-in components/standardised parts; determine how manufacturers make use of components/standardised parts in products made from selected materials;*
• 'just-in-time' manufacture;	*research and record definitions of 'Just-in-Time' – examining how waste of time, labour, and resources can be minimised; establish the implications for quality assurance, quality control and stock control;*
• manufacture for home assembly;	*establish the criteria behind the growth of self/home assembly and flat pack marketing;* *identify how reduced storage/transport space volume can bring benefits to manufacturers;* *using visits to outlets and manufacturers' data examine implications for quality control;* *analyse self assembly instruction leaflets for sequencing, clarity of instruction and relevance of illustrative information;*
• the use of ICT in designing and manufacturing processes;	*use visits, video data or visiting speakers to establish how industrial designers and manufacturing teams are using ICT;* *analyse where these techniques can be used by a candidate;*
• CAD/CAM as used in industry/commerce – the underlying concepts – reduction of working/processing time, elimination of operator error, reduction of labour costs, tool working life extension, improved flexibility and variety of design situations and greater predictability of costings;	*examine how CAD/CAM can be used for the prototyping of products;* *ICT assisted manufacture – establish through visits/videos, visiting speakers etc. how these are used in industry by tracking a product through its stages of manufacture;*

• ICT in stock control – monitoring, purchasing logistics in industry;	*examine how industry uses ICT to monitor its stock holding, bought-in components, guaranteeing quality control over supplies;* *identify the merits and limitations of ICT stock control;* *examine what lessons can be learnt and transferred to small-scale manufacture or prototyping in an educational environment;*
• high volume production and automation;	*examine the logistical difficulties that high volume production presents for the manufacturer, user and maintenance providers, i.e. nuts, bolts, needles, screws, resistors and IC's, plastic fittings such as case hinges, snap toggles for rucksacks and carrying bags, 'wood biscuit' joints;* *compare small scale and large scale production methods for the production of domestic products, i.e. children's toys, clothing, domestic equipment;*
• the benefits to the customer/consumer of these industrial production processes/procedures.	*analyse whether improved quality, volume sales bring about reduced costs for customers.*

Commercial Practice

• examine the role of marketing in product design.	*consider how marketing is used to assess consumer needs and to examine its role in product development, pricing, promotion and distribution.*

The Forms of Energy Used by the Industry, its Impact on Design and Manufacturing and on the Environment

Candidates should demonstrate an understanding of the application in system design of:

• the energy sources, forms of storage, conversion, transmission and effective use in manufacturing processes;	*consider a variety of energy sources and storage methods and discuss the effect of increased energy use both for the cost to the consumer and to the environment;*
• the energy needs during the life of a product or system;	*consider the relative merits of using mains power for electrical goods/products and projects compared with the use of battery power;* *examine common domestic products to chart/record changing energy needs within the product or system;*

• the energy potential when a product or system life is ended;	*be sensitive to the cost of recycling system components and disposal of obsolete items;* *examine and create energy transfer diagrams, e.g. hair dryer, portable electric drill;*
• the terms – availability, conservation, pollution, and health and safety applied to energy;	*consider alternative energy supplies for the control of systems; the use of wind power or reclaimed heat generation to contribute to the overall energy consumption of an industrial site;* *examine and record the Eco labelling of domestic consumer systems, e.g. relative energy use in washing machines/dishwashers;* *explore and record alternative energy sources, e.g. 'clockwork' radio, solar batteries, wind and wave sources;* *examine how these terms affect production costs;*
• recycling and green issues in product and systems design.	*look at alternative energy sources and the effect on running costs and the environment;* *consider the disposal problems associated with battery power and the ethical problems associated with buying them in third world countries;* *consider alternatives, e.g. the wind up/solar powered radio/clockwork torch and the possibility of using similar principles for other control systems;* *explore and record aspects of energy saving techniques in the production of artefacts/products;* *examine and record need for Eco labelling, environmentally friendly materials, e.g. Tencel;* *explore the environmental, moral and social aspects underpinning recycling and 'green' issues, e.g. cost effectiveness, dumping, waste disposal;* *assess the environmental impact of products using Life Cycle Assessment.*

5.5.3.2 Health and Safety of Designers, Makers and the Public

Health and Safety Issues

Candidates should demonstrate an understanding of the application in system design of:

• the regulatory and legislative framework related to materials and equipment using Health And Safety At Work (HASAW), trade description and sale of goods legislation, BSI standards applied to products/systems;	
• health and safety issues relating to: – protection of the worker/operator; – protection of the user/customer; – protection of the environment;	*identify and record how health and safety issues affect designers, makers, users and the environment;* *recognise the impact that these have upon the manufacturing processes of common products/systems;* *recognise the role that the Health and Safety Inspectorate have in policing the legal framework;*
• standard risk assessment procedures in systems design and manufacturing – identification of risks; – risk assessment; – reduction of risks.	*develop an understanding of how risk assessment procedures are applied in manufacturing situations;* *write a risk assessment for a common workshop procedure such as soldering, drilling or making a PCB.*

5.5.3.3 Form and Function of Products

Aesthetics and Function – Shape, Form and Colour

The study of aesthetics should not be considered in isolation but should pervade the whole course and is particularly relevant in the Product Analysis work undertaken in Module 2519.

Candidates should:

• develop a critical awareness of designed objects/products in such terms as colour, form, shape, texture/surface finish; the way these aspects come together to influence appearance, relationships, harmony/disharmony;	*identify how repeating patterns can be used in product design;* *examine the use of tactile surfaces in product design, e.g. paving systems for partially sighted people;* *explore the composition of colour, contrast, harmony/disharmony, human reactions to colour through the analysis of products;*

• understand the use of shape and structure to optimise material performance, resulting from the exploitation of sections, corrugations and forms;	*determine how these aspects influence product outcomes, e.g. consider how industry uses modelling/prototyping to assess the validity of material performance;*
• understand the relationship between aesthetic and technological requirements of products and compromises that product designers have to make to satisfy marketing, manufacturing and consumer needs;	*consider how issues such as costs, materials, tooling, packaging, transportation and the functional requirements of users act as constraints on the aesthetic aspects of product design, e.g. examine volume products like pens (biros), to establish how these aspects interact;*
• demonstrate strategies for understanding products and their sub-systems, including ergonomic and anthropometric implications;	*explore and develop knowledge of ergonomic and anthropometric aspects of products;*
• understand the functional criteria of product users.	*determine how product designers establish and respond to the needs of product users.*

Social and cultural issues

Candidates should develop a knowledge and understanding of:

• social and cultural issues.	*examine the effect of fashion, trends, ethnic and cultural dimensions to the design and manufacture of domestic products.*

5.5.3.4 Communication

Candidates should be able to:

• produce creative design drawings of products for manufacture;	*explore, develop and use where necessary, a range of graphic illustrative techniques to convey the form, shape and function of an artefact/product as a pre-marketing or pre-production strategy, e.g. graphical simulations;*
• convey component information using diagrammatic or systematic representation.	*draw circuit diagrams for electronic and pneumatic systems;* *construct circuit board layout diagrams;* *draw system diagrams as applied to the utilisation of electrical/electronic/mechanical/pneumatic components/systems;* *explore the use of detail drawings, assembly drawings, instruction/assembly sheets.*

5.5.4 Section B Content

5.5.4.1 Wood: Composition and Characteristics

Candidates should develop a knowledge and understanding of the application in product design of:

• the use of timbers – commonly available hardwoods and softwoods;	
• manufactured timber materials – their application with existing products and how they interact to provide a required function;	*veneers, plywoods, laminated boards, chip and compressed boards (MDF);*
• merits and limitations of the use of these materials;	*identify products that use hard and softwoods and manufactured boards and how the materials meet product requirements;* *identify the commonly available forms of manufactured timber boards and their methods of manufacture;* *furniture in the home, shop and retail fittings, leisure equipment, nursery toys, industrial applications – house building, boat building;*
• the use of general properties; consideration should be given to physical and mechanical properties including strength, toughness, density, weight, durability, thermal conductivity and flame resistance in terms of their suitability for specific products;	*determine how the properties outlined opposite have been used in a range of product applications;* *identify how the rate of growth and uniformity of growth in timbers affect their performance characteristics;*
• the selection of timbers and manufactured boards to meet the requirements of products;	*domestic furniture, communal and educational seating, work surfaces;* *selection with reference to acid resistance, resistance to decay, stability in use, aesthetic appearance;* *identify the criteria for selecting timbers to suit an identified external or internal design and make situation;* *use of timber as a modelling medium for architectural models, spatial and tactile models;*

• the energy requirements in the conversion, artificial seasoning and machining timbers and the manufacture of manufactured boards, the environmental implications of manufacturing and disposal/degrading of these materials.	*identify the economic and environmental factors in the manufacture of manufactured boards and consider how these affect design decisions;* *consider how the disposal/degrading of timber waste and manufactured boards influences design decisions for timber products.*

In addition, all candidates will need to have the knowledge specified in Sections 5.5.4.6 – 5.5.4.11 for their material area(s). See pages 59-69.

5.5.4.2 Metals: Composition and Characteristics

Candidates should develop a knowledge and understanding of the application in product design of:

• the use of common ferrous and non-ferrous metals their application within existing products and how they interact to provide a required function;	*mild steel, high carbon steels and non-ferrous metals – copper and alloys of brass, aluminium and zinc, and common foils;*
• merits and limitations of use of these materials;	*analyse a number of metal products to identify which metals have been used and why, e.g. table cutlery, bicycles, sports and leisure equipment;* *identify differences between ferrous and non - ferrous metals and their application to product requirements, e.g. in household electrical appliances, garden equipment, trophies;* *identify the commonly available market forms of these materials and examine how these affect choices in product design and manufacture, e.g. extruded aluminium handles on kitchen cupboards;*
• the use of general working properties, consideration given to physical and mechanical properties, including strength, toughness, ductility and malleability, weight, durability and thermal and electrical conductivity in terms of suitability for specific consumer products;	*determine how the properties have been used in a range of product applications, e.g. electric power cable pylons, holding tools, jewellery, sports/leisure equipment;* *identify how modern and smart materials are used in the production of industrial metal based products, e.g. the use of shape memory alloy (smart wire), high strength alloys;*

• the selection and use of metals to meet the requirements of products;	*analyse a sample of products to identify how these properties have affected the material selection and performance, e.g. strength and density in a zimmer frame, malleability and ductility of lead/tin alloys, die casting models, edge tools;* *establish criteria for selecting different classes of metals to suit an identified external or internal design and make situation;* *construction of turbine blades, personal jewellery;*
• the energy requirements in the extraction, conversion and manufacture of commonly available market forms – sheet and sections; the environmental implications of extraction, conversion manufacture and the disposal/degrading of these materials and products.	*using commonly available market forms of metals determine how these respond to heat, resistance to corrosion and decay;* *aluminium and brass alloys, stainless steels;* *identify the surface treatments available for metals to enhance appearance;* *anodising, plating;* *consider the economic and environmental factors in the manufacture of metal products;* *consider how the disposal/recycling/degrading of metals influences design decisions for metal products.*

In addition, all candidates will need to have the knowledge specified in Sections 5.5.4.6 – 5.5.4.11 for their material area(s). See pages 59-69.

5.5.4.3 Plastics: Composition and Characteristics

Candidates should develop a knowledge and understanding of the application in product design of:

• the use of common thermoplastics;	*polystyrene, polyethylene, acrylic, polypropylene, PVC, ABS and PET, and their application within existing products and how they interact to provide a required function;*
• the use of common thermosetting plastics;	*phenol resins – phenol formaldehyde, melamine formaldehyde, urea formaldehyde, epoxy resins and synthetics, i.e. polyamide (nylon); their application within existing products;*

• merits and limitations of the use of these materials;	*identify the applications of plastics in everyday products:* *fast food containers, carrier bags, disposable pens and pencils, shop signs and general signage;* *identify the qualities and design opportunities that differing manufacturing processes bring to products;*
• the use of physical and mechanical properties, strength, toughness, weight, plasticity, durability, thermal conductivity, electrical insulation and flame resistance in terms of their suitability for specific consumer products;	*determine how the properties of thermoplastics can be modified by the use of foaming agents;* *fast food containers, carrier bags. shop signs, pens;* *determine how the properties outlined above have been used in a range of product applications;* *the selection and use of plastics to meet the requirements of products;* *determine how the thermo forming of plastics influences material choices for products;* *using specific product examples identify how the techniques of reforming and casting are used to create specific requirements for products;* *plastic casings of pens;* *analyse sample of plastic products to assess how properties of strength and density, durability, resistance to decay or corrosion are used and how the 'make up' of plastics is managed to bring about required properties;*
• Identify how modern and smart materials are used in the production of industrial products;	*the use of polymorph for product modelling, electroluminescent panels, the inclusion of thermochromic pigments in injection moulded products, the use of conductive plastics, the use of self healing plastics;*

• the energy requirements in the manufacture of plastics; the environmental implications of manufacturing and disposal/degrading of these materials.	*identify how plastics degrade;* *consider the environmental issues arising from non-degradable plastics;* *carrier bags or thermosetting plastic products;* *consider the economic and environmental factors in the manufacture of plastic materials/products;* *consider how the disposal/degrading of these materials influences design decisions.*

In addition, all candidates will need to have the knowledge specified in Sections 5.5.4.6 – 5.5.4.11 for their material area(s). See pages 59-69.

5.5.4.4 Graphics: The Use of Papers/Boards

Solid boards and corrugated boards; their application within existing products and how they interact to provide a required function:

• merits and limitations of the use of these materials;	*identify and select appropriate papers/boards for specific applications;* *consider how these materials meet the needs of products;* *examine how industry and commerce use these materials;* *e.g. in board engineering, pop-up mechanisms, board games, greeting boards and decorative storage/display;* *identify how these forms of papers/boards are industrially printed and the design opportunities that result;*
• the use of common composite materials, e.g. Kevlar, carbon fibre, Teflon;	
• the use of general working properties; consideration given to physical and mechanical;	

• range of properties – relative strength, toughness, weight, durability, thermal conductivity/insulation, flame resistance, in terms of their suitability for specific products;	*identify and select the properties of strength and density, strength in pliability, thermal conductivity, insulation, weight, toughness as appropriate;* *examine a range of graphic (paper/board) products to determine how the properties have been used, i.e. promotional wine bottle carrier;* *identify how modern and smart materials are used in the production of industrial graphic products;* *the use of thermochromic and phosphorescent inks/films, electroluminescent panels, holograms and holographic films;*
• the selection and use of paper/board to meet the requirements of products;	*e.g. a promotional shop display for a new video;* *determine how folding and forming techniques can change the working properties of papers and board derivatives;* *how the properties of these paper and boards can be modified or changed;* *using varnishing techniques to improve stain resistance and lamination to waterproof;* *determine how paper/board products meet the industrial needs of insulation, heat resistance and moisture resistance, e.g. packaging of take away meals;*
• the energy requirements in manufacture of papers/boards;	
• the environmental implications of: manufacturing and disposal/degrading of these materials.	*consider the economic and environmental factors in the manufacture of papers and boards, e.g. the bonding agent used in corrugated board;* *consider how disposal/degrading of these materials influence design decisions for paper, boards and board products.*

In addition, all candidates will need to have the knowledge specified in Sections 5.5.4.6 – 5.5.4.11 for their material area(s). *See pages 59-69.*

5.5.4.5 Textiles: Composition and Characteristics

Candidates should develop a knowledge and understanding of the application in product design of:

Fibres

• the use of natural and man-made fibres, their application within existing products and how they interact to provide a required function;	
– natural fibres;	*cotton, flax, hemp and mineral fibres; animal (protein), e.g. wool and silk (cultivated), vegetable (cellulosic);*
– man-made fibres – synthetic fibres;	*polyamide, polyester, acrylic, elastomeric;*
– regenerated fibres;	*viscose, lyocell, modal;*
– inorganic fibres;	*glass, carbon, metal threads/foil;*
• merits and limitations of the use of these fibres.	*identify and record a range of products made from a range of natural and man-made fibres;* *explore the performance characteristics of fibres and their suitabiliity for specific uses;* *identify how modern and smart fibres and fabrics are used in the production of industrial textile products;* *the use of thermochromic inks, encapsulates, e.g. Tee shirts which smell of chocolate, wearable electronics.*

Yarns

• the use of staple and filament yarns, their application within existing products and how they interact to provide a required function;	
– yarns as single yarn;	
– spun yarns.	*worsted/woollen, filament, multifilament, folded, plyed and cut pile yarns.*

Mixtures, Blends and Laminates – Fibre Content, Performance Characteristics, Applications, Reasons for Use

- finishes applied to yarns, texturing and structural effects;
- merits and limitations of these yarns;
- the use of general working properties; consideration should be given, as appropriate, to the physical and performance characteristics of fibres and yarns;
- tensile strength, elasticity, resilience/durability, weight, thermal conductivity/insulation, chemical resistance, flammability, absorbency/water repellence, and electrostatic charge.

determine how the performance characteristics of fibres and yarns have been used in a range of textiles.

Fabric Construction

- woven, knitted and non-woven applications;
- the uses of woven fabrics;

different types of weaves:
basic weaves – plain;
complex weaves – twills, sateen, jacquard, crepes;
pile weaves – loop/cut pile;
e.g. velvet, terry, their application within existing products and how they interact to provide a required function;

- the use of knitted forms;

machine processes:
weft knit, e.g. single and double jersey;
warp knit, e.g. tricot;
lock knit;
their application within existing products and how they interact to provide a required function;

- the use of non-woven fabrics, e.g. felt, wool felts, bonded fabrics;

dry laid, wet laid and direct spun; their application within existing products and how they interact to provide a required function;

- merits and limitations of the use of these fabric constructions;
- identify the design opportunities presented by different constructions and how they satisfy different product needs;

- the use of general working properties, consideration as appropriate, to the physical and performance characteristics of fabrics;

- tensile strength, elasticity, resilience/durability, weight, thermal quality, chemical resistance, flammability, absorbency/water repellence, stretch, creasing and formability;

- identify how the performance characteristics above have been used in a range of product applications and use in product design;

  the selection and use of fabrics to meet the requirements of products; e.g. examine a range of fabrics to identify performance characteristics;

- the energy requirements in the manufacture of fibres, yarns and fabrics; the environmental implications of manufacturing and the disposal/degrading of these materials.

  consider the economic and environmental factors in the manufacture of fibres, yarns and fabrics within textile products;

  consider how recycling, disposal/degrading/recycling of these materials influences design decisions for textile products whether as wearing apparel, working apparel or industrial applications.

In addition, all candidates will need to have the knowledge specified in Sections 5.5.4.6 – 5.5.4.11 for their material area(s). See pages 59-69.

5.5.4.6 Surface Finishes

Candidates should develop a knowledge and understanding of the application in product design of:

- the nature and suitability of surface finishes and coatings across a range of products;

  develop a familiarity with coatings for decoration, resistance to decay and wear, absorption and aesthetic qualities;

- finishes that enhance appearance:

  – for woods; *varnishing, waxing, oiling, stains, polishing;*

  – for metals; *paints, dip coating, varnishes, lacquering and electro plating;*

  – for plastics; *edge polishing, chemical finishing;*

  – for graphics (paper and boards); *varnishing, laminating, foil blocking;*

– for textiles;	*mechanical and chemical finishes, raising, calendaring brushing, shrinking, pressing, water proofing; transfer printing, stencilling , screen, block and roller printing –hand and machine; diffusing, and quilting and the design opportunities they present;*
– understanding the principles of dyeing technology;	
– examine a number of domestic products to determine the finishes applied, evaluate their effectiveness in terms of resistance to wear, decay, decorative improvement;	*domestic, industrial dyeing methods – vat discharge and resist, dye fastness and their application in product design;*
– examine the effects of finishes applied to a range of materials to meet design requirements;	
– justify the selection of finishes to meet design requirements;	
• edge finishing of selected materials.	*use the edge finishes appropriate to woods, plastics, paper/boards, textiles and as appropriate to metals in handcrafted products;* *lippings for timber board edges, polishing for plastic and metal products, textile edge treatments, e.g. seam finish, hems, facings and binding;* *identify the edge finishes applied by manufacturers to volume produced products made from woods, metals, plastics, graphics (paper/boards) and textiles and consider when designing;* *colour fastness, durability, bending, compression, hardness, tension and shear when selecting materials for a design situation.*

5.5.4.7 Principles and Techniques of Testing Applied to Product Design

Candidates should develop a knowledge and understanding of the application in product design of:

- the use of data derived from a variety of tests;

- use data derived from a variety of tests on fibres to establish the effects of moisture absorption factors of extensibility, elastic recovery, flammability and identification burning tests;

carry out a range of simple tests to identify characteristic/properties, using results to determine selection;

paper and board forms suitable for packaging/display, stability v weight in wooden structures, weight v durability;

examine the directional strength of wood, paper/board and textile fabrics;

examine and record standard testing regimes used in industry to assess performance characteristics of materials, including for textiles;

durability, dimensional stability;

crease and stretch recovery, pilling, snagging, insulation, waterproofing, colour fastness and flammability;

examine a range of products to identify where and how test results can be used to justify the selection of materials and/or quality control.

- an awareness of safety implications in the testing of materials.

5.5.4.8 Hand and Industrial Methods of Preparing, Processing, Manipulating Materials to Produce Products

Candidates should develop a knowledge and understanding of the application in product design of:

Common Processes

• common industrial processes used to manufacture products from paper/boards, and/or textile fibres, and/or plastics, and/or wood, and/or metals for the materials being studied;	
• hand and machine led manufacturing processes resulting in diversity of product outcomes:	*from prototype items to mass produced articles;*
– for graphics (papers and boards);	*understanding the principles of off-set lithography, flexography, gravure, screen printing, digital printing and their application to products;*
– for plastics;	*understanding the principles of injection, vacuum, blow and compression moulding, extrusion, and their application to products;*
– for metals;	*understanding of the principles of die casting, fabrication from common sections and components, mechanical fixing and their application to products;*
– for textiles.	*understanding of the principles of machine and hand stitching; seams – plain and double stitched; temporary methods – pinning and tacking; fusing methods such as 'bondaweb' and iron-on interfacing;* *understand the principles that underpin surface decoration;* *screen, block printing, transfer printing, stencilling, direct application methods, embroidery, diffusing and quilting and the design opportunities they present.*

Joining

• the merits and limitations of a range of joining methods commonly found in modern products:	
– for woods;	*common joints as used in a range of domestic products, adhesives for interior and exterior use, high strength applications;*
– for metals;	*epoxy resins and super glues, permanent methods, e.g. welding, brazing, soldering; semi-permanent methods, e.g. rivets, bolts and screws, KD fittings;*
– for plastics;	*plastic welding, chemical fusion, semi-permanent methods, e.g. rivets, bolts and screws, KD fittings;*
– for graphics (papers and boards);	*tabs, common folded/locking systems for packaging, e.g. crash bottom;*
– for textiles.	*adhesives, bonding, mechanical joining, fastenings such as zip, buttons, poppers, velcro;* *pre-manufactured components, e.g. parachute clips.*

Wasting

• common process of wasting methods – uses of hand, machine including CAM controlled 3 axis routers, and assembly line wasting as applied to a variety of materials;	*develop a knowledge of industrial wasting techniques, e.g. drilling, milling, turning, grinding, spark erosion, laser cutting, stamping/profiling, sintering as applied to product manufacture; die cutting;* *examine a range of products to determine methods of wasting applied to achieve required 'forms';*
• changing the form of materials;	*e.g. producing chipboard using reconstituted materials, forming and moulding, e.g. die casting, press forming, injection moulding, vacuum forming, blow moulding, extrusion and compression moulding.*
• recycling of paper and board, textiles, woods, metals.	

Forming

- common industrial forming processes for paper and boards, fibres/fabrics, plastics, wood and metals as applied to a range of products.

fabrication from sheet materials;

embossing papers/boards, primary and secondary, packaging, point of sale displays, using CAD/CAM, e.g. plotter/cutters, laser cutters;

forming and folding metals and plastics;

car panels, ducting and ventilation systems laminating thin timber sections to create strong, light weight structures – seating/chairs;

building structures – stair units;

design of simple jigs, presses and moulds to achieve forming processes;

consider how disposal of fullness such as gathering, darts, pleating, drawing, layering and the forming of felts are used to shape textile products;

using visits to outlets and manufacturers' data examine implications for quality control.

5.5.4.9 Industrial and Commercial Practices

Candidates should develop a knowledge and understanding of the application in product design of:

Manufacturing Systems

Manufacturing/Production Systems

• one-off, batch, high volume, and bought-in parts and components leading to an understanding of differing levels of production taking into account economic factors;	
• Candidates should develop an understanding of the benefits to the manufacturer of:	
– modular production systems;	*research and record how industry uses modular systems in product production;*
– 'just-in-time' manufacture;	*research and record definitions of 'just-in-time';* *examining how waste of time, labour and resources can be minimised;* *establishing the implications for quality assurance and quality control;* *identify the benefits that 'just-in-time' can bring to quality control and stock control;*
– manufacture for home/industrial assembly;	*establish the criteria behind the growth of self/home assembly and flat pack marketing;* *textile kits such as toy making and cross stitch kits;* *identify how reduced storage/transport space-volume can bring benefits to manufacturers;* *the benefits to manufacturers and consumers of flat packing graphic products, e.g. point of sale displays;* *examine what lessons can be learnt and transferred to small scale manufacture;* ***or*** *analyse self assembly instruction leaflets for sequencing, clarity of instruction and relevance of illustrative information;*

– components/standardised parts;	*research and record principles of interchangeability, bulk production, waste elimination and automation;* *examine a range of products and identify where these aspects have been used, e.g. 13 amp plugs, children's constructional toys like Lego, graphic products such as blister packaging;* *identify how quality control can be improved by using bought-in components/standardised parts;* *determine how manufacturers make use of components/standardised parts in products made from selected materials, e.g. textile fastenings and trims or wood fastening devices;*
– ICT in designing and manufacturing processes;	*use visits, secondary sources to establish how industrial designers and manufacturing teams use ICT and CAD/CAM;* *analyse where these techniques can be applied in the candidate's situation or in prototyping a product solution;*
– understand the opportunities and benefits of ICT and CAD/CAM as used in industry/commerce reduction of working/processing time, elimination of operator error, reduction of labour costs, tool working life extension, improved flexibility and variety of design situations and greater predictability of costings; improved communication within the organisation and between different organisations;	*examine how CAD/CAM can be used in the prototyping of products;* *examine how industry uses ICT for stock control, purchasing, guaranteeing quality control, logistics;* *identify the merits and limitations of ICT stock control;* *prototyping in an educational environment;*
– high volume production and automation;	*examine the logistical difficulties that high volume production presents for the manufacturer, user and maintenance providers, e.g. nuts, bolts, needles, screws, resistors and integrated circuits, plastic fittings such as case hinges, snap toggles for rucksacks and carrying bags, 'wood biscuit' joints;* *compare small scale and large scale production methods for the production of domestic products, e.g. children's toys, clothing, domestic equipment;*
– the benefits to the customer/consumer of these industrial production processes/procedures.	*analyse whether improved quality, volume sales bring about reduced costs for customers.*

Component Drawings

- detail drawings, assembly drawings, instruction/assembly sheets.

e.g. for textiles – pattern instruction sheet for a commercial pattern.

Products and Applications

- enhancement techniques used in designing;

examine the role that fashion, trends, ethnic and cultural dimensions have upon domestic products and clothing;

- use of new technologies.

establish appraisal criteria for assessing the performance of a range of domestic and industrial products and record their results;

effectiveness, dumping, waste disposal.

Forms of Energy Used by Industry, its Impact on Design and Manufacturing and on the Environment

- the energy sources, forms of storage, conversion, transmission and effective use in manufacturing processes;
- the energy needs during the life of a product;

the energy used in the maintenance of a textile product, e.g. non iron or quick dry;

- the energy potential when product life is ended;
- the terms availability, conservation, pollution and health and safety issues applied to energy;

explore and record alternative energy sources, e.g. 'clockwork' radio, solar batteries, wind and wave sources;

establish accepted definitions for these forms and conduct product diagnosis to determine which has been used to create the product and/or its components;

examine how these terms affect production costs;

- recycling and 'green' issues in product design.

examine and record the need for Eco labelling, environmentally friendly materials, e.g. Tencel/Polartec;

examine the recycling of materials, e.g. paper/boards, fabric fibres, wood fibres and alloys;

explore the environmental, moral and social aspects underpinning recycling and 'green' issues, e.g. cost.

5.5.4.10 Health and Safety of Designers, Makers, Users and the Public

Candidates should develop a knowledge and understanding of the application in product design of:

Health and Safety Issues

- the regulatory and legislative framework related to materials and equipment using Health and Safety at Work regulations (HASAW), trade description and sale of goods legislation, BSI standards applied to products;

- health and safety issues and note that there are **three** core areas:

  – protection of the worker/operator;

  – protection of the user/customer;

  – protection of the environment;

  identify and record how health and safety issues affect designers, makers, users and the environment;

  recognise the impact that these have upon the manufacturing processes of common products;

  recognise the role that the Health and Safety inspectorate have in policing the legal framework;

- standard risk assessment procedures in product design and manufacturing:

  – identification of risks;

  – risk assessment;

  – reduction of risks.

  develop an understanding of how risk assessment procedures are applied in manufacturing situations;

  write a risk assessment for a common working procedure, e.g. cutting or drilling, joining materials using heat or mechanical means, applying finishes.

5.5.4.11 Form and Function of Different Products

Candidates should develop a knowledge and understanding of the application in product design of:

- aesthetics and functional constraints adapted to materials used to make products.

Aesthetics and Function – Shape, Form and Colour

The study of aesthetics should not be considered in isolation but should pervade the whole course and is particularly relevant in the Product Analysis work undertaken in Module 2519.

- development of critical awareness of designed objects/products in such terms as colour, form, shape, texture/surface finish; the way these aspects come together to influence appearance – relationships – harmony/disharmony;
- through analysis of common products such as mobile telephones, kettles, garments and graphic products such as posters, determine how the principles of aesthetics contribute to the overall design;

  e.g. examine volume products like pens (biros), to establish how these aspects interact;
- the relationship between aesthetic and technological requirements of products and compromises that product designers have to make to satisfy marketing, manufacturing and consumer needs;

  apply to issues such as costs – materials, tooling, packaging, transportation and how the functional requirements of users act as constraints on the aesthetic aspects of product design.
- the functional criteria of product users.

Creative Design

- creative design drawing of products for manufacture.

  explore, develop and use where necessary, a range of graphic illustrative techniques to convey the form, shape and function of an artefact/product as a pre-marketing or pre-production strategy, e.g. graphical simulations;

  the role of CAD and ICT in creative design applications – virtual modelling, global design teams, interactive presentations.

5.6 MODULE 2521: SYSTEMS AND CONTROL TECHNOLOGY I (THE DESIGN OF ENERGY DEPENDENT PRODUCTS)

C3.1a, C3.1b, C3.2, C3.3; N3.1, N3.3; IT3.1, IT3.2, IT3.3.	**WO3.1, WO3.2, WO3.3.**

5.6.1 Introduction

The subject content of this module is focused towards:

- systems and their applications;
- selection and application of components and materials used within control systems;
- industrial and commercial practices.

It is essential that systems, their components and materials are taught from the perspective of analysing modern control systems, their design and function within the context of:

- systems development;
- industrial and commercial applications.

Candidates should study the systems and their application as appropriate to the chosen route.

The aim of this module is not to overburden candidates with large amounts of factual information, but rather to give them a framework for analysing existing control systems. This will enable them to make considered selections of appropriate components and materials to guide the prototyping of structurally sound, functional control systems.

The module builds upon the work undertaken at GCSE in Design and Technology and brings together the knowledge, understanding and skills acquired in the study of modules 2518 and 2519. The knowledge and understanding gained by candidates should also directly contribute to work undertaken in Modules 2522 and 2523.

5.6.2 Question Paper (Unit 2521)

Section A of the written paper presents candidates with **five** generic product design based questions. These questions test a candidate's understanding of:

- the effects of design decisions upon the environment;
- the pressures placed on the designers of products by such issues as:
  – energy;
  – the environment;
  – the human interface;
  – aesthetics;
  – scale of production;
  – production technologies;
  – fashion;
  – product life;
  – commercial issues.

Candidates are required to answer **three** questions.

Section B of the written paper presents candidates with **six** questions, which are systems context based. These are set within the specific areas of electrical and electronic systems, mechanical systems and pneumatic systems.

The six questions will be:

- two electrical and electronic systems;
- two mechanical systems;
- two pneumatic systems.

Candidates are required to answer any **two** questions.

Candidates can use the formulae given in the formulae sheet.

5.6.3 Section A Content

Note: Section A in Modules 2520 and 2521 are common.

5.6.3.1 Industrial and Commercial Practice

Manufacturing Systems

Candidates should demonstrate an understanding of the application in system design of:

• one-off, batch, high volume and bought-in parts and components leading to an understanding of differing levels of production taking into account economic factors;	*the relative costs involved in the production of single printed circuit boards or volume batch production of the same design;* *consideration of the options available for producing a casing for a system, off-the-shelf bought-in cases or purpose designed, vacuum formed, injection moulded case;*
• modular production systems;	*research and record how industry uses modular systems in product production, e.g. textiles, automotive industry;*
• standardised parts;	*research and record principles of interchangeability, bulk production, waste elimination and automation;* *examine a range of systems' components and identify where these aspects have been used;* *examine a range of products and identify where these aspects have been used, e.g. 13 amp plug, children's constructional toys like Lego;* *identify how quality control can be improved by using bought-in components/standardised parts; determine how manufacturers make use of components/standardised parts in products made from selected materials;*

• ‘just-in-time’ manufacture;	*research and record definitions of ‘Just-in-Time‘ – examining how waste of time, labour, and resources can be minimised; establish the implications for quality assurance, quality control and stock control;*
• manufacture for home assembly;	*establish the criteria behind the growth of self/home assembly and flat pack marketing;* *identify how reduced storage/transport space volume can bring benefits to manufacturers;* *using visits to outlets and manufacturers’ data examine implications for quality control;* *analyse self assembly instruction leaflets for sequencing, clarity of instruction and relevance of illustrative information;*
• the use of ICT in designing and manufacturing processes;	*use visits, video data or visiting speakers to establish how industrial designers and manufacturing teams are using ICT;* *analyse where these techniques can be used by a candidate;*
• CAD/CAM as used in industry/commerce – the underlying concepts – reduction of working/processing time, elimination of operator error, reduction of labour costs, tool working life extension, improved flexibility and variety of design situations and greater predictability of costings;	*examine how CAD/CAM can be used for the prototyping of products;* *ICT assisted manufacture – establish through visits/videos, visiting speaker’s etc. how these are used in industry by tracking a product through its stages of manufacture;*
• ICT in stock control – monitoring, purchasing logistics in industry;	*examine how industry uses ICT to monitor its stock holding, bought-in components, guaranteeing quality control over supplies;* *identify the merits and limitations of ICT stock control;* *examine what lessons can be learnt and transferred to small-scale manufacture or prototyping in an educational environment;*

• high volume production and automation;	*examine the logistical difficulties that high volume production presents for the manufacturer, user and maintenance providers, i.e. nuts, bolts, needles, screws, resistors and IC's, plastic fittings such as case hinges, snap toggles for rucksacks and carrying bags, 'wood biscuits' joints;* *compare small scale and large scale production methods for the production of domestic products, i.e. children's toys, clothing, domestic equipment;*
• the benefits to the customer/consumer of these industrial production processes/procedures.	*analyse whether improved quality, volume sales bring about reduced costs for customers.*

Commercial Practice

• examine the role of marketing in product design.	*consider how marketing is used to assess consumer needs and to examine its role in product development, pricing, promotion and distribution.*

The Forms of Energy Used by the Industry, its Impact on Design and Manufacturing and on the Environment

Candidates should demonstrate an understanding of the application in system design of:

• the energy sources, forms of storage, conversion, transmission and effective use in manufacturing processes;	*consider a variety of energy sources and storage methods and discuss the effect of increased energy use both for the cost to the consumer and to the environment;*
• the energy needs during the life of a product or system;	*consider the relative merits of using mains power for electrical goods/products and projects compared with the use of battery power;* *examine common domestic products to chart/record changing energy needs within the product;*
• the energy potential when a product or system life is ended;	*be sensitive to the cost of recycling system components and disposal of obsolete items;* *examine and create energy transfer diagrams, e.g. hair drier, portable electric drill;*

• the terms – availability, conservation, pollution, and health and safety applied to energy;	*consider alternative energy supplies for the control of systems; the use of wind power or reclaimed heat generation to contribute to the overall energy consumption of an industrial site;* *examine and record the Eco labelling of domestic consumer systems, e.g. relative energy use in washing machine/dishwashers;* *explore and record alternative energy sources, e.g. 'clockwork' radio, solar batteries, wind and wave sources;* *examine how these terms affect production costs;*
• recycling and green issues in product and systems design.	*look at alternative energy sources and the effect on running costs and the environment;* *consider the disposal problems associated with battery power and the ethical problems associated with buying them in third world countries;* *consider alternatives, e.g. the wind up/solar powered radio/clockwork torch and the possibility of using similar principles for other control systems;* *explore and record aspects of energy saving techniques in the production of artefacts/products;* *examine and record need for Eco labelling, environmentally friendly materials, e.g. Tencel;* *explore the environmental, moral, social aspects underpinning recycling and 'green' issues, e.g. cost effectiveness, dumping, waste disposal;* *assess the environmental impact of products using life cycle assessment.*

5.6.3.2 Health and Safety of Designers, Makers and the Public

Health and Safety Issues

Candidates should demonstrate an understanding of the application in system design of:

• the regulatory and legislative framework related to materials and equipment using Health And Safety At Work (HASAW), trade description and sale of goods legislation, BSI standards applied to products/systems;	
• health and safety issues relating to: – protection of the worker/operator; – protection of the user/customer; – protection of the environment;	*identify and record how health and safety issues affect designers, makers, users and the environment;* *recognise the impact that these have upon the manufacturing processes of common products/systems;* *recognise the role that the Health and Safety Inspectorate have in policing the legal framework;*
• standard risk assessment procedures in systems design and manufacturing – identification of risks; – risk assessment; – reduction of risks.	*develop an understanding of how risk assessment procedures are applied inmanufacturing situations;* *write a risk assessment for a common workshop procedure such as soldering, drilling or making a PCB.*

5.6.3.3 Form and Function of Products

Aesthetics and Function – Shape, Form and Colour

The study of aesthetics should not be considered in isolation but should pervade the whole course and is particularly relevant in the Product Analysis work undertaken in Module 2519.

Candidates should:

• develop a critical awareness of designed objects/products in such terms as colour, form, shape, texture/surface finish; the way these aspects come together to influence appearance, relationships, harmony/disharmony;	*identify how repeating patterns can be used in product design;* *examine the use of tactile surfaces in product design, e.g. paving systems for partially sighted people;* *explore the composition of colour, contrast, harmony/disharmony, human reactions to colour through the analysis of products;*

• understand the use of shape and structure to optimise material performance, resulting from the exploitation of sections, corrugations and forms;	*determine how the above aspects influence product outcomes, e.g. consider how industry uses modelling/prototyping to assess the validity of material performance;*
• understand the relationship between aesthetic and technological requirements of products and compromises that product designers have to make to satisfy marketing, manufacturing and consumer needs;	*consider how issues such as costs, materials, tooling, packaging, transportation and the functional requirements of users act as constraints on the aesthetic aspects of product design, e.g. examine volume products like pens (biros), to establish how these aspects interact;*
• demonstrate strategies for understanding products and their sub-systems, including ergonomic and anthropometric implications;	*explore and develop knowledge of ergonomic and anthropometric aspects of products;*
• understand the functional criteria of product users.	*determine how product designers establish and respond to the needs of product users.*

Social and cultural issues

Candidates should develop a knowledge and understanding of:

• social and cultural issues.	*examine the effect of fashion, trends, ethnic and cultural dimensions to the design and manufacture of domestic products.*

5.6.3.4 Communication

Candidates should be able to:

• produce creative design drawings of products for manufacture;	*explore, develop and use where necessary, a range of graphic illustrative techniques to convey the form, shape and function of an artefact/product as a pre-marketing or preproduction strategy, e.g. graphical simulations;*
• convey component information using diagrammatic or systematic representation.	*draw circuit diagrams for electronic and pneumatic systems;* *construct circuit board layout diagrams;* *draw system diagrams as applied to the utilisation of electrical/electronic/mechanical/pneumatic components/systems;* *explore the use of detail drawings, assembly drawings, instruction/assembly sheets.*

5.6.4 Section B Content

5.6.4.1 Electrical and Electronic Systems

Candidates should demonstrate an understanding of the application in system design of:

- the use of the following electrical and electronic components, their application within existing systems and how they interact to provide a required function;
  use of calculations to determine reasons for component selection;
  use of the formulae given in the formulae sheet:

  – input devices:

  potential divider circuits, to include potentiometer;

  light sensing devices; *LDR, photodiode, optical devices using infra-red;*

  temperature sensing devices; *ntc thermistor, LM35;*

  IR sensing; *IR emitting diode and sensor, slotted opto switch;*

  switches including microswitch and reed switch; *use of manufacturers data to identify suitable input devices for specific sensing applications;*

  – processing devices: *use of manufacturers' data to interpret function of devices;*

  logic gates; (AND, NAND, OR, NOR, NOT, EOR) in isolation and in simple combinations, reason for the use of NAND, NOR equivalents;

  production of a monostable and astable signal, including calculations from a given formula;

  operational amplifier used as a voltage comparator;

  microprocessor based devices, circuits and simple programs;

  debouncing circuit for input switch, binary counter IC, conversion from BCD to driver for a 7-segment display, discrete transistors and transistor arrays for operating a relay, n channel MOSFET as an output driver;

– output devices:

optical devices;	*lamp, LED, 7-segment display;*
DC motor including fluid pump, fan, relay, DC solenoid for pneumatic and fluid control;	*identify and select appropriate output devices for specific applications using manufacturers' data;*
7- segment display;	

– power sources:

mains, transformed supply and battery sources;	*suitable voltage and current characteristics;*
matching supply to requirements of system;	*use 7805 IC to provide a regulated power supply;*
design and build a range of devices to measure/monitor/control environmental levels.	*such as light, temperature, wind, humidity;* *build a thermostatically controlled fan or water heater;* *build an automatic plant watering system;* *build a batch counter for components on a conveyor belt or a counter for customers entering a shop;* *build a simple door entry access control system.*

In addition, all candidates will need to have the knowledge specified in Sections 5.6.4.4 – 5.6.4.9 for their system focus area(s). See pages 80-85.

5.6.4.2 Mechanical Systems

Candidates should demonstrate an understanding of the application in system design of:

- the use of the following mechanical components, their application within existing systems and how they interact to provide a required function;
  use of calculations to determine reasons for component selection;
  use of the formulae given in the formulae sheet:

– transfer of motion;	*spur gears, bevel gears, worm gears, rack and pinion;*
– transfer of drive;	*belt and pulleys, chain drive, idler gears, crank and slider, levers, cams, shaft (including flexible) couplings;*
– plain and ball race bearings;	

– calculation of gear ratio and mechanical advantage;	*use low cost proprietary nylon gearbox and motor to build a simple winch – investigate reduction ratios, output torque, ability to lift a load and modes of failure;* *design and build a range of devices using a proprietary kit to provide motion, motion transfer, force transfer or automation to a system;*
– providing rigidity for mechanical systems;	*webs, indents, braces, creases;*
– understanding of tension, compression, torsion and bending in providing structural stability within mechanical systems;	
– investigate the design of existing mechanical systems;	*radio control servo motor, audio and video cassette recorders, computer printers and disk drives, power tools, door and access systems;*
– power sources for mechanical systems.	*dc motors.*

In addition, all candidates will need to have the knowledge specified in Sections 5.6.4.4 – 5.6.4.9 for their system focus area(s). See pages 80-85.

5.6.4.3 Pneumatic Systems

Candidates should demonstrate an understanding of the application in system design of:

- the use of the following pneumatic components, their application within existing systems and how they interact to provide a required function;
  use of calculations to determine reasons for component selection;
  use of the formulae given in the formulae sheet:

– pressure regulating components, cylinders (single and double acting), cylinder mounting devices, 3/2 valves, 5/2 valves (manually, mechanically and pilot operated), flow control valves (bi-directional and uni-directional), solenoid valves, reservoirs;	*build a product stamping or labelling rig;* *build model sliding doors with user controls and time delays;* *control of the speed at which doors open/close;*
– systems to provide a logic function;	*build a lifetime testing rig to provide a controlled test for consumer goods, e.g. the accelerated testing of hinges and springs or the abrasion resistance of fabric;* *integration of electronic systems for monitoring;*

– cushioned cylinders; – safety legislation.	*compare different control and automation strategies for automatic doors in a variety of applications in respect of electrical, electronic, pneumatic and mechanical/structural control and actuation.*

In addition, all candidates will need to have the knowledge specified in Sections 5.6.4.4 – 5.6.4.9 for their system focus area(s). See pages 80-85.

5.6.4.4 Programmable Control Devices

Candidates should demonstrate an awareness of the application in system design of:

• programmable control devices – integrated with electronic or mechanical or pneumatic components to provide efficient control of systems; awareness of the benefits and drawbacks of their use.	*investigate the domestic, commercial and industrial applications of programmable control devices, e.g. central heating systems, dishwasher, washing machine, domestic timer switches, commercial car wash, industrial process control.*

5.6.4.5 Materials

Candidates should demonstrate an awareness of the application in system design of:

• the use of the following materials, within the focus areas, for structural strength;	
• reasons for material selection for specific applications using available data;	
• metals – ferrous (mild steel and high carbon steels), non-ferrous (brass, aluminium alloy, copper for electrical use only);	*selection of material to provide force transfer, e.g. lever, in a mechanical system;* *construction of a test bed for a product lifetime testing rig;* *selection of materials where friction between two surfaces is a factor;* *selection of material for a heatsink;* *selection of material for the gears in a gearbox;* *selection of material for use out of doors;*
• thermoplastics;	*use of nylon gears in light duty gearboxes;* *vacuum forming of components or casings;* *use of clear acrylics to cover/filter electronic displays;* *use of ABS in proprietary casings to protect a system from environmental factors (heat, light, water, dust, impact);*

• composites;	*glass reinforced plastic (GRP) for printed circuit boards (PCBs), nylon filled gears, MDF, reinforced rubber vee belt;*
• smart/modern materials.	*uses of shape memory alloys in system design.*

5.6.4.6 Principles and Techniques of Testing Applied to System Design

Candidates should demonstrate an understanding of the application in system design of testing for the chosen focus area(s) taken from:

• electrical and electronic systems:	
– DC voltage, current and resistance measurements in a circuit and be able to test for design requirements;	*use a multimeter to make measurements in a circuit and be able to test for design requirements;*
• mechanical systems:	
– pressure measurements and force calculations in mechanical and pneumatic systems;	*use force meters to make measurements in a mechanical system;*
– a basic awareness of the way forces act within a system and how structural rigidity is achieved. Tension, compression torsion and bending;	*use teaching equipment which heightens the awareness of forces within structural members;* *design and build mechanical systems and identify modes of failure;* *examine where existing structural sub-systems are used to achieve stability, e.g. rail track, pylons, mobile phone transmitter masts;*
• pneumatic systems:	
– test for design requirements being met.	*use a pressure gauge to test the validity of a pneumatic system.*

5.6.4.7 Industrial and Commercial Practices

Candidates should demonstrate an understanding of the application in system design of manufacturing/production systems:

Manufacturing Systems

• job production, batch production, repetitive flow production, continual flow production methods;	
• use of bought-in parts, sub-assemblies and components leading to an understanding of differing levels of production taking into account economic factors;	*the relative costs involved in the production of single printed circuit board or volume batch production of the same design; consideration of the options available for producing a casing for a system, off-the-shelf bought-in cases or purpose designed, vacuum formed, injection moulded case;*
• high volume production and automation; examine the logistical difficulties that high volume production presents for the manufacturer, user and maintenance providers;	*nuts, bolts, needles,screws, resistors, ICs, plastic fittings such as case hinges, snap toggles for rucksacks and carrying bags, 'wood biscuits' joints;* *compare small scale and large-scale production methods for the production of domestic products for example children's toys, clothing, domestic equipment;*
• 'just-in-time' manufacture;	*research and record definitions of 'just-in-time' – examining how waste of time, labour, and resources can be minimised; establish the implications for quality assurance, quality control and stock control;*
• standardised parts; use of pre-manufactured components.	*research and record principles of interchangability, bulk production, waste elimination and automation;* *examine a range of systems components and identify where these aspects have been used.*

The Use of ICT in Designing and Manufacturing Processes

• use visits, video data or visiting speakers to establish how industrial designers and manufacturing teams are using ICT assisted manufacture;	*track a product through its stages of manufacture;* *analyse where these techniques have been used in system design and manufacture;*
• CAD/CAM as used in modelling, designing, testing and manufacture;	*the underlying concepts – reduction of working/processing time, elimination of operator error, reduction of labour costs, tool working life extension, improved flexibility and variety of design situations and greater predictability of costings;*
• ICT in stock control – monitoring, purchasing logistics in industry.	*examine how industry uses ICT to monitor its stock holding, bought-in components, guaranteeing quality control over supplies;* *identify the merits and limitations of ICT stock control;* *examine what lessons can be learnt and transferred to small-scale manufacture or prototyping in an educational environment.*

Forms of Energy Used by Industry, its Impact on Design and Manufacturing and on the Environment

Candidates should demonstrate an understanding of the application in system design of energy used before, during and after manufacture with reference to:

• the energy sources, forms of storage, conversion, transmission and effective use in manufacturing systems;	*consider a variety of energy sources and storage methods and discuss the effect of increased energy use both for the cost to the consumer and to the environment;*
• the energy needs during the life of a system;	*consider the relative merits of using mains power for electrical goods /products and projects compared with the use of battery power;*
• the energy potential when system life is ended;	*be sensitive to the cost of recycling system components and disposal of obsolete items;*
• the terms availability, conservation, pollution and health and safety issues applied to energy;	*consider alternative energy supplies for the control of systems – the use of wind power or reclaimed heat generation to contribute to the overall energy consumption of an industrial site;* *examine and record the Eco labelling of domestic consumer systems, i.e. relative energy use in washing machine/dishwashers;*

• recycling and 'green' issues in systems design.	*look at alternative energy sources and the effect on running costs and the environment;* *consider the disposal problems associated with battery power and the ethical problems associated with buying them in third world countries;* *consider alternatives – i.e. the wind up/solar powered radio/clockwork torch – and the possibility of using similar principles for other control systems.*

5.6.4.8 Health and Safety of Designers, Makers, Users and the Public

Candidates should develop a knowledge and understanding of the application in system design of:

Health and Safety Issues

• the regulatory and legislative framework related to materials and equipment using Health and Safety at Work regulations (HASAW), trade description and sale of goods legislation, BSI standards applied to products/systems;	
• health and safety issues and note that there are **three** core areas: – protection of the worker/operator; – protection of the user/customer; – protection of the environment;	*identify and record how health and safety issues affect designers, makers, users and the environment;* *recognise the impact that these have upon the manufacturing processes of common products/systems;* *recognise the role that the Health and Safety inspectorate have in policing the legal framework;*
• standard risk assessment procedures in product design and manufacturing: – identification of risks; – risk assessment; – reduction of risks.	*develop an understanding of how risk assessment procedures are applied in manufacturing situations;* *write a risk assessment for a common workshop procedure, e.g. soldering, drilling or making a PCB.*

5.6.4.9 Form and Function of Different Products which Contain a System

Candidates should demonstrate an understanding of the application in system design of:

• strategies for understanding products and their sub-systems, including ergonomic, anthropometric and aesthetic implications of designs used in control systems;	*explore and develop knowledge of ergonomic and anthropometric aspects of products, which contain a system;* *examine the impact of aesthetic, visual and tactile aspects of products containing a system, for example mobile phones or personal CD players;*
• convey system and control or component information using diagrammatic or systematic representation.	*draw circuit diagrams for electronic or pneumatic systems as applicable using standard symbols;* *construct circuit board layout diagrams;* *draw system diagrams as applied to the utilisation of electrical/electronic/mechanical /pneumatic components/systems.*

5.7 MODULE 2522: DESIGNING

COURSEWORK

C3.2, C3.3; IT3.1, IT3.2, IT3.3

LP3.1, LP3.2, LP3.3; PS3.1, PS3.2.

5.7.1 Introduction

This module is a demanding intellectual learning experience, which is intended to draw upon and develop further those designing skills learnt in earlier modules. The outcome is a project involving the identification by the candidate of a problem or opportunity involving a product need, research into the wider issues of the context involved, the development and refinement of innovative design solutions, modelling and experimental work, research into relevant materials and technologies, the analysis of all this material and the final development of a preferred and justified solution up to and including the production of working drawings.

This project is marked by the teacher, internally standardised within the Centre and externally moderated by OCR.

The module provides opportunities for the candidate to address all aspects of product research, analysis, design and development, at a personal level within a prescribed framework, and to demonstrate a depth of understanding of relevant technologies.

The topic selected by the candidate must be set in the context of:

- materials, components and their uses;
- industrial and commercial practices;
- product development;
- an in-depth study of needs and opportunities;
- a designing and making activity in any materials/components appropriate to the product.

Making, testing and evaluation of the solution forms the basis of Module 2523.

The outcome of Module 2522 is presented as a folio of research and design material in an A3 format.

About 10 hours of the time spent on this module should be allocated to the development or enhancement of appropriate skills and about 40 hours spent on the assessed piece of work, (Unit 2522).

Details of this assessed piece of work (Unit 2522) are given in Section 5.8.

It is expected that the item designed in Unit 2522, which will be produced for assessment in Unit 2523, will involve a significant amount of demanding construction work.

It is suggested that the planning for the project should begin at the latest by June in the third term of the AS/A2 course.

5.7.2 Examples of Teaching and Learning Opportunities

Recognition, Investigation and Synthesis of Design Opportunities

Candidates should be able to:

- select and introduce a design opportunity, suitable for developing within the recommended time allocation of the unit, explaining in detail the reasons for choice; present an initial design brief and identify important, relevant issues for investigation;

  examine a series of project titles to determine suitability and opportunities;
  examine personal interests and links with industry and commerce to identify possible context areas;
  look at sample project titles to identify strategies for investigation;
- produce a realistic time plan for the unit, from initial investigation through to the working drawing, which includes as much detail as can be projected at this stage, together with evidence of adapting the plan to changing circumstances;

  group work to identify key stages for a plan of action and how to set realistic time schedules;
  individual work to expand this framework for a specific project;
- identify primary and secondary sources of information relevant to the problem;

  revision exercises based on work originally done for Module 2519;
- present and analyse edited research to identify strengths and weaknesses in existing products to provide information for later use;

  revision of similar work done in Module 2519;
- present and analyse edited research to identify the constraints caused by environmental factors, moral issues, social issues, user and manufacturer needs, cost factors and market opportunities, to provide information for use in the development of a design specification;

  the identification of constraints on the design of a specific product, which come from environmental factors and moral issues;
  explore the possibly conflicting needs of the user and the manufacturer;
- produce a detailed and justified design specification from the objective analysis of research data;

  identify elements of a detailed specification.

Generation, Modelling and Development of Ideas

Candidates should be able to:

- generate and modify a range of innovative ideas using annotated sketching and modelling, leading to a final justified proposal which takes into account aesthetics, suitability of materials, manufacturing processes and fitness for purpose;

  further practice of annotated sketching;
- produce first generation 2D and 3D models to aid the development of ideas and to establish the validity of their chosen solution;

  revise work from Module 2519;
- evaluate ideas and models against the design specification and justify decisions for choice or rejection;

produce various models to explore a specific design problem and evaluate their suitability;

- undertake and record the edited results of relevant additional research into information needed for further development of ideas including as appropriate, available materials, types and properties of materials appropriate to specific needs, suitable components, costings, ergonomics and manufacturing processes;

  a focused research exercise into material properties needed for specific products;
  identify the suitable use of available components in manufactured products;

- for the chosen solution, consider the influence of relevant design constraints, including environmental factors, moral issues, social issues, cost factors, ergonomics, market opportunities and user and manufacturer needs;

  evaluate the effective use of ergonomics in a specific situation or product;

- produce high quality working drawings using CAD, in a format appropriate to the type of product and which could be used by a third party with no further guidance;

  develop skills in orthographic projection;
  examine exploded parts drawings;
  practise the use of CAD;

- produce a well presented and informative design folio, using a combination of text, graphical techniques and ICT;

  review of similar work done in Module 2519.

The examples of teaching and learning opportunities (given in italics above) are not prescribed or a complete set but are intended only as a guide to the type of teaching and learning experiences that would enhance or develop those skills required by candidates to produce the assessed work in Unit 2522.

5.8 UNIT 2522: DESIGNING

GUIDANCE AND MARKING CRITERIA

Unit 2522 is marked out of 90.

The realisation, testing and evaluation of the solution developed in Unit 2522 are undertaken in the linked unit, Unit 2523.

Candidates should be careful in their choice of project to ensure that it will allow for a significant and demanding making opportunity in Unit 2523. The outcome must be a working prototype that can be tested in use. Conceptual models are not acceptable. Graphics based projects must lead to a graphics product that can be tested and evaluated as a genuine working prototype. Projects based on architecture, interior design or landscape design are not appropriate, as they do not lead to a product that can be genuinely tested or modified for commercial production. Similarly, the design of a web site alone is unlikely to provide the practical making experience required in Unit 2523.

Candidates are required to identify a problem or opportunity, involving a product need, which provides them with opportunities to address all aspects of product research, analysis, design and development within the framework of the assessment criteria for the unit. The project involves investigation into the wider context of the problem, the analysis of edited research material culminating in the production of a detailed design specification. Candidates will then be required to present a wide range of appropriate and significantly different design ideas, which are developed to include the production and evaluation of first generation models, leading to the refinement of a justified solution and a working drawing.

The topic for the project must be submitted to OCR for approval and comment by completing form OPF prior to commencing work.

Candidates will need to present a folio of design work covering product design. The material should be presented in an A3 format, using a range of appropriate communication techniques, including the use of ICT. This work should be presented in approximately 30 sheets, including clear photographs of models produced.

Working drawings larger than A3 may be included if they are appropriate, but these must be able to be folded down to A3 size.

The folio should include written and graphic content with the weighting more towards graphic communication. The skills and knowledge learnt in earlier modules, in particular, research, analysis of information and ideas, visual communication techniques, especially annotated sketching, use of objective criteria for evaluation, material properties, production processes and basic modelling techniques are developed to higher levels in this A2 work.

Videocassettes, audiocassettes, computer disks or CD-ROMs must not be included for moderation purposes. Plastic individual sleeves must not be used for folio sheets.

5.8.1 Marking Criteria

Recognition, Investigation and Synthesis of Design Opportunities **[33 marks]**

- Selection and rationale of suitable design opportunity [6]
- Production of time plan with adaptations [3]
- Identification of relevant sources of information [3]
- Strengths and weaknesses in existing products [6]
- Identification of relevant design constraints [9]
- Production of a design specification [6]

Generation, Modelling and Development of Ideas **[57 marks]**

- Innovative ideas to a final justified proposal [18]
- Production of ideas and models [9]
- Evaluation and reasons for choice [6]
- Additional research [3]
- Influence of relevant design constraints [6]
- Production of CAD drawings [9]
- Production of design folio [6]

5.8.1.1 Recognition, Investigation and Synthesis of Design Opportunities [33 marks]

Selection and rationale of suitable design opportunity **[max 6 marks]**

Candidates should be able to select and introduce a design opportunity, suitable for developing within the recommended time allocation of the unit, explaining in detail the reasons for choice; present an initial design brief and identify important, relevant issues for investigation.

Candidates:

- select a suitable design problem and give a detailed introduction which explains thoroughly the reasons for choice; present a detailed design brief and identify important, relevant issues for investigation; [5-6]
- select a suitable design problem and give a reasonable introduction which include some explanation of choice; present a clear design brief and identify some relevant issues for investigation; [3-4]
- select a design problem with little explanation or justification in the introduction; present only a simple design brief and take a superficial view of what investigation is needed. [0-2]

Production of time plan with adaptations **[max 3 marks]**

Candidates produce a realistic time plan for the unit, from initial investigation through to the working drawings, which includes as much detail as can be projected at this stage, together with evidence of adapting the plan to changing circumstances.

Candidates:

- produce a realistic time plan for the unit, which include all aspects of work identifiable at this stage with clear evidence of adapting to changing circumstances; [3]
- produce a realistic time plan for the unit, which includes most of the aspects of work identifiable at this stage, though specific detail may be lacking; there is some evidence of adapting to changing circumstances; [2]
- produce a vague plan of action, which lacks detail and shows little awareness of realistic time allocation; little or no evidence of adapting to changing circumstances. [0-1]

Identification of relevant sources of information **[max 3 marks]**

Candidates identify primary and secondary sources of information relevant to the problem.

Candidates:

- identify several primary and secondary sources of information and explain their value to the project; [3]
- identify the more obvious primary and secondary sources of information and show some understanding of their relevance to future needs; [2]
- identify few sources of information and lack evidence of understanding of relevance. [0-1]

Strengths and weaknesses in existing products **[max 6 marks]**

Candidates present and analyse edited research to identify strengths and weaknesses in existing products to provide information for later use.

Candidates:

- present thorough analysis of edited research, identify clearly the strengths and weaknesses in existing products and present key information for later use; [5-6]
- present reasonable analysis of edited research, show reasonable awareness of the strengths and weaknesses in existing products and identify some useful information for later use. [3-4]
- present analysis of research which is only at a subjective or low level, strengths and weaknesses of existing products are only recognised at a superficial level and little useful information is gained for later use. [0-2]

Identification of relevant design constraints **[max 9 marks]**

Candidates present and analyse edited research to identify the constraints caused by environmental factors, moral issues, social issues, user and manufacturer needs, cost factors and market opportunities, to provide information for use in the development of a design specification.

Candidates:

- present thorough analysis of the constraints caused by environmental factors, moral issues, social issues, user and manufacturer needs, cost factors and market opportunities, and identify key information for use in the development of a design specification; [7-9]
- present reasonable analysis of the constraints caused by environmental factors, moral issues, social issues, user and manufacturer needs, cost factors and market opportunities, though not all in adequate depth and identify some useful information for use in the development of a design specification; [4-6]
- present analysis of the constraints caused by environmental factors, moral issues, social issues, user and manufacturer needs, cost factors and market opportunities which is only at a subjective or low level, not all important issues are covered and identify little or no useful information for use in the development of a design specification. [0-3]

Production of a design specification **[max 6 marks]**

Candidates produce a detailed and justified design specification from the objective analysis of research data.

Candidates:

- produce a detailed and justified design specification from the objective analysis of research data; [5-6]
- produce an adequate specification covering a range of issues; justification is fair and is based on some objective analysis of research data; [3-4]
- present only a basic or superficial specification; show little evidence of objective analysis of research data and justification is generally subjective or lacking. [0-2]

5.8.1.2 Generation, Modelling and Development of Ideas [57 marks]

Innovative ideas to a final justified proposal [max 18 marks]

Candidates generate and modify a range of innovative ideas using annotated sketching and modelling, leading to a final justified proposal which takes into account aesthetics, suitability of materials, manufacturing processes and fitness for purpose.

Candidates:

- present a wide range of appropriate and annotated innovative ideas which are each developed as far as possible; ideas are modified and developed using analysis and thorough modelling; present a detailed and justified final modification of the solution with careful reference to aesthetics, materials, manufacturing processes, fitness for purpose and the results of testing; [13-18]
- present a good range of appropriate innovative ideas, annotated to varying levels with limited development of each or some of them supported by competent modelling; present a reasonable final modification of the solution, with limited justification and with moderate reference to aesthetics, materials, manufacturing processes, fitness for purpose and the results of testing; [7-12]
- present a limited range of ideas, with little evidence of innovation, using annotation and modelling at a basic level only; ideas are only developed at a simplistic level or not at all; present further limited modification of the final solution with little justification but with some reference to aesthetics, materials, manufacturing processes, fitness for purpose and the results of testing. [0-6]

Production of ideas and models [max 9 marks]

Candidates produce first generation 2D and 3D models to aid the development of ideas and to establish the validity of their chosen solution.

Candidates:

- produce good quality first generation experimental 2D and 3D models suitable for aiding the development of ideas and for establishing the validity of the initial design thinking and the chosen solution; [7-9]
- produce competent first generation experimental 2D and 3D models, which will aid the development of ideas and provide some information for establishing the validity of the initial design thinking and the chosen solution; [4-6]
- produce poor quality first generation experimental 2D and 3D models, which are of limited use in developing the ideas and which will provide little or no information for establishing the validity of the initial design thinking and the chosen solution. [0-3]

Evaluation and reasons for choice **[max 6 marks]**

Candidates evaluate ideas and models against the design specification and justify decisions for choice or rejection.

Candidates:

- present a detailed and objective evaluation of ideas and models against the design specification and justify all decisions; [5-6]
- present an adequate and mainly objective evaluation of ideas and models against the design specification with some justification of decisions; [3-4]
- present only a limited and mainly subjective evaluation of ideas and models with little or no justification of decisions; little or no reference made to the design specification. [0-2]

Additional research **[max 3 marks]**

Candidates undertake and record the edited results of relevant additional research into information needed for further development of ideas including as appropriate, available materials, types and properties of materials appropriate to specific needs, suitable components, costings, ergonomics and manufacturing processes.

Candidates:

- undertake and record in concise detail the results of additional research into information needed for further development of ideas including as appropriate, available materials, types and properties of materials relevant to specific needs, suitable components, relevant costings, ergonomics and manufacturing processes; editing is thorough and relevance of material is clear; [3]
- undertake and record in reasonable detail the results of additional research into information needed for further development of ideas including as appropriate, available materials, types and properties of materials relevant to specific needs, suitable components, relevant costings, ergonomics and manufacturing processes; show some evidence of editing and awareness of relevance of material; [2]
- undertake research as appropriate, into available materials, types and properties of materials relevant to specific needs, suitable components, relevant costings, ergonomics and manufacturing processes at a limited or superficial level and results are recorded haphazardly; little evidence of meaningful editing or of understanding relevance of material. [0-1]

Influence of relevant design constraints **[max 6 marks]**

Candidates, for the chosen solution, consider the influence of relevant design constraints, including environmental factors, moral issues, social issues, cost factors, ergonomics, market opportunities and user and manufacturer needs.

Candidates:

- show careful and perceptive consideration of the influence of design constraints on the chosen solution, including environmental factors, moral issues, social issues, cost factors, ergonomics, market opportunities and user and manufacturer needs; [5-6]
- show adequate consideration of the influence of design constraints on the chosen solution, including environmental factors, moral issues, social issues, cost factors, ergonomics, market opportunities and user and manufacturer needs, though to varying levels; [3-4]
- show only a simplistic consideration of the influence of design constraints on the chosen solution, including environmental factors, moral issues, social issues, cost factors, ergonomics, market opportunities and user and manufacturer needs and not all issues are covered adequately. [0-2]

Production of CAD drawings **[max 9 marks]**

Candidates produce high quality working drawings using CAD, in a format appropriate to the type of product and which could be used by a third party with no further guidance.

Candidates:

- produce high quality working drawings using CAD at a high level, in an appropriate format which could be used by a third party with no further guidance; [7-9]
- produce reasonable working drawings using CAD to a reasonable level, in an appropriate format which could be used by a third party with limited further guidance; [4-6]
- produce low quality working drawings in an appropriate format but lacking sufficient detail for making by a third party without significant further guidance; CAD is only used at a low level. [0-3]

Production of design folio **[max 6 marks]**

Candidates produce a fluent, well-presented and informative design folio, using a combination of text, graphical techniques and ICT.

Candidates:

- produce a fluent and well-presented folio, using a range of good communication techniques, including ICT; [5-6]
- produce a competent folio that communicates reasonably well using a moderate range of techniques, including ICT; [3-4]
- produce a folio that lacks fluency and clarity, using limited techniques for presenting and analysing information; ICT may have been used at a very low level or not at all. [0-2]

2522 Designing – details provided for internal Centre use only

Recognition, Investigation and Synthesis of Design Opportunities (33 marks). Candidates should be able to:

- select and introduce a design opportunity, suitable for developing within the recommended time allocation of the unit, explaining in detail the reasons for choice; present an initial design brief and identify important, relevant issues for investigation; **[6]**
- produce a realistic time plan for the unit, from initial investigation through to the working drawings, which includes as much detail as can be projected at this stage, together with evidence of adapting the plan to changing circumstances; **[3]**
- identify primary and secondary sources of information relevant to the problem; **[3]**
- present and analyse edited research to identify strengths and weaknesses in existing products to provide information for later use; **[6]**
- present and analyse edited research to identify the constraints caused by environmental factors, moral issues, social issues, cost factors and market opportunities, to provide information for use in the development of a design specification; **[9]**
- produce a detailed and justified design specification from the objective analysis of research data. **[6]**

SELECTION and RATIONALE of SUITABLE DESIGN OPPORTUNITY	**6**	
Select a suitable design problem and give a detailed introduction which explains thoroughly the reasons for choice; present a detailed design brief and identify important, relevant issues for investigation.	5-6	
Select a suitable design problem and give a reasonable introduction which include some explanation of choice; present a clear design brief and identify some relevant issues for investigation.	3-4	
Select a design problem with little explanation or justification in the introduction; present only a simple design brief and take a superficial view of what investigation is needed.	0-2	
PRODUCTION of TIME PLAN with ADAPTATIONS	**3**	
Produce a realistic time plan for the unit, which include all aspects of work identifiable at this stage with clear evidence of adapting to changing circumstances.	3	
Produce a realistic time plan for the unit, which includes most of the aspects of work identifiable at this stage, though specific detail may be lacking; there is some evidence of adapting to changing circumstances.	2	
Produce a vague plan of action, which lacks detail and shows little awareness of realistic time allocation; little or no evidence of adapting to changing circumstances.	0-1	
IDENTIFICATION of RELEVANT SOURCES of INFORMATION	**3**	
Identify several primary and secondary sources of information and explain their value to the project.	3	
Identify the more obvious primary and secondary sources of information and show some understanding of their relevance to future needs.	2	
Identify few sources of information and lack evidence of understanding of relevance.	0-1	
STRENGTHS and WEAKNESSES in EXISTING PRODUCTS	**6**	
Present thorough analysis of edited research, identify clearly the strengths and weaknesses in existing products and present key information for later use.	5-6	
Present reasonable analysis of edited research, show reasonable awareness of the strengths and weaknesses in existing products and identify some useful information for later use.	3-4	
Present analysis of research which is only at a subjective or low level, strengths and weaknesses of existing products are only recognised at a superficial level and little useful information is gained for later use.	0-2	
IDENTIFICATION of RELEVANT DESIGN CONSTRAINTS	**9**	
Present thorough analysis of the constraints caused by environmental factors, moral issues, social issues, user and manufacturer needs, cost factors and market opportunities, and identify key information for use in the development of a design specification.	7-9	
Present reasonable analysis of the constraints caused by environmental factors, moral issues, social issues, user and manufacturer needs, cost factors and market opportunities, though not all in adequate depth and identify some useful information for use in the development of a design specification.	4-6	
Present analysis of the constraints caused by environmental factors, moral issues, social issues, user and manufacturer needs, cost factors and market opportunities which is only at a subjective or low level, not all important issues are covered and identify little or no useful information for use in the development of a design specification.	0-3	
PRODUCTION of a DESIGN SPECIFICATION	**6**	
Produce a detailed and justified design specification from the objective analysis of research data.	5-6	
Produce an adequate specification covering a range of issues; justification is fair and is based on some objective analysis of research data.	3-4	
Present only a basic or superficial specification; show little evidence of objective analysis of research data and justification is generally subjective or lacking.	0-2	
RECOGNITION, INVESTIGATION and SYNTHESIS of DESIGN OPPORTUNITIES	**33**	

Generation, Modelling and Development of Ideas (57 marks) Candidates should be able to:

- generate and modify a range of innovative ideas using annotated sketching and modelling, leading to a final justified proposal which takes into account aesthetics, suitability of materials, manufacturing processes and fitness for purpose; **[18]**
- produce first generation 2D and 3D models to aid the development of ideas and to establish the validity of their chosen solution; **[9]**
- evaluate ideas and models against the design specification and justify decisions for choice or rejection; **[6]**
- undertake and record the edited results of relevant additional research into information needed for further development of ideas including as appropriate, available materials, types and properties of materials appropriate to specific needs, suitable components, costings, ergonomics and manufacturing processes; **[3]**
- for the chosen solution, consider the influence of relevant design constraints, including environmental factors, moral issues, social issues, cost factors, ergonomics, market opportunities and user and manufacturer needs; **[6]**
- produce high quality working drawings using CAD, in a format appropriate to the type of product and which could be used by a third party with no further guidance; **[9]**
- produce a fluent, well-presented and informative design folio, using a combination of text, graphical techniques and ICT. **[6]**

INNOVATIVE IDEAS to a FINAL JUSTIFIED PROPOSAL	**18**	
Present a wide range of appropriate and annotated innovative ideas which are each developed as far as possible; ideas are modified and developed using analysis and thorough modelling; present a detailed and justified final modification of the solution with careful reference to aesthetics, materials, manufacturing processes, fitness for purpose and the results of testing.	13-18	
Present a good range of appropriate innovative ideas, annotated to varying levels with limited development of each or some of them supported by competent modelling; present a reasonable final modification of the solution, with limited justification and with moderate reference to aesthetics, materials, manufacturing processes, fitness for purpose and the results of testing.	7-12	
Present a limited range of ideas, with little evidence of innovation, using annotation and modelling at a basic level only; ideas are only developed at a simplistic level or not at all; present further limited modification of the final solution with little justification but with some reference to aesthetics, materials, manufacturing processes, fitness for purpose and the results of testing.	0-6	
PRODUCTION of IDEAS and MODELS	**9**	
Produce good quality first generation experimental 2D and 3D models suitable for aiding the development of ideas and for establishing the validity of the initial design thinking and the chosen solution.	7-9	
Produce competent first generation experimental 2D and 3D models, which will aid the development of ideas and provide some information for establishing the validity of the initial design thinking and the chosen solution.	4-6	
Produce poor quality first generation experimental 2D and 3D models, which are of limited use in developing the ideas and which will provide little or no information for establishing the validity of the initial design thinking and the chosen solution.	0-3	
EVALUATION and REASONS for CHOICE	**6**	
Present a detailed and objective evaluation of ideas and models against the design specification and justify all decisions.	5-6	
Present an adequate and mainly objective evaluation of ideas and models against the design specification with some justification of decisions.	3-4	
Present only a limited and mainly subjective evaluation of ideas and models with little or no justification of decisions; little or no reference made to the design specification.	0-2	
ADDITIONAL RESEARCH	**3**	
Undertake and record in concise detail the results of additional research into information needed for further development of ideas including as appropriate, available materials, types and properties of materials relevant to specific needs, suitable components, relevant costings, ergonomics and manufacturing processes; editing is thorough and relevance of material is clear.	3	
Undertake and record in reasonable detail the results of additional research into information needed for further development of ideas including as appropriate, available materials, types and properties of materials relevant to specific needs, suitable components, relevant costings, ergonomics and manufacturing processes; show some evidence of editing and awareness of relevance of material.	2	
Undertake research as appropriate, into available materials, types and properties of materials relevant to specific needs, suitable components, relevant costings, ergonomics and manufacturing processes at a limited or superficial level and results are recorded haphazardly; little evidence of meaningful editing or of understanding relevance of material.	0-1	
INFLUENCE of RELEVANT DESIGN CONSTRAINTS	**6**	
Show careful and perceptive consideration of the influence of design constraints on the chosen solution, including environmental factors, moral issues, social issues, cost factors, ergonomics, market opportunities and user and manufacturer needs.	5-6	
Show adequate consideration of the influence of design constraints on the chosen solution, including environmental factors, moral issues, social issues, cost factors, ergonomics, market opportunities and user and manufacturer needs, though to varying levels.	3-4	
Show only a simplistic consideration of the influence of design constraints on the chosen solution, including environmental factors, moral issues, social issues, cost factors, ergonomics, market opportunities and user and manufacturer needs and not all issues are covered adequately.	0-2	
PRODUCTION of CAD DRAWINGS	**9**	
Produce high quality working drawings using CAD at a high level, in an appropriate format which could be used by a third party with no further guidance.	7-9	
Produce reasonable working drawings using CAD to a reasonable level, in an appropriate format which could be used by a third party with limited further guidance.	4-6	
Produce low quality working drawings in an appropriate format but lacking sufficient detail for making by a third party without significant further guidance; CAD is only used at a low level.	0-3	
PRODUCTION of DESIGN FOLIO	**6**	
Produce a fluent and well-presented folio, using a range of good communication techniques, including ICT.	5-6	
Produce a competent folio that communicates reasonably well using a moderate range of techniques, including ICT.	3-4	
Produce a folio that lacks fluency and clarity, using limited techniques for presenting and analysing information; ICT may have been used at a very low level or not at all.	0-2	
GENERATION, MODELLING and DEVELOPMENT of IDEAS	**57**	
TOTAL	**90**	

5.9 MODULE 2523: MAKING AND EVALUATING

COURSEWORK

C3.2, C3.3 | **LP3.1, LP3.2, LP3.3; PS3.2, PS3.3**

5.9.1 Introduction

This module, the outcome of which is the making, testing and evaluating of the product designed in Unit 2522, is a demanding intellectual learning experience, which builds on the skills learnt in previous modules. The module provides opportunities for the candidate to improve existing practical skills and to develop new ones. It requires intensive testing and evaluation skills and also requires an in-depth understanding of commercial and manufacturing issues in the context of the candidate's own designing.

This module is structured to enable it to be used as a vehicle for the delivery of the Knowledge and Understanding and Focus areas (QCA Subject Criteria for Design and Technology, 1999).

It builds on the skills developed in Module 2519.

This module includes the making, testing and evaluation of the product developed in Module 2522, in any materials/components appropriate to the product.

The outcome of Module 2523 is presented as a folio of design material in an A3 format.

About 10 hours of the time allocation for this module should be allocated to the development of appropriate skills and about 40 hours spent on the assessed piece of work (Unit 2523).

Details of this assessed piece of work (Unit 2523) are given in Section 5.10.

The folio of work for Module 2523 must be submitted to the moderator by the agreed date in the year of the examination.

The work for Unit 2522 and Unit 2523 should be sent together but as separate folios by the agreed date.

5.9.2 Examples of Teaching and Learning Opportunities

Planning and Making

Candidates should be able to:

- produce a thorough plan for making which includes details of materials and processes to be used, health and safety issues, including a risk assessment of procedures and materials involved, and quality control measures;

  s*ample risk assessment of a practical process;*
  identify hazards in the use of certain materials;
  identify aspects of quality control and quality assurance;

- produce a high quality outcome that demonstrates substantial making skills and innovation;

  p*ractise the skills needed for a specific project;*

- record and evaluate progress during making, incorporating changes to the plan or the intended outcome if necessary; show evidence of the use of well planned quality control processes in the making of their product and the use of a variety of appropriate materials, tools and equipment in a safe and efficient manner;

  d*iscuss ways of keeping a record of practical work;*
  hold regular discussions during the making stages;

Testing and Evaluation

Candidates should be able to:

- show evidence of user testing of their final solution against the specification to objectively identify strengths and weaknesses;

  e*xamine the difference between subjective and objective criteria and their use in evaluation;*
  identify opportunities for genuine user tests;

- show a positive and responsive attitude in the face of first hand external evaluation;

  g*roup discussion on opportunities for external evaluation;*

- present detailed drawn modifications to improve the identified weaknesses in their one-off prototype;

  p*ractice exercise for presenting detailed modifications for a chosen product;*

- prepare a full cost analysis and compare this with previously conducted market research;

  e*xamine the factors in cost analysis;*

- show a good understanding of the potential of the product for industrial production and present drawn details of the modifications necessary to make the prototype suitable for commercial manufacture;

  i*dentify the constraints of commercial production;*
  investigate common manufacturing processes and their constraints;
  explore specific requirements when designing for injection moulding;
  identify features of products designed for batch production.

The examples of teaching and learning opportunities (given in italics above) are not prescribed or a complete set but are intended only as a guide to the type of teaching and learning experiences that would enhance or develop those skills required by candidates to produce the assessed work in Unit 2523.

5.10 UNIT 2523: MAKING AND EVALUATING

GUIDANCE AND MARKING CRITERIA

Unit 2523 is marked out of 90.

It involves the making, testing and evaluation of the product developed in Unit 2522, in any materials/components appropriate to the product.

Candidates are required to make, test and evaluate the product they designed in Unit 2522. This includes a detailed plan for manufacture, and the making of the final one-off prototype. This prototype must be thoroughly tested and evaluated against the original specification, to identify strengths and weaknesses in the solution, leading to recommended improvements and modifications necessary to make the product suitable for commercial manufacture. This unit builds upon the work undertaken in earlier modules and candidates are expected to demonstrate a high level of making, testing and evaluation skills.

The outcome must be a working prototype that can be tested in use. Conceptual models are not acceptable.

Candidates need to present a folio of design work providing evidence of the planning, making, testing and evaluation of the design solution.

The folio must be presented to an A3 size, using a range of appropriate communication techniques, including photography and the use of ICT. This work should be presented in approximately 15 sheets, including detailed photographic evidence of the realised solution.

The folio should contain written and graphic material with the balance appropriate to this stage in the design process.

No three-dimensional material should be included in the folder; evidence of stages of making and testing should be in the form of good quality mounted photographs.

Photographic evidence of the realised solution is required. This should consist of:

- one sheet, containing 2 or 3 clear photographs (6” x 4”), showing the whole product from various angles;
- one sheet, containing 2 or 3 clear photographs (6” x 4”), or more if required, to show close-up detail of construction features and the quality of finish.

Videocassettes, audiocassettes, computer disks or CD-ROMs must not be included for moderation purposes. Plastic individual sleeves must not be used for folio sheets.

5.10.1 Marking Criteria

Planning and Making **[69 marks]**

- Production of plan [9]
- Production of high quality outcome [51]
- Record of progress [9]

Testing and Evaluation **[21 marks]**

- Evidence of user testing against specification [6]
- Response to external evaluation [3]
- Modifications to one-off prototype [3]
- Preparation and comparison of cost analysis [3]
- Potential and modifications for commercial manufacture [6]

5.10.1.1 Planning and Making [69 marks]

Production of plan **[max 9 marks]**

Candidates produce a thorough plan for making which includes details of materials and processes to be used, health and safety issues, including a risk assessment of procedures and materials involved, and quality control measures.

Candidates:

- produce a thorough plan for making, which includes details of materials and processes to be used, health and safety issues, including a risk assessment of procedures and materials involved, and sound quality control measures; [7-9]
- produce a reasonable plan for making which includes, at a moderate level, details of materials and processes to be used, some health and safety issues, including an attempt at risk assessment of procedures and materials involved, and some moderate quality control measures; [4-6]
- produce a superficial plan for making which includes, at a limited level, some details of materials and processes to be used, few health and safety issues, little or no attempt at risk assessment of procedures and materials involved, or of quality control measures. [0-3]

Production of high quality outcome **[max 51 marks]**

Candidates produce a high quality outcome that demonstrates substantial making skills and innovation.

Candidates:

- demonstrate a high level of skill in the making of a well-made product; the outcome shows clear evidence of innovation; [34-51]
- demonstrate a sound level of skill in the making of a reasonably well-made product; there is some evidence of innovation; [18-33]
- demonstrate a generally low level of skill in the making of a poor or incomplete product; there is little or no evidence of innovation. [0-17]

Record of progress **[max 9 marks]**

Candidates record and evaluate progress during making, incorporating changes to the plan or the intended outcome if necessary; show evidence of the use of well planned quality control processes in the making of their product and the use of a variety of appropriate materials, tools and equipment in a safe and efficient manner.

Candidates:

- record and evaluate progress thoroughly but concisely during their making, and incorporate changes to the plan or the intended outcome if necessary; include evidence of the application of well-planned quality control processes to their product making and evidence of the use of appropriate materials, tools and equipment in a safe and efficient manner; [7-9]
- record and evaluate progress during their making, and show some awareness of the possible need to incorporate changes to the plan or the intended outcome; include evidence of the application of limited quality control processes to their product making and evidence of the use of appropriate materials, tools and equipment in a safe and reasonably efficient manner; [4-6]
- present little evidence of recording and evaluating progress during their making, and show little or no awareness of the possible need to incorporate changes to the plan or the intended outcome; include little or no evidence of the application of even limited quality control processes in the making of their product and evidence of the use of a limited range of materials, tools and equipment in a fairly safe and efficient manner. [0-3]

5.10.1.2 Testing and Evaluation [21 marks]

Evidence of user testing against specification **[max 6 marks]**

Candidates show evidence of user testing of their final solution against the specification to objectively identify strengths and weaknesses.

Candidates:

- show evidence of thorough user testing of their final solution against the specification and objectively identify strengths and weaknesses; [5-6]
- show evidence of reasonable user testing of their final solution against the specification and identify with moderate objectivity some strengths and weaknesses; [3-4]
- show limited or no evidence of user testing of their final solution against the specification and identify few if any strengths and weaknesses at a subjective level. [0-2]

Response to external evaluation **[max 3 marks]**

Candidates show a positive and responsive attitude in the face of first hand external evaluation.

Candidates:

- show a positive and responsive attitude in the face of first hand external evaluation; [3]
- show a reasonable response in the face of first hand external evaluation; [2]
- show little awareness of the need to respond to external evaluation or fail to involve external evaluation; any external evaluation is reported and not first hand. [0-1]

Modifications to one-off prototype **[max 3 marks]**

Candidates present detailed drawn modifications to improve the identified weaknesses in their one-off prototype.

Candidates:

- present detailed drawn modifications to improve the identified weaknesses in their one-off prototype; [3]
- present some drawn modifications to improve the identified weaknesses in their one-off prototype; [2]
- show little awareness of the modifications needed to improve any weaknesses in their one-off prototype. [0-1]

Preparation and comparison of cost analysis [max 3 marks]

Candidates prepare a full cost analysis and compare this with previously conducted market research.

Candidates:

- prepare a full cost analysis showing an understanding of commercial issues and compare this with previously conducted market research; [3]
- prepare a reasonable cost analysis showing a limited understanding of commercial issues and compare this with previously conducted market research; [2]
- show no understanding of costing issues or prepare a superficial cost analysis and compare this subjectively with any previously conducted market research. [0-1]

Potential and modifications for commercial manufacture [max 6 marks]

Candidates show a good understanding of the potential of the product for industrial production and present drawn details of the modifications necessary to make the prototype suitable for commercial manufacture.

Candidates:

- show a good understanding of the potential of the product for industrial production involving scale of production, time and cost constraints, suitable materials and manufacturing processes and present full drawn details of the modifications necessary to make the prototype suitable for commercial manufacture; [5-6]
- show a reasonable understanding of the potential of the product for industrial production involving scale of production, time and cost constraints, suitable materials and manufacturing processes and present some limited drawn details of the modifications necessary to make the prototype suitable for commercial manufacture; [3-4]
- show little or no understanding of the potential of the product for industrial production involving scale of production, time and cost constraints, suitable materials and manufacturing processes and present little or no detail of any modifications necessary to make the prototype suitable for commercial manufacture. [0-2]

2523 Making and Evaluating – details provided for internal Centre use only

Planning and Making (69 marks)

Candidates should be able to:

- produce a thorough plan for making which includes details of materials and processes to be used, health and safety issues, including a risk assessment of procedures and materials involved, and quality control measures; **[9]**
- produce a high quality outcome that demonstrates substantial making skills and innovation; **[51]**
- record and evaluate progress during making, incorporating changes to the plan or the intended outcome if necessary; show evidence of the use of well planned quality control processes in the making of their product and the use of a variety of appropriate materials, tools and equipment in a safe and efficient manner; **[9]**

PRODUCTION of PLAN	**9**	
Produce a thorough plan for making, which includes details of materials and processes to be used, health and safety issues, including a risk assessment of procedures and materials involved, and sound quality control measures.	7-9	
Produce a reasonable plan for making which includes, at a moderate level, details of materials and processes to be used, some health and safety issues, including an attempt at risk assessment of procedures and materials involved, and some moderate quality control measures.	4-6	
Produce a superficial plan for making which includes, at a limited level, some details of materials and processes to be used, few health and safety issues, little or no attempt at risk assessment of procedures and materials involved, or of quality control measures.	0-3	
PRODUCTION of HIGH QUALITY OUTCOME	**51**	
Demonstrate a high level of skill in the making of a well-made product; the outcome shows clear evidence of innovation.	34-51	
Demonstrate a sound level of skill in the making of a reasonably well-made product; there is some evidence of innovation.	18-33	
Demonstrate a generally low level of skill in the making of a poor or incomplete product; there is little or no evidence of innovation.	0-17	
RECORD of PROGRESS	**9**	
Record and evaluate progress thoroughly but concisely during their making, and incorporate changes to the plan or the intended outcome if necessary; include evidence of the application of well-planned quality control processes to their product making and evidence of the use of appropriate materials, tools and equipment in a safe and efficient manner.	7-9	
Record and evaluate progress during their making, and show some awareness of the possible need to incorporate changes to the plan or the intended outcome; include evidence of the application of limited quality control processes to their product making and evidence of the use of appropriate materials, tools and equipment in a safe and reasonably efficient manner.	4-6	
Present little evidence of recording and evaluating progress during their making, and show little or no awareness of the possible need to incorporate changes to the plan or the intended outcome; include little or no evidence of the application of even limited quality control processes in the making of their product and evidence of the use of a limited range of materials, tools and equipment in a fairly safe and efficient manner.	0-3	
PLANNING and MAKING	**69**	

Testing and Evaluation (21 marks)

Candidates should be able to:

- show evidence of user testing of their final solution against the specification to objectively identify strengths and weaknesses; **[6]**
- show a positive and responsive attitude in the face of first hand external evaluation; **[3]**
- present detailed drawn modifications to improve the identified weaknesses in their one-off prototype; **[3]**
- prepare a full cost analysis and compare this with previously conducted market research; **[3]**
- show a good understanding of the potential of the product for industrial production and present drawn details of the modifications necessary to make the prototype suitable for commercial manufacture; **[6]**

EVIDENCE of USER TESTING AGAINST SPECIFICATION	**6**	
Show evidence of thorough user testing of their final solution against the specification and objectively identify strengths and weaknesses.	5-6	
Show evidence of reasonable user testing of their final solution against the specification and identify with moderate objectivity some strengths and weaknesses.	3-4	
Show limited or no evidence of user testing of their final solution against the specification and identify few if any strengths and weaknesses at a subjective level.	0-2	
RESPONSE to EXTERNAL EVALUATION	**3**	
Show a positive and responsive attitude in the face of first hand external evaluation.	3	
Show a reasonable response in the face of first hand external evaluation.	2	
Show little awareness of the need to respond to external evaluation or fail to involve external evaluation; any external evaluation is reported and not first hand.	0-1	
MODIFICATIONS to ONE-OFF PROTOTYPE	**3**	
Present detailed drawn modifications to improve the identified weaknesses in their one-off prototype.	3	
Present some drawn modifications to improve the identified weaknesses in their one-off prototype.	2	
Show little awareness of the modifications needed to improve any weaknesses in their one-off prototype.	0-1	
PREPARATION and COMPARISON of COST ANALYSIS	**3**	
Prepare a full cost analysis showing an understanding of commercial issues and compare this with previously conducted market research.	3	
Prepare a reasonable cost analysis showing a limited understanding of commercial issues and compare this with previously conducted market research.	2	
Show no understanding of costing issues or prepare a superficial cost analysis and compare this subjectively with any previously conducted market research.	0-1	
POTENTIAL and MODIFICATIONS for COMMERCIAL MANUFACTURE	**6**	
Show a good understanding of the potential of the product for industrial production involving scale of production, time and cost constraints, suitable materials and manufacturing processes and present full drawn details of the modifications necessary to make the prototype suitable for commercial manufacture.	5-6	
Show a reasonable understanding of the potential of the product for industrial production involving scale of production, time and cost constraints, suitable materials and manufacturing processes and present some limited drawn details of the modifications necessary to make the prototype suitable for commercial manufacture.	3-4	
Show little or no understanding of the potential of the product for industrial production involving scale of production, time and cost constraints, suitable materials and manufacturing processes and present little or no detail of any modifications necessary to make the prototype suitable for commercial manufacture.	0-2	
TESTING and EVALUATION	**21**	
TOTAL	**90**	

5.11 MODULE 2524: PRODUCT DESIGN 2

C3.1a, C3.1b, C3.2, C3.3; IT3.1, IT3.2, IT3.3.

WO3.1, WO3.2, WO3.3

5.11.1 Introduction

The subject content of this module is focused towards products and applications, their analysis and development in respect of:

- materials, components and their uses;
- making and manufacturing processes;
- industrial and commercial practices.

It is essential that materials and components are taught from the perspective of analysing and designing modern products that satisfy identified consumer needs. This leads to the design for making of prototype products and should be taught within the context of:

- product development;
- industrial and commercial practices.

Candidates should be familiar with a range of materials from the pliable to the more resistant as used in the manufacture of commonly available products and be able to make critical comparisons between them.

Candidates' experience should be a progression from Advanced Subsidiary GCE. This should result in the ability to use knowledge and understanding within the context of designing for the making of products and be complementary to the work undertaken in Modules 2522 and 2523.

5.11.2 Question Paper (Unit 2524)

Section A presents candidates with **seven** questions, which are product context based. These are set within the specific material areas of: wood, metals, plastics, graphics (paper/boards) and textiles and focused on materials, processes and components.

The seven questions will be:

- one wood;
- one metal;
- one plastics;
- two graphics (paper/boards);
- two textiles.

Candidates are required to answer any **two** questions.

Section B assesses the abilities of candidates to make immediate design thinking responses to a given situation. It is intended to be a discriminator in identifying those candidates who can effectively use their experiences and knowledge in designing and making to successfully 'self start' on a design task.

Candidates are required to:

- identify the criteria that a successful solution must satisfy;
- present initial ideas that will address the given situation;
- justify a proposed route for development.

Candidates are **not** required to produce a fully developed final solution ready for prototype production. Up to **five** design problems are posed. Candidates are required to respond to **one** given situation. The situations posed have a common mark structure and guidance is printed on the question paper indicating the allocation of marks.

Outlines of each given situation are sent to Centres approximately one month in advance of the examination date.

Candidates should make themselves aware of the given situations by exploring the background and nature of each. Outlines will also be posted on the OCR website: (www.ocr.org.uk).

Candidates may **not** take into the examination room any prepared material. The preparation for the examination should be carried out by the candidate. It is not intended that the preparatory work should be formally taught.

5.11.3 Section A Content

5.11.3.1 Wood: Composition and Characteristics

Candidates should use the experiences gained in Advanced Subsidiary study and further develop their knowledge and understanding as applied to product design of:

the use of a range of different timber species, their merits and limitations, their selection for differing product needs, relating to cellular structure, composition, relative strengths, aesthetic and visual appearance:

• the modification of properties through changes in form and performance characteristics, for example laminating to satisfy design needs;	*establish the criteria for selecting different timbers to suit a range of domestic products;* *identify and record where laminating techniques are used in furniture and building constructions, for example rockers on a rocking chair, timber beams;* *understand how/why certain species have been used in the past to meet design needs i.e damp/wet conditions, resistance to decay/fire, lightness v strength – aircraft, boats;* *leisure/recreational equipment, for example teak – acid resistance, elm – withstands wet/dry conditions;*

• the use of the following characteristics, where appropriate as applied to the properties of timbers and timber products: hardness, flexibility, tensile strength, compressive strength, sheer strength, strength to weight ratio, chemical resistance, elasticity, stiffness and impact resistance when selecting materials;	
• up to date developments of new forms of timber products and their potential applications.	*finger jointing to create usable timber lengths from short ends, elimination of defects, joining techniques, for example 'biscuits';* *consider how developments are likely to affect product design and product life.*

In addition, all candidates will need to have the knowledge specified in Sections 5.11.3.6 – 5.11.3.11 for their material area(s). See pages 113-121.

5.11.3.2 Metals: Composition and Characteristics

Candidates should use the experiences gained in Advanced Subsidiary study and further develop their knowledge and understanding as applied to product design of:

• the merits and limitations of using the following range of metals to satisfy design needs: stainless steels, cast iron, brasses and aluminium alloys and tin alloys – their structure, composition and relative strengths;	*identify examples of the uses of metals in drink/food industry packaging, e.g. aluminium alloy in two piece drinks can, tin plated onto steel for a three piece food tin;*
• the role of heat treatment in the modification of working properties to achieve new and different performance characteristics;	*understand, and use as appropriate, how the microstructure, processes of age and work hardening, tempering, annealing and normalising can be achieved through the application of heat;* *apply their understanding to their own prototyping decisions;*
• the use of the following terms, where appropriate as applied to the properties of metals: hardness, brittleness, tensile strength, plasticity, compressive strength, sheer strength, strength to weight ratio, stiffness and impact resistance, and chemical resistance when selecting materials;	*establish and record how these properties are utilised in products, for example couplings, bench vices etc.;* *use published data relating to the properties opposite in the selection of metals for product needs;* *establish simple tests to test these properties and use the results as appropriate in their own prototyping;*
• up to date developments of new metal alloys and their potential application.	*consider how developments are likely to affect product design and product life.*

In addition, all candidates will need to have the knowledge specified in Sections 5.11.3.6 – 5.11.3.11 for their material area(s). See pages 113-121.

5.11.3.3 Plastics: Composition and Characteristics

Candidates should use the experiences gained in Advanced Subsidiary study and further develop their knowledge and understanding as applied to product design of:

the use of, merits and limitations of foam boards, rigid foams, PTFE-type of polymerisation, plasticizers and co-polymers as appropriate and opportunities these create when designing:

• the benefits of combining two or more polymers to enhance product performance;	*analyse and record where co-polymers have advantageous properties, i.e. ABS co-polymers as used in design and making;*
• the role of additives and fillers and the opportunities these create when designing;	*build up data on the use of fillers, for example plasticizers in PVC, pigments and stabilisers;* *identify how anti-blocking agents, slip agents, antioxidants improve basic properties;*
• the use of the following characteristics, where appropriate as applied to the properties of plastics: hardness, brittleness, tensile strength, plasticity, compressive strength, sheer strength, strength to weight ratio, chemical resistance of plastics, elasticity, stiffness and impact resistance;	*use published data relating to the above properties when selecting plastics to meet design needs;* *identify and record testing methods to achieve quantitative results for these and use as appropriate in the selection of materials for their own prototyping;* *consider the effect of cross linking between chains and its effect on physical properties;*
• up to date developments of new materials and their potential applications.	*determine how these developments are likely to affect product design and product life.*

In addition, all candidates will need to have the knowledge specified in Sections 5.11.3.6 – 5.11.3.11 for their material area(s). See pages 113-121.

5.11.3.4 Graphics: The Use of Papers/Boards

Candidates should use the experiences gained in Advanced Subsidiary study and further develop their knowledge and understanding as applied to product design of:

the use of graphics (papers/boards) – solid boards, laminates, corrugation and cellular forms:

• the merits and limitations for use in product design of these materials relating to cellular structure, composition and relative strengths and the opportunities these create when designing;	
• the modification of properties through changes in form and performance characteristics by laminating and folding techniques;	*identify how these properties determine the selection and use materials for packaging, display and modelling;* *devise simple tests to test the properties of boards used for packaging, display and modelling; i.e. loading tests;* *establish the reasons for laminating boards used in products, i.e. surface finish/protections;* *identify and record printing techniques used for packaging and display products made from boards, i.e. as used to promote products;*
• use the following characteristics where appropriate, as applied to properties of paper/boards: hardness, tensile strength, plasticity, compressive strength, sheer strength, strength to weight ratio, chemical resistance of materials, elasticity, stiffness and impact resistance, when selecting materials;	
• chemical resistance of materials, elasticity, stiffness and impact resistance;	*appropriate in selection of materials for their own prototyping;*
• up to date developments of new materials and their application.	*determine how developments are likely to affect product design and product life.*

In addition, all candidates will need to have the knowledge specified in Sections 5.11.3.6 – 5.11.3.11 for their material area(s). *See pages 113-121.*

5.11.3.5 Textiles: Composition and Characteristics

Candidates should use the experiences gained in Advanced Subsidiary study and further develop their knowledge and understanding as applied to product design of:

Fibres

Natural fibres – plant (cellulosic) cottons, flax, jute; animal protein – wool, silk, hair fibres – mohair, cashmere, angora and inorganic fibres – natural polymers – cellulose, rubbers;

Man-made fibres – synthetic fibres, e.g. chlorofibres, olefins, vinyls – PVC;

The use of inorganic fibres derivatives – glass, carbon, metallic fibres;

• the merits and limitations for use in product design of these fibres/materials;	*natural fibres – identify and record and use as appropriate. jute, wild silks and hair fibres;*
• the performance characteristics of fibres – reaction to light; alkali, acid and other chemicals, micro-organisms; the effects of moisture; tenacity and elasticity, and the design opportunities and restrictions these create.	*man-made fibres – identify and record as appropriate, the application of the listed man-made fibres in textile products;* *identify how these performance characteristics are used in textile products.*

Yarns

The use of yarn types – rotor, ring yarns – core and fancy, yarn numbering, texturing systems, structural and lustre effect;

• merits and limitations for use in product design of these materials;	
• selecting fibres and yarns to meet design and manufacturing requirements.	*examine a range of fibres and yarns to identify performance characteristics – tensile strength, elasticity, insulation, lustre, absorbancy etc. products;* *use manufacturers' data and/or testing to determine their appropriateness for design requirements.*

Fabric Construction

The methods and production of woven, non-woven and knitted fabrics, woven processes piqué, colour woven fabrics – pin stripe, checks and tartan; knitted fabric processes, different types of knitted fabric, for example weft, warp/rib knitted – raschel net, raschel lace;

An awareness of needle felts, stitch bonded fabrics and tufting. Open work fabrics such as lace matting etc;

- merits and limitations of the use of these materials in textile products and the design opportunities they offer;
- selecting fabrics to meet design and manufacturing requirements;
- use of the following characteristics where appropriate, as applied to fibres and fabrics identified above: tensile strength, resilience, thermal conductivity, insulation, chemical resistance, elasticity, absorbency, shrinkage, air permeability, water proofing and water vapour permeability, washability, resistance to sunlight and fading when selecting for products;
- up to date developments of new forms of fibres and fabrics, e.g. smart and modern fabrics and micro fibres, manufacturing methods and their applications.

identify and record the variety of woven, non-woven and knitted fabric constructions and their application to textile products;

identify and record the relevant performance characteristics determining the selection of fabrics for applications;

use manufacturers' data and other sources relating to the above performance characteristics to enhance the selection process for product requirements.

In addition, all candidates will need to have the knowledge specified in Sections 5.11.3.6 – 5.11.3.11 for their material area(s). *See pages 113-121.*

5.11.3.6 Surface Finishes

Candidates should use the experiences gained in Advanced Subsidiary study and further develop their knowledge and understanding as applied to product design of:

- the common processes for surface protection of materials, resistance to decay, wear and absorption as appropriate;

– for woods;	*exterior and interior finishes for timber products – polishes, lacquers, oils, chemical preservation, pressure impregnation;*
– for metals;	*anodising, electroplating, galvanising, plastic coating and paints;*
– for plastics;	*finishes that are the outcome of moulding and forming processes;*
– for graphics (paper and boards);	*laminating, embossing, stamping, roller impressions, and plastic coating;*
– for textiles;	*finishes that are the outcome of weaving and knitting processes, raising glazing, calendering, shrinkage, pressing, pleating, stone and sand washing;* *anti-static, flame resistance, anti-pilling, stain resistance, easy care, laminating, hygenic sanitising;*

- the selection of suitable finishes for prototypes being developed.

selecting finishes that meet the needs of products – aesthetic considerations, visual appearance, function, durability – ease of preparation and application;

explore and test a range of finishes suitable for a product under development.

5.11.3.7 Principles and Techniques of Testing

Candidates should use the experiences gained in Advanced Subsidiary study and further develop their knowledge and understanding as applied to product design of:

Testing

- simple testing of materials/components as appropriate to enable candidates to predict performance in prototype work.

establish an awareness of materials/components used in products across the range of materials being studied;

establish and use simple 'fault finding' tests on materials/components used in prototyping;

the awareness of non destructive and destructive testing regimes as appropriate to materials studied;

the use of published data as a guide to material selection;

the awareness of how ultrasonic, photo-elastic tests can provide data for improved design and product life;

use published data to understand stiffness v strength, strength v density, strength v costs 'maps' to identify promising materials for a given application.

Quality Control and Quality Assurance

- the use of quality control and quality assurance as applied in manufacturing situations;
- the establishing of the criteria that underpin quality control for the designer and maker, and their impact on the user and the environment;

explore product issues as part of the candidate's research work in Modules 2522 and 2523;

explore and record the types of quality control checks that are applied in the product area being prototyped in Modules 2522 and 2523;

how industry scales up quality control and quality assurance for large scale productions in, for example the electronics industry and textile industries to include aspects such as quality circles, total quality management, quality controls – limits and tolerances;

• exploring the detailed design of control systems, loops, feedback control functions to achieve designed outcomes.	*assess the merits and limitations of these in product manufacture;* *apply and assess these aspects to their own prototype solution;* *use schematic layouts where appropriate, to aid the interpretation of their designing and making processes.*

5.11.3.8 Hand and Commercial Methods of Preparing, Processing, Manipulating and Combining Materials to Enhance their Properties

Candidates should use the experiences gained in Advanced Subsidiary study and further develop their knowledge and understanding as applied to product design of:

Joining– Permanent and Non Permanent Joining Techniques

• the use of plastic welding, heat fusion and chemical bonding techniques, use of fastenings, e.g. seams, laces, rouleau loops, commercial methods of joining seams, e.g. overlocking, use of adhesives and KD fittings in timber products.	*through product analysis, identify and record where these are effectively used in the manufacture of products, for example packaging foods, flooring materials, building construction, etc;* *examine the use of new machine joining techniques for composite materials, for example techniques of joining small lengths of timber to eliminate waste etc.*

Wasting

• apply the knowledge gained in Advanced Subsidiary study to their prototype products in Module 2523;	*identify how wasting techniques influence design decisions and manufacturing costs;* *examine how fabrication techniques can influence the costs of products and where appropriate, the making of their own prototypes;*
• identify how industry uses ICT to minimise waste when using wasting techniques.	*CAD packages to optimise tessellated layout on sheet material patterns, nets, etc.*

Forming

• use product analysis to create an understanding of common processes for reinforcing and/or manipulating materials to improve strength/durability – GRP, laminating, corrugation, interfacing, reinforced stitching, arrowhead linings, reinforcement of identified key areas of products and the design opportunities these create;	*identify and record as appropriate, where these processes improve the strength and durability of products, for example in leisure/sports equipment, boat building etc;* *apply knowledge gained to their designing and prototyping situation in Modules 2522 and 2523;*
• use product analysis to determine where heat (melt) and heat/wet forming are used in product manufacture – polymer melt processes, molten metal forming (casting), heat/wet forming for felts ,giving thermoplastic fibres and yarns additional bulk by heat setting, permanent heating and the design opportunities these create.	*manufacture of thermoplastic polymeric articles by extrusion, blow and injection moulding, vacuum forming, for example in component parts, component casings, fizzy drink bottles, chocolate box trays;* *manufacture of components from thermosetting plastics by compression and/or transfer moulding, for example light switches, lighting components;* *manufacture of metallic products using sand casting, lost wax casting, continuous pressure die casting, for example in turbine blades, jewellery production, model toy cars and trains;* *heat/wet forming processes to shape felt products.*

Detailed Manufacturing Methods When Combining or Processing Materials

• different levels of production taking into account decisions and where appropriate, traditional, modern and emerging methods of manufacturing and assembling components to form completed products when made from boards, fibres/fabrics, plastics, wood and metals;	*for board and laminates – stamping, embossing, plastic coating, modifications to achieve flexibility, rigidity, and extended product life;* *for textiles – pattern construction or adaptation– sizing, grading, lay-planning etc. – machine embroidery techniques enhancing the quality of finished products; use of hand embroidery processes – beading, silk painting, reverse appliqué, shisha; industrial processes to achieve water repellence, stain and flame resistance, anti static, moth proofing, anti-pilling, rot proofing etc.;* *for plastics – GRP, transfer moulding, rotational moulding, calendering and strip bending;* *for woods – surface treatments for timbers – pressure impregnation, laminating and steam bending, CAM routering;* *for metals – forging, sand/lost wax casting, surface treatments, processing – drilling, turning, grinding, spark erosion, laser cutting and sintering;*
• combining materials to create electrical and thermal insulation.	*identify how electrical and thermal insulation is achieved in a variety of products that combine a number of materials in their construction, for example 13 amp plug.*

5.11.3.9 Industrial and Commercial Practices

Candidates should use the experiences gained in Advanced Subsidiary study and further develop their knowledge and understanding as applied to product design of:

Progression from Prototype to Volume Production

• manufacturing systems including one-off, batch, high volume, bought-in parts, leading to an understanding of differing levels of production and taking account of economic factors;	*the use of standardised components by a window manufacturer;* *the manufacture/assembly of a motor car using bought-in parts;* *the use of bought-in components in the manufacture of recreational/sports kit bags;*
• the application of ICT (CAD/CAM) as appropriate, to the production of the prototype in Modules 2522 and 2523 and a knowledge of the use of computers in industrial and commercial management, design and production;	
• component drawings in a variety of forms, appropriate to the material/product, i.e. isometric, orthographic, axonometric, patterns and sketches;	*choosing the most appropriate graphic communication format for the task in hand;* *the use of patterns/templates in product manufacture;*
• the compilation and use of detailed working and procedural drawings.	*producing working drawings for their own product;* *gain an awareness of the use of drawings by local industries;* *the use of planning charts in the management of product manufacture.*

Methods of Management Control for Volume Production

Candidates should use the experiences gained in Advanced Subsidiary study and further develop their knowledge and understanding as applied to product design of:

• production planning and control systems;	*progressive bundle, Unit Production System, Toyota System and reasons why industries adopt these systems;*
• the use of ICT in stock control, component ordering and product tracking through the production process;	*the use of 'just-in-time' (JIT) in manufacturing;*

• the economy in product design in relation to the use of materials, components and processing costs and its impact on marketing.	*examine products to see how minimum use of materials has not compromised required strength or durability;* *examine products to see how optimum use of components has been achieved.*

Service to the Customer

Candidates should use the experiences gained in Advanced Subsidiary study and further develop their knowledge and understanding as applied to product design of:

• the responsibility for reliability and life time functioning of products, warranties, guarantees, after-sales care and design for maintenance.	*explore, record and use as appropriate, responsibilities of designers/manufacturers for reliability, functional life and after-sales maintenance on a selected range of products, for example domestic equipment – jug kettles, irons, food mixers, electrical tools – screwdrivers, drills, and garden equipment, clothing and upholstery.*

5.11.3.10 Health and Safety of Designers, Makers, Users and the Public

Candidates should use the experiences gained in Advanced Subsidiary study and further develop their knowledge and understanding as applied to product design of:

Progression from Prototype to Volume Production

• developing and using safe working practices including identifying hazards and making risk assessments during the production of their own artefacts;	*identification of risks in industrial processes such as welding, wood machining, guillotining, dyeing, printing, assembling and finishing;*
• considering the future safety of would-be purchasers, users and the possible impact that their prototype could have on communities and the environment;	*use an awareness to assess the potential impact of their own artefact(s) as part of the evaluation process;*
• effective labelling of product care – use of national and international codes, effects of cleaning agents and chemicals.	*examine and use appropriately national and international codes, safety labelling for materials being used in product or in prototypes under construction.*

5.11.3.11 Products and Applications

The study of aesthetics should not be considered in isolation but should pervade the whole course.

Candidates should use the experiences gained in Advanced Subsidiary study and further develop their knowledge and understanding as applied to product design of:

Form and Function of Differing Products

• using existing products to identify how aesthetic attitudes to style/form/fashion have influenced product design;	
• how the constraint of cost may influence design decisions that affect form whilst retaining function;	*identify a range of products and determine how these aspects have been used, for example component parts of promotional and general use pens (biros), promotional clothing etc.;*
• the role of the designer;	*analyse the interface between client/designer/manufacturer and user;* *identify the moral, economic, social and environmental responsibilities placed on product designers;*
• the role of ergonomic/anthropometric data in the creation and styling of products;	*identify a range of products and determine how these aspects have been used;*
• how manufacturing processes provide design opportunities and can influence the choice of material and form of the product.	*compare a rolled metal screw bottle top for a drinks bottle with an injection moulded plastic one that performs the same function;* *compare a glass milk bottle with a laminated board milk carton.*

Enhancement Techniques used in Designing and the use of New Technologies

• a variety of graphic enhancement techniques;	*use rendering, air brushing, marker pens as appropriate;* *understand graphical techniques used in pre-launch publicity;*
• good practice in using ICT aided graphic representations.	*explore and use appropriately ICT graphic imagery to convey data.*

Value Issues

• the impact of value issues – technical, economic, aesthetic, social, environmental and moral implications – within technological solutions.	*demonstrate an awareness of these issues and their potential impact on technological activities, including their potential impact on prototype solutions;* *examine the environmental issues of products such as off-road vehicles or disposable drinking cups or promotional clothing;* *examine the implications of sustainable and non-sustainable resources in product manufacture.*

5.11.4 Section B Content

Section B assesses the abilities of candidates to make immediate design thinking responses to a given situation. It is intended to be a discriminator in identifying those candidates who can effectively use their experiences and knowledge in designing and making to successfully 'self start on a design task.

Candidates are required to:

- identify the criteria that a successful solution must satisfy;
- present initial ideas that will address the given situation;
- justify a proposed route for development.

Candidates are **not** required to produce a fully developed final solution ready for prototype production. Up to **five** design problems are posed. Candidates are required to respond to **one** given situation. The situations posed have a common mark structure and guidance is printed on the question paper indicating the allocation of marks.

Outlines of each given situation are sent to Centres approximately one month in advance of the examination date.

Candidates should make themselves aware of the given situations by exploring the background and nature of each. Outlines will also be posted on the OCR website: (www.ocr.org.uk).

Candidates may **not** take in to the examination room any prepared material. The preparation for the examination should be carried out by the candidate. It is not intended that the preparatory work should be formally taught.

5.12 MODULE 2525: SYSTEMS AND CONTROL TECHNOLOGY 2 (THE DESIGN OF ENERGY DEPENDENT PRODUCTS)

C3.1a, C3.1b, C3.2, C3.3; N3.1, N3.2, N3.3; IT3.1, IT3.2, IT3.3.	**WO3.1, WO3.2, WO3.3.**

5.12.1 Introduction

The subject content of the module is focused towards systems and control, their applications and analysis in respect of:

- systems and their applications;
- selection and application of components and materials used within control systems;
- industrial and commercial practices.

It is essential that systems, their components and materials are taught from the perspective of analysing and designing modern control systems, their design and function within products and/or prototypes within the context of:

- systems development;
- industrial and commercial practices.

Candidates' experience should be a progression from Advanced Subsidiary GCE. This should result in the ability to use knowledge and understanding within the context of designing for the making of systems and be complementary to the work undertaken in Modules 2522 and 2523.

5.12.2 Question Paper (Unit 2525)

Section A of the written paper presents candidates with **six** questions, which are systems context based. These are set within the specific areas of: electrical and electronic systems, mechanical systems, pneumatic systems.

The six questions will be:

- two electrical and electronic;
- two mechanical;
- two pneumatic.

Candidates are required to answer any **two** questions.

Section B assesses the abilities of candidates to make immediate design thinking responses to a given situation. It is intended to be a discriminator in identifying those candidates who can effectively use their experiences and knowledge gained through the course in designing and making to 'self start' successfully on a design task.

Candidates are required to:

- identify the criteria that a successful solution must satisfy;
- present initial ideas that will address the given situation;
- justify a proposed route for development.

Candidates are **not** required to produce a fully developed final solution ready for prototype production. Up to **three** design situations are posed. Candidates are required to respond to **one** given situation. The situations posed have a common mark structure and guidance is printed on the question paper indicating the allocation of marks.

Outlines of each given situation are sent to Centres approximately one month in advance of the examination date.

Candidates should make themselves aware of the given situations by exploring the background and nature of each. Outlines will also be posted on the OCR website: (www.ocr.org.uk).

Candidates may **not** take into the examination room any prepared material. The preparation for the examination should be carried out by the candidate. It is not intended that the preparatory work should be formally taught.

Candidates can use the formulae given in the formulae sheet.

5.12.3 Section A Content

5.12.3.1 Electrical and Electronic Systems

Candidates should use the experiences gained in Advanced Subsidiary study and further develop their knowledge and understanding as applied to system design of:

- input devices:

photodiode, phototransistor, slotted/reflective opto-switch, temperature-sensing IC, microphone, strain gauge, pressure-sensing transducer, switches (pressure, thermal, tilt and float);	*identify and select appropriate input devices for specific sensing applications using manufacturers' data;* *design and build circuits to process the signals from these transducers;*

- processing devices:

operational amplifiers (used as non-inverting, inverting, summing and differential amplifiers and voltage follower, concept of gain, single rail and split rail power supplies, use of appropriate formulae), D-type flip-flops (use for toggling, bistable and frequency halving), BCD-to-decimal decoder IC, multi-digit counter IC (for directly driving LCD or multiplexed LED display), N-channel MOSFET as a linear device for driving the output devices listed above;	*design and build devices which monitor and control various conditions: thermostats, ice warning, wind speed and direction, proximity of human/animal/material, sound level, fluid depth, event counting, information display, remote control, security etc.;*

Schmitt trigger inputs and tri-state outputs; comparison of logic IC families;

pulse width modulation (PWM) as a means of controlling the speed of a DC motor and for sending control signals to a miniature servo;

- output devices:

multiplexed 7-segment LED display (and awareness of other formats, e.g. dot matrix), liquid crystal displays (multi-digit 7-segment, 'intelligent' alpha-numeric and awareness of other formats, e.g. colour dot matrix screen), piezo-electric sounder, loudspeaker, stepper motor (and driver), servo (miniature radio-control type);

identify and select appropriate output devices for specific sensing applications using manufacturers' data;

- power sources:

awareness of range of rechargeable and non-rechargeable battery types and their applications;

battery capacity and battery life.

design and build a variety of systems to monitor and control in a range of domestic, industrial and leisure applications, e.g. a weather station, a sound-triggered switch, a two-input audio mixer, an ultrasonic 'breaking glass' detector, a fluid depth control system, an rpm meter, a message display system, a servo-actuated robotic head which responds to simple stimuli, a motor speed controller.

In addition, all candidates will need to have the knowledge specified in Sections 5.12.3.4 – 5.12.3.10 for their system focus area(s). *See pages 126-132.*

5.12.3.2 Mechanical Systems

Candidates should demonstrate an understanding of the application within existing systems and how they interact to provide a required function; use of appropriate calculations:

- structures:

use of simple structures to provide support, force transfer and other functions;

build simple structures to provide support for loads, e.g. a gantry crane, a simple bridge;

calculation of forces in the members of a simple 2D structure; resolving forces; equilibrium of moments;

use force meters to investigate the loads in a simple structure;

stress, strain, elasticity, Young modulus, ultimate tensile strength, ultimate shear strength, safety factor, consideration of how the cross-sectional shape of a member affects its rigidity, modes of failure;

practical investigation of load/extension curves and breaking load for various materials; investigate modes of failure for different materials and shapes: tensile, compressive and shear;

- mechanisms:

epicyclic gear systems, bearings (taper, linear, thrust), lead screw, clutches (plate clutch, dog clutch, centrifugal clutch);	*design and build moving devices to provide mechatronic solutions to various problems: rotating turntable, gearbox, winch, lift, simple pick-and-place machine;*
DC motor speed controllers (principle of operation – pulse width modulation method and resistive method – no circuit details);	*use commercial speed controllers to control motors in robot devices;*
stepper motors (no circuit details);	*use a computer with suitable interface to control a stepper motor;*
torque (moment), work done and power in linear and rotating systems use of appropriate equations.	*investigate the structures and drive mechanisms in various existing products, e.g. VCR, CD-player, printer, electric screwdriver etc.*

In addition, all candidates will need to have the knowledge specified in Sections 5.12.3.4 – 5.12.3.10 for their system focus area(s). See pages 126-132.

5.12.3.3 Pneumatic Systems

Candidates should use the experiences gained in Advanced Subsidiary study and further develop their knowledge and understanding as applied to system design of:

- valves:

diaphragm (pressure sensitive) valve, logic valves (AND, OR, NOT), use of a 3-port valve as a NOT-valve, quick exhaust valve, exhaust filters and silencers;	*identify and select appropriate devices for specific applications using manufacturers' data;*

- vacuum lifting technology:

vacuum pumps and vacuum cups, concept of vacuum level, calculation of lifting force and air consumption;	*identify and select appropriate devices for specific applications using manufacturers' data;* *use vacuum lifting technology to transfer components from one pile to another;*

- cylinders:

compression ratio for a pneumatic system, calculation of air consumption;	*identify and select appropriate devices for specific applications using manufacturers' data;*

- processes:

air preparation (compressor, reservoir, filtering, pressure regulation, lubrication);	*identify and select appropriate devices for specific applications using manufacturers' data;*

air bleed occlusion sensing, pressure decay sensing, sequential control of pneumatic systems, use of reservoir to create pulse signals, use of mechanical counter module.	*use logic valves to provide advanced pneumatic sensing systems, use pressure decay sensing to minimise the number of signal valves in a sequential operation system, use an air bleed occlusion to sense the presence of objects;* *integrate pneumatic systems with electronic or programmable systems to provide advanced control functions and feedback sensing, e.g. make a simple pick-and-place machine using vacuum cups, make an animated robot head, a gripper hand etc., a wooden puzzle-playing machine, e.g. noughts and crosses, tower building, draughts;* *make industrial visits and investigate the safety legislation relating to existing industrial pneumatic installations.*

In addition, all candidates will need to have the knowledge specified in Sections 5.12.3.4 – 5.12.3.10 for their system focus area(s). See pages 126-132.

5.12.3.4 Programmable Control Devices

Candidates should use the experiences gained in Advanced Subsidiary study and further develop their knowledge and understanding as applied to system design of:

• the use of programmable control devices to solve problems in system design; no specific type of controller or language is required, but candidates should be familiar with the use of flow charts to prepare programs;	*investigate the use of programmable control devices in a variety of products, for example central heating, domestic appliances, electronic games, security systems, automated production lines etc.;* *draw and analyse flow charts for various controlled applications; consider needs for input and output lines;*
• the integration of programmable control devices with electronic **or** mechanical **or** pneumatic systems;	*use programmable control devices, e.g. PICs, SMART boxes, PLCs etc., to simplify system design and provide advanced control in a variety of projects;* *integrate the various input and output devices studied in Sections 5.12.3.1-3 (the focus areas) to programmable control devices;*
• the need for signal conditioning between the subsections of a system; debouncing, filtering (to remove noise) and buffering to drive output devices;	

• conversion of analogue signals into digital number forms and vice versa (no circuit details).	*use a programmable control device with a built-in analogue-to-digital converter (ADC) to monitor the signal from an analogue transducer.*

5.12.3.5 Materials

Candidates should use the experiences gained in Advanced Subsidiary study and further develop their knowledge and understanding as applied to system design of:

• the performance characteristics of materials for structural strength, weight, rigidity, thermal and electrical conduction and insulation, friction, resistance to wear, heat and oxidisation;	*use of tables and test data to identify reasons for material selection;* *selection of materials based on cost and implications for the environment;*
• the use of SMART materials.	*identify and select appropriate materials for specific applications using manufacturers' data.*

5.12.3.6 Awareness of Up-to-Date Developments of New Devices and their Applications

Candidates should use the experiences gained in Advanced Subsidiary study and further develop their knowledge and understanding as applied to system design of:

• modern devices at the forefront of fast-changing technology.	*investigate the uses of, for example, programmable control devices, 'intelligent' displays, vacuum technology used in material and product transfer, servo systems and the use of ICT for designing, modelling, prototyping and testing;* *design and use systems incorporating new components, e.g. PIC and STAMP or similar controllers and any other devices as they become available;* *make industrial visits to experience the industrial use of modern technology;* *use software to program and test a programmable controller for an application;* *keep abreast of changing technology through the use of resource material – journals, catalogues, CD-ROMs and the Internet.*

5.12.3.7 Principles and Techniques of Testing Applied to System Design

Candidates should use the experiences gained in Advanced Subsidiary study and further develop their knowledge and understanding as applied to system design of:

- using test results of complete systems and/or sub-systems in fault finding;

  use the results of voltage, current or pressure measurements in an active circuit to analyse a faulty component, or investigate the wear of components in a mechanical system;

  use test results to evaluate the performance of a system and suggest changes to improve the operating characteristics;

- an appreciation of the significance of component tolerance and adjustable component setting in systems design.

  realise whether a test measurement is within or outside allowed tolerance;

  realise the need for adjustment in some systems, for example door speed, detection sensitivity.

Candidates should also demonstrate an understanding of the application in system design of testing for the chosen focus area(s) taken from:

- electrical and electronic systems:

  – measuring and interpreting AC signals in electronic circuits;

  use an oscilloscope to make measurements in a circuit; measure amplitude, period and frequency; record wave shapes;

  use a signal generator to test and analyse a voltage amplifier circuit, or apply logic pulses to a digital circuit;

- mechanical systems:

  – measuring forces in 2D structures;

  using force meters to check theoretical figures;

  investigation of the extension of a sample under load;

  destructive testing of samples and structures to investigate ultimate strengths and modes of failure;

- pneumatic systems:

  – testing the validity of pneumatic circuits.

  use a pressure gauge to check system pressure against theoretical figures;

  investigate pressure changes in feed lines as a cylinder operates.

5.12.3.8 Industrial and Commercial Practices – Progression from Prototype to Volume Production

Candidates should use the experiences gained in Advanced Subsidiary study and further develop their knowledge and understanding as applied to system design of:

Manufacturing Systems

• the different needs involved when designing a system for volume production or for one-off prototype, e.g. designing for: large scale assembly, maintenance and ease of fault finding, reliability, consistency of performance between units;	*use experiences gained when developing project work for Modules 2522 and 2523;*
• the economy in system design in relation to the use of components, materials and processing costs, and its impact on marketing;	*examine a system to see how the minimum use of materials has not compromised required strength and durability;* *examine a system to see how the optimum use of components has been achieved;*
• the techniques available to the large scale designer which may not be realistic for small scale production – CNC machined components, cast components, injection-moulded components, custom-programmed ICs, surface mounted technology (SMT), system miniaturisation;	*investigate how the use of dedicated microcontrollers, moulded cases, custom parts or miniaturisation enhance the features of commercial products;* *visit a company which produces CNC machined parts;* *identify components in the Module 2522/2523 project which could be CNC produced, e.g. PCB, drilled control panel, gearbox housing etc.;* *experience working with SMT components;*
• an awareness of assembly methods for large scale production of a product, e.g. pick-and-place machines and industrial large-scale PCB soldering techniques; e.g. manual, mechanical and automated assembly of systems;	*visit industrial sites to experience pick-and-place machines assembling a circuit board and view soldering methods;* *visit a PCB manufacturing company;* *research using component catalogues to investigate how components are designed with automated assembly in mind, e.g. SMT components and sealed components to withstand circuit board washing;*

The Use of ICT in Designing and Manufacturing Processes

• the role of 3D modelling to predict the outcome of a volume produced product;	*the use of various materials to model a design; use experiences gained from Modules 2522 and 2523;*
• the role of ICT in developing a prototype for volume production;	*use of 3D design software to help when developing a prototype;* *rapid prototyping of parts, e.g. PCBs, fasteners etc.;* *use of ICT in costing a prototype;*
• the use of programmable controllers, computers or dedicated controllers to control the production or assembly of components;	*visit industrial situations to view production control systems; or use video material or visiting speakers;*
• the use of ICT in stock control, component ordering and product tracking through the production process.	*the use of JIT;* *testing and quality control*

Service to the Customer

• understanding the responsibility for reliability and lifetime functioning of systems warranties, guarantees, after-sales care, design for maintenance and provision of maintenance procedures.	*explore, record and use as appropriate, responsibilities of designers/manufacturers for reliability, functional life and after-sales maintenance on a selected range of products, e.g. domestic equipment – kettles, irons, food mixers, electrical tools – screwdrivers, drills, garden equipment and other systems;* *identify reasons for the failure of a system, (for example the overheating of an electronic component, or the stripping of teeth in a drill gearbox, or the malfunction of automatic doors) and produce a fault finding procedure for use by maintenance personnel.*

5.12.3.9 Health and Safety of Designers, Makers, Users and the Public

Candidates should use the experiences gained in Advanced Subsidiary study and further develop their knowledge and understanding as applied to system design of:

• developing and using safe working practices including identifying hazards and making risk assessments during the production of their own artefacts;	*identification of risks in industrial processes such as welding, machining, assembling, soldering etc.;*
• considering the future safety of would-be purchasers, users and the possible impact that their prototype could have on communities and the environment;	*assess the potential impact of their own artefacts as part of the evaluation process;*

• effective labelling of product care – use of national and international codes, effects of cleaning agents and chemicals.	*examine and use appropriately national and international codes, safety labelling for materials being used in product or in prototypes under construction, for example PCB processing chemicals, pneumatic installations etc.*

5.12.3.10 Products and Applications

Candidates should use the experiences gained in Advanced Subsidiary study and further develop their knowledge and understanding as applied to system design of:

Detailed Design of Control Systems

• the principles and effects of positive feedback and negative feedback in a control system;	*consider simple examples of feedback and control loops in various natural and manmade systems; analogies found in nature;*
• the principles of open loop and closed loop control systems;	
• concepts of gain, hunting, damping, lag and hysteresis in control systems.	*applications in electronic systems, mechanical drive systems, e.g. free-play between gears and linkages, and pneumatic systems; investigate the relevance in servo systems.*

Critical Observation of the Designed Product, its System and Subsystems

• the significance of monitoring the performance of a product – setting observation parameters and assessing the results; assessing the process and stability of a whole system in achieving its specified function;	*use the experience gained when critically and quantitatively evaluating the Module 2522/2523 project.*
• the significance of tolerance when evaluating the results of monitoring, i.e. deciding whether a system performs well within specification, just within specification or does not meet the specification requirements;	
• presenting detailed modifications to improve the identified weaknesses of a product;	
• preparing a full cost analysis of a product and comparing this with previously conducted market research;	
• ethical, environmental and other issues.	

Value Issues

• the impact of values issues – technical, economic, aesthetic, social, environmental and moral implications within technological solutions.	*demonstrate an awareness of these issues and their potential impact on technological activities, including their potential impact on prototype solutions;* *examine the environmental issues relating to energy choice, for example conversion, storage, transmission, pollution;* *examine the implications of sustainable and non-sustainable resources in system design and manufacture.*

The examples of teaching and learning opportunities (given in italics above) are not prescribed or a complete set but are intended only as a guide to the type of teaching and learning experiences that would enhance or develop those skills required by candidates to produce the assessed work in Unit 2525.

5.12.4 Section B Content

Section B assesses the abilities of candidates to make immediate design thinking responses to a given situation. It is intended to be a discriminator in identifying those candidates who can effectively use their experiences and knowledge gained through the course in designing and making to 'self start' successfully on a design task.

Candidates are required to:

- identify the criteria that a successful solution must satisfy;
- present initial ideas that will address the given situation;
- justify a proposed route for development.

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Candidates can use the formulae given in the formulae sheet.

6 FURTHER INFORMATION AND TRAINING FOR TEACHERS

To support teachers using this specification, OCR will make the following materials and services available:

- up-to-date copies of this specification;
- a dedicated subject-specific telephone number;
- a full programme of In-Service Training (INSET) meetings;
- past question papers and mark schemes after each examination session;
- coursework guidance materials;
- written advice on coursework proposals;
- individual feedback to each Centre on the moderation of coursework;
- a report on the examination, compiled by Principal Examiners and Moderators, after each examination session.

If you would like further information about the specification, please contact OCR (www.ocr.org.uk).

7 BOOKS AND RESOURCES LIST

TITLE	AUTHOR	PUBLISHER	YEAR	ISBN
Design in the High Street	G Michell	Architectural Press	1986	0 851 39159 1
New Metric Handbook Planning and Design Data	D Adler	Architectural Press	1999	0 851 39468 X
Public Places Urban Spaces	EM Carmona	Architectural Press	2002	
Materials for Engineering Technician	RA Higgins	Arnold	1997	0 340 67654 X
Electronics and Control Technology	A Philpot	Basil Blackwell		0 631 90141 8
Anthropometry for Designers	J Croney	Batsford	1980	0 713 41567 3
Furniture Making	E Joyce	Batsford	1987	0 713 44407 X
Textiles – Properties and Behaviour	Miller	Batsford	1995	0 713 42752 3
Timber in Construction	J Sunley B Bedding	Batsford	1995	0 713 45053 3
Introducing Pneumatics	C Weaving	Bedford Educational Services		0 907 04116 7
Architects Data 3rd Edition	E Neufert P Neufert	Blackwell Science	2002	
Fashion Design and Product Development	H Carr Pomeroy	Blackwell Science	1992	0 632 02893 9
Fashion Marketing	M Easy	Blackwell Science	1994	0 362 03459 9
Design in Context	P Sparke	Bloomsbury		0 747 51094 6
Anthropometrics: An Intro. for Schools/ Colleges (posters and booklet)	S Pheasant	BSI (tel 0208 996 9001)	1984	
Compendium of Essential DT Standards for Schools and Colleges	British Standards	BSI (tel 0208 996 9001)	1999	
Standards for Workshops in Schools and Colleges	British Standards	BSI BS 4163	2000	
Materials Testing	J Cunnington J Leeks	BSI PP 7318	1988	0 580 16082 3
Language of Labels	British Standards	BSI Educ PP 666	1991	0 580 19186 9
Anthropometrics: An Introduction	S Pheasant	BSI Educ PP 7310	1990	0 580 18234 7
Ergonomics Standards and Guidelines for Schools and Colleges	S Pheasant	BSI Educ PP 7317	1987	0 580 15391 6
Materials For Engineering	W Bolton	Butterworth & Heinemann	1994	0 750 61838 8
How Designers Think	B Lawson	Butterworth Architecture Press		0 750 63073 6

TITLE	AUTHOR	PUBLISHER	YEAR	ISBN
The Business of Fashion	L Drew	Cambridge University Press	1992	0 521 40825 3
20th Century Design	C McDermott	Carlton	1998	1 858 68557 5
CAPP (Computer Aided Process Planning)	J Tulkoff	CASA/SME		0 872 63187 7
CNC Part Programming	D Gibbs	Cassell		0 304 31355 6
Introduction to Polymers	RJ Young PA Lovell	Chapman Hall		0 412 30640 9
The Essential Plastics Industry	M Driver J Pitt	CIEC/University of York (tel: 01904 432523)	2003	1 853 42581 8
GCSE Total Revision GCSE D&T Resistant Materials	C Chapman	Collins Educational	2001	0 007 11204 1
Real World Technology Resistant Materials 2nd Edition	C Chapman	Collins Educational	2002	0 007 11532 6
Marketing – When the Wind Blows	R Kilborn	Taylor and Francis		0 906 89093 4
The Complete Metalsmith	T McCreight	Davis		0 871 92240 1
Perspective	C Alison	Dorling Kindersley		0 863 18934 2
Analogue Electronics	J Morris	Ed Arnold		0 340 54461 9
Digital Electronics	J Morris	Ed Arnold		0 340 55638 2
Pneumatic Control		Festo Didactic		3 812 70851 5
The Technology of Textile Properties	M Taylor	Forbes	1993	0 901 76282 2
The Way Things Work	D Macaulay	Guild	1988	
How to Store just about Anything	A Jackson D Day	Harper Collins	1992	0 004 12653 X
The Smart House	JG Trulove	Harper Collins	2002	
Advanced D&T for EdExcel Product Design Graphics with Matl. Tech	L Creswell	Heinemann	2000	0 435 75771 7
Advanced D&T for EdExcel Product Design RMT	L Creswell	Heinemann	2000	0 435 75770 9
Design Presentation	D Beasley	Heinemann		0 435 75054 2
GCSE D&T for EdExcel RMT	B Lambert	Heinemann	2002	0 435 75771 7
Resistant Materials Technology	B Lambert	Heinemann	2002	0 435 41783 5

TITLE	AUTHOR	PUBLISHER	YEAR	ISBN
Textiles, Fabrics and Design	J Vulker H Cooper	Heinemann	1987	0 435 42899 3
Finding Out About Advertising		Hobson		1 853 24181 4
Advanced Manufacturing	RSA Schools Technology Project	Hodder & Stoughton	1999	0 340 70528 0
Advanced Manufacturing Teacher's Guide	RSA Schools Technology Project	Hodder & Stoughton	1999	0 340 70529 9
Basic Electronics	M Plant	Hodder & Stoughton		0 340 41190 1
Complete Technology and Design	R Caldwell	Hodder & Stoughton	2001	0 340 78244 7
Electronics: A System Approach	A Johnson	Hodder & Stoughton	1989	0 340 37156 X
Manufacturing Technology	M Haslehurst	Hodder & Stoughton	1985	0 340 26980 4
Materials for Engineering Technicians	RA Higgins	Hodder & Stoughton	1987	0 340 41476 6
Materials for Engineering Technology	RA Higgins	Hodder & Stoughton	1998	0 340 67654 X
Principles of Engineering Production	AJ Lissaman SJ Martin	Hodder & Stoughton	1982	0 340 28173 1
Workshop Technology	WAJ Chapman	Hodder & Stoughton	1989	0 713 13269 8
Workshop Technology for Technicians	Kempster	Hodder & Stoughton	1989	0 340 23019 3
Making the Most of Small Spaces	S Crafti	Images Publishing	2002	
Packaging – The Facts	EA Emblem J McDermott	Institute of Packaging (tel: 01664 500055)	2000	0 946 46704 8
Effective Publicity and Design	J Zeitlyn	InterChange Books	1988	0 948 09032 X
Electronics for Today and Tomorrow	T Duncan	John Murray		0 719 54183 2
Success in Electronics	T Duncan	John Murray		0 719 54015 1
Technology In Practice	TEP	John Murray	2000	0 719 57179 0
This is Citizenship	T & J Fiehn	John Murray	2002	0 719 57721 7
Design Methods	C Jones JR	John Wiley & Sons		0 471 27958 7
Green Design	D Mackenzie	Laurence King	1991	1 856 69001 6
Production for Graphic Designers	A Pipes	Laurence King		1 856 69028 8
GCSE D&T Study Guide		Letts	2002	1 858 05939 9
GCSE D&T Success Guide (Resistant Materials)		Letts	2002	1 843 15020 4
Letts Revise GCSE D&T	R Davis	Letts	2001	1 858 05939 0
Manufacturing Technology	RL Timings	Longman	1987	0 582 41356 7

TITLE	AUTHOR	PUBLISHER	YEAR	ISBN
Advanced Design and Technology (3rd Edition)	Norman, Urry, Cubitt, Whittaker	Longman	2000	0 582 32831 4
Design Capability and Awareness	J Morrison J Twyford	Longman	1994	0 582 05687 X
Electronics (Science at Work)	D Harrison	Longman		0 582 02869 8
Make The Future Work	C Budgett Meakin	Longman	1992	0 582 08838 0
The Engineering Design Process	B Hawkes R Abinett	Longman		0 582 99471 3
Advanced Marker Techniques	D Powell	Macdonald	1990	0 356 14279 5
Design Source Book	N Clark, J Rollason, A Cambell, J Mills	Macdonald	1986	0 356 12005 8
Italic, Graphic Design Source Book	L McQuiston	Macdonald		0 357 14809 2
Packaging Source Book	R Opie	Macdonald		0 356 17665 7
Presentation Techniques	D Powell	Macdonald	1988	0 356 17584 7
CAD CAM Systems	PF Jones	Macmillan		0 333 48532 7
Mastering Electronics	J Watson	Macmillan		0 333 40823 3
Timber – Its Properties, Pests and Preservation	HE Desch JM Dinwoodie	Macmillan	1986	0 333 25752 9
Textiles: Fibre and Fabric	Potter Corbman	McGraw	1983	0 070 66236 3
Handbook of Textile Fibres (Man Made)	JG Cook	Merrow		0 904 09540 1
Design and Technology	C Calborn	Nelson Thornes		0 174 48162 4
Electronic Systems	MW Brimicombe	Nelson Thornes	1986	0 174 48067 9
Electronics	J Adams R Hutchings	Nelson Thornes		0 174 48251 5
Engineering Design	MD Brooks D Oldham	Nelson Thornes	1981	0 859 50303 8
The Chemical and Mechanical Finishing of Textile Materials	Carty Burn	Newcastle Polytechnic Production	1987	0 906 47141 9
PIC in Practice (accompanies ECL's PIC Training Kit)	DW Smith	Newnes		0 750 64812 0
Industrial Design	E Tjalve	Newnes Butterworths	1979	0 408 00388 X
An Introduction to Robotics	H Sandhu	Nexus		1 854 86153 0
Design and Technology Product Design	Addison, Wesley, Longman	Nuffield		0 582 23464 7

TITLE	AUTHOR	PUBLISHER	YEAR	ISBN
Electronics	P Fay R Pickup	Oliver & Boyd		0 050 03791 9
Electronics Workbook		Oliver & Boyd		0 050 04516 4
Electronics Teachers' Guide	P Fay R Pickup	Oliver & Boyd		0 050 03792 7
Problem Solving Workbook	R Page, R Clarke J Poole	Oliver & Boyd		0 050 03394 8
Problem Solving Teachers' Guide	R Clarke M Gibson	Oliver & Boyd		0 050 03392 1
Design Topics: Design in Society	T Liddament	Oxford University Press	1991	0 198 32779 X
Design Topics: Human Factors	S Garner	Oxford University Press	1991	0 198 32783 8
Design Topics: Product Design	S Atkinson	Oxford University Press		0 198 32784 6
Design Topics: Product Modelling	J Cottis	Oxford University Press	1991	0 198 32761 7
Industrial Design	J Heskett	Oxford University Press		0 195 20218 X
Textiles Technology to GCSE	J Down	Oxford University Press	1999	0 198 32813 3
The Modelmaker`s Handbook	A Jackson D Day	Pelham	1987	0 720 71688 8
Metals in Service of Man	A Street W Alexander	Pelican	1989*	0 140 14889 2
Practical Opto-Electronic Projects	B Balsani	Penfold		0 859 34349 9
The New Science of Strong Materials	JE Gordon	Penguin		0 140 20920 4
Fibre Properties	P Carty	Pentaxion	1996	1 874 43088 8
Materials Selection in Mechanical Design	MF Ashby	Pergamon Butterworth Heinemann	1999	0 750 64357 9
Basic Design and Layout	A Swann	Phaidon Press	1989	0 714 82487 9
Commissioning Illustration	M Colyer	Phaidon Press	1990	0 714 82648 0
Communicating with Rough Visuals	A Swann	Phaidon Press	1989	0 714 82598 0
Design and Marketing	A Swann	Phaidon Press	1990	0 714 82647 2
Graphic Artist	J Mulherin	Phaidon Press	1988	0 714 82488 7
Preparing Design for Print	L John	Phaidon Press	1988	0 714 82558 1
Trademarks and Logos	J Murphy M Rowe	Phaidon Press	1988	0 714 82557 3
Type and Colour	M Beaumont	Phaidon Press	1987	0 714 82489 5

* Regular Revisions

TITLE	AUTHOR	PUBLISHER	YEAR	ISBN
Technology and Production	G Clews R Leonard	Philip Allan	1985	0 860 03527 1
The Engineering Design Process	B Hawkes R Abinett	Pitman	1984	0 273 01895 7
Designing for the Disabled	S Goldsmith	RIBA	1992	0 900 63050 7
Century Makers	D Hillman D Gibbs	Seven Dials	1998	1 841 88026 4
Textile Fibres under the Microscope	Sawbridge Ford	Shirley Institute	1987	
The Encyclopaedia of Wood	Forest Products Laboratory	Sterling	1989	0 806 96994 6
World Woods in Colour	WA Lincoln	Stobart Davis	1986	0 854 42028 2
Paper Engineering	M Hiner	Tarquin		0 906 21249 9
Up-Pops (Paper Engineering)	M Hiner	Tarquin		0 906 21279 0
Bodyspace Second Edition	S Pheasant	Taylor & Francis		0 748 40326 4
The Design of Everyday Things	DA Norman	Taylor & Francis	2000	0 262 64037 6
Clothing Technology	H Eberle	Tekot International	1996	3 808 56221 8
An Introduction to Polymers	TEP	TEP		
Manufacturing (post 16)	TEP	TEP	1999	1 898 12695 X
Material Selection and Processing (Book)	TEP	TEP	2000	1 901 35132 7
Material Selection and Processing (CD ROM)	TEP	TEP	2000	
Material Selection and Processing (Teacher Support Book)	TEP	TEP	2000	1 901 35131 9
Technology 14-16 Manufacturing	J Cave	TEP	1997	1 898 12610 0
Young Technologists' Handbook	TEP	TEP	2001	1 898 12655 0
Textile Innovation		textile.innovation@btinternet.com	2001	
Drawing For 3D Design	A Pipes	Thames & Hudson	1990	0 500 23560 0
Frog. Form Follows Emotion	F Sweet	Thames & Hudson	1999	0 500 01917 7
Packaging Design – Graphics Materials Technology	S Sonsino	Thames & Hudson		0 500 23580 5
Philippe Starck Subverchic Design	F Sweet	Thames & Hudson	1999	0 500 01865 0

TITLE	AUTHOR	PUBLISHER	YEAR	ISBN
Terence Conran Design and the Quality of Life	F Sweet	Thames & Hudson	1999	0 500 01918 5
Colour in Industrial Design	D Russell	The Design Council	1991	0 850 72283 7
Critical Paths – Designing for Secure Travel	ST Atkins	The Design Council	1989	0 850 72279 9
Green Design	P Burall	The Design Council	1991	0 850 72284 5
Industrial Design in Engineering	CH Flurscheim	The Design Council	1983	0 850 72123 7
Humanscale 1-2-3	Diffrient, Tilley Bardagjy	The MIT Press	1974	0 262 54027 4
Humanscale 4-5-6	Diffrient, Tilley Harman	The MIT Press	1981	0 262 04059 X
Humanscale 7-8-9	Diffrient, Tilley Harman	The MIT Press	1981	0 262 04059 X
Routing and Shaping: The Art of Woodworking		Time Life Books	1993	0 809 49937 1
Designing for a Future: Appropriate Technology for KS3 & 4	P Howard-Jones	UWIC Press (tel: 029 2041 6515)	2000	1 902 72403 8
Production Design Models	R Lucci P Orlandini	Van Nostrand Reinhold	1990	0 442 20654 2
Airbrush Rendering	G Buckley	Walter Foster		1 560 10025 7
Textile Design	C Joyce	Watson Guphill	1997	0 823 05325 3
Designers Guide to Creating Charts and Diagrams	N Holmes	Watson Guptill		0 823 01338 3
Rendering in Mixed Media	J Ungar	Watson Guptill		0 823 07427 7
Rendering with Markers	RB Kemnitzer	Watson Guptill		0 823 04532 3
Introduction to Ergonomics	WT Singleton	World Health Organisation	1978	
GCSE D&T Resistant Materials: Revision Workbook		Coordination Group Publications www.cgpbooks.co.uk	2003	1 841 46797 9
GCSE D&T Resistant Materials: The Revision Guide		Coordination Group Publications www.cgpbooks.co.uk	2002	1 841 46792 8
The Essentials of GCSE D&T: Graphic Products	Ed. D Eason	Lonsdale Guides www.lonsdalesrg.co.uk	2002	1 903 06846 0
The Essentials of GCSE D&T: Product Design	Ed. B Russell	Lonsdale Guides www.lonsdalesrg.co.uk	2003	1 903 06881 9

TITLE	AUTHOR	PUBLISHER	YEAR	ISBN
The Essentials of GCSE D&T: Resistant Materials	Ed. B Russell	Lonsdale Guides www.lonsdalesrg.co.uk	2002	1 903 06847 9
GCSE DT Textiles: The Student Book		Heinemann	2002	0 435 41786 X

OTHER RESOURCES		
A Range Especially Suitable for Electronics and Textiles	Books	Blue Fish
Making and Shaping Steel – Videos	Videos	British Steel Education Service
Various Resources and Information		British Textile Technology Group, Wira House, West Park Ring Road, Leeds, LS16 6QL
Technical Graphics	Video	Classroom Video, PO Box 19 Newport 2106
Which	Magazine	Consumers Association, PO Box 44, HertfordX SG14 1SH (tel: 0845 307 4000)
Design – The Journal of the Design Council (4 issues a year)	Magazine	Design Council
Airbrushing	Video	Dryad, PO Box 38, Leicester, LE1 9BU
New Textiles	CD-ROM	Duncan Beiley, Atomic Multimedia
Textile Resources and Specialist Materials	Resources	Heart of England Sewing Machines (e-mail: pandpmay@aol.com) for details, including a comprehensive list of textiles websites
Fashion 4 All (4 issues a year)	Magazine	Emtex – can download from the Internet sarah@emtex.org.uk
Plastics Manufacturing Processes – Animated Processes	CD-ROM	Focus Educational Software Ltd, PO Box 52, Truro TR1 1ZJ (tel 01872 222391)
Resistant Materials Database	CD-ROM	Focus Educational Software Ltd, PO Box 52, Truro TR1 1ZJ (tel 01872 222391)
Wide range	Books, resources and teaching materials	ITDG Publishing, 103-105 Southampton Row, London WC1B 4HL (tel: 0207 436 9761)
Design Image Base	CD-ROM	Longman Education
Wide range including SMART materials	Resources/ teaching packs	Teaching Resources Ltd. Unit 10, The IO Centre, Lea Road, Waltham Cross, Herts EN9 1AS (tel 01992 716052)
Textile Magazine (4 issues a year)	Magazine	The Textile Institute, 10 Blackfriars Street, Manchester M3 5DR

A SELECTION OF WEBSITES	
www.bsi.org.uk	(British Standards Institute)
www.ciec.org.uk	(Chemical Industry Education Centre)
www.cpcares.com/clocks.html	(American site, robot kits competitively priced)
www.data.org.uk	(Design and Technology Association)
www.designandtech.com	
www.designcouncil.org.uk	(Design Council)
www.ecl-ltd.com	(Electronic Controls Ltd – PIC Training Kit)
www.eelab.su.oz.au/digital_tutorial	(Australian tutorial – aimed at first year degree level)
www.electronicsforu.com/efyhome/index2.html	(Electronics for You magazine)
www.engineeringzones.com	(Materials Database)
www.epemag.wimborne.co.uk	(Everyday Practical Electronics magazine)
www.howstuffworks.com	
www.iee.org.uk/schools/welcome.html	(Institute of Electronic Engineers site)
www.incpen.org/pep	(Packaging Education Programme)
www.itdg.co.uk [www.sda-uk.org	(Intermediate Technology Development Group) Sustainable Design Awards]
www.national.com	(National Semiconductor – Data Sheets)
www.remotecontrols.co.uk	(Remote control supplier)
www.robotics.com/robots.html	(Robot circuits, design and supplies site)
www.schoolsnet.com	
www.st.com	(ST Microelectronics – Data Sheets)
www.teacherxpress.com	
www.tep.org.uk/index2.html	(Technology Enhancement Programme)
www.tinaja.com/pic500.html	(Comprehensive PIC source site with good links)
www.ubasics.com/adam/pic/archive.shtml	(PIC information and program site)
www.web-ee.com/Schematics/schematics.htm	(Higher level circuit designs)
www.which.net	(Which? magazine)

- A range of books and resources are listed which cover the various DT aspects and elements of the AS/A level course. Details have been submitted by teachers involved in delivering this Specification. Thank you to all those who have contributed. OCR DT Subject Officers will be pleased to hear of suitable new books and resources as they become available. Please contact OCR at the Birmingham office. Details of these resources can then be made available at INSET sessions.
- Some of the items listed may be quite costly. They are included because of their value as reference resources.
- Some GCSE items are included. There are many other GCSE items which are useful as foundational resources.
- Some titles are likely to be out of print. Books and resources felt to be particularly useful have been retained on the list because it is still possible to obtain some of these titles from specialist suppliers, to use them in libraries or to lend them from other Centres who may have them.
- A display of some of the above resources usually forms part of OCR's Annual INSET Meetings for Teachers.

8 FORMULAE SHEET

for use in Design and Technology:

Systems and Control examinations

This is included as an insert in Question Papers 2521/02 and 2525/01.

General

Area of rectangle	$= l \times w$
Area of triangle	$= \frac{b \times h}{2}$
Area of circle	$= \frac{\pi d^2}{4}$
Circumference of circle	$= \pi d$
Volume of rectangular prism	$= l \times w \times h$
Volume of cylinder	= area of base circle x h
Volume of cone	$= \frac{\text{area of base circle x } h}{3}$

Electrical and Electronic Systems

$V = I \times R$

$W = V \times I$

Resistors in series $R_{total} = R_1 + R_2 + R_3$ etc.

Resistors in parallel $\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$ etc.

OR

$$R_{total} = \frac{R_1 \times R_2}{R_1 + R_2}$$

Potential Divider $V_{out} = V_{in} \times \frac{R_2}{R_1 + R_2}$

Capacitor time constant $T = C \times R$

Capacitors in series $\frac{1}{C_{total}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$ etc.

Capacitors in parallel $C_{total} = C_1 + C_2 + C_3$ etc.

Mark space ratio $= \frac{T_{on}}{T_{off}}$

Astable frequency (f) $= \frac{1}{1.4 \times C_1 \times R_1}$

555 astable frequency (f) $= \frac{1.44}{(R_a + 2R_b)C}$

output high time $= 0.693(R_a + R_b)C$

output low time $= 0.693(R_b)C$

555 monostable time constant

on time $= 1.1R_aC$

Voltage gain $= \frac{V_{out}}{V_{in}}$

Non inverting amplifier $V_{out} = V_{in} \times \frac{(R_f + R_{in})}{R_{in}}$

Inverting amplifier $V_{out} = -V_{in} \times \frac{R_f}{R_{in}}$

Summing amplifier $V_{out} = -R_f \times (\frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3})$ etc.

Differential amplifier $V_{out} = \frac{-R_f}{R_a} \times (V_2 - V_1)$

MOSFET $g_m = \frac{\Delta I_d}{\Delta V_{gs}}$

Battery life battery capacity = current x time

Mechanical Systems

Moment = force x perpendicular distance

Stress = $\frac{\text{force}}{\text{cross sectional area}}$

Strain = $\frac{\text{change in length}}{\text{original length}}$

Young modulus of elasticity = $\frac{\text{stress}}{\text{strain}}$

Work done = force x distance moved

Power = force x velocity

Work done	= torque x angle turned
Power	= torque x angular velocity

Pneumatic Systems

Force	= pressure x area
Compression ratio	= $\frac{\text{gauge pressure + atmospheric pressure}}{\text{atmospheric pressure}}$
Volume of air used	= area x stroke x compression ratio
Lifting load	= vacuum level x area

APPENDIX A: KEY SKILLS

This Appendix offers detailed guidance on the Key Skills evidence that a candidate might produce during their programme of study. It focuses on the evidence required to meet the criteria for the internally assessed Key Skills portfolio. For example, in producing work for assessment as evidence of C3.2 (Read and synthesise information from two extended documents about a complex subject. One of these documents should include at least **one** image.) the candidate is required to:

- select and read material that contains the information you need;
- identify accurately, and compare, the lines of reasoning and main points from text and images; and
- synthesise the key information in a form that is relevant to your purpose.

The Key Skills and Evidence Requirements below are quoted from the Part B of the QCA Key Skills specifications and, as such, are addressed to the candidate. The text below the Evidence Requirements is guidance for teachers about how the specifications might be used to provide teaching and learning opportunities and/or assessment opportunities for the Key Skill.

For further information about the requirements of these units, teachers should refer to QCA's Key Skills specifications for use in programmes starting from September 2004.

For further information about the assessment and certification of Key Skills, teachers should contact OCR.

C3 Communication Level 3

C3.1a Contribute to a group discussion about a complex subject.

Evidence requirements

(i) Make clear and relevant contributions in a way that suits your purpose and situation.

(ii) Listen and respond sensitively to others, and develop points and ideas.

(iii) Create opportunities for others to contribute when appropriate.

Possible opportunities

Modules 2520, 2521, 2524 and 2525

Opportunities through group discussions in teaching and learning situations and/or group seminars.

C3.1b Make a presentation about a complex subject, using at least **one** image to illustrate complex points.

Evidence requirements

(i) Speak clearly and adapt your style of presentation to suit your purpose, subject, audience and situation.

(ii) Structure what you say so that the sequence of information and ideas may be easily followed.

(iii) Use a range of techniques to engage the audience, including effective use of images.

Possible opportunities

Modules 2520, 2521, 2524 and 2525.

Opportunities through candidate led seminars/discussions on specification topics.

C3.2 Read and synthesise information from **two** extended documents about a complex subject. One of these documents should include at least **one** image.

Evidence requirements

(i) Select and read material that contains the information you need.

(ii) Identify accurately, and compare, the lines of reasoning and main points from texts and images.

(iii) Synthesise the key information in a form that is relevant to your purpose.

Possible opportunities

Module 2518

System choice objectives and research plan.

Research and recording of information.

Analysis of information and conclusions.

Module 2519

Investigation of chosen product

Synthesis

Development and Modelling

Modules 2520, 2521, 2524 and 2525

Opportunities through preparation of candidate presentations, essay work and personal study topics.

Module 2522

Recognition and investigation of design opportunities.

Module 2523

Planning and making.

Testing and evaluation.

C3.3 Write **two** different types of documents about complex subjects. One piece of writing should be an extended document and include at least **one** image.

Evidence requirements

(i) Select and use a form and style of writing that is appropriate to your purpose and complex subject matter.

(ii) Organise relevant information clearly and coherently, using specialist vocabulary when appropriate.

(iii) Ensure your text is legible and your spelling, grammar and punctuation are accurate so your meaning is clear.

Possible opportunities

Module 2518

Proposals and personal evaluation

Module 2519

Investigation of chosen product.

Synthesis

Generation of initial ideas.

Development and modelling.

Modules 2520, 2521, 2524 and 2525

Opportunities through candidate contribution to group knowledge and understanding using a non-extended document format or graphical presentation.

Module 2522

Recognition and investigation of design opportunities.

Generation of initial ideas.

Development and modelling.

Module 2523

Planning and making.

Testing and evaluation.

N3 Application of Number Level 3

You must:

Plan and carry through at least one substantial and complex activity that includes tasks for N3.1, N3.2 and N3.3.

N3.1 Plan and interpret information from **two** different types of sources, including a large data set.

Evidence requirements

(i) Plan how to obtain and use the information required to meet the purpose of your activity.

(ii) Obtain the relevant information.

(iii) Choose appropriate methods for obtaining the results you need and justify your choice.

Possible opportunities

Modules 2521 and 2525

Determining component for systems design.

N3.2 Carry out multi-stage calculations to do with:

(a) amounts and sizes;

(b) scales and proportion;

(c) handling statistics;

(d) rearranging and using formulae.

You should work with a large data set on at least **one** occasion.

Evidence requirements

(i) Carry out calculations to appropriate levels of accuracy, clearly showing your methods.

(ii) Check methods and results to help ensure errors are found and corrected.

Possible opportunities

Module 2525

Determining components for systems design.

N3.3 Interpret results of your calculations, present your findings and justify your methods. You must use at least **one** graph, **one** chart and **one** diagram.

Evidence requirements

(i) Select appropriate methods of presentation and justify your choice.

(ii) Present your findings effectively.

(iii) Explain how the results of your calculations relate to the purpose of your activity.

Possible opportunities

Modules 2521 and 2525

Determining components for systems design.

IT3 IT Level 3

You must:

Plan and carry through at least one substantial activity that includes tasks for IT3.1, IT3.2 and IT3.3.

IT 3.1

Plan and use different sources to search for, and select, information required for **two** different purposes.

Evidence requirements

(i) Plan how to obtain and use the information required to meet the purpose of your activity.

(ii) Choose appropriate sources and techniques for finding information and carry out effective searches.

(iii) Make selections based on judgements of relevance and quality.

Possible opportunities

Module 2518

System choice, objectives and research plan.

Research and recording of information.

Module 2519

Synthesis.

Modules 2520, 2521, 2524 and 2525

Opportunities through access to CD-ROM material, data handling, recalling material.

Module 2522

Synthesis.

IT 3.2 Explore, develop and exchange information, and derive new information, to meet **two** different purposes.

Evidence requirements

(i) Enter and bring together information in a consistent form, using automated routines where appropriate.

(ii) Create and use appropriate structures and procedures to explore and develop information and derive new information.

(iii) Use effective methods of exchanging information to support your purpose.

Possible opportunities

Modules 2520, 2521, 2524 and 2525

Opportunities through candidate contributions to teaching and learning.

Module 2522

Synthesis.

IT3.3 Present information from different sources for **two** different purposes and audiences. Your work must include at least **one** example of text, **one** example of images and **one** example of numbers.

Evidence requirements

(i) Develop the structure and content of your presentation using the views of others, where appropriate, to guide refinements.

(ii) Present information effectively, using a format and style that suits your purpose and audience.

(iii) Ensure your work is accurate and makes sense.

Possible opportunities

Modules 2520, 2521, 2524 and 2525

Opportunities through candidate contribution to teaching and learning.

Module 2522

Synthesis.

WO3 Working with Others Level 3

You must:

Provide at least **one** substantial example of meeting the standard for WO3.1, WO3.2 and WO3.3 (you must show you can work in both one-to-one and group situations).

WO3.1 Plan complex work with others, agreeing objectives, responsibilities and working arrangements.

Evidence requirements

(i) Agree realistic objectives for working together and resources needed to achieve them.

(ii) Exchange information, based on appropriate evidence, to help agree responsibilities.

(iii) Agree suitable working arrangements with those involved.

Possible opportunities

Modules 2520, 2521, 2524 and 2525

Opportunities through candidate contributions to teaching and learning.

WO3.2 Seek to establish and maintain cooperative working relationships over an extended period of time, agreeing changes to achieve agreed objectives.

Evidence requirements

(i) Organise and carry out tasks so you can be effective and efficient in meeting your responsibilities and produce the quality of work required.

(ii) Seek to establish and maintain co-operative working relationships, agreeing ways to overcome any difficulties.

(iii) Exchange accurate information on progress of work , agreeing changes where necessary to achieve objectives.

Possible opportunities

Modules 2520, 2521, 2524 and 2525

Opportunities through candidate contributions to teaching and learning.

WO3.3 Review work with others and agree ways of improving collaborative work in the future.

Evidence requirements

(i) Agree the extent to which work with others has been successful and the objectives have been met.

(ii) Identify factors that have influenced the outcome.

(iii) Agree ways of improving work with others in the future.

Possible opportunities

Modules 2520, 2521, 2524 and 2525

Opportunities through candidate contributions to teaching and learning.

LP3 Improving Own Learning and Performance Level 3

You must:

Provide at least **one** substantial example of meeting the standard for LP3.1, LP3.2 and LP3.3

LP3.1 Agree targets and plan how these will be met over an extended period of time, using support from appropriate people.

Evidence requirements

(i) Seek information on ways to achieve what you want to do, including factors that might affect your plans.

(ii) Use this information to agree realistic targets with appropriate people.

(iii) Plan how you will effectively manage your time and use of support to meet targets, including alternative action for overcoming possible difficulties.

Possible opportunities

Modules 2518, 2519, 2522 and 2523

Opportunities through task management in all these four modules.

LP3.2 Take responsibility for your learning by using your plan, and seeking feedback and support from relevant sources, to help meet targets.

Improve your performance by:

- studying a complex subject;
- learning through a complex practical activity;
- further study or practical activity that involves independent learning.

Evidence requirements

(i) Prioritise action and manage your time effectively to complete tasks, revising your plan as necessary.

(ii) Seek and actively use feedback and support from relevant sources to help you meet targets.

(iii) Select and use different ways of learning, to improve your performance, adapting methods to meet new demands.

Possible opportunities

Modules 2518, 2519, 2522 and 2523

Opportunities through task management in all these four modules.

LP3.3 Review progress on **two** occasions and establish evidence of achievements, including how you have used learning from other tasks to meet new demands.

Evidence requirements

(i) Provide information on the quality of your learning and performance, including factors that have affected the outcome.

(ii) Identify targets you have met, seeking information from relevant sources to establish evidence of your achievements.

(iii) Exchange views with appropriate people to agree ways to further improve your performance.

Possible opportunities

Modules 2518, 2519, 2522 and 2523

Opportunities through task evaluation in all these four modules.

PS3 Problem Solving Level 3

You must:

Provide at least one substantial example of meeting the standard for PS3.1, PS3.2 and PS3.3;

PS3.1

Explore a complex problem, come up with **three** options for solving it and justify the option selected for taking forward.

Evidence requirements

(i) Explore the problem accurately analysing its features, and agree with others how to show success in solving it.

(ii) Select and use a variety of methods to come up with different ways of tackling the problem.

(iii) Compare the main features of each possible option, including risk factors, and justify the option you select to take forward.

Possible opportunities

Module 2519

Generation of initial ideas.

Development and modelling.

Module 2522

Generation of initial ideas.

Development and modelling.

PS3.2

Plan and implement at least **one** option for solving the problem, review progress and revise your approach as necessary.

Evidence requirements

(i) Plan how to carry out your chosen option and obtain agreement to go ahead from an appropriate person.

(ii) Implement your plan, effectively using support and feedback from others.

(iii) Review progress towards solving the problem and revise your approach as necessary.

Possible opportunities

Module 2519

Development, modelling and testing.

Module 2522

Development and modelling.

Module 2523

Planning and making.

PS3.3 Apply agreed methods to check if the problem has been solved, describe the results and review your approach to problem solving.

Evidence requirements

(i) Agree with an appropriate person methods to check if the problem has been solved.

(ii) Apply these methods accurately, draw conclusions and fully describe the results.

(iii) Review your approach to problem solving, including whether alternative methods and options might have proved more effective.

Possible opportunities

Module 2519

Testing.

Module 2523

Testing and evaluation.