Advanced Higher Course Specification

Advanced Higher Design and Manufacture

Course code:	C819 77
Course assessment code:	X819 77
SCQF:	level 7 (32 SCQF credit points)
Valid from:	session 2019–20

This document provides detailed information about the course and course assessment to ensure consistent and transparent assessment year on year. It describes the structure of the course and the course assessment in terms of the skills, knowledge and understanding that are assessed.

This document is for teachers and lecturers and contains all the mandatory information required to deliver the course.

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Contents

Course overview

This course consists of 32 SCQF credit points, which includes time for preparation for course assessment. The notional length of time for candidates to complete the course is 160 hours.

The course assessment has two components.

Component	Marks	Duration
Component 1: question paper	80	see 'Course assessment' section
Component 2: assignment	120	see 'Course assessment' section

Recommended entry	Progression
Entry to this course is at the discretion of the centre. Candidates should have achieved the Higher Design and Manufacture course or equivalent qualifications and/or experience prior to starting this course.	♦ a range of design and/or manufacturing-related Higher National Diplomas (HNDs) ♦ degrees in design and/or manufacturing-related disciplines ♦ careers in design and/or manufacturing design fields

Conditions of award

The grade awarded is based on the total marks achieved across both course assessment components.

Course rationale

National Courses reflect Curriculum for Excellence values, purposes and principles. They offer flexibility, provide time for learning, focus on skills and applying learning, and provide scope for personalisation and choice.

Every course provides opportunities for candidates to develop breadth, challenge and application. The focus and balance of assessment is tailored to each subject area.

This course allows candidates to further develop the skills, knowledge and understanding required to contribute and adapt to the diverse opportunities within the design and manufacturing industries.

Candidates develop knowledge of commercial design practices and commercial manufacture together with the creative and practical skills required to design solutions to real problems. Candidates also gain an understanding of the impact design and commercial manufacture has on society, the environment, and the economy.

The course encourages candidates to take a broad view of design and manufacture. They do this by analysing and evaluating, forming opinions, making decisions, generating and developing ideas, applying knowledge, justifying decisions, and taking responsibility for their own actions. These transferrable skills place candidates in a strong position regardless of the career path they choose.

Purpose and aims

The course allows candidates to enhance their practical design skills and further develop their knowledge and understanding of design and manufacture.

Candidates study the design and manufacture of products and the design process. This helps them develop creative design skills. They also learn to appreciate issues that influence the design and manufacture of products, and the need for balance and compromise when developing successful commercial products. Studying the evolution of products provides further insight into the issues that influence the design and manufacture of products and their impact on society, the environment, and the economy.

Candidates develop:

- research skills
- analysis skills
- skills in designing products
- knowledge and understanding of materials and commercial manufacture
- knowledge and understanding of design
- an understanding of the impact of design and manufacturing technologies on society, the environment and the workforce
- knowledge and understanding of the evolution of products, past, present and future

Who is this course for?

The course is suitable for candidates with an aptitude for the creative and practical activities required to design and manufacture commercial products. It allows candidates to be innovative and resourceful when exploring and resolving problems. The course provides a reliable foundation for those considering further study or a career in design, manufacturing, engineering, science, marketing, and related disciplines.

The course also offers a complementary practical experience for those studying subjects in the technologies and expressive arts.

Course content

The course has two areas of study:

Design

Candidates study the evolution of products, the design of products and the design process. This helps them develop the skills, knowledge and understanding required to initiate, develop, articulate and communicate design proposals, and appreciate the impact design has on society, the economy and the environment. Candidates enhance their understanding of the iterative nature of the design process by using the design, make and test process to reach a viable solution.

Manufacture

Candidates study the manufacture of commercial products. They develop knowledge of materials, processes, assembly, production and planning systems, and strengthen their understanding of how these influence the design of products. This gives them the knowledge and understanding required to develop a viable design proposal for a commercial product, and to plan its production.

Integrating the two areas of study is fundamental to delivering the course successfully. It helps candidates to understand the relationship between designing products and manufacturing products, and it helps them appreciate how this connection influences a product's life cycle. By combining the study of design with the study of manufacturing, candidates also develop a better understanding of the impact design and manufacturing technologies have on society, the environment and the workforce.

Skills, knowledge and understanding

Skills, knowledge and understanding for the course

The following provides a broad overview of the subject skills, knowledge and understanding developed in the course:

- analysing and evaluating the design and manufacture of commercial products
- exploring a range of traditional and contemporary techniques for visualising, modelling, testing and evaluating design proposals
- developing skills, techniques and strategies for communicating ideas appropriate to a range of audiences and users
- developing knowledge and understanding of the role of design and manufacturing in contributing to a global economy
- developing a critical understanding of factors which influence and support the design and manufacture of commercial products — past, present and future
- developing knowledge and understanding of the ethical, social, and environmental impact of the design and manufacture of commercial products
- planning, managing and undertaking a significant design and manufacture assignment

Skills, knowledge and understanding for the course assessment

The following table provides details of skills, knowledge and understanding sampled in the course assessment.

Assignment		**Question paper**	
Skills	**Candidates demonstrate the ability to:**	**Knowledge and understanding**	**Candidates demonstrate knowledge and understanding of:**
Define a design opportunity	♦ carry out research ♦ develop a specification	Brief	♦ the purpose of the design brief in the design process ♦ reasons why design opportunities occur
		Research	♦ the purpose and effective use of research: — throughout the design process — of existing products ♦ methods of gathering information: — primary and secondary research ♦ the following techniques: — comparisons — questionnaires — surveys — tests and test rigs — user trial — user trip
		Specification	♦ the purpose of the design specification in the design process ♦ the purpose and information specified in the following specification types: — product design — performance — technical

Assignment		Question paper	
Skills	**Candidates demonstrate the ability to:**	**Knowledge and understanding**	**Candidates demonstrate knowledge and understanding of:**
		Product analysis	♦ information gathered from product analysis ♦ analysing commercial products: — identifying influences on their performance o function o durability o maintenance o value for money o safety o aesthetics o ergonomics — evaluating their performance: o comparisons o tests and test rigs o user trial o user trip — analysing their manufacture: o identifying and justifying materials o identifying and justifying processes o identifying and justifying manufacturing features o identifying and justifying assembly methods o justifying possible production systems — analysing their impact on: o society o the environment

Assignment		Question paper	
Skills	**Candidates demonstrate the ability to:**	**Knowledge and understanding**	**Candidates demonstrate knowledge and understanding of:**
			Note: candidates carry out a range of practical activities during the course to analyse the commercial manufacture of products. Candidates must reference this analysis when answering question 1 in the question paper.
Generate initial ideas	♦ generate initial ideas	Idea generation	♦ the use of idea-generation techniques ♦ the key stages and/or activities of the following idea-generation techniques: — analogy (technology transfer, biomimicry) — brainstorming — morphological analysis
Apply modelling techniques	♦ use modelling to develop a design proposal	Modelling in the design process	♦ the use of modelling during the design process to: — generate and explore — test and refine — communicate ♦ the purpose of, and information gained from: — physical models: sketch models, block models, scale models, test rigs and prototypes — computer-generated models and simulations
Manufacture a presentation model	♦ manufacture an accurate and detailed model		
Apply graphic techniques	♦ use graphics to develop a design proposal	Graphics in the design process	♦ the use of graphics during the design process to: — generate and explore — test and refine — communicate

Assignment		Question paper	
Skills	**Candidates demonstrate the ability to:**	**Knowledge and understanding**	**Candidates demonstrate knowledge and understanding of:**
Develop ideas	♦ explore ideas ♦ refine ideas ♦ apply knowledge and understanding of: — design — materials, manufacture and assembly methods	Function	♦ the influence of function on the design of products ♦ influence on the function of products ♦ primary and secondary function
		Performance	♦ the influence of performance on the design of products ♦ influence on the performance of products ♦ fitness for purpose of products ♦ the impact of planned obsolescence on the manufacturer, consumer and the environment ♦ maintenance issues associated with products ♦ value for money
		Safety	♦ the influence of safety on the design of products ♦ influence on the safety of products ♦ how to ensure safety in products ♦ safety assurance: — certification — British Standards — kitemarks

Assignment		Question paper	
Skills	**Candidates demonstrate the ability to:**	**Knowledge and understanding**	**Candidates demonstrate knowledge and understanding of:**
		Market	♦ product lifecycle: — introduction — maturity — growth — decline ♦ influences on product lifecycle: — target market — market trends — marketing techniques — niche marketing — fad, fashion and style — economics — research and development costs — the economy ♦ technology push, market pull ♦ branding ♦ product recall ♦ product relaunch ♦ product redesign: — reasons and alternatives — incremental and radical change — risk ♦ issues that influence commercial success or failure ♦ diversification

Assignment		Question paper	
Skills	**Candidates demonstrate the ability to:**	**Knowledge and understanding**	**Candidates demonstrate knowledge and understanding of:**
		Aesthetics	♦ the influence of aesthetics on the design of products ♦ influences on the aesthetics of products
		Ergonomics	♦ the influence of ergonomics on the design of products: — anthropometrics — psychology — physiology ♦ influence on the ergonomics of products ♦ inclusive design ♦ use of ergonomic data
		Conflict resolution	♦ the conflict and balance between: — design issues when designing products — society, economics and the environment when manufacturing products — consumers, designers and manufacturers when designing and manufacturing products ♦ methods and activities to resolve conflicts
		Materials used in the commercial manufacture of products	♦ properties and appropriate use of: — thermoplastics: ABS, acrylic, nylon, polypropylene, polycarbonate, polystyrene, polythene, polyvinyl chloride

Assignment		Question paper	
Skills	**Candidates demonstrate the ability to:**	**Knowledge and understanding**	**Candidates demonstrate knowledge and understanding of:**
			— thermosetting plastics: melamine formaldehyde, urea formaldehyde — elastomers: o natural rubber: latex o synthetic rubber: styrene-butadiene, neoprene, silicone — bio-based plastics: bio-based polymers, biodegradable polymers — ferrous metals/alloys: iron, mild steel, high-speed steel, stainless steel — non-ferrous metals/alloys: aluminium, brass, copper, tin, zinc — hardwoods, softwoods and manufactured boards — composite materials: carbon-fibre plastics, glass-reinforced plastic — plastic additives and fillers ♦ issues that influence the selection of materials for products ♦ the influence materials have on the design and manufacture of products ♦ current developments in materials and their potential impact on products

Assignment		Question paper	
Skills	**Candidates demonstrate the ability to:**	**Knowledge and understanding**	**Candidates demonstrate knowledge and understanding of:**
		Processes used in the commercial manufacture of products	♦ appropriate uses and features of: — injection and extrusion blow moulding — compression moulding — gravity and high pressure die casting — drop forging — injection moulding, two-shot injection moulding and gas-assisted injection moulding — over-moulding — press forming — rotational moulding — thermoforming — 3D printing — laser cutting — CNC machining ♦ issues that influence the selection of processes for commercial manufacture ♦ the influence processes have on the design and manufacture of products

Assignment		Question paper	
Skills	**Candidates demonstrate the ability to:**	**Knowledge and understanding**	**Candidates demonstrate knowledge and understanding of:**
		Designing for manufacture	♦ mould and pattern design — wall thicknesses — placement of split lines and injection and ejector points — purpose of draft angles, location pins, fillets and radius corners — impact of transitions between thick and thin wall thickness, undercuts, shrinkage and thinning of sheet materials ♦ integrated assembly features ♦ purpose of bosses, ribs and webs
		Assembly methods used in the commercial manufacture of products	♦ methods used to join materials ♦ issues that influence the assembly of commercially manufactured products ♦ simplifying the assembly of products: — limit handling and number of operations — standardisation of parts and operations — limit number of parts ♦ use of jigs

Assignment		Question paper	
Skills	**Candidates demonstrate the ability to:**	**Knowledge and understanding**	**Candidates demonstrate knowledge and understanding of:**
Produce a plan for commercial manufacture	♦ plan the commercial manufacture of a proposal	Production and planning systems	♦ one-off production, batch production, mass production ♦ commercial production: — automation — CAD/CAM — CNC machining — standard components — standardisation (global) — just-in-time production — flexible manufacturing systems — sub-contracting ♦ Gantt and flow charts ♦ quality assurance: — quality checks on materials, components and machinery — training and monitoring of staff — sampling and testing

Assignment		Question paper	
Skills	**Candidates demonstrate the ability to:**	**Knowledge and understanding**	**Candidates demonstrate knowledge and understanding of:**
		People who influence design	♦ the roles and responsibilities of people who influence the design of products: — designers — ergonomists — lawyers — production engineers — project managers — market researchers — materials technologists ♦ communication between members of a design team ♦ in-house and sub-contracted design teams
		Intellectual property rights	♦ types of intellectual property rights: — copyright — design rights — patents — trademarks ♦ features of intellectual property rights: — type of property covered — length of cover ♦ cost

Assignment		Question paper	
Skills	**Candidates demonstrate the ability to:**	**Knowledge and understanding**	**Candidates demonstrate knowledge and understanding of:**
		The impact of design and manufacturing technologies on society and the environment and the workforce	♦ methods designers and manufacturers can use to limit a product's impact on the environment: — design for re-use, repair and recyclability — efficiency ♦ the impact traditional and new manufacturing technologies have on society, the environment and the workforce ♦ the sustainability of products: — economic — environmental
		Product evolution	♦ the key stages in the historical evolution of a commercial product: — its origins — reasons for significant changes and turning points — failures and successes — influential products, companies and/or designers — impact on society, economy and the environment ♦ influences of the following on the evolution of products: — materials — manufacturing — technology — society

Assignment		Question paper	
Skills	**Candidates demonstrate the ability to:**	**Knowledge and understanding**	**Candidates demonstrate knowledge and understanding of:**
			— external factors — designers — safety — economics — ergonomics ♦ changes to products during their evolution: — aesthetics — function — performance — safety — economics — ergonomics ♦ the future evolution of products

Skills, knowledge and understanding included in the course are appropriate to the SCQF level of the course. The SCQF level descriptors give further information on characteristics and expected performance at each SCQF level, and are available on the SCQF website.

Skills for learning, skills for life and skills for work

This course helps candidates to develop broad, generic skills. These skills are based on SQA's Skills Framework: Skills for Learning, Skills for Life and Skills for Work and draw from the following main skills areas:

2 Numeracy

2.2 Money, time and measurement
2.3 Information handling

4 Employability, enterprise and citizenship

4.2 Information and communication technology (ICT)

5 Thinking skills

5.4 Analysing and evaluating
5.5 Creating

Teachers and lecturers must build these skills into the course at an appropriate level, where there are suitable opportunities.

Course assessment

Course assessment is based on the information in this course specification.

The course assessment meets the purposes and aims of the course by addressing:

- breadth — drawing on knowledge and skills from across the course
- challenge — requiring greater depth or extension of knowledge and/or skills
- application — requiring application of knowledge and/or skills in practical or theoretical contexts as appropriate

This enables candidates to:

- apply knowledge and demonstrate understanding of:
  - commercial design principles and practices
  - design and commercial manufacture
  - product evolution: past, present and future
- apply skills and knowledge to:
  - analyse and evaluate products
  - solve design problems in both practical and theoretical contexts
  - produce a design proposal in response to a valid design opportunity

Course assessment structure: question paper

Question paper — 80 marks

The question paper has 80 marks out of a total of 200 marks for the course assessment.

It assesses knowledge and understanding from the following areas of design and manufacture:

Area	Range of marks
Product evolution	10–20
Product analysis	10–20
Design	15–30
Manufacture	15–30

Details of these areas can be found in the 'Skills, knowledge and understanding for the course assessment' table in this document.

The question paper has two sections.

Section 1 has 30 marks. It consists of two questions. Both questions require candidates to reference activities carried out and information gained from analysing, evaluating and researching products while undertaking the course.

Question 1 assesses knowledge and understanding candidates gain from evaluating the performance and analysing the manufacture of a commercial product(s).

Question 2 assesses knowledge and understanding candidates gain from researching the evolution of a product(s).

Section 2 has 50 marks. It consists of four or five questions that focus on the design and manufacture of commercial products, and the impact design and manufacturing technologies have on society, the environment and the workforce.

The questions require candidates to give reasoned responses to a range of question types.

Setting, conducting and marking the question paper

SQA sets and marks the question paper. It is conducted in centres under conditions specified for external examinations by SQA.

Candidates have 2 hours and 15 minutes to complete the question paper.

Specimen question papers for Advanced Higher courses are published on SQA's website. These illustrate the standard, structure and requirements of the question papers. The specimen papers also include marking instructions.

Course assessment structure: assignment

Assignment 120 marks

The assignment has 120 marks out of a total of 200 marks for the course assessment.

The assignment assesses candidates' ability to apply design skills and knowledge to define a design opportunity and develop a proposal to meet its requirements. It provides an opportunity to demonstrate the skills as listed in the 'skills, knowledge and understanding for the course assessment' table in this document. Marks are allocated as follows:

Skill	Marks
♦ defining a design opportunity	12
♦ generating initial ideas	6
♦ exploring ideas	16
♦ refining ideas	12
♦ applying graphic techniques	12
♦ applying modelling techniques	12
♦ applying knowledge and understanding of design	14
♦ applying knowledge and understanding of materials, manufacturing and assembly methods	14
♦ producing a plan for commercial manufacture	10
♦ manufacturing a presentation model	12

Setting, conducting and marking the assignment

The assignment is:

- set by centres within SQA guidelines
- conducted under some supervision and control
- submitted to SQA for external marking

The assignment must be in response to a design opportunity candidates identify independently or through discussion with teachers and lecturers.

Teachers and lecturers must ensure the design opportunity is appropriate and presents sufficient levels of challenge and complexity to allow candidates to demonstrate the skills specified in the course specification.

It must be achievable within the constraints of time, expertise and resources.

SQA quality assures all marking.

Assessment conditions

Time

Candidates generate evidence of their design skills by responding to a suitable design opportunity. They produce evidence for the assignment over an extended period of time. This allows them to develop and refine their work before presenting it for assessment.

There must be no interruption for learning and teaching once the assignment has started. Once candidates begin their assignment, they must continue in each subsequent class period until they complete it.

Supervision, control and authentication

The assignment is produced under some supervision and control. This means that:

- candidates do not need to be directly supervised at all times
- the use of resources, including the internet, is not tightly prescribed
- the work an individual candidate submits for assessment is their own
- teachers and lecturers can provide reasonable assistance

Teachers and lecturers must put in place measures to ensure that the work an individual candidate submits for assessment is their own.

Teachers and lecturers must also retain the candidate's work between assessment sessions.

Resources

There are no restrictions on the resources that candidates may access while producing their assignment.

Reasonable assistance

Candidates must carry out the assessment independently. However, they can receive reasonable assistance before the formal assessment process takes place. The term 'reasonable assistance' is used to balance the need for support with the need to avoid giving too much help. If candidates need more than what is thought to be 'reasonable assistance', they may not be ready for assessment or they may have been entered for the wrong level of qualification.

If a candidate working on their assignment is faced with more than one possible solution to a problem, teachers and lecturers can discuss the pros and cons of different options with them. The candidate can then decide on a solution based on the discussion.

Once candidates submit their completed assignment for assessment, it must not be changed by candidates or by teachers or lecturers.

Evidence to be gathered

Candidates must

- produce a design folio in response to a suitably challenging design opportunity
- demonstrate the skills specified in the 'Skills, knowledge and understanding for the course assessment' table

Forms of evidence are likely to include, but are not restricted to: notes and annotation, graphics and photographs, physical and CAD models, justification and evaluations.

Volume

Candidates must present their work on a maximum of 20 single-sided A3-sized sheets or equivalent. This includes the photographic evidence required for 'manufacturing a model to communicate the proposal'.

There is no word count.

Grading

Candidates' overall grades are determined by their performance across the course assessment. The course assessment is graded A–D on the basis of the total mark for both course assessment components.

Grade description for C

For the award of grade C, candidates will typically have demonstrated successful performance in relation to the skills, knowledge and understanding for the course.

Grade description for A

For the award of grade A, candidates will typically have demonstrated a consistently high level of performance in relation to the skills, knowledge and understanding for the course.

Equality and inclusion

This course is designed to be as fair and as accessible as possible with no unnecessary barriers to learning or assessment.

Guidance on assessment arrangements for disabled candidates and/or those with additional support needs is available on the assessment arrangements web page: www.sqa.org.uk/assessmentarrangements.

Further information

- Advanced Higher Design and Manufacture subject page
- Assessment arrangements web page
- Building the Curriculum 3–5
- Guide to Assessment
- Guidance on conditions of assessment for coursework
- SQA Skills Framework: Skills for Learning, Skills for Life and Skills for Work
- Coursework Authenticity: A Guide for Teachers and Lecturers
- Educational Research Reports
- SQA Guidelines on e-assessment for Schools
- SQA e-assessment web page
- SCQF website: framework, level descriptors and SCQF Handbook

Appendix 1: course support notes

Introduction

These support notes are not mandatory. They provide advice and guidance to teachers and lecturers on approaches to delivering the course. Please read these course support notes in conjunction with the course specification and the specimen question paper and coursework.

Developing skills, knowledge and understanding

This section provides advice and guidance about skills, knowledge and understanding that teachers and lecturers could include in the course. There is considerable flexibility to select contexts that stimulate and challenge candidates, offering both breadth and depth.

Candidates enhance the skills, knowledge and understanding they gained at Higher and apply them to new situations and/or tasks. They also develop new skills, knowledge and understanding specific to the Advanced Higher course.

Teachers and lecturers must ensure candidates have the opportunity to:

- enhance their research skills and apply them when designing and evaluating products
- develop and enhance their analysis skills and use them to evaluate, examine and investigate commercial products and their manufacture
- enhance their graphic and modelling skills and use them to develop proposals and communicate information
- develop skills to manufacture physical presentation models
- increase their breadth of knowledge and depth of understanding of materials and commercial manufacture and apply this when designing, evaluating and analysing commercial products
- increase their breadth of knowledge and depth of understanding of design and apply this when designing, evaluating and analysing commercial products
- enhance their understanding of the impact of design and manufacturing technologies on society, the environment and the workforce
- develop a knowledge and understanding of the evolution of products: past, present and future

Appendix 2 of this document provides a comparison between the Higher and Advanced Higher course content. This identifies content common to both levels, and specific skills, knowledge and understanding developed at Advanced Higher.

Appendix 3 of this document provides advice on developing additional skills, knowledge and understanding not developed at Higher, together with some suggested teaching activities and approaches.

Approaches to learning and teaching

Learning and teaching approaches should balance direct teaching and activity-based learning using practical tasks.

Direct teaching can help to:

- introduce topics
- demonstrate skills and give the information required to undertake activities and tasks
- supplement knowledge and understanding developed from activities and tasks
- cover theory-based topics, or topics not easily covered by practical activities

Activity-based learning can help to:

- enhance and develop skills
- deepen understanding
- provide contexts for learning
- encourage independence

Candidates could cover the content of the course through analysing, evaluating and researching products, studying design and developing design proposals.

Teachers and lecturers should plan the course so that candidates develop design skills alongside knowledge and understanding of the influences on the design and manufacture of commercial products. To encourage candidates to be actively involved in developing this knowledge and understanding, and applying what they have learned to their own design proposals, teachers and lecturers could focus on three broad areas of study:

- product analysis
- product evolution
- product development

At Advanced Higher, a significant amount of learning is self-directed. Candidates should be able to demonstrate initiative and work on their own. Some candidates may find this challenging so it is important to have strategies in place to support them, for example providing resources and structured tasks with clear deadlines, and planning time for regular feedback sessions.

Product analysis

Analysing commercial products covers:

- research
- product analysis
- design factors (function, performance, safety, aesthetics and ergonomics)
- conflict resolution
- materials used in the commercial manufacture of products
- processes used in the commercial manufacture of products
- designing for manufacture
- assembly methods used in the commercial manufacture of products
- production and planning systems
- the impact of design and manufacturing technologies on society, the environment and the workforce

Teachers and lecturers should provide a range of products suitable for analysis. Each product should illustrate the influence and impact of different materials, processes and assembly methods and be designed for a range of different purposes. Some products must be assembled from several parts and be able to be completely stripped down. This allows candidates to analyse assembly and manufacturing features and access the inner workings of the products.

The more experience candidates have with a range of products, the more knowledge they can draw on when developing their own design proposals and responding to the question paper.

Candidates must have the opportunity to analyse commercial products by:

- identifying influences on products' performance
- evaluating the performance of products
- analysing the manufacture of products
- analysing the impact of products on society and the environment

All four areas could be covered by carrying out one complete analysis of a suitably complex product. However, using different products to focus on each area individually is likely to be more informative.

Product analysis does not have to be a discrete activity. Teachers and lecturers could use it to introduce the course, as a starting point to a design task, or to provide insight and technical detail during the development of a design proposal.

Identifying influences on and evaluating performance of products

Evaluating common products should become second nature to candidates. Developing the ability to identify issues that influence the performance of products is a key skill. Candidates learn how to evaluate products and design proposals effectively, define design opportunities and improve their development by focusing on important issues.

Methods of analysing and identifying the influences on products, and evaluating their performance, include:

User trips — can provide personal insight into products and allow candidates to analyse and/or evaluate performance. When carrying out user trips, it is important to use the products at critical stages of their life cycle (purchase, transportation, installation, use, maintenance) in the environments they were intended for.

User trials — can provide information from the intended user when analysing and/or evaluating products. They can also provide information and gather opinions from a range of different user groups.

Comparisons — can analyse and evaluate similar products by matching and comparing appropriate aspects, features and characteristics. They can also be used in conjunction with user trips and trials to provide more objective information.

Tests and test rigs — can provide impartial measurable information free from personal opinion. Information should be based on primary research, such as measuring, weighing and timing.

Teachers and lecturers should encourage candidates to select and use appropriate methods to gather the information they require.

The task below requires candidates to evaluate the performance of a suitably complex commercial product using a range of appropriate techniques. It could be used to cover:

- methods of gathering information
- information gathered from product analysis
- identifying influences on the performance of commercial products
- evaluating the performance of commercial products
- influence of function, performance, safety, market, aesthetics and ergonomics on the design of products
- fitness for purpose of products
- maintenance issues associated with products
- value for money
- how to ensure safety in products
- safety assurance
- the influence materials have on the design and manufacture of products

Candidates should apply knowledge and understanding of design factors that illustrate the increase in challenge from Higher to Advanced Higher.

Suggested learning and teaching task — evaluate a hand-held product which has clear functional, performance, safety and ergonomic requirements, for example electric kettle, hairdryer, hair-straighteners, electric food blender, household iron, electric screwdriver, hand-held vacuum cleaner.

Teachers and lecturers could:

- provide a suitable product

Candidates could:

- carry out a user trip and/or user trial and/or comparison to identify the influence on the performance of a commercial product by:
  - identifying the key functional features and requirements
  - identifying the key aesthetic features and requirements
  - identifying interactions required for use and maintenance
  - establishing type and frequency of maintenance
  - identifying possible areas of wear and tear (durability)
  - identifying possible safety issues or concerns
- develop an evaluation strategy to evaluate factors, features and requirements identified by:
  - planning a user trial to evaluate issues such as: fit for purpose, comfort, ease of use
  - writing a questionnaire or survey to evaluate issues such as: aesthetics, function, value for money
  - developing tests to evaluate issues such as: durability, safety, function
- evaluate the product using their evaluation strategy
- draw up conclusions and present their findings

Candidates can present information in a range of ways, for example text, presentation, storyboard, sequence.

Candidates could develop a matrix to highlight the information they need to find out, why it is important to the evaluation, and how they will test and evaluate it.

Analysing the manufacture of commercial products

Candidates should develop the ability to:

- investigate how commercial products are manufactured
- analyse the impact and influence that materials, processes, assembly methods and production systems have on the product's performance and on the environment

By analysing the manufacture of existing products, candidates gain insight into:

- the interrelationship between designing and manufacturing products
- knowledge and understanding required to make informed decisions about a product's manufacture
- technical information and details required to develop design proposals

Teachers and lecturers should encourage candidates to apply this information to their own design proposals. Candidates could use the knowledge and understanding they develop from analysing commercial products to develop more refined design proposals or when responding to the question paper.

Methods of analysing products could range from basic visual inspections to complete teardowns (disassembling products) and destructive tests. Methods of analysing the manufacture of commercial products include:

Visual inspections — can identify materials from their physical properties such as colour, texture and weight, or by identification symbols. Manufacturing processes can also be identified from manufacturing features such as accuracy, surface texture and form, or by the performance required from the product or component part.

Teardowns — can enhance knowledge and understanding about designing for manufacturing, and issues that influence the assembly of products. Teardowns should result in detailed information about the materials, processes, assembly and production systems used to manufacture products and their component parts. Teardowns are likely to involve visual inspections, tests, comparisons and secondary research.

Tests — can identify materials when visual inspections are inconclusive. Under the supervision of the teacher or lecturer, candidates could use burn, spark and float tests to identify materials.

Comparisons — can identify materials, processes, assembly methods and production systems in other products or components.

Secondary research — can confirm that information gathered from primary research is correct and valid.

The task below requires candidates to analyse the manufacture of a suitably complex commercial product using a range of appropriate techniques, and apply knowledge and understanding of design and manufacture.

It could be used to cover:

- methods of gathering information
- analysis of the manufacture of commercial products
- the influence of function, performance, safety, market, aesthetics and ergonomics on the manufacture of products
- fitness for purpose of products
- the impact of planned obsolescence on the manufacturer, consumer and the environment
- the conflict and balance between consumers, designers and manufacturers when designing and manufacturing products
- materials used in the commercial manufacture of products
- processes used in the commercial manufacture of products
- design for manufacture
- assembly methods used in the commercial manufacture of products
- production and planning systems

Suggested learning and teaching task — analyse the manufacture of a hand-held product manufactured from a range of materials using a number of processes and assembled from a number of component parts, for example electric kettle, electric iron, toaster, hairdryer or hair-straighteners.

Centres must ensure that all electrical products have their plugs removed and cannot be reconnected to the mains supply.

Teachers and lecturers could:

- provide a suitable product(s) and help candidates disassemble it
- discuss the influence and impact of the materials, processes and manufacturing features on the manufacture of products
- suggest suitable methods to identify and justify materials and processes
- help candidates to test materials
- discuss the influence on, and impact of, assembly features and methods
- discuss how production systems influence the manufacture of products
- suggest further areas of research

Candidates could:

- disassemble the product(s), carefully recording how it came apart and collecting all components and fixings
- identify assembly features and methods used (for example bosses, webs, location points, integrated assembly features, threads, and permanent and semi-permanent fixings)
- identify materials used to manufacture the main component parts
- justify the materials used to manufacture the main component parts (justifications could be based on issues such as performance requirement of individual parts)
- identify the method of production, volume of production, economics, sustainability, the environment, obsolescence, aesthetics
- justify processes used to manufacture the main component parts (justifications could be based on issues such as performance requirement of individual parts, method of production, volume of production, economics, sustainability, the environment, obsolescence, aesthetics)
- identify manufacturing features used to improve the product or its manufacture (features could include ribs, webs, radius corners, draft angles, split lines, ejection and/or injection points, wall thickness, surface finish)
- justify the manufacturing features (for example, ease of manufacture and strength)
- reassemble a product(s) by reversing the sequence used to disassemble it
- justify assembly methods (for example, bosses, webs, location points, integrated assembly features, threads, and permanent and semi-permanent fixings)
- justify possible production systems such as one-off, batch or mass (for example, materials, manufacturing processes, life expectancy, product type, features, methods of assembly)

Candidates could record information using text, photographs and storyboards.

Analysing the impact of products on society and the environment

Candidates should consider the impact of products at different stages of their lifecycle. This helps candidates to develop an awareness of how products impact on society and the environment. Candidates could use the knowledge and understanding gained from analysing the impact of products on society and the environment to develop more considered design proposals, or when responding to the question paper.

Candidates could use primary and secondary research to investigate the impact of products on society and the environment. They could do this as a discrete study, or incorporate it when evaluating the performance and analysing the manufacture of commercial products. The task below could be used to cover:

- methods of gathering information
- analysing products' impact on society and the environment
- the conflict and balance between society, economics and the environment when manufacturing products
- the impact of design and manufacturing technologies on society, the environment and the workforce

Candidates investigate the impact of a commercial product(s) on society and the environment and apply their knowledge and understanding of design and manufacture to make decisions and reach conclusions.

Suggested learning and teaching task — investigate the impact of a product(s) on society and the environment. Note: products must have made a significant impact on society and the environment as a result of their manufacture and/or use, for example cars, bicycles, domestic appliances, healthcare products, communication devices, and computers.
Teachers and lecturers could: ♦ suggest suitable products to investigate ♦ discuss the different ways products can impact on society and provide case studies ♦ discuss the different ways products can impact on the environment and provide case studies
Candidates could: ♦ select a product(s) ♦ investigate the positive and negative impact its manufacture and/or use has had on society, considering issues such as the workforce, production systems, volume of production, availability, way of life, standard of living ♦ investigate the positive and negative impact its manufacture and/or use has had on the environment, considering issues such as depletion of non-renewable resources, pollution, landfill, sustainability
Candidates could record information in a short report using text and images.

Product evolution

This is an area of study that is only covered at Advanced Higher but draws on the skills, knowledge and understanding developed in the Higher Design and Manufacture course. Candidates will enhance their understanding of the influence and impact of design issues on commercial products by researching products from the past, present and future.

This is not a discrete area of study. It covers a range of content specified in the 'skills, knowledge and understanding for the course assessment' table, for example:

- research
- design factors (function, performance, safety, market, aesthetics, ergonomics)
- conflict resolution
- materials used in the commercial manufacture of products
- processes used in the commercial manufacture of products
- production and planning systems
- people who influence design
- intellectual property rights
- the impact of design and manufacturing technologies on society, the environment and the workforce
- product evolution

Teachers and lecturers should provide a range of products suitable for studying the influences on and impact of product evolution. Each product should allow candidates to investigate why products change during their evolution, and the impact these changes have on the product, society and the environment.

Product evolution is split into four sections in the 'skills, knowledge and understanding for the course assessment' table:

- key stages in the historical evolution of a commercial product
- influences on the evolution of products
- changes to products during their evolution
- the future evolution of products

Teachers and lecturers should ensure that candidates can use the internet efficiently, as this is likely to be where candidates carry out most of their research. Teachers and lecturers should also encourage candidates to use libraries and museums, where possible.

Key stages in the historical evolution of a commercial product

Investigating the key stages in the historical evolution of a commercial product enhances candidates' understanding of the issues that influence and impact on the design and manufacture of products. Studying a product's evolution illustrates how design opportunities arise, why products change, the reasons for successes and failures, and the impact products have on society, the economy and the environment. This increases candidates' understanding of why they need to consider materials, manufacturing, technology, safety, economics and ergonomics when developing their own design proposals.

Candidates need the knowledge and understanding gained from investigating the key stages in the historical evolution of a commercial product when responding to section 1 of the question paper.

The task below could be used to develop knowledge and understanding of the key stages in the historical evolution of a commercial product, and the influences on and changes to products during their evolution.

The task requires candidates to research the evolution of a commercial product using a range of appropriate techniques, and applying knowledge and understanding of design and manufacture. It could be used to cover:

- methods of gathering information
- reasons why design opportunities occur
- influence of function, performance, safety, market, aesthetics and ergonomics on the design of products
- product lifecycle
- influences on product lifecycle:
  - issues that influence commercial success or failure
  - intellectual property rights
  - the key stages in the historical evolution of a commercial product

Suggested learning and teaching task — investigate the evolution of a commercial product(s).

Note: the product must provide opportunities to carry out a detailed study that considers more than superficial aesthetic changes to a product over several decades, for example vacuum cleaners, kettles, electric irons, radio, portable music players, televisions and toasters.

Teachers and lecturers could:

- use timelines to illustrate and discuss the evolution of products, and provide timelines covering the introduction and developments in significant materials, manufacturing and technology
- provide information on issues that influence commercial success or failure
- provide information on product recall, product relaunch, product redesign
- discuss the positive and negative impact of products on society, the economy and the environment
- ensure candidates have the skills to access relevant information

Candidates could:

- select a suitable commercial product
- investigate the origins of the product (what influenced the original idea?). It may be helpful to identify people accredited with its invention, and consider the influence of developments in materials, manufacture and technology, scientific breakthroughs and changes in society.
- identify notable changes and turning points during the product's evolution and investigate the reasons behind them. Reasons could include:
  - the introduction and development of materials, manufacturing and technology
  - changes in society, including changes in population, urbanisation, equality, health, education, mobility, quality of life
  - external factors, including changes in the economy, global events, scientific and engineering developments, fashion and style, legislation
- identify significant products, companies and/or designers that influenced the evolution of a product and investigate their impact
- identify successful and unsuccessful changes to a product during its evolution and investigate the reasons for success and failure
- identify the impact on society, the economy and the environment of the introduction of significant changes to a product during its evolution, including changes in attitudes and way of life, improved standards of living and health, depletion of natural resources, pollution, landfill and carbon footprint

Changes in products could include changes and/or improvements to function, performance, aesthetics, ergonomics, popularity, availability, affordability, user interface and environmental impact.

Candidates could record information in a short report using text and images, annotated timelines or any other appropriate method.

The future evolution of products

The task below requires candidates to predict the future evolution of a commercial product by applying knowledge and understanding of new and emerging technologies, materials and predicted development in society. It could be used to cover:

- methods of gathering information
- reasons why design opportunities occur
- the influence of function, performance, safety, market, aesthetics and ergonomics on the design of products
- the future evolution of products
- current developments in materials and their potential impact on products
- product redesign

Suggested learning and teaching task — investigate the future evolution of products.
Teachers and lecturers could: ♦ give candidates information on new and emerging technologies, materials and predicted developments in society ♦ discuss the potential of using new and emerging technologies and materials
Candidates could: ♦ investigate the potential impact of the following on the design, manufacture and/or performance of products: — new and emerging technology — new and emerging materials — predicted developments in society
Candidates could record information in a short report using text and images, annotated timelines or any other appropriate method.

Product development

Developing design proposals covers a range of content specified in the ‘skills, knowledge and understanding for the course assessment’ table, such as:

- define a design opportunity
- product analysis
- design factors (function, performance, safety, aesthetics, ergonomics)
- conflict resolution
- materials used in the commercial manufacture of products
- processes used in the commercial manufacture of products
- designing for manufacture

- assembly methods used in the commercial manufacture of products
- production and planning systems
- the impact of design and manufacturing technologies on society, the environment and the workforce

Teachers and lecturers should:

- provide opportunities for candidates to enhance their design skills
- demonstrate how candidates could use specific techniques to inform the development of their design proposals
- provide a range of tasks that focus on discrete parts of the design process, avoiding unnecessary repetition
- encourage candidates to use the skills, knowledge and understanding gained from studying existing products to provide depth and detail to their own design work
- help candidates to develop modelling and graphics skills to communicate information, analyse problems, test and evaluate solutions, and improve understanding
- encourage candidates to use CAD and/or CAM to communicate technical details, especially during the later stages of the design process

Candidates should become fluent in key design and manufacture skills such as:

- sketching
- creating sophisticated models
- analysing complex problems and communicating in detail
- manually producing and/or computer-generating models and graphics

In addition to the modelling skills gained at Higher, candidates must develop practical and/or computer skills to manufacture a physical presentation model. These skills could be integrated into other tasks, or developed by separate focused tasks.

Although there is no definitive design process, most approaches are comparable and require candidates to apply the same key skills, knowledge and understanding to:

- define design opportunities
- generate ideas
- explore ideas
- refine ideas
- plan for manufacture

Define design opportunities

Designers often have to design products for target markets, user groups or situations they are unfamiliar with. To design successful products, they must fully understand the issues that influence the design and be able to relate to users' needs. Defining the opportunity is the

initial stage in the design process. This provides focus, generates understanding and can be used to analyse and evaluate ideas and concepts.

Analysing existing products, situations, open design briefs or tasks could provide a suitable starting point. The information candidates gather should help them develop a detailed specification.

Generate initial ideas

Candidates should develop graphic and modelling skills that allow them to generate, present and evaluate ideas quickly and efficiently. Ideas should be original and innovative and avoid restyling. There should be enough detail to allow candidates to reflect on the qualities and potential of their ideas in order to meet the demands of the specification.

Explore ideas

This skill involves exploring the requirements of the design, investigating alternatives and considering different approaches to:

- design issues (such as function, aesthetics, safety and ergonomics)
- manufacturing issues (such as materials, processes and assembly)

Candidates need to use specific skills such as creative thinking, sketching, modelling, testing and evaluating techniques to investigate and experiment with relevant issues. Changes at this stage do not have to result in improvement to the design. Trialling ideas may prove the initial idea was right in the first place. However, exploration provides greater insight into the requirements of the design proposal and highlights issues not apparent in the initial ideas.

Identifying areas for exploration is an important aspect of the process. Candidates should identify areas that have a significant influence on a design to ensure exploration is meaningful. As the exploration unfolds, candidates identify additional areas of research. Research at this stage supplements the specification and helps drive exploration and give it depth.

Refine ideas

Refinement involves applying skills, knowledge and understanding to:

- narrow the choices considered during exploration
- inform decisions
- ensure the proposal meets the requirements of the specification
- ensure the product can be manufactured successfully

Modifications to the design concept at this stage focus on improving the performance of the proposal and providing manufacturing details. Candidates use specific sketching and drawing techniques to develop and communicate manufacturing details. They test and evaluate concepts using more sophisticated graphic and modelling techniques such as CAD and CAM.

To develop a detailed proposal, candidates carry out ongoing research into issues such as function, ergonomics, materials, assembly, manufacturing features and costs.

Plan for manufacture

Commercial products are often assembled from component parts manufactured from different material and processes. Planning requires detailed knowledge of material and processes, assembly methods and manufacturing details.

Materials have to meet the requirements of the product or component part and be compatible with the manufacturing process.

The manufacturing processes must be suitable and consider the form, detail, accuracy volume and cost of production. Assembly features must suit the performance of the product, volume and method of assembly. Manufacturing features should be incorporated into the product or its component parts to ensure they can be manufactured successfully.

Candidates could use models (including scale models) to help plan the manufacture of a proposal.

Modelling

Candidates can use modelling at various stages of the design process to visualise, analyse and test ideas, and improve understanding. Whether the models are physical or computer-generated depends on their purpose, stage of the design process and the information required.

Integrating the development of modelling skills into a design task helps to ensure the skills are developed in context.

Design tasks

Teachers and lecturers should give candidates tasks to develop and enhance their skills and confidence when designing products. The design tasks should focus on different skills and allow candidates to apply knowledge and transfer skills gained from analysing and investigating products.

The task below requires candidates to develop a detailed and considered proposal based on knowledge and understanding that builds on Higher. It could be used to cover:

- purpose of the design brief in the design process
- reasons why design opportunities occur
- purpose and effective use of research
- analysing commercial products
- use of idea-generation techniques
- use of modelling during the design process
- purpose of, and information gained from, physical models

- use of graphics during the design process
- influences on function, performance, safety and ergonomics
- fitness for purpose of products
- product redesign
- conflict and balance between design issues when designing products
- issues that influence the selection of materials for products
- influence materials have on the design and manufacture of products
- issues that influence the selection of processes for commercial manufacture
- influence processes have on the design and manufacture of products

Suggested learning and teaching task — redesign a school marking gauge to be easier for S1 and S2 pupils to use.

Note: candidates could use any simple functional product which presents a real problem to a specific user group.

Teachers and lecturers could:

- provide candidates with a typical school marking gauge
- discuss methods to identify problems and issues with its use
- discuss problems associated with S1 or S2 pupils learning to use a marking gauge
- help candidates to plan and prepare a user trial
- arrange for candidates to carry out a user trial with an S1 or S2 class

Candidates could:

- carry out a user trip, and:
  - use the product (marking gauge) as intended in an appropriate location (school workshop)
  - identify what a product needs to do to perform successfully
  - identify difficulties when using the product
  - identifying possible safety issues or concerns
- plan a user trial of the intended user group, and:
  - establish tasks and questions to investigate areas of confusion, difficulty, discomfort and safety concerns
- observe and interview user group and record the findings
- generate ideas:
  - use modelling to generate alternative forms suitable for holding and moving the marking gauge when marking, setting and adjusting
  - sketch over photographs of models to add details
  - research and incorporate alternative to the spur, adjusting, locking and measuring
  - annotate ideas referencing feedback from modelling, benefits and drawbacks of alternatives, areas of further development and research
- explore one idea:
  - identify a promising idea
  - use sketches and modelling to improve the function considering alternatives for marking, setting and adjusting
  - use foam board (for example Styrofoam) full-sized models to explore ergonomics, size, form and position of parts
  - consider physiology and psychology to create a more intuitive easy-to-use product
  - explore the concept by considering alternative materials and manufacturing processes and their influence on form, function, economics and manufacturing features
- refine the idea:
  - carry out a user trial with user group to gain feedback on comfort and ease of use
  - refine ergonomics and establish critical sizes through modelling
  - incorporate necessary design features
- create a prototype to be tested by a user group

Candidates could record information using photographs, video, sketches, models, or any other appropriate method.

The task below requires candidates to use research to develop a highly detailed and considered proposal based on their knowledge and understanding of design and manufacture. It could be used to cover:

- purpose of the design brief in the design process
- purpose of the design specification in the design process
- purpose and effective use of research
- use of idea-generation techniques
- use of modelling during the design process
- purpose of, and information gained from, physical models
- use of graphics during the design process
- influences on function, performance, safety and ergonomics
- influence of ergonomics on the design of products
- fitness for purpose of products
- conflict and balance between design issues when designing products
- issues that influence the selection of materials for products
- influence materials have on the design and manufacture of products
- issues that influence the selection of processes for commercial manufacture
- influence processes have on the design and manufacture of products

Suggested learning and teaching task — redesign a balance bike to ensure it grows with the child and is easy to carry and store.

Note: candidates could use any suitable product with clear functional, safety, performance and ergonomic requirements aimed at a specific user group.

Teachers and lecturers could:

- provide candidates with a design brief and/or specification
- provide research on the target market, anthropometric (adult and child) information on standard components such as wheels, brakes, bearings, methods of adjustment and holding
- discuss requirements and develop a specification with the candidate
- provide scale drawings and/or models of standard components

Candidates could:

- generate ideas:
  - sketch a scale drawing of wheels to create basic frames
  - generate ideas for a wooden-framed bike
  - generate ideas for a plastic-framed bike
  - generate ideas for a metal-framed bike
  - use modelling to generate and evaluate complex forms that are difficult to sketch
  - sketch over photographs of models to add details
  - annotate ideas referencing benefits and drawbacks of alternatives and areas of further research
- explore one idea:
  - identify a promising idea
  - use sketches and modelling to explore and improve the function, performance, safety, aesthetics and ergonomics
  - identify different aspects of the bike requiring adjustment
  - identify adjusting methods and features used in other products and apply them to explore an idea
  - identify methods and features for holding and carrying that are used in other products and apply them to explore an idea
  - use scale models to explore ergonomics, size, position of parts, ease of use
  - consider physiology and psychology to create a more intuitive and easy-to-use product
  - explore the concept by considering alternative materials and manufacturing processes and their influence on form, function, economics and manufacturing features
- refine the idea:
  - refine and establish materials and manufacture of the bike frame
  - refine and establish methods of assembly
  - refine ergonomics and establish critical sizes through scale drawings and sketches and CAD models
  - incorporate necessary design features

Candidates could record information using photographs, sketches, models, or any other appropriate method.

The task below requires candidates to develop a detailed and considered proposal based on their knowledge and understanding of design and manufacture that builds on that acquired at Higher. It could be used to cover:

- purpose of the design brief in the design process
- purpose and effective use of research
- analysing the manufacture of commercial products
- use of idea-generation techniques
- use of modelling during the design process
- purpose of, and information gained from, physical and computer-generated models
- use of graphics during the design process
- influences on function, performance, safety and ergonomics
- influence of ergonomics on the design of products
- fitness for purpose of products
- conflict and balance between design issues when designing products
- issues that influence the selection of materials for products
- influence materials have on the design and manufacture of products
- issues that influence the selection of processes for commercial manufacture
- influence processes have on the design and manufacture of products
- mould and pattern design
- integrated assembly feature
- purpose of bosses, ribs and webs
- methods used to join materials
- issues that influence the assembly of commercially manufactured products

Suggested learning and teaching task — redesign a simple hand-held product for a specific market group with accompanying research.

Note: providing a specific market group also focuses the aesthetic direction of the product.

Teachers and lecturers could:

- provide information on the design for manufacture specified in the course specification
- provide appropriate research

- identify changes required to ensure the product is fit for purpose and suited to its target market
- carry out a product teardown to analyse the manufacture of the product:
  - identify features required to aid manufacture and assembly
  - identify the standard components and record sizes and methods to incorporate them into the product
- generate ideas:
  - use sketches and modelling to generate alternative ideas incorporating functional requirements, aesthetic and ergonomic features that ensure it is fit for purpose and suited to its target market
- explore ideas:
  - use modelling to create a comfortable and easy-to-use product by making adjustments to aspects such as overall size and form, positions of parts and controls, texture, materials and colour
- refine ideas:
  - establish which materials, processes and assembly methods to use
  - finalise placement of component parts
  - use appropriate graphic techniques to incorporate manufacturing features and assembly features required to ensure the product can be successfully manufactured
- plan for manufacture:
  - identify materials, processes and assembly methods for the proposal and its component parts
  - create a dimensioned sketch and/or drawing of the proposal and its components parts
  - use appropriate graphic techniques to illustrate the internal working and manufacturing features
- manufacture a presentation model

Preparing for course assessment

Teachers and lecturers must ensure that candidates are fully prepared for both components of the course assessment. Candidates should be aware of the expectations and standards required for success.

The way in which individual centres prepare their candidates for assessment varies. However, all centres must provide time for candidates to:

- prepare for the question paper
- prepare for the coursework assessment task
- carry out the stages of the coursework assessment task

Candidates are only assessed on the content listed in the 'skills, knowledge and understanding for the course assessment' table in the course specification.

Throughout the course, teachers and lecturers should use both formative and summative assessment strategies to provide feedback and monitor candidates' progress. Candidates should be aware of their progress and have clear strategies to improve their performance.

During the latter part of the course, it may be appropriate to use more formal, timed activities to assess candidates' readiness to undertake the course assessment.

Question paper

Candidates should develop the skills to:

- read questions and identify the focus of the question
- refer to information, images and contexts provided in the question paper
- respond to question types and command words used in the question paper
- plan answers
- provide extended answers appropriate to the mark allocation
- answer questions under timed conditions

Candidates should apply their knowledge and understanding and develop their exam technique by completing specimen and past papers.

Section 1

Candidates must refer to their own product analysis and product evolution when responding to section 1 of the question paper. Candidates must have studied a range of products and be able to refer to:

- appropriate products
- activities used when analysing products
- the information gained from product analysis and product evaluation

Section 2

Candidates must demonstrate knowledge and understanding of the design and manufacture of commercial products, and the impact design and manufacturing technologies have on society, the environment and the workforce. Candidates could develop their knowledge and understanding of design, design factors, commercial design practices, manufacture, and the impact of design and manufacturing technologies by studying products and completing design tasks. Candidates must be able to:

- analyse unseen products through images provided to identify, justify, describe, explain or discuss issues and influences on their design and manufacture
- analyse contexts and scenarios to respond to questions relating to the design and manufacture of products
- evaluate materials, processes and products to respond to questions relating to design and manufacture
- integrate knowledge and understanding from a range of topics

Assignment

Teachers and lecturers must give candidates the instructions for the assignment before they begin their assessment.

The assignment requires candidates to demonstrate skills when developing a proposal in response to a suitably challenging design opportunity.

Candidates should develop their ability to:

- work independently under the conditions specified in the assignment
- demonstrate skills assessed in the assignment
- demonstrate a suitable breadth of knowledge and depth of understanding of design, materials, manufacture and assembly when developing a design proposal

The table below provides additional guidance on the content assessed in the assignment.

Skill	Additional guidance
Defining a design opportunity	Candidates have to develop the skills to define design opportunities rather than responding to given design tasks. When selecting a design opportunity, candidates should consider: ♦ Is it a real problem or valid opportunity? ♦ Is it manageable in the time? (Don't take on too much.) ♦ Is it simple enough for the candidate to fully develop and present a detailed proposal? ♦ Is it aimed at a niche market? ♦ Is it clearly influenced by a number of design factors?

Skill	Additional guidance
	♦ Will it demonstrate knowledge and understanding of commercial manufacture? Possible starting points: ♦ redesign to meet user needs ♦ local environment ♦ transport ♦ street furniture ♦ retail outlets Research methods used must be appropriate to the information required. For example: ♦ user trips could be an effective way of developing a better understanding of problems and requirements or identifying possible areas of improvement ♦ site visits, observations and surveys may be effective when investigating opportunities and requirements relating to different locations and environment ♦ interviews, observations and user trials could be used to understand the requirement of a specific user group ♦ measuring and recording critical sizes Suitable methods of presenting information include: ♦ charts and graphs for statistical information ♦ quotes and extracts from interviews and surveys ♦ annotated photographs or images Candidates should only present valid information used to identify and/or define the problem. They should avoid storing information. Candidates may find it helpful to research the following when drawing up a brief and/or specification: ♦ the target market and user group ♦ purpose of the product ♦ benefits of the product ♦ the location and conditions the proposal will be used in ♦ environmental considerations ♦ safety, aesthetics, ergonomics and economics

Skill	Additional guidance
	Candidates' brief and/or specification must be based on their research. They should avoid including statements not backed up by research. Candidates may identify further areas of research as a result of drawing up a design brief and/or specification and carry out additional research to ensure there is appropriate detail.
Generating initial ideas	Candidates should avoid looking at existing solutions at this stage to avoid restyling existing products. They should develop the skills to create original ideas that are innovative from the ground up. It is important to make clear links between the ideas presented and the candidate's brief and/or specification. Candidates could annotate their presentation to make these links clear and provide additional detail. They could also use annotation to record initial thoughts on how well the ideas meet the specification, and possible areas for further investigation. At this stage there are likely to be more questions than answers. It may be helpful to use a combination of 2D and 3D sketches and sketch models created from materials that can be quickly and easily shaped to generate ideas. Candidates' creativity should not be limited by their sketching ability. The quality of the sketch only has to be good enough to communicate the idea. Teachers and lecturers could encourage candidates to use modelling to generate ideas that are difficult to sketch.
Exploring ideas	Exploration uses many of the skills applied when generating ideas, but focuses on experimenting with alternatives to a promising concept. Exploration is a significant part of the design process. It provides a framework for candidates to demonstrate their ability to: ♦ think creatively ♦ solve problems ♦ use graphics and modelling ♦ apply their knowledge and understanding of design, materials, and manufacture and assembly methods Changes at this stage may be bold, experimental and focus on looking at ways to improve the original idea. Candidates should record and reflect on successful and unsuccessful changes.

Skill	Additional guidance
	Candidates should focus their exploration on factors and issues that have the greatest impact on the success of the proposal. These issues will depend on the task, research and the brief and/or specification. Candidates should avoid focusing on one or two design issues. This does not create a balanced design, and restricts opportunities to demonstrate their knowledge and understanding of design, materials, manufacture and assembly methods. Candidates should avoid exploring design factors in isolation. They should develop the skills to consider the interrelationship between design issues when exploring a proposal. Frequently asking questions such as the ones below could help stimulate and encourage exploration. ♦ Could the idea be more suited to its purpose? ♦ Could the idea be easier and/or safer to use? ♦ Are the aesthetics suitable or could they be improved? ♦ Could the idea be manufactured using different materials? If so, how would this influence the function, aesthetics, ergonomics, cost, manufacturing and assembly methods and impact on the environment? ♦ Could the idea be manufactured differently? If so, how would this influence the function, aesthetics, ergonomics, cost and impact on the environment? ♦ Could the idea be assembled in different ways? If so, how would this influence the function, aesthetics, cost, safety, manufacturing and assembly methods and impact on the environment? Exploration can raise questions and present unforeseen problems, as well as providing answers. Candidates should be prepared to carry out additional research to enhance their exploration. Candidates could also use knowledge gained from analysing and studying the evolution of commercial products. Candidates should use a range of appropriate graphic techniques when exploring ideas. For example, they could: ♦ use 2D and 3D sketching to visualise and analyse ideas and present information ♦ sketch sectional and exploded views when exploring interior elements and assembly ♦ work to scale when exploring ergonomics

Skill	Additional guidance
	Candidates should use a range of appropriate modelling techniques when exploring ideas. Models do not need to be sophisticated at this stage. For example, candidates could use: ♦ card models to visualise and test basic concepts ♦ block and scale models to explore and test ergonomics
Refining ideas	Refining ideas requires the skills to make final decisions about the proposal and ensure it can be manufactured successfully. Candidates apply their knowledge and understanding of design and manufacture to test and evaluate their proposal to ensure it meets the requirements of the specification. They must also provide technical details. Candidates should be prepared to carry out additional research at this stage to enhance their refinement. They should: ♦ select and justify materials and processes ♦ incorporate manufacturing and assembly features ♦ establish assembly methods ♦ test ergonomics and finalise sizes ♦ test and finalise decisions on function, maintenance, safety and costings Candidates could use the knowledge gained from analysing commercial products to develop the technical details required to manufacture and assemble their proposal. Refining ideas requires candidates to think in a convergent way to develop a viable proposal in response to their brief and/or specification. Refinement should involve a series of revisions and adjustments to the original concept based on tests, evaluations and analysis. Areas of refinement will depend on the task and the brief and/or specification. However, candidates should ensure their refinement results in a functional product with suitable aesthetics that meets users' needs and can be manufactured successfully. Candidates could: ♦ consider working to scale to establish critical sizes and costings ♦ use prototypes and test rigs to ensure the product performs as expected ♦ produce full-size models to create a sound user interface

Skill	Additional guidance
	♦ carry out user trials to ensure the product meets the need of the intended user group Refinement should provide all the information required to plan the manufacture of the proposals, including: ♦ dimensions of the product and its component parts ♦ materials and processes for the product and its component parts ♦ manufacturing details required to ensure the proposal performs as expected, such as wall thicknesses, ribs and/or webs and surface texture ♦ manufacturing details required to ensure the product can be manufactured successfully, such as draft angles, radius corners and injection points ♦ assembly details such as number of component parts, assembly feature and sequence of assembly
Applying graphic techniques	Candidates use graphics to communicate the proposal and its development. This is not an exercise in presentation. Candidates are not required to redraw and redraft their work to produce fully rendered and finished pieces of art. Although candidates need not be proficient in sketching and drawing, they should be able to select appropriate graphic techniques depending on the stage of the process, what they are trying to achieve and what they need to communicate. Candidates should not spend too much time generating graphics: their focus should be on developing the proposal using efficient techniques. Graphics should enhance the development of the proposal by allowing candidates to visualise, analyse and evaluate their work. Candidates' graphics are likely to be rough in the initial stages of the design process and gradually become more refined and sophisticated as the development progresses. Candidates should demonstrate a range of skills and avoid relying on one or two graphic techniques. Candidates can use manual and computer graphics at any stage. Computer graphics can be particularly useful towards the end of the process when refining the proposal and planning its manufacture.

Skill	Additional guidance
Applying modelling techniques	Candidates use models to inform and communicate decisions. Candidates should be proficient at manufacturing physical and/or computer-generated models. They should be able to select and use them at appropriate stages during the design process, depending on what they are trying to achieve and what they need to communicate. Candidates should use materials and techniques suitable for the type of model required. Models should inform the development of the proposal by allowing candidates to visualise, analyse, evaluate and test their work. Candidates' models are likely to be rough in the initial stages of the design process and gradually become more refined and sophisticated as the development progresses. Candidates can use physical and computer models at any stage. Physical models offer more opportunities for testing and feedback from user trips and user trials. Candidates can produce these manually, or by using CNC machining and/or 3D printing. Candidates must clearly record how they used models and the information the models provided. Candidates could: ♦ take a sequence of photographs to illustrate how the model was used to test issues such as stability ♦ take photographs of the model as it is being used to highlight ergonomic issues ♦ take photographs of models during their manufacture to illustrate decisions and ongoing changes ♦ use annotations to highlight what they learned ♦ explain their next steps Models should highlight issues that were not obvious from drawings and sketches. Candidates should be critical when evaluating their ideas and look for genuine areas for development. Highlighting problems should be seen as a positive step in developing a viable design proposal.

Skill	Additional guidance
Applying knowledge and understanding of design	Every aspect of the design process requires candidates to apply their knowledge and understanding of design. When generating initial ideas, candidates could apply their knowledge and understanding of: ♦ the target market, user and location to influence the aesthetics, function and performance ♦ design issues when evaluating them against the specification When exploring ideas, candidates could apply their knowledge and understanding of: ♦ function when exploring features or aspects of a product such as mechanisms, controls or handles ♦ performance when exploring how to make the product fit for purpose and easy to maintain ♦ aesthetics when experimenting with form, proportion, colour and texture ♦ ergonomics when experimenting with overall form, size of products and position of aspects and component parts When refining ideas, candidates could apply their knowledge and understanding of: ♦ function to inform decisions about material and processes ♦ performance to ensure the proposal results in a product that is easy to clean and repair ♦ aesthetics to ensure the proposal results in a product with the desired image, look and feel ♦ ergonomics to ensure the proposal results in a product that is safe, comfortable and easy to use Applying detailed knowledge and understanding of design is likely to produce a valid, well-considered design proposal Markers infer effective application of knowledge and understanding from the quality of candidates' decisions and the changes they have made when developing the proposal. Candidates should clarify any significant changes and decisions through written comments.

Skill	Additional guidance
Applying knowledge and understanding of materials, manufacturing and assembly methods	Every aspect of the design process requires candidates to apply their knowledge and understanding of materials, manufacturing and assembly methods. When generating initial ideas, exploring ideas and refining ideas, candidates could apply knowledge and understanding of: ♦ materials ♦ manufacturing ♦ assembly methods Applying detailed knowledge and understanding of materials, manufacturing and assembly methods is likely to produce a proposal that could be commercially manufactured. Markers infer effective application of knowledge and understanding from the quality of candidates' decisions and the changes they have made when developing the proposal. Candidates should clarify any significant changes and decisions through written comments.
Producing a plan for commercial manufacture	Candidates should be able to identify and communicate key information required to manufacture a product, including materials, dimensions, manufacturing and assembly features, and assembly methods. Candidates should use appropriate graphic techniques to present information generated from developing the proposal. When producing a plan for manufacture, candidates could produce manual or computer-generated: ♦ scale drawings to communicate dimensions ♦ sectional views to communicate manufacturing and assembly features ♦ exploded views to communicate the relationship between component parts and their assembly ♦ flow charts to communicate the sequence of assembly ♦ tables outlining materials and processes used for each component part and methods of assembly

Skill	Additional guidance
Manufacturing a presentation model	Manufacturing a presentation model requires candidates to refine the model-making skills they developed at Higher. They must produce a physical model manufactured using practical skills and/or by CNC machining, laser cutting or 3D printing. The model must be suitably complex to ensure it demonstrates a higher level of skill in manufacturing models. Candidates can demonstrate their modelling skills through the model itself, or by creating an environment or context that enhances the presentation of the model. Candidates could manufacture their presentation model based on information gathered in their planning for manufacture, or enhance a model generated during exploration or refinement. Whatever approach they adopt, candidates must create a model that could be used to pitch their design to a potential client by: ♦ accurately representing the forms and textures of the finished proposal ♦ communicating functional and ergonomic aspects ♦ communicating features and details ♦ demonstrating how the proposal meets the specification

Developing skills for learning, skills for life and skills for work

Teachers and lecturers should identify opportunities throughout the course for candidates to develop skills for learning, skills for life and skills for work.

Candidates should be aware of the skills they are developing and teachers and lecturers can provide advice on opportunities to practise and improve them.

SQA does not formally assess skills for learning, skills for life and skills for work.

There may also be opportunities to develop additional skills depending on the approach centres use to deliver the course. This is for individual teachers and lecturers to manage.

The table below highlights opportunities to develop these skills.

2 Numeracy	
2.2 Money, time and measurement	Cost and value, measurement, dimension, anthropometrics, Gantt charts
2.3 Information handling	Carry out research, develop a specification, methods of gathering information, analysing commercial products
4 Employability, enterprise and citizenship	
4.2 Information and communication technology (ICT)	Carry out research, methods of gathering information, computer-generated models and simulations, 3D printing, CAD/CAM, CNC machining
5 Thinking skills	
5.4 Analysing and evaluating	Situational analysis, product evaluation, thinking and analysing through modelling
5.5 Creating	Ideas, innovation and conceptual solutions to problems

Appendix 2

This table shows the relationship between the knowledge and understanding assessed in the question paper component of course assessment at both Higher and Advanced Higher.

Please also refer to the 'skills, knowledge and understanding' tables in the course specifications for each level.

Teachers and lecturers could use this table to:

- design and plan learning activities for multi-level teaching
- ensure seamless progression between levels
- identify important prior learning for Advanced Higher candidates

The specific skills, knowledge and understanding introduced at Advanced Higher are highlighted **in bold**.

Higher		**Advanced Higher**	
Knowledge and understanding	**Candidates demonstrate knowledge and understanding of:**	**Knowledge and understanding**	**Candidates demonstrate knowledge and understanding of:**
Brief	♦ the purpose of the design brief in the design process ♦ open and closed design briefs	Brief	♦ purpose of the design brief in the design process ♦ **reasons why design opportunities occur**
Research and evaluation	♦ the purpose of research and evaluation: — throughout the design process — of existing products ♦ information gathered through research or evaluation ♦ methods of gathering information: — primary and secondary research	Research	♦ purpose and effective use of research: — throughout the design process — of existing products ♦ methods of gathering information: — primary and secondary research ♦ **the following techniques:** — **comparisons**

Higher		Advanced Higher	
Knowledge and understanding	**Candidates demonstrate knowledge and understanding of:**	**Knowledge and understanding**	**Candidates demonstrate knowledge and understanding of:**
	♦ key stages of the following techniques: — comparisons — questionnaires — surveys — tests and test rigs — user trial — user trip		— **questionnaires** — **surveys** — **tests and test rigs** — **user trial** — **user trip**
Specification	♦ the purpose of, and information specified in, the following specification types: — product design — performance — technical	Specification	♦ **purpose of the design specification in the design process** ♦ the purpose and information specified in the following specification types: — product design — performance — technical
Not assessed at this level		**Product analysis**	♦ **information gathered from product analysis** ♦ **analysing commercial products:** — **identifying influences on their performance:** ○ **function** ○ **durability** ○ **maintenance** ○ **value for money** ○ **safety** ○ **aesthetics** ○ **ergonomics** — **evaluating their performance:**

Higher		Advanced Higher	
Knowledge and understanding	**Candidates demonstrate knowledge and understanding of:**	**Knowledge and understanding**	**Candidates demonstrate knowledge and understanding of:**
			○ **comparisons** ○ **tests and test rigs** ○ **user trial** ○ **user trip** — **analysing their manufacture:** ○ **identifying and justifying materials** ○ **identifying and justifying processes** ○ **identifying and justifying manufacturing features** ○ **identifying and justifying assembly methods** ○ **justifying possible production systems** — **analysing their impact on:** ○ **society** ○ **the environment** Note: candidates carry out a range of practical activities during the course to analyse the commercial manufacture of products. Candidates must refer to this analysis when answering Question 1 in the question paper.
Idea-generation techniques	♦ the use of idea-generation techniques ♦ the key stages or activities of the following idea-generation techniques: — analogy — brainstorming — lifestyle or mood board — morphological analysis	Idea-generation techniques	♦ use of idea-generation techniques ♦ key stages or activities of the following idea-generation techniques: — analogy (technology transfer, biomimicry) — brainstorming — morphological analysis

Higher		Advanced Higher	
Knowledge and understanding	**Candidates demonstrate knowledge and understanding of:**	**Knowledge and understanding**	**Candidates demonstrate knowledge and understanding of:**
Modelling in the design process	♦ use of modelling during the design process to: — generate and explore — test and refine — communicate ♦ the purpose of, and information gained from: — physical models: sketch models, block models, scale models, test rigs and prototypes — computer-generated models and simulations ♦ benefits and drawbacks of rapid prototyping	Modelling in the design process	♦ use of modelling during the design process to: — generate and explore — test and refine — communicate ♦ purpose of, and information gained from: — physical models: sketch models, block models, scale models, test rigs and prototypes — computer-generated models and simulations
Graphics in the design process	♦ the purpose and appropriate use of graphic techniques when developing, resolving and communicating ideas throughout the design process ♦ the advantages of using manual and computer-generated graphics in the design process	Graphics in the design process	♦ use of graphics during the design process to: — generate and explore — test and refine — communicate
Function	♦ the influence of function on the design of products ♦ primary and secondary functions	Function	♦ influence of function on the design of products ♦ **influence on the function of products** ♦ primary and secondary functions

Higher		Advanced Higher	
Knowledge and understanding	**Candidates demonstrate knowledge and understanding of:**	**Knowledge and understanding**	**Candidates demonstrate knowledge and understanding of:**
Performance	♦ the influence of performance on the design of products ♦ fitness for purpose of products ♦ the influence of planned obsolescence on the manufacturer, consumer and the environment ♦ maintenance issues associated with products ♦ value for money	Performance	♦ influence of performance on the design of products ♦ **influences on the performance of products** ♦ fitness for purpose of products ♦ impact of planned obsolescence on the manufacturer, consumer and the environment ♦ maintenance issues associated with products ♦ value for money
Safety	♦ the influence of safety on the design of products ♦ how to ensure safety in products	Safety	♦ influence of safety on the design of products ♦ **influences on the safety of products** ♦ how to ensure safety in products ♦ **safety assurance:** — **certification** — **British Standards** — **Kitemarks**
Market	♦ the influence of the target market on the design and marketing of products ♦ technology push ♦ market pull ♦ economics ♦ product lifecycles: introduction, maturity, growth, and decline ♦ the influence of fashion, market trends, style	Market	♦ product lifecycle: — introduction — maturity — growth — decline ♦ influences on product lifecycle: — target market — market trends — fad, fashion and style

Higher		Advanced Higher	
Knowledge and understanding	**Candidates demonstrate knowledge and understanding of:**	**Knowledge and understanding**	**Candidates demonstrate knowledge and understanding of:**
	♦ marketing techniques to influence sales ♦ niche marketing ♦ branding		— economics — research and development costs — influence of the economy — use of marketing techniques — niche marketing ♦ technology push, market pull ♦ branding ♦ **product recall** ♦ **product relaunch** ♦ **product redesign:** — **reasons and alternatives** — **incremental and radical change** — **risk** ♦ **issues that influence commercial success or failure** ♦ **diversification**
Aesthetics	♦ the aesthetics of products ♦ influences on the aesthetics of products	Aesthetics	♦ **influence of aesthetics on the design of products** ♦ influences on the aesthetics of products

Higher		Advanced Higher	
Knowledge and understanding	**Candidates demonstrate knowledge and understanding of:**	**Knowledge and understanding**	**Candidates demonstrate knowledge and understanding of:**
Ergonomics	♦ the influence of ergonomics on the design of products ♦ anthropometrics ♦ psychology ♦ physiology	Ergonomics	♦ influence of ergonomics on the design of products: — anthropometrics — psychology — physiology ♦ **influences on the ergonomics of products** ♦ **inclusive design** ♦ **use of ergonomic data**
Not assessed at this level		**Conflict resolution**	♦ **conflict and balance between:** — **design issues when designing products** — **society, economics and the environment when manufacturing products** — **consumers, designers and manufacturers when designing and manufacturing products** ♦ **methods and activities to resolve conflicts**
Materials used in the commercial manufacture of products	♦ properties and appropriate uses of: — thermoplastics: ABS, acrylic, nylon, polypropylene, polystyrene, polythene, polyvinyl chloride — thermosetting plastics: melamine formaldehyde, urea formaldehyde — elastomers — ferrous metals or alloys: cast iron, mild steel, high-speed steel, stainless steel	Materials used in the commercial manufacture of products	♦ properties and appropriate use of: — thermoplastics: ABS, acrylic, nylon, polypropylene, **polycarbonate**, polystyrene, polythene, polyvinyl chloride — thermosetting plastics: melamine formaldehyde, urea formaldehyde — elastomers: ○ **natural rubber: latex** ○ **synthetic rubber: styrene-butadiene, neoprene, silicone**

Higher		Advanced Higher	
Knowledge and understanding	**Candidates demonstrate knowledge and understanding of:**	**Knowledge and understanding**	**Candidates demonstrate knowledge and understanding of:**
	— non-ferrous metals or alloys: aluminium, brass, copper, tin, zinc — hardwoods: ash, beech, mahogany, oak — softwoods: spruce, pine — manufactured boards: plywood, blockboard, chipboard, hardboard, MDF, flexiply veneered boards — composite materials: carbon-fibre plastics, glass-reinforced plastic ♦ the influence materials have on the design and manufacture of products ♦ methods used to identify materials in commercially manufactured products ♦ developments in new materials and their impact on products		— **bio-based plastics: bio-based polymers, biodegradable polymers** — ferrous metals or alloys: iron, mild steel, high-speed steel, stainless steel — non-ferrous metals or alloys: aluminium, brass, copper, tin, zinc — hardwoods, softwoods and manufactured boards — composite materials: carbon-fibre plastics, glass-reinforced plastic — **plastic additives and fillers** ♦ **issues that influence the selection of materials for products** ♦ influence materials have on the design and manufacture of products ♦ **current developments in materials and their potential impact on products**
Processes used in the commercial manufacture of products	♦ appropriate uses and identifying features of: — bending — blow moulding — compression moulding — die casting — drop forging — extrusion — injection moulding — piercing and blanking	Processes used in the commercial manufacture of products	♦ appropriate uses and features of: — **injection and extrusion blow moulding** — compression moulding — **gravity and high-pressure die casting** — drop forging — injection moulding, **two-shot injection moulding and gas-assisted injection moulding** — **over-moulding** — press forming

Higher		Advanced Higher	
Knowledge and understanding	**Candidates demonstrate knowledge and understanding of:**	**Knowledge and understanding**	**Candidates demonstrate knowledge and understanding of:**
	— press forming — rotational moulding — sand casting — vacuum forming — 3D printing — laser cutting ♦ appropriate uses and identifying features of: — chrome plating — galvanising — plastic dip coating ♦ manufacturing features of component parts: complexity, cross section along its length, draft angles, ejection marks, flashing, injection points, shear marks, split lines, surface finish, symbols and labels, thinning of sheet material, wall thickness ♦ purpose of bosses, location pins, ribs and webs ♦ issues that influence the processes used in commercially manufactured products		— rotational moulding — **thermoforming** — 3D printing — laser cutting — **CNC machining** ♦ issues that influence the selection of processes for commercial manufacture ♦ **influence processes have on the design and manufacture of products**

Higher		Advanced Higher	
Knowledge and understanding	**Candidates demonstrate knowledge and understanding of:**	**Knowledge and understanding**	**Candidates demonstrate knowledge and understanding of:**
Not assessed at this level		**Designing for manufacture**	♦ **mould and pattern design:** — **wall thicknesses** — **placement of split lines and injection and ejector points** — **purpose of draft angles, location pins, fillets and radius corners** — **impact of transitions between thick and thin wall thicknesses, undercuts, shrinkage and thinning of sheet material** ♦ **integrated assembly features** ♦ **purpose of bosses, ribs and webs**
Assembly methods used in the commercial manufacture of products	♦ methods used to join material: — adhesive, carcass and frame joints, knock-down fittings, nuts, bolts, screws, snap and press fit, riveting, spot welding, arc welding, thermal bonding ♦ methods used to identify assembly methods in commercially manufactured products ♦ issues that influence the assembly of commercially manufactured products	Assembly methods used in the commercial manufacture of products	♦ methods used to join material ♦ issues that influence the assembly of commercially manufactured products ♦ **methods to aid the assembly of products:** — **limit handling and number of operations** — **standardisation of parts and operations** — **limit number of parts** ♦ **use of jigs**

Higher		Advanced Higher	
Knowledge and understanding	**Candidates demonstrate knowledge and understanding of:**	**Knowledge and understanding**	**Candidates demonstrate knowledge and understanding of:**
Production and planning systems	♦ one-off production, batch production, mass production ♦ methods used to improve production: — automation — CAD/CAM — CNC machining — Gantt and flow charts — jigs — just-in-time production — standard components	Production and planning systems	♦ one-off production, batch production, mass production ♦ commercial production methods: — automation — CAD/CAM — CNC machining — standard components — **standardisation (global)** — just-in-time production — flexible manufacturing system — **sub-contraction** ♦ Gantt and flow charts ♦ **quality assurance:** — **quality checks: materials, components, machinery** — **training and monitoring of staff** — **sampling and testing**
People who influence design	♦ the roles and responsibilities of people who influence the design of products: — designers — ergonomists — lawyers — production engineers — project managers — market researchers — materials technologists	People who influence design	♦ roles and responsibilities of people who influence the design of products: — designers — ergonomists — lawyers — production engineers — project managers — market researchers — materials technologists

Higher		Advanced Higher	
Knowledge and understanding	**Candidates demonstrate knowledge and understanding of:**	**Knowledge and understanding**	**Candidates demonstrate knowledge and understanding of:**
	♦ communication between members of a design team ♦ advantages and disadvantages of an in-house design team and sub-contracting		♦ communication between members of a design team ♦ in-house and sub-contracted design teams
Intellectual property rights (IPR)	♦ the purpose of IPR ♦ methods of protecting IPR: copyright, design rights, patents and trademarks	Intellectual property rights (IPR)	♦ types of IPR: — copyright — design rights — patents — trademarks ♦ **features of IPR:** — **type of property covered** — **length of cover** — **cost**
Impact of design and manufacture on society, the environment and the world of work	♦ methods designers and manufacturers can use to limit a product's impact on the environment: — design for recyclability — design for re-use — efficiency ♦ the impact traditional and new manufacturing technologies have on society, the environment and the workforce ♦ impact of material on the environment and society	The impact of design and manufacturing technologies on society, the environment and the world of work	♦ methods designers and manufacturers can use to limit a product's impact on the environment — design for re-use, **repair** and recyclability — efficiency ♦ the impact traditional and new manufacturing technologies have on society, the environment and the workforce ♦ **sustainable design and manufacture:** — **economic** — **environmental**

Higher		Advanced Higher	
Knowledge and understanding	**Candidates demonstrate knowledge and understanding of:**	**Knowledge and understanding**	**Candidates demonstrate knowledge and understanding of:**
	♦ methods to support sustainability ♦ investigation of a product's sustainability and its impact on the environment		
Not assessed at this level		**Product evolution**	♦ **the key stages in the historical evolution of a commercial product:** — **its origins** — **reasons for significant changes and turning points** — **failures and successes** — **influential products, companies and/or designers** — **impact on society, the economy and the environment** ♦ **influences of the following on the evolution of products:** — **materials** — **manufacturing** — **technology** — **society** — **external factors** — **designers** — **safety** — **economics**

Higher		Advanced Higher	
Knowledge and understanding	**Candidates demonstrate knowledge and understanding of:**	**Knowledge and understanding**	**Candidates demonstrate knowledge and understanding of:**
			— **ergonomics** ♦ **changes to products during their evolution:** — **aesthetics** — **function** — **performance** — **safety** — **economics** — **ergonomics** ♦ **the future evolution of products**

Appendix 3

This table provides guidance on developing the knowledge and understanding introduced at Advanced Higher and assessed in the question paper.

Topic	Candidates should demonstrate knowledge and understanding of:
Brief	♦ reasons why design opportunities occur: — changes in society — new legislation — changes or advances in materials, manufacture and technology — changes in fashion
Research	♦ the techniques of comparisons, questionnaires, surveys, tests and test rigs, user trials and user trips, for example: — key stages — information gained — appropriate use — how the information they provide influences the design of products
Product analysis	♦ analysing commercial products by identifying influences on their performance, function, durability, maintenance, value for money, safety, aesthetics and ergonomics, for example: — carrying out user trips and/or user trials — generating surveys and questionnaires — comparing similar products ♦ evaluating commercial products performance using comparisons, for example: — rating aesthetics — ranking functional features — assessing value for money ♦ evaluating commercial products using tests and test rigs, for example: — destructive tests — safety tests — time, weigh and measure ♦ evaluating commercial products using user trials, for example: — validating feedback from user trips — assessing fitness for purpose — gathering data from different user groups about function, safety and ergonomics ♦ evaluating commercial products using user trips, for example: — personal appraisal of function, safety and ergonomics ♦ analysing the manufacture of commercial products by identifying and justifying materials, for example: — identifying: visual inspection, labels, testing, comparing

Topic	Candidates should demonstrate knowledge and understanding of:
	— justifying: suitability for process, match properties with performance, influence on the product's performance, sustainability ♦ analysing the manufacture of commercial products by identifying and justifying processes, for example: — identifying: visual inspection, manufacturing features, accuracy — justifying: volume of production, cost, product type, performance required ♦ analysing the manufacture of commercial products by identifying and justifying manufacturing features, for example: — identifying: visual inspection — justifying: removal from moulds, improving material flow, strengthening ♦ analysing the manufacture of commercial products by identifying and justifying assembly methods, for example: — identifying: disassembly, visual inspection — justify: performance required, materials and processes used, assembly method, safety, obsolescence ♦ analysing the manufacture of commercial products by justifying possible production systems, for example: — volume of production, availability, retail price, consumer demand ♦ analysing the impact of commercial products on society, for example: — improved standard of living, health and communication — more dependent on technology — changes in the workforce ♦ analysing the impact of commercial products on the environment, for example: — increased waste and pollution — depletion of natural resources — reduction of carbon footprint
Function	♦ influences on the function of products, for example: — target market or user group — fit for purpose — technology — material and manufacture — frequency of use

Topic	Candidates should demonstrate knowledge and understanding of:
Performance	♦ influences on the performance of products, for example: — target market and or user — life expectancy — conditions and location of use — materials and manufacture
Safety	♦ influences on the safety of products, for example: — legislation — user groups — location of use — materials, manufacture and assembly ♦ safety assurance: certification, for example: — purpose of the CE mark — what is covered by the CE mark — benefits of obtaining a CE mark ♦ safety assurance: British Standards, for example: — purpose of British Standards — services offered — advantages of British Standards ♦ safety assurance: Kitemarks, for example: — obtaining a Kitemark — benefits to manufacturer and/or consumer
Market	♦ product recall, for example: — logistics of recalling products — financial loss — loss of reputation, impact on brand — impact on competitors ♦ product relaunch, for example: — challenges — gaining trust — marketing strategies ♦ product redesign: reasons and alternatives, for example: — reasons: product recall, changes in fashion, legislation, loss of market share — alternatives: updates, pricing strategies, personalisation, offer a range ♦ product redesign: incremental and radical change, for example: — benefits and drawbacks — impact on consumers — appropriate marketing strategies — challenges to designers and manufacturers

Topic	Candidates should demonstrate knowledge and understanding of:
	♦ product redesign: risk, for example — cost of research and development may not be recouped — unpredictable sales — consumers unwilling to update ♦ issues that influence commercial success or failure, for example: — market research — marketing strategies — changes in fashion and trends — competition ♦ diversification, for example: — spreading risk across a number of products — capitalising on a strong brand image — risk to brand image — using existing expertise — increasing market share
Aesthetics	♦ influences on the aesthetics of products, for example: — target market and/or user group — location of use — materials — fashion and trends
Ergonomics	♦ influences on the ergonomics of products, for example: — target market and/or user group — location of use — frequency of use — materials ♦ inclusive design, for example: — methods to create safe and easy-to-use products for all user groups — methods to accommodate people, regardless of their age, gender, mobility, ethnicity or circumstances ♦ use of ergonomic data, for example: — influence on function, safety, comfort and ease of use of products — application of anthropometric data
Conflict resolution	♦ the conflict and balance between design issues when designing products, for example: — form versus function — environment versus materials and manufacture — performance versus obsolescence

Topic	Candidates should demonstrate knowledge and understanding of:
	♦ the conflict and balance between society, economics and the environment when manufacturing products, for example: — affordability and availability versus design and manufacturing costs — volume of production versus waste and pollution ♦ the conflict and balance between consumers, designers and manufacturers when designing and manufacturing products, for example: — consumer demands versus manufacturing constraints — aspiration of designers versus investment from manufacturer ♦ methods and activities to resolve conflicts, for example: — market research — research and evaluation — testing and prototyping — user trips and trials
Materials used in the commercial manufacture of products	♦ elastomers — natural rubber: latex, for example: — properties and uses — suitable manufacturing processes — advantages and disadvantages ♦ elastomers — synthetic rubber: styrene-butadiene, neoprene, silicone, for example: — properties and uses — suitable manufacturing processes — advantages and disadvantages ♦ bio-based plastics: bio-based polymers, biodegradable polymers, for example: — properties and uses — limitations — advantages and disadvantages — difference between bio-based polymers and biodegradable polymers ♦ plastic additives and fillers, for example: — enhancing properties — improving manufacture — improving appearance — impact on the environment
Processes used in the commercial manufacture of products	♦ appropriate uses and features of injection and extrusion blow moulding, for example: — products made from injection blow moulding — accuracy and complexity created from injection blow moulding — products made from extrusion blow moulding — benefits and drawbacks of extrusion blow moulding

Topic	Candidates should demonstrate knowledge and understanding of:
	— forms possible from blow moulding — reasons for blow moulding ♦ appropriate uses and features of gravity and high-pressure die casting, for example: — products made from high-pressure die casting — accuracy and complexity created from high-pressure die casting — products made from gravity die casting — forms possible from gravity die casting — benefits and drawbacks of gravity die casting ♦ appropriate uses and features of two-shot injection moulding and gas-assisted injection moulding, for example: — products made from gas-assisted injection moulding — accuracy and complexity created from gas-assisted injection moulding — products made from two-shot injection moulding — benefits and drawbacks of two-shot injection moulding ♦ appropriate uses and features of over-moulding, for example: — examples of over-moulding — benefits and drawbacks of over-moulding
Designing for manufacture	♦ mould and pattern design, for example: — wall thicknesses — placement of split lines and injection and ejector points — purpose of draft angles, location pins, fillets and radius corners — impact of transitions between thick and thin wall thicknesses, undercuts, shrinkage and thinning of sheet material ♦ integrated assembly features, for example: ♦ bosses and ribs: — press and snap fits — moulded threads
Assembly methods used in the commercial manufacture of products	♦ methods to aid the assembly of products, for example: — limit handling and number of operations — standardisation of parts and operations — limit number of parts ♦ benefits of the use of jigs, for example: — aid assembly — secure and align parts during assembly — improve accuracy and quality — improve efficiency

Topic	Candidates should demonstrate knowledge and understanding of:
Production and planning systems	♦ commercial production methods — standardisation (global), for example: — affordable products — efficient assembly — reduction in manufacturing costs — ease of maintenance ♦ commercial production methods — sub-contraction, for example: — benefits and drawbacks — risk — flexibility — quality control — cost reduction — access to expertise ♦ quality assurance, for example: — quality checks; materials, components, machinery — training and monitoring of staff — sampling and testing
Intellectual property rights (IPR)	♦ features of IPR, for example: — type of property covered — length of cover — cost
Impact of design and manufacturing technologies on society, the environment and the world of work	♦ sustainable design and manufacture — economic, for example: — production and consumption of products — provision of jobs — continued growth ♦ sustainable design and manufacture — environmental, for example: — conservation of natural resources — use of renewable resources — design for recycling, re-use and disposal
Product evolution	♦ key stages in the historical evolution of a commercial product — its origins, for example: — inventions and scientific breakthroughs — new materials — new technology — changes in society ♦ key stages in the historical evolution of a commercial product — reasons for significant changes and turning points, for example: — advances and developments in materials, manufacture and technology — changes in society — fashion

Topic	Candidates should demonstrate knowledge and understanding of:
	♦ key stages in the historical evolution of a commercial product — failures and successes, for example: — examples of failures and successes — reasons for failures and successes ♦ key stages in the historical evolution of a commercial product — influential products, companies and/or designers, for example: — impact of the Dyson DC10 on domestic vacuum cleaners — impact of the Sony Walkman on portable music players — impact of Sir Jonathan Ive on personal computers ♦ key stages in the historical evolution of a commercial product — impact on society, economy and the environment, for example: — impact on attitudes and quality of life — increased demand and production — depletion of natural resources and increased pollution ♦ influences of the following on the evolution of products: — materials — manufacturing — technology — society — external factors — designers — safety — economics — ergonomics ♦ changes to products during their evolution, for example: — aesthetics — function — performance — safety — economics — ergonomics ♦ the future evolution of products, for example: — impact of new and emerging materials and technologies — impact of predicted changes in society — impact on society, economy and the environment

Administrative information

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History of changes

Version	Description of change	Date
2.0	Course support notes added as appendix 1. Relationship between knowledge and understanding assessed in the question paper at both Higher and Advanced Higher added as appendix 2. Guidance on developing the knowledge and understanding introduced at Advanced Higher and assessed in the question paper added as appendix 3.	August 2019

Note: please check SQA's website to ensure you are using the most up-to-date version of this document.