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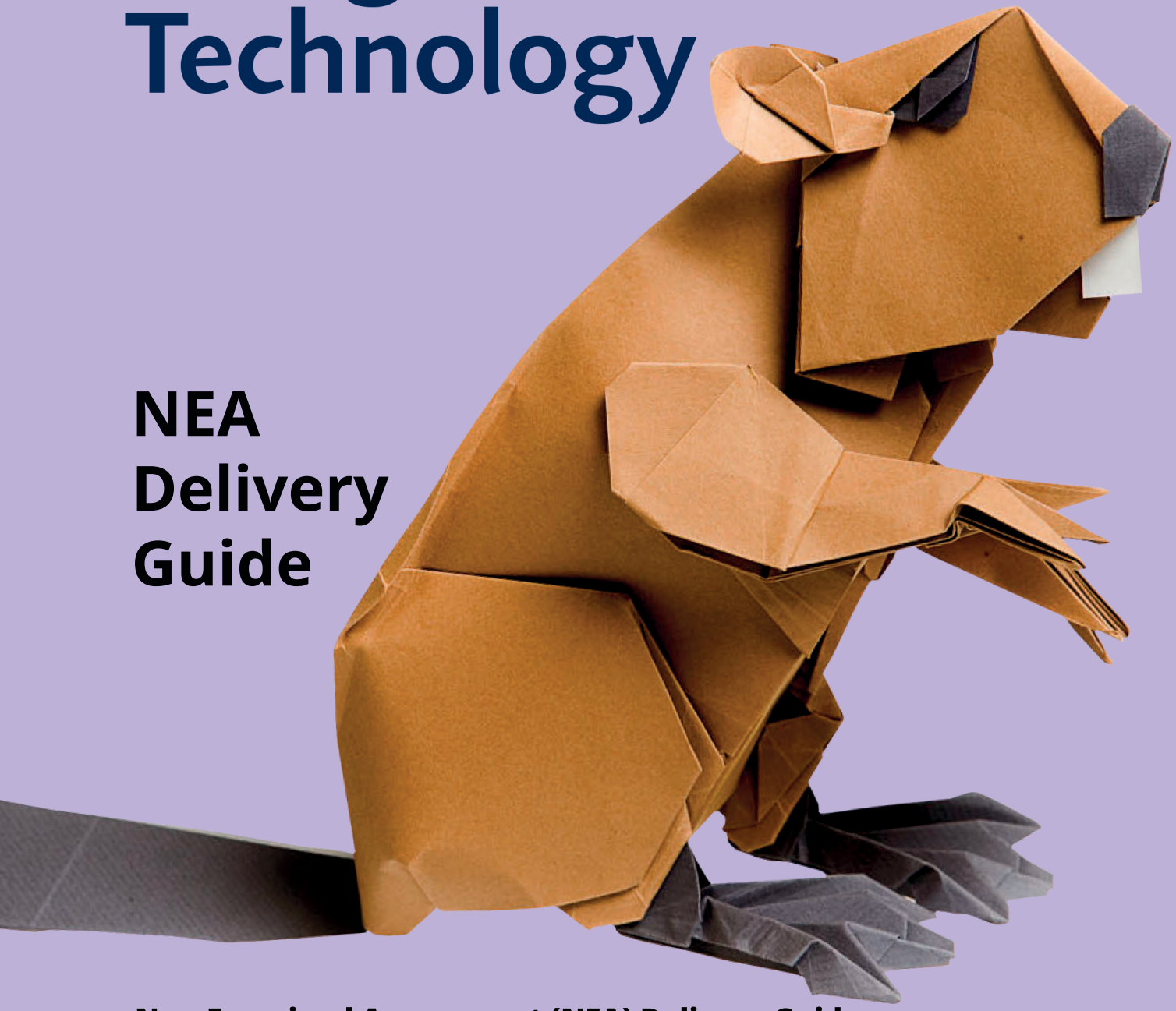
A Level Design and Technology



NEA Delivery Guide

Non-Examined Assessment (NEA) Delivery Guide

Pearson Edexcel Level 3 Advanced GCE in Design and Technology

9DT0/02

First teaching from September 2017

First certification from 2019

Issue 1

Pearson

Content

NEA Independent Design and Make Project

The purpose of this component is to undertake a substantial design, make and evaluate project which will test candidates' skills in designing and making a prototype. The term 'prototype' means an appropriate working solution to a need or want that is sufficiently developed to be tested and evaluated (for example, full-sized products, scaled working models, architectural models or functioning systems).

It is synoptic assessment which requires candidates to work across different parts of a qualification and to show their accumulated knowledge and understanding of a topic or subject area. The synoptic assessment enables candidates to show their ability to combine their skills, knowledge and understanding with breadth and depth of the subject.

Component 2: Independent Design and Make Project (Paper code: 9DT0/02)

Non-examined assessment is 50% of the qualification (Maximum of 120 marks)

Content overview

- candidates individually and/or in consultation with a client/end user identify a problem and design context.
- candidates will develop a range of potential solutions which include the use of computer aided design and evidence of modelling.
- candidates will be expected to make decisions about the designing and development of the prototype in conjunction with the opinions of the client/end user.
- candidates will realise one potential solution through practical making activities with evidence of project management and plan for production.
- candidates will incorporate issues related to sustainability and the impact their prototype may have on the environment
- candidates are expected to analyse and evaluate design decisions and outcomes for prototypes/products made by themselves and others
- candidates are expected to analyse and evaluate of wider issues in design technology, including social, moral, ethical and environmental impacts.

Assessment overview

- The investigation report is internally assessed and externally moderated.
- candidates will produce a substantial design, make and evaluate project which consists of a portfolio and a prototype
- The portfolio will contain approximately 20-40 sides of A3 paper (or electronic equivalent) along with any models and their prototype.
- It will be internally assessed but externally moderated
- The final prototype must be produced under immediate guidance or supervision.
- The assessment will be carried out under controlled conditions, as specified in the specification.
- There are four parts to the assessment:
  - **Part 1: Identifying and outlining possibilities for design**
    Identification and investigation of a design possibility, investigation of client/end user needs, wants and values, research and production of a specification
  - **Part 2: Designing a prototype**
    Design ideas, development of design idea, final design solution, review of development and final design and communication of design ideas
  - **Part 3: Making a final prototype**
    Design, manufacture and realisation of a final prototype, including tools and equipment and quality and accuracy
  - **Part 4: Evaluating own design and prototype**
    Testing and evaluation

NB. Candidates will not be penalised specifically on the basis of the amount of work that they produce, or the size of the paper used (for hard copy or electronic equivalent). However, excessively high or low amounts of work may restrict students' ability to evidence the skills outlined in the marking criteria.

Task setting

The process will involve a collaborative approach to identify a design possibility to create a portfolio of work that will investigate, design, make and evaluate prototypes that lead to a final prototype.

Candidates should work collaboratively with the client group as it is a vital component of a commercial approach to ensure that the final design is a success and all requirements are met.

Candidates are individually required to in consultation with a client identify a design possibility and design context from which they develop a range of potential solutions and then realise one through practical making activities. The project must allow candidates to apply knowledge and understanding in a product development process to design, make and evaluate prototypes.

The context of the design possibility should be suitably challenging as to allow a range of alternative approaches to be taken and allow candidates to investigate the wider implications of their design decisions.

Candidates will be encouraged to use creativity and imagination when applying iterative design processes to develop and modify designs, and to design and make prototypes that solve real world problems, considering others' needs, wants and values.

There are no limits to project selection beyond the time and resources available and the appropriateness of selection in matching individual candidate's potential. Candidates are expected to take ownership of all aspects of their work in this project, in order to allow them total control of their responses and to target assessment criteria effectively, and to maximise their achievements.

In order to reach high attainment levels, candidates must adopt a commercial design approach to their work, reflecting how a professional designer might deal with a design problem and its resolution. This means that they must identify the problems or needs of a client and user group to develop a product that may fulfil these needs. The client could be:

- A target market opportunity: This will mean that they will need to identify a gap or a demand in the market or problem that needs to be solved.
- Local business or organisation: In consultation with the company they identify a specific design problem that they need resolved, such as a point of sale display in a showroom.
- An individual client: Working to a specific design problem identified by the client.

Client	User Group	Typical problem
A target market opportunity. e.g. General public	The end user. e.g. Potential customers	Candidaites have asked a wide range of people, and identified a need for storage devices for mobile communication Accessories.
Local Business or organisation. e.g. perfume company	End users. e.g. Customers of the Business or organisation	A perfume company needs a point of sale display to encourage people to buy the product(s).
An individual client. e.g. Your grandparents	The individual client. e.g. Your grandparents	Your grandparents need to ergonomic seating for when they are in the garden.

The process will involve a collaborative approach with their identified client to create a portfolio of work that will investigate, design, make and evaluate prototypes that lead to a final prototype that is sufficiently developed and high enough quality to be tested and evaluated (for example, full-sized products, scaled working models, architectural models or functioning systems).

NB. It is important that candidates identify a sophisticated design problem that allows them the opportunity to present a portfolio that demonstrates a range of accomplished skills in research, design, manufacture and evaluation that are at **Advanced Level standard**.

The level of demand, range of skills and complexity throughout every stage to the production of a high-quality fully functioning prototype that fully meets the design specification and be capable of being tested and evaluated in the final section but also provides a suitable level of challenge that is higher than both GCSE or AS level standard.

Part 1(a): Identifying and outlining possibilities for design

1. Identification and investigation of design possibilities

Content	Skills and Evidence
a) Investigation of the needs, wants and values of the client.. b) Identification, investigation and justification of a design possibility.	**Investigate** client, wants and values – ask pertinent questions and seek answers to learn about a broad range of user needs, wants and values that could be addressed and gain an understanding of related design considerations in order to support the informed identification of a design possibility **Identify** and **investigate** a design possibility – refine the scope of possibilities down to a focused area based on investigations. Conduct further investigation of the chosen area of focus to support a full understanding of the relevant design factors and the needs, wants and values of end users **Justify** design possibility – provide a rationale as to how and why the design possibility has been identified, supported by evidence from investigations. Provide evidence of the factors that have been considered and how their importance has been gauged. Investigation of client/end user requirements is initially likely to be in the form of a series of questions that will consider the key factors that will influence the design decisions and allow for the design needs to be established. Justification of the design possibility will establish a preliminary design brief and may include evidence of investigations conducted through the internet, interviews, newspaper clippings or user centre-based information. This section will be evidenced through any form of appropriate effective communication.

Grid 1

Level	Mark	Identification and investigation of design possibilities (AO1 1a 9 marks)
	0	No rewardable material.
Level 1	1–3	• Evidence of basic investigation of superficially relevant design possibilities. • Basic identification and justification of a design possibility. • Basic investigation of the needs, wants and values of the client/end user to inform design requirements.
Level 2	4–6	• Evidence of sound investigation of relevant design possibilities. • Competent identification and justification of a design possibility. • Sound investigation of the needs, wants and values of the client/end user to inform design requirements.
Level 3	7–9	• Evidence of in-depth investigation of pertinent design possibilities. • Effective identification and justification of a design possibility. • Comprehensive investigation of the needs, wants and values of the client/end user to inform design requirements.

General guidance for the section

In this section candidates are expected to identify market needs and opportunities that will provide design requirments for the development of new products.

Candidates should:

- Identify a suitable client situation (Market opportunity, local business / organisation, individual client).
- Evidence of in-depth investigation of pertinent design possibility in consultation with the client.
- Effective identification and justification of a design possibility.
- Comprehensive investigation of the needs wants and values of the client/end user to inform design requirements.

This section will be evidenced through any form of appropriate effective communication. The order of these sections is not defined but the process should demonstrate an iterative approach to the identification and investigation of design possibilities.

Candidates should be able to demonstrate high level skills in approximately 1 - 3 sides of A3 paper (or electronic equivalent).

To achieve higher marks in this section candidaites will need to:

Identify a suitable client situation.

To work in a commercial way candidates must identify the problems or needs of a client to develop a product that may fulfil their needs. The client could be, a target market opportunity, a local business or organisation or an individual client:

Example of an **individual client** or **business contact**

Name: *Willie Maykit, (Horizon Narrow Boats)*
Age: *45*
Occupation: *Canal Barge Hire Company Owner*
Give details of the client: *Add in any details of the client,* *If individual client - details of where they live, occupation, hobbies, biography.* *If business client - details of the company, what does the business do, location*
Introduce the situation for the design possibility: *In this particular instance there may be a range of design opportunities related to the client, but this may be focused down to one area.*

Example of **target market** opportunity (user group)

Category: *Family Dog Owners*
Age Group: *18 - 90*
Give details of the target market: *Adults that are potential users of dog related products in home environment.*
Introduce the situation for the design possibility: *In this particular instance there may be a range of design opportunities related to dog products in the home environment.*

Provide evidence of in-depth investigation of pertinent design possibilities in consultation with the client

In consultation with the client, provide evidence of the following:

- Discussion of design possibilities with your client within the chosen situation.

- Show an understanding of the design considerations in order to support the informed identification and justification of a design possibility.
- Refine the scope of possibilities down to a focused area based on investigations.

Candidates can explore a design possibility by undertaking some market research. The questions asked at this stage are very important as they will steer the direction of the project and may give some criteria that cannot be excluded as the design moves forward.

The candidates should consider all potential users of the design solution or the individuals if it is a single client.

Examples of this would include:

a) A questionnaire to assess a target market opportunity

These can be more general questions to identify a need or gap in the market, but questions must be relevant and focus on specific information that will help candidates establish a design possibility. This form of questionnaire will allow candidates to identify if there is a demand for a solution in a particular area.

For example, as the number of mobile communication accessories grows they have a higher risk of being damaged or lost. A questionnaire is a good way to establish if there could be a design possibility related to this area.

- *Do you have a need for a storage solution for mobile communication accessories?*
- *What items would you require to be stored?*
- *What other features should be included in a storage solution?*
- *What would be the budget range that you would think is acceptable?*

b) Conducting an interview with individuals within a company or as an individual client.

These questions can be more specific and targeted to a specific situation identified by the clients. This kind of interview will be open ended and could be from an area of their work, leisure or social life but become more focussed once they identify a specific problem. Clients may already have a specific area that needs a solution such as fitness, outdoor seating, storage or transport.

For example,

- Are there any specific requirements for the problem that need to be solved?
- What is the specific space or area where the problem exists?
- Who is going to be using the finished design?
- What is the maximum budget for the project?

Once candidates have gathered the information from the potential client they need to produce a summary of their findings to make a decision on the potential design possibility which will be used to produce a preliminary design brief. Candidates also need to give a justification of these requirements which focusses on a specific design problem and show how the solution will benefit the potential client.

Provide an effective identification and justification of a design possibility.

In consultation with their clients, the candidates need to use the information gathered about the potential design possibilities and produce a preliminary design brief which sets out the fundamental basics of the problem being faced.

A preliminary design brief at this stage will be open ended but will give enough detail to inform the investigation of the problem and the areas that need to be consulted upon with the client group in the research. For example:

NB. A more detailed brief will be sought after the research has been undertaken.

Candidates must justify the key points that relate to the specific design problem and show how the solution will benefit the potential client.

Example 1:

Preliminary design brief / possibility: Architectural Design

The local council is planning to build a riverside restaurant/café along the banks of the boating lake in one of its parks.

Justification: *The justification will come for the questionnaire / interview with the client / potential users and may include things such as; It has been noticed that there is a lot of people using the park and they are bringing their own food and creating a mess. The intention is to offer refreshment to visitors who, whilst they wait to use the boats on the lake and enjoy the views. A design proposal is required for the new restaurant/café; which is to be sited along the banks of the boating lake where there is public access. Sustainability and environmental issues are a major influence and should be considered in the design.*

Example 2:

Preliminary design brief / possibility: Outdoor seating for the elderly.
The client is an elderly person that wants suitable outdoor seating that is going to be specific to their needs.

Justification: *The justification will come for the interview with the client such as. Nothing suitable on the market, (too heavy, too large and not comfortable), their relative dimensions do not suit commercially available products; they may not have the budget available, there needs to be a specific functional aspect which is pertinent to their age. Sustainability and environmental issues are a major influence and should be considered in the design.*

Example 3:

Preliminary design brief / possibility: Point of sale display
A perfume company needs a point of sale display to encourage people to buy the product(s) in their high street retail outlet.

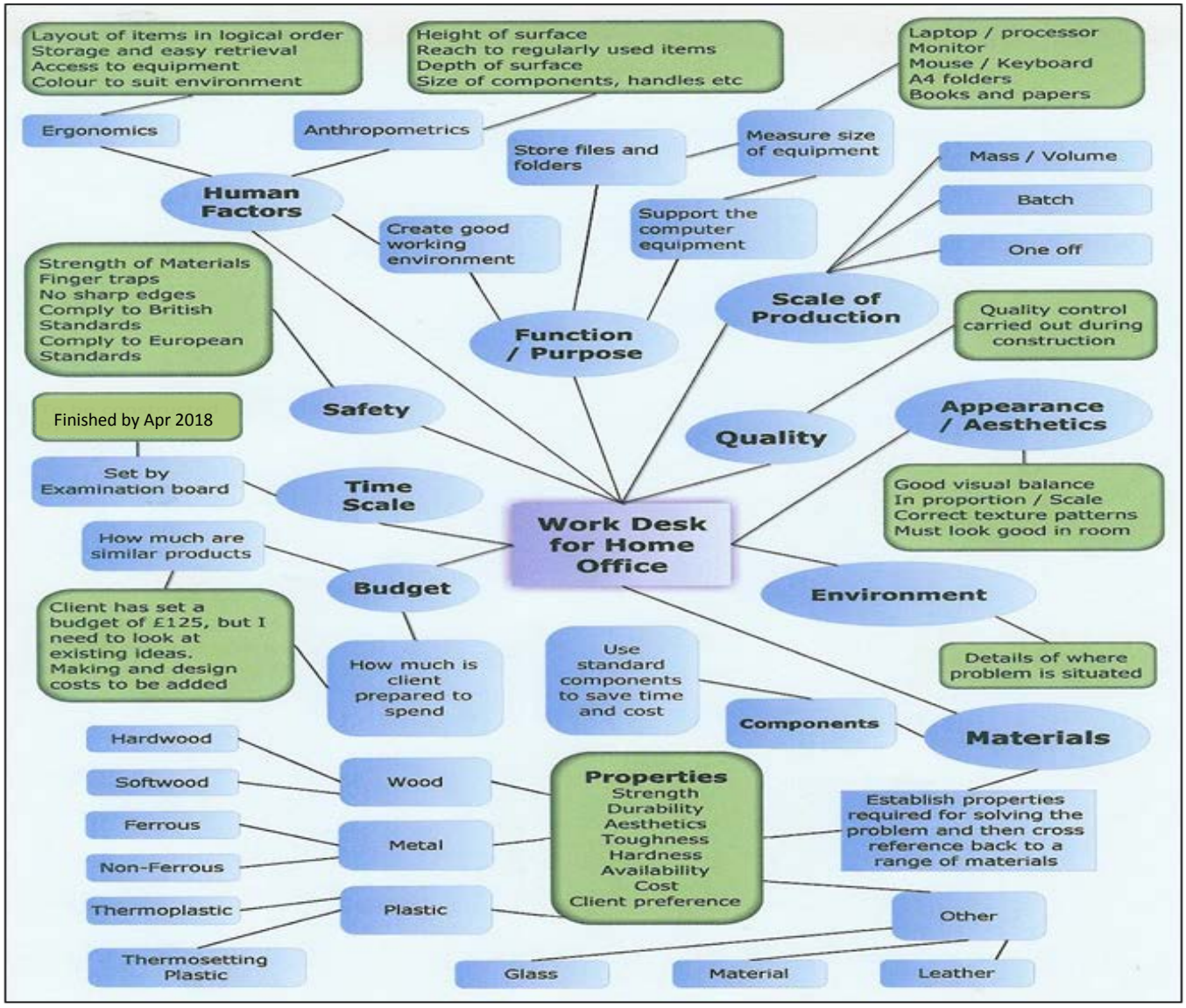
Justification: *The justification will come for the questionnaire / interview with the client and may include things such as; Falling sales in a certain product line, there is no existing solution, the existing solution is not fit for purpose (takes up too much space, does not fit colour scheme, the product line has changed and there is a promotion on new stock. Sustainability and environmental issues are a major influence and should be considered in the design.*

Produce a comprehensive investigation of the needs wants and values of the client to inform design requirements.
Once candidates have identified the design possibility they need to produce a comprehensive investigation of the problem to identify the key information that needs to be researched to inform the design requirements.

This may require candidates going back to the client to get further information. The information can be produced in any format such as a table, spider diagram, mind map, brainstorm or grid. It must analyse and identify the key points of the problem. Areas to consider would include: form, function, sustainability, level of production and also ease of use (ergonomics), sizes (anthropometrics), location, safety, materials, components, existing products, performance, environment, quality, safety, budget or maintenance.

The information identified in this section would form the basis of the more developed assessment of the needs in Grid 2.

For example, the candidate below is considering the problem of designing a work desk for the home office. They have used a mind map to identify the needs, wants and values of the client to inform design requirements.



Links to the NEA exemplar

More detailed guidance on how to achieve the higher levels including moderator comments, definitions and activities are included in the NEA exemplar.

Part 1(b): Identifying and outlining possibilities for design

2. Investigation of needs and research

Content	Skills and Evidence
a) Assess the needs, wants and values of the client and the needs of the prototype. b) Research of existing commercial products, ergonomic information and standards relevant to the design possibility, using knowledge and understanding of designing and making. c) Consideration of user-centred design, taking into account the investigation of the identified design possibility, design context, and the needs, wants and values of the client. d) Consideration of levels of production and potential methods to improve the sustainability of the prototype across its life cycle.	**Assess** client, wants and values and the needs of the prototype **–** consider all of the factors that have been investigated, weighing up their importance and making decisions about how they will be addressed through the design brief and specification **Select** research sources and **make links** between the design needs and the research undertaken – conduct research into sources that have been considered and chosen for their relevance to the design possibility and the factors that have been investigated. Demonstrate the ways that the research undertaken is relevant to and informs the needs of the design (including client needs, wants and values and prototype needs). Research can be presented graphically, written or digitally and may be seen throughout the portfolio.

Grid 2

Level	Mark	Investigation of needs and research (AO1 1a 15 marks)
	0	No rewardable material.
Level 1	1–3	• Superficial assessment of the needs, wants and values of the client. • Superficial assessment of the needs of the prototype with limited consideration of form, and function. • Limited links between the design needs and the research undertaken. • Basic selection of research sources, including existing products, ergonomic information and standards, which provide limited insight to the design context, showing a partial understanding of the design possibility and related design problems.
Level 2	4–7	• Partially developed assessment of the needs, wants and values of the end user. • Partially developed assessment of the needs of the prototype with generally relevant consideration of form, function and sustainability. • Partially sound links between the design needs and the research undertaken. • Partially sound selection of research sources, including existing products, ergonomic information and standards, which provide a partially sound insight to the design context, showing a consistent understanding of the design possibility and related design problems.

Level 3	8–11	• Mostly developed assessment of the needs, wants and values of the user. • Mostly developed assessment of the needs of the prototype with relevant consideration of form, function, sustainability and level of production. • Sound links between the design needs and the research undertaken. • Sound selection of research sources, including existing products, ergonomic information and standards, which provide a sound insight to the design context, showing a considered understanding of the design possibility and related design problems.
Level 4	12–15	• Comprehensively developed assessment of the needs, wants and values of the client. • Comprehensively developed assessment of the needs of the prototype with pertinent consideration of form, function, sustainability and level of production. • Perceptive links between the design needs and the research undertaken. • Perceptive selection of research sources, including existing products, ergonomic information and standards, which provide perceptive insight to the design context, showing a comprehensive understanding of the design possibility and related design problems.

General guidance for the section

In this section candidaites are expected to identify market needs and opportunities that will provide design requirements for the development of new products.
Candidates should:

1. Make a detailed analysis of the problem with regard to the needs, wants and values of the user and the development of a prototype.

2. Research all relevant information to inform the design process.

This section will be evidenced through any form of appropriate effective communication.

Candidates should be able to demonstrate high level skills in approximately 4 - 5 sides of A3 paper (or electronic equivalent)

To achieve higher marks in this section candidaites will need to:

- Comprehensively developed assessment of the needs, wants and values of the user.

- Comprehensively developed assessment of the needs of the prototype with pertinent consideration of form, function, sustainability and level of production.

Having identified a design possibility and identified the key areas of the problem candidates need to complete a full analysis of the problem and identify the information that needs to be researched. This will cover areas such as form, function, sustainability, level of production and also ease of use (ergonomics), sizes (anthropometrics), location, safety, materials, components, existing products, performance, environment, quality, safety, budget or maintenance.

Candidates do not need to cover all of these points as every design will be different. They need to select the topics that are pertinent to your design problem and establish the needs central to the problem.

Analysis Area	What candidaites may need to research
Evaluation of designs and prototypes made by others	How can existing products inform your designing? What already exists, what features do they have, what dimensions are they, how much do they cost
Form	What are the aesthetic needs, does it have to match any existing styles, products, is it on show or purely functional
Function	What is the design supposed to do? If it is for storage, candidaites will need to research items to be stored.
Ease of use (Ergonomics)	How can the interaction with the human be made more easy, (weight, portability, rounded corners, labelling etc.
Sizes (Anthropometrics)	What anthropometric information needs to be taken into consideration?
Location	What are the space limitations for the problem? A site analysis needs to be carried out but there also needs to be consideration on getting the design in place.
Sustainability	How can the design be made more environmentally friendly in the construction, maintenance and final disposal.
Budget	Has the client set a budget or will this need to be established by looking at the competition.
Safety	Any risk to the user needs to be examined such as sharp edges, chemicals, user strengths, stability.
Materials	It is usually inappropriate to consider materials at this stage, but it is relevant if the client has specified a material, or the design brief has specified certain criteria that need to be incorporated such as lightweight, suitable for outdoor use, match existing timber.
Level of production	Generally candidaites will be making a single prototype so construction is a ‘one off’. It is usually inappropriate to consider different construction methods at this stage, but it is relevant if the client has specified a process such as laminating, veneering, casting or chrome plating.

Perceptive links between the design needs and the research undertaken

Once candidates have identified the analysis areas they also need to justify why the information is useful to their problem and where the information can be sourced. Some of the analysis points may mean that candidates have to return to the client for the information. Below is an example of key point to be considered but these would be expanded on in a live project.

Example analysis for designing compact seating for Canal Barge Hire Company

Analysis Area	What candidaites may need to research	Justification	Where to gather the research
Evaluation of designs and prototypes made by others	Are there any other examples of foldable / storable seating that solve parts of the problem? What sizes are they, what features do they have, what materials are they made from, how do they fold or are stored?	Looking for inspiration from solutions to the problem and design decisions made from other designers	Look at other ideas on the market, visit other barge holders
Form	What other seating will it have to match in with other furniture on the barge, will it be in view?	So the solution integrates well with other furniture.	Liaise with client and refer to existing styles on the barge.
Function	What functions does the seating need to have? Cup holders, collapsible, comfort how have these been incorporated into designs in the past. What are the sizes of the cups if a cup holder is needed?	As these requirements have been stated by the client as elements that must be included.	Talk to client and look at existing ideas.
Ease of use (Ergonomics)	How will the individual interact with the seat; how much do they weigh, how much can they carry, what will make it comfortable?	This is to enable the product to be easily used and moved by a range of users	Examine areas of interaction that people have with seating such as holding points
Sizes (Anthropometrics)	What anthropometric information needs to be taken into consideration for seating, what is the correct seat height, width, arm rest height, seat angle?	The final design has to fit a range of other users so that it is comfortable.	Gather anthropometric data from the internet or books that are specific to seating.
Location	How much space is available on the barge for the seating when in use and when it is to be stored?	The design has to fit the specified space and be able to be inserted into the space for it to work	Complete a full site analysis of the problem and identify all access point that may impact the placement.

Sustainability	How can the design be made more environmentally friendly in the construction, maintenance and final disposal.	This is to ensure that the design can be maintained over the length of it life and eventual disposal.	Consider how products are made sustainable, what recycled materials available, non-toxic finishes.
Budget	What budget has the client set for the project?	This must be realistic to existing products and relate to the users requirements	Interview with client
Safety	The seating will need to be moved and folded so I will need to find out about any safety aspects such as sharp edges, user strengths, stability in use.	The design has to be safe in use and not harm the user and strong enough for purpose	Look at any legislation, safety guidelines and client interview
Materials	My client has stated that the design must fit in with the timber used on the barge and it needs to be weather resistant so the choice of materials is limited to these and I will need to research these.	The materials must be suitable in relation to strength, durability, decay so that they will be fit for purpose.	Site analysis, and research into appropriate timbers that are weather resistant.

Perceptive selection of research sources, including existing products, ergonomic information and standards, which provide perceptive insight to the design context, showing a comprehensive understanding of the design possibility and related design problems.

Perceptive research means that candidates target their research to the specific problem and do not gather information that will not support the designing. If candidates are working for a specific client, much of the research could be gathered by individual interviews but a lot will need to be gathered from alternative sources such as data, legislation, measuring.

Information should not just be downloaded from the internet, the research must be focused and it should clearly show what information is important and is relevant and where it could be used. The information should be annotated and key details highlighted.

Research can be presented graphically, written or digital and may be seen throughout the portfolio, as there may be areas that are not obvious at this stage such as materials selection or production methods that are more useful once design decisions have been made.

For example

- **Evaluation of designs and prototypes made by others:**
  Do not research products that are not relevant.
  Do look for products that have design features that would help, see how aspects of the problem have been solved before.

- **Function:**
  Do not ignore other items related to a product.
  Do find out the sizes of items related to the design, items to be fitted on or stored in.

- **Sizes (Anthropometrics):**
  Do not show irrelevant anthropometric information;
  Do focus on areas specific to your design.
  If designing a desk, gather relevant information such as, heights of desks / chairs, reach envelopes.
  If designing seating, gather relevant information such as, on seat heights, back rest angles, seat width.

- **Location:**
  Do not make assumptions on space.
  Do make accurate measurements of the space available and any other contributing factors such as access through doors etc.

- **Materials:**
  Do not research materials if you have not made any design decisions.
  Do research materials if there has been specific guidance by the client / user group. Materials research will be more relevant in the development section and will still be credited.

Links to the NEA exemplar

More detailed guidance on how to achieve higher levels including moderator comments, definitions and activities are included in the NEA exemplar.

Part 1(c): Identifying and outlining possibilities for design

2. Specification

Content	Skills and Evidence
a) Production of a refined design brief based on outcomes of research and investigations. b) Production of a technical design specification considering form, function, sustainability and standards relevant to the needs, wants and values of the intended client. c) Evidence of client/end user influence in the specification. d) Identification and justification of performance requirements for the prototype. e) Consideration of scale of manufacture and how this reflects on relevant cost.	**Identify** and **Justify** performance requirements – outline performance requirements providing a rationale as to how they have been determined to ensure a working solution to the design possibility, supported by evidence from research and investigations. A refined design brief and specification must be produced. The design brief should reflect the needs, wants and values of the client. The specification should be informed by the questions raised by research and investigation findings. Specification points should b technical and measurable to allow for realistic testing and evaluation. An effective specification is organised logically and could be achieved by using sub-headings such as: • Purpose/function • Form • User requirements • Performance requirements (considering relevant standards) • Material and component requirements • Scale of manufacture and cost Each specification point should contain more than a single piece of information, so that each statement is fully justified by giving a reason for the initial point. This section will be evidenced through any form of appropriate effective communication.

Grid 3

Level	Mark	Specification (AO1 1b 9 marks)
	0	No rewardable material.
Level 1	1–3	• Basic design brief that reflects some of the investigated needs, wants and values of the client/end user. • Superficial range of specification points which are realistic, technical and measurable in relation to a basic design problem. • Limited justification of the performance requirements for the prototype.
Level 2	4–6	• Considered design brief that reflects most of the investigated needs, wants and values of the client/end user. • Developed range of specification points which are realistic, technical and measurable in relation to an effective design problem. • Sound justification of the performance requirements for the prototype.
Level 3	7–9	• Comprehensive design brief that fully reflects the investigated needs, wants and values of the client/end user. • Comprehensive range of specification points which are realistic, technical and measurable in relation to a sophisticated design problem • Perceptive justification of the performance requirements for the prototype.

General guidance for the section

In this section candidaites are expected to identify market needs and opportunities that will provide design requirements for the development of new products.
Candidates should:

- Create a comprehensive design brief that fully reflects the investigated needs, wants and values of the client.
- Create a comprehensive range of specification points which are realistic, technical and measurable in relation to a sophisticated design problem.

Candidates should be able to demonstrate high level skills in approximately 1 - 2 sides of A3 paper (or electronic equivalent)

To achieve higher marks in this section candidaites will need to:

Create a comprehensive design brief that fully reflects the investigated needs, wants and values of the client.
In the previous section candidates will have analysed the problem and gathered all relevant research. Candidates now need to develop this into a formal statement of intent called the Design Brief. This should summarise the potential problem identified previously and highlight what needs to be done **NOT** describe the solution to the design problem.

The design brief should:

- Explain the existing situation that needs to be resolved.
- Summarize the needs, wants and values of the client which may include function, aesthetics, location and any specific criteria.

Example design brief for compact seating for Canal Barge Hire Company

> *Design and make portable compact seating that can be used on a canal barge. The current solution is uncomfortable and takes up too much valuable storage space on the barge. The seating needs be easy to use, comfortable, safe, aesthetically pleasing and suitable for adults. The seating will be used on the deck of the barge but must be able to be stored away in a limited amount of space. The seats need to be strong enough for purpose and be able to withstand outdoor conditions.*

Candidates may choose to add photographs, data or user comments to assist the understanding of the problem being presented.

Create a comprehensive range of specification points which are realistic, technical and measurable in relation to a sophisticated design problem

The design brief is a summary statement of intent. To start designing candidates will also need detailed information that will form a specification for the design.

A good specification is very important at this stage as it gives a framework for designing with all the key information candidates are likely to need. It will also give them the details that need to be evaluated at different stages of the project as it progresses. There is usually a direct correlation between a good specification and a good evaluation at the end of the project.

- The key areas candidates researched are a good starting point for a detailed specification and there should be a clear link back to the research.

- Candidates need to agree the points with your client as this is the starting point for designing.

- The specification points must be realistic, technical and measurable so they can be evaluated against.

- The specification focus areas should be flexible and suit the individual problem.

- The specification points should be justified.

Example specification for designing a dog bed for a kitchen with includes additional storage.

Focus Area	***Specification details***	***Justification***
Purpose / Function	• *Provide a safe and comfortable sleeping area for a Labrador.* • *The design must store the items needed for the dog. Food bowl, max dimensions 300 x 300 x 50mm. Two leads 50 x 50 x 50mm, folded blanket 300 x 300 x 100mm.* • *The dog requires 800 x 600 mm of space to sleep as it is a Labrador.* • *The design must support the weight of the dog, which is 50kg*	*Talk to client and look at existing ideas. It is important that the dog feels comfortable so that it will use the bed. The items to be stored are the items that are regularly needed with a dog.*
Form	• *The design has to match the existing furniture in the kitchen which has oak units.* • *Must match the kitchen units which are in a shaker style.* • *The design must have surface protection.*	*The design has to be in keeping with the environment it is to be placed as it will be on show.*
Ease of use (Ergonomics)	• *The storage section needs to be raised off the ground for easy access.* • *It must store all items requested by the client* • *Must be easy to clean and have removable cushioning for the dog.* • *The dog must have easy access so the sleeping area cannot be more than 300mm off the ground.*	*The ease of use needs to be focused on the client, such as the storage. However, there does need to be easy access for the dog to get in and out.*
Sizes (Anthropometrics)	• *The design must fit a Labrador when sleeping.* • *The storage must be easily accessed by the user and be no lower than 20mm from the ground.* • *The handles need to fit the hand.*	*The anthropometrics of reach is important for the user, but the size of the dog is a critical dimension.*
Location	• *The design will fit in the design of the kitchen which has oak cabinets.* • *The design must fit within the maximum space available is 1000 x 1000 x 1000mm* • *The design must be able to fit through a door that is 800mm wide and fit the back of a car for transport (1200 x 1200 x 800mm)*	*The design cannot be any larger than the space available by the client. It also needs to be able to fit through the doors to get in to the kitchen*
Sustainability	• *The design must be made so that it has limited impact so reclaimed timber or man-made timer should be considered wherever possible.* •	*The design needs to be long lasting with low environmental impact*
Budget	• *The client has set a budget of £200 for the cost of materials. This is to cover the materials and not the manufacturing costs.* • *There should be no further maintenance costs*	*This cannot be exceeded although manufacturing costs will not be included.*

Safety	• *The design must not have any sharp edges or parts that may come loose and hurt the dog.* • *The design must be stable in use and not wobble.* • *The design must also be safe for the client and if it weighs more than 50kg it needs to be able to be taken apart so that it is easy to lift.* • *The design must adhere to legislation on fire and soft furnishings.*	*The safety of the dog is paramount as they will be using the bed every day, while the client will have intermittent use but it is still very important to avoid risks*
Materials	• *My client has stated that the design must fit in with the oak cabinets in the kitchen which means that oak needs to be incorporated into the design.* • *Manufactured boards will be used wherever possible to reduce the cost.* • *Materials must have protection against fluids.*	*Although the outward looking materials have been decided, I will need to look at options of making the design out of cheaper materials where possible.*

Other areas that may be included in a specification would be:

- Performance requirements
- User requirements
- Material and component requirements
- The scale of manufacture
- Quality assurance / control, including tolerances
- Life expectancy
- Maintenance
- British standards
- Cultural, social and ethical issues
- Components and construction methods

At this stage candidates may suggest ways in which their outcomes can be tested and how will the measure success as this may inform some of the design decisions being made.

Links to the NEA exemplar

More detailed guidance on how to achieve the higher levels including moderator comments, definitions and activities are included in the NEA exemplar.

Part 2(a): Designing a Prototype

4. Design ideas

Content	Skills and Evidence
a) Production of a range of design Proposals that are realistic, workable, and which address the criteria in the specification. b) Exploration of different design approaches, processes and techniques to produce realistic design ideas. c) Selection and application of design strategies and knowledge of materials and/or components, processes and techniques to produce design ideas that address client/end user needs, wants and values. d) Design ideas show consideration and use of aesthetics, including cultural and historical influences. e) Decisions made in consultation with the client/end user.	**Select** and **apply** design strategies - Consider different strategies and select them through their relevance to the design possibility and related factors and their ability to work effectively with design ideas presented. Demonstrate an ability to use the selected strategies to generate and produce design ideas. **Present** design ideas– demonstrate an ability to solve a design problem. **Use** aesthetic features – Incorporate aesthetic understanding into features of designs **Demonstrate understanding** of materials, processes, techniques and the intended use of the prototype – show an ability to select and apply relevant knowledge in the context of designing new prototypes to demonstrate understanding of its appropriate use in practice The initial design ideas will contain a ideas that show different approaches to the design possibility and solving the design problems it presents. Designs should be annotated with design decisions justified. They should also explain details of design thinking and offer thoughts on design proposals. Ideas should demonstrate interaction with client/end user and designer, possibly through the use of photographs, email, transcript or market research. This section will be evidenced through any form of appropriate effective communication.

Grid 4

Level	Mark	Design ideas (AO2 9 marks)
	0	No rewardable material
Level 1	1–3	• Basic selection and use of design strategies to inform decisions. • Present ideas that show a limited consideration for the user needs and specification parameters. • Basic use of aesthetic features with basic consideration of historical and cultural influences showing a limited understanding of the intended use of the prototype. • Ideas demonstrate a basic understanding of relevant materials and processes.

Level 2	4–6	• Considered selection and use of design strategies to inform decisions. • Present ideas that show sound consideration for the user needs and specification parameters. • Effective use of aesthetic features with sound consideration of historical and cultural influences showing a sound understanding of the intended use of the prototype. • Ideas demonstrate a sound understanding of relevant materials, processes and techniques.
Level 3	7–9	• Sophisticated selection and use of design strategies to inform decisions. • Present ideas that show an in-depth consideration for the user needs and specification parameters. • Accomplished use of aesthetic features with perceptive consideration of historical and cultural influences showing an in-depth understanding of the intended use of the prototype. • Ideas demonstrate an in-depth understanding of relevant materials, processes and techniques.

General guidance for the section

In this section it is expected that candidates will use a range of design strategies to produce a range of design ideas that are realistic, workable and address the criteria in the specification criteria from the previous section. Candidates should be thinking like a commercial designer and apply their knowledge of technical skills and materials and back it up with the research they have carried out previously and any additional research that may be required. Be imaginative and draw inspiration for many areas such as nature, industry, design movements and new technology.

Throughout this section candidates should:

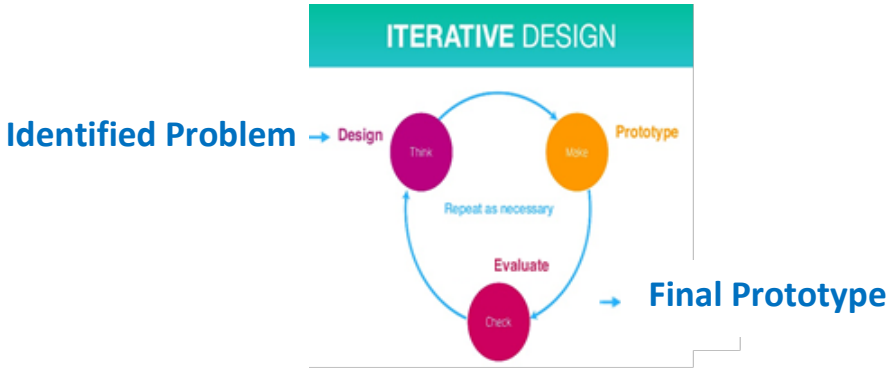
- Demonstrate a sophisticated selection and use of design strategies to inform design decisions.
- Present ideas that show an in-depth consideration for the user needs and specification parameters.
- Demonstrate an accomplished use of aesthetic features with perceptive consideration of historical and cultural influences showing an in-depth understanding of the intended use of the prototype.
- Demonstrate an in-depth understanding of relevant materials, processes and techniques.

Candidates should be able to demonstrate high level skills in approximately 4 - 6 sides of A3 paper (or electronic equivalent).

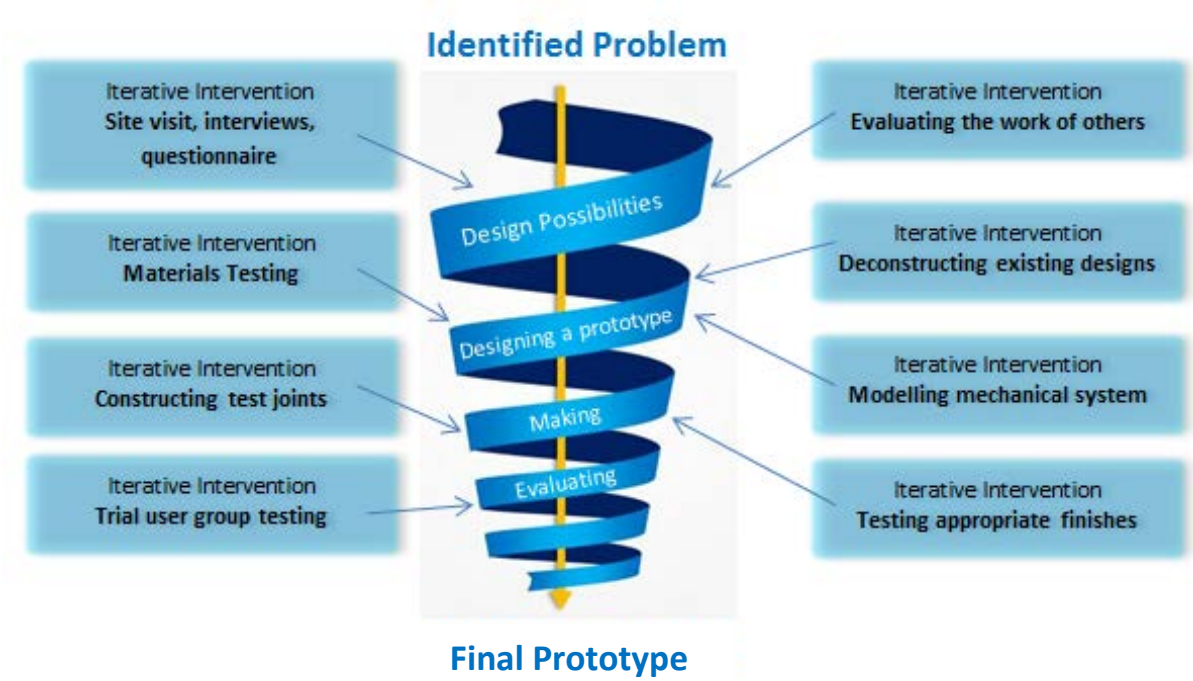
To achieve higher marks in this section candidaites will need to:

Demonstrate an iterative design approach.

Iterative Design can be cyclic approach to design where there is a continuous process of designing, prototyping, testing, and evaluating at all stages of the design process. This will include using client feedback on sketches, material testing, modelling, field trials and evaluation. Each iteration of the design moves the solution forward until all problems are resolved and a finished design is produced.



Iterative Design can also be seen in a linear way where a candidate will takes the identified problem through to the finished prototype but seeks the iterative intervention at appropriate points in the design process.



Throughout the project the candidates should be collaborating with the client group. Collaboration allows candidates to draw on the experience and specialist knowledge of others. This could be from the client or from expert or professionals in the chosen material such as a welder, carpenter, textile worker or even a working designer. The input could come at any stage in the design process such as initial research, reviewing design ideas and prototypes, manufacturing or evaluating the final design.

Designs should be imaginative, innovative and creative, try not to constrain candidates' thoughts and avoid design fixation.

Designing is an imaginative, innovative and creative process but it does not always run smoothly. Candidates may find that your prototype does not work exactly as they had anticipated. It is important that candidates are flexible in their approach and do not become fixated on their original design. Candidates should try to use a collaborative approach and seek advice from others; try modelling rather than drawing as it may highlight issues by looking at the problem in a different way. Go back to the problem and take a fresh approach that may be more experimental, with shapes or materials.

Present a range of ideas that address the criteria in the specification.

There are not a set number of ideas that would demonstrate a 'range' of ideas; but candidates should provide enough ideas or part solutions that are workable and clearly show a number of potential solutions to the problem. Not all ideas need to be fully developed; some may have more development possibilities than others.

Present ideas that clearly demonstrate the connection to the research in the previous section.

Do not just copy information from the research but apply the information gathered and draw out specifics that are relevant to each design, e.g. Specific anthropometric information relevant to certain design features.

Clearly show where the needs and wants of the client have been included in the design solution.

When designing, candidates need to clearly demonstrate a clear understanding of materials and components which may mean that further research needs to be carried out in this stage.

When referencing suitable materials candidates should use specific names where possible to show a clear understanding of the properties of the materials. Avoid the use of term as such as Wood, Metal and Plastic and identify specific materials such as Aluminium if the design needs to be light, corrosion resistant or Pine for outdoor seating that needs to be weather resistant or strong.

When designing, candidates should be experimental with the aesthetics but need to refer back to the needs of the client as areas such as colour shape and style may have a large impact on the outcome.

It is often good to start with overall shapes for the design and do not get too focused on the detail, this allows the form to be more experimental. Once the form has been proposed then the detail needs to be included and this will then include the materials and construction techniques. In a good design the overall aesthetics will be as important as the exploration of construction methods and potential materials.

Candidates should be able to suggest suitable manufacturing techniques or processing methods that could be used to produce the design.

When referencing suitable manufacturing methods the processes should be related to the scale of production or clearly show an alternative that could be used when designing a one off prototype. For example, small plastic components could be injection moulded in large quantities but 3D printed in the school workshop. For large scale production, timber furniture may be constructed with knock down fittings but as a one off, traditional jointing may be quicker.

Candidates should link back to existing solutions and make reference to cultural and historical solutions as these will usually have some limiting factors or may provide some guidance on potential issues that have been solved in the past.

This may include construction methods previously used or design features that work with very little alteration.

Candidates should use modelling techniques to demonstrate design aspects.

The use of modelling is a technique that is often misunderstood. Modelling must be used for a purpose and be used to demonstrate a feature that could not be adequately demonstrated by a drawing. This may include testing a construction technique or the strength of a particular joint. It could be for aesthetic purposes to show proportions of a part and the scale of the finished design in relation to the space available.

A range of presentation methods needs to be demonstrated.

These will vary a great deal and will depend on the strengths of the candidates but it is good to demonstrate a wide range that are selected to suit different needs and allow the client / examiner a clear understanding of your thought and ideas. This could include the use of.

- Brainstorming of different ideas.
- Demonstration of design thinking and problem solving
- Thumbnail sketches.
- Freehand sketches can be in 2D and 3D, (isometric, oblique, perspective, orthographic).
- Computer-aided design (CAD) for parts of designs or whole designs.
- Computer-aided manufacture (CAM) to demonstrate construction or features.
- Use of models (CAD or traditional.)
- Use of systems or schematic diagrams.
- Cut and paste from other sources.
- Add in digital photography.
- Annotation / labelling of ideas (use of arrows).
- Colour and shading using pencils or markers.
- Exploded drawings to show how parts locate or fit together.
- Sub-systems to demonstrate things like construction, how a section operates.

- Dimensioning
- Justification of the selection of materials or processes.
- Feedback from client.
- Systems approach to break down more complex issues.
- In addition to your client collaborative with others.

Before moving on to the development section it is good to evaluate the range of ideas against the specification and make decisions on which designs could be developed.

A good specification produced earlier will form a checklist where candidates can assess your designs and give reasons for selecting or rejecting ideas. Candidates also need to consult the client to make sure that they are happy in the direction that is being taken.

Links to the NEA exemplar

More detailed guidance on how to achieve the higher levels including moderator comments, definitions and activities are included in the NEA exemplar.

Part 2(b): Designing a Prototype

5. Development of Design ideas

Content	Skills and Evidence
a) Demonstration of the application of an iterative approach to design development. This is informed by the application of knowledge of materials and the needs, wants and values of the client/end user. b) Modelling/simulation used to test appropriate features including proportions, scale, function, sub-systems. Modelling/simulation can be achieved through the use of traditional materials, or 2D and/or 3D computer simulations. c) Ongoing developmental changes are informed by technical application of research, experimenting, and client/end user feedback in order to improve, refine and realise a design.	**Use** research – draw from information and understanding gained from research to inform ongoing developmental changes. **Use** an iterative approach – employ a process of planning, experimenting, designing, modelling, testing and reviewing, including use of input from client/end user to inform decision making, make improvements and refine designs at each stage of development. **Apply knowledge** of materials and processes - show an ability to use relevant technical knowledge to inform the development of designs **Apply** modelling/simulation techniques – use of modelling/simulation as part of an iterative design approach to visualise developing designs and inform decisions **Demonstrate understanding** of the need for testing - show an ability to select and apply knowledge of relevant testing methods in the context of designing new prototypes in order to demonstrate understanding of its importance in the development of a final prototype This section of the portfolio is likely to consist of design developments, including drawings and details of the final design idea. There will be evidence in this section of candidates developing a final design idea with reference to the specification and improvements being supported by appropriate annotation. The evidence of modelling should be presented through clear, well-annotated photographs or screenshots. Client/end user interaction could include the use of photographs, email transcripts, market research or client/end user annotation of designs.

Grid 5

Level	Mark	Development of design ideas (AO2 9 marks)
	0	No rewardable material
Level 1	1–3	• Superficial use of research to inform ongoing developmental changes. • Basic use of an iterative approach to the development of a design solution, including superficial input of client/end user feedback to inform decisions throughout the process. • Changes and alternatives to designs are informed by the basic application of technical knowledge of materials and processes. • Limited application of modelling/simulation techniques to inform decisions showing a basic understanding of the need for testing in the development of a final prototype.
Level 2	4–6	• Considered use of research to inform ongoing developmental changes. • Sound use of an iterative approach to the development of a design solution, including considered input of client/end user feedback to inform decisions throughout the process. • Changes and alternatives to designs are informed by the sound application of technical knowledge of materials and processes. • Effective application of modelling/simulation techniques to inform decisions showing a sound understanding of the need for testing in the development of a final prototype.
Level 4	7–9	• Perceptive use of research to inform ongoing developmental changes. • Accomplished use of an iterative approach to the development of a design solution, including perceptive input of client/end user feedback to inform decisions throughout the process. • Changes and alternatives to designs are informed by the in-depth application of technical knowledge of materials and processes. • Sophisticated application of modelling/simulation techniques to inform decisions showing an in-depth understanding of the need for testing in the development of a final prototype.

General guidance for the section

In this section candidates are expected to use a range of design strategies to build upon the design ideas produced in the previous section. They should not be afraid to take steps back in this section and look for alternative solutions and continually check with the client so that their wants and needs are covered.

Candidates should be thinking like a commercial designer and apply their knowledge of technical skills and materials and processes and back it up with the research they have carried out previously and any additional research or experimenting, and client feedback in order to improve, refine and realise a design to meet the needs, wants and values of the client.

Modelling / simulations can be achieved through the use of traditional materials, or 3D and/or 3D computer simulations.

Candidates should:

- Show a perceptive use of research to inform ongoing developmental changes.
- Demonstrate accomplished use of an iterative approach to the development of a design solution, including perceptive input of client feedback to inform decisions throughout the process.
- Show how changes and alternatives to designs are informed by the in-depth application of technical knowledge of materials and processes.
- Demonstrate a sophisticated application of modelling/simulation techniques to inform decisions showing an in-depth understanding of the need for testing in the development of a final prototype.

Candidates should be able to demonstrate high level skills in approximately 4 - 6 sides of A3 paper (or electronic equivalent) .

To achieve higher marks in this section candidaites will need to:

Demonstrate an iterative design approach so that candidates continually develop, model, test and evaluate all decisions in the development of a prototype.

Iterative Design is a cyclic approach to design where there is a continuous process of designing, prototyping, testing, and evaluating. This will include using client feedback on sketches, material testing, modelling, field trials and evaluation. Each iteration of the design moves the solution forward until all problems are resolved and a finished design is produced.

Iterative Design can also be seen in a linear way where a candidate will takes the identified problem through to the finished prototype but seeks the iterative intervention at appropriate points in the design process.

Collaboration allows candidates to draw on the experience and specialist knowledge of others. This could be from your client or from expert or professionals in your chosen material such as a welder, carpenter, textile worker or even a working designer.

Refine the designs offered in the previous section with feedback from the client user group and bring together the best and most appropriate parts of the designs to meet the needs and wants of the client user group and fulfil the details in the specification. There may be features from different designs that work well together.

Feedback or meetings with clients or user groups could be shown as a transcript of a conversation, emails, market research or photographs. Clients could also annotate the design pages as long as they are noted as client feedback.

Continue to present ideas that clearly demonstrate the connection to the research and justify the decisions that have been made to move the design forward.

The designs need to show an evolution and there needs to be significant changes from the initial designs to improve the designs.
Significant changes can take many forms;

- Changes in the way a design is to be constructed.
- Changes in the overall aesthetics or shape of the design.
- Changes in design features that lead to a more successful design solution.

Clearly show where the needs and wants of the client have been included in the design solution. Go back to the user requirements consider the aesthetics, ergonomics and anthropometrics.

When designing, candidates need to clearly demonstrate a clear understanding of materials and components which may mean that further research needs to be carried out in this stage. Also consider standard components and how they can be incorporated into the design.

When referencing suitable materials candidates should use specific names where possible to show a clear understanding of the properties of the materials. Give clear reasons for the choice of materials based on the functions they are to perform. For example,

Mechanical Properties		**Physical Properties**	
Strength	Ability to withstand force. Can be Compressive or Tensile.	**Density**	How much mass is in the material.
Elasticity	Ability to bend without fracture when subjected to a force.	**Electrical conductivity**	The ability to conduct electricity.
Plasticity	Ability to permanently deform without fracture when subjected to a force.	**Thermal Conductivity**	The ability to conduct heat.
Malleability	Ability to be worked without fracture	**Size**	The dimensions of a material.
Ductility	Ability to be drawn out without fracture	**Corrosion**	The ability of a material to resist oxidisation.
Hardness	Ability to resist abrasive wear.	**Joining**	Ability of the material to be joined.
Toughness	Ability to withstand sudden stress or shocks.	**Optical**	The ability of a materials to allow light to pass through.
Brittleness	In inability to withstand sudden stress or shocks.	**Aesthetics**	How attractive or pleasing the material needs to be in a product in terms of form, colour and texture.
Durability	Ability to withstand deterioration over a period of time.		
Stability	Ability to resist changes in shape over a period of time.		
Stiffness	Ability to resist bending		

Other properties

Environmental factors	The energy consumption, pollution, sustainability from the material's initial sourcing and extraction, manufacture, use and disposal.
Availability	Materials need to be readily available in their raw form or as components. Materials that are specialist, scarce or difficult to source will have a higher cost. The use of stock materials will benefit designers and customers.
Cost	The cost of the raw material, processing through to manufacture of the product, heavily influenced by the scale of production.
Method of production	Do candidaites have the skills / facilities for the production methods. How many products need to be made. What level of finish is required.
Social factors	Companies must consider social factors when selecting materials and the needs of the people have a high priority. Examples are the specific needs of children, disabled or elderly where safety may be a critical factor or the consumer society / obsolescence, such as trends and fashions may drive the quality of materials used.
Cultural factors	Different faiths and beliefs may impact the development of products. This does not just impact design; the origin of materials may be important, for example products that have been derived from the body of an animal.
Ethical factors	Materials should be purchased from ethical sources, such as wood that has been responsibly managed and accredited by the Forest Stewardship Council (FSC) or products endorsed by the FairTrade Foundation.

Candidates should be able to suggest suitable manufacturing techniques or processing methods that could be used to produce the design.

When referencing suitable manufacturing methods the processes should be related to the scale of production or clearly show an alternative that could be used when designing a one off prototype. Candidates need to demonstrate an understanding of commercial manufacturing and construction methods that they may be using. Modelling construction methods is very useful at this stage as part of the iterative process.

Candidates should be should provide detailed information that is technical and measurable and clearly shows the details of the design. This would include quantities, dimension, techniques, appropriate finishes etc.

Candidates should link back to existing solutions and make reference to cultural and historical solutions as these will usually have some limiting factors or may provide some guidance on potential issues that have been solved in the past.

Candidates should demonstrate a sophisticated use of modelling or simulation techniques to demonstrate design or construction aspects.

Modelling must be used for a purpose and be used to demonstrate a feature that could not be adequately demonstrated by a drawing or features that need to be tested to ensure that they function properly. Good photographic evidence or screenshots of modelling needs to be included. Examples of modelling would include:

- Use of CAD simulations to demonstrate mechanical features or for accuracy.
- Scale models to demonstrate design features, proportions, size, colour or shapes.
- Trial construction methods to assess suitability of strength
- The manufacture of sub-systems to test the functioning

- Ergonomic modelling to test out the fit with the user
- When choosing materials candidaites may test the properties of materials for strength, colour finish etc.

Modelling can be can be completed in many ways such as CAD, use of cheap materials such as paper, card, plastics, clay or plasticine. Models can be made as frames to demonstrate construction, using straws or balsa. Kits can also be used for more technical aspects such as construction, electronic or pneumatic kits.

As with the previous section candidates should use a range of presentation techniques to give the client / examiner a clear understanding of their thoughts and ideas. This could include the use of.

- Demonstration of design thinking and problem solving
- Thumbnail sketches.
- Freehand sketches can be in 2D and 3D, (isometric, oblique, perspective, orthographic).
- Computer-aided design (CAD) for parts of designs or whole designs.
- Computer-aided manufacture (CAM) to demonstrate construction or features.
- Use of models.
- Use of systems or schematic diagrams.
- Cut and paste from other sources.
- Digital photography.
- Annotation / labelling of ideas (use of arrows).
- Colour and shading using pencils or markers.
- Exploded drawings to show how parts locate or fit together.
- Sub-systems to demonstrate things like construction, how a section operates.
- Dimensioning
- Justification of the selection of materials or processes.
- Feedback from client.
- Systems approach to break down more complex issues.
- In addition to your client candidates can collaborative with others.

Links to the NEA exemplar

More detailed guidance on how to achieve the higher levels including moderator comments, definitions and activities are included in the NEA exemplar.

Part 2(c): Designing a Prototype

6. Final Design Solution

Content	Skills and Evidence
a) Design proposals are refined down to a final design solution which includes all requirements for fitness for purpose, including technical details of all materials and/or component parts, processes and techniques. b) Specification of materials and/or components and processes shows consideration of sustainability. Decisions are made based on research information on the environmental costs of extracting and processing the selected materials, the prototype manufacture, lifespan and disposal. c) Application of the calculation and cost of materials based on quantities to reduce wastage.	**Refine** design proposals – Make final decisions about proposed designs and present a single design solution that meets the requirements of the design specification. **Produce** a manufacturing specification – fully document all details of the final design solution, including sufficient technical information to allow accurate interpretation by a third party. **Apply** calculations – use appropriate mathematical knowledge to determine material quantities and costs related to the production of the prototype **Demonstrate understanding** of methods of reducing wastage – use outcomes of calculations to plan the most efficient use of materials and resources in the manufacture of the prototype Evidence is likely to include a graphical representation of a final design with working/component drawings.

Grid 5

Level	Mark	Final design solution (AO1 3 marks, AO2 6 marks)
	0	No rewardable material
Level 1	1–3	• The manufacturing specification generally addresses the needs and wants of the client/end user and includes basic technical details to allow partially accurate interpretation by a third party. • Basic refinement of design proposals to generate a design solution that generally meets the requirements of the design specification. • Basic project management including application of calculations to determine material quantities and costs related to the production of the prototype, showing a basic understanding of methods which can be applied to reduce wastage.
Level 2	4–6	• A manufacturing specification that effectively addresses the needs and wants of the client/end user is presented that includes effective technical details to allow mostly accurate interpretations by a third party. • Effective refinement of design proposals to generate a design solution that effectively meets the requirements of the design specification. • Effective project management including application of calculations to determine material quantities and costs related to the production of the prototype, showing an effective understanding of methods which can be applied to reduce wastage.

Level 3	7–9	• A manufacturing specification that comprehensively addresses the needs and wants of the client/end user is presented that includes comprehensive technical details to allow fully accurate interpretation by a third party. • Sophisticated refinement of design proposals to generate a design solution that comprehensively meets the requirements of the design specification. • Accomplished project management including application of calculations to determine material quantities and costs related to the production of the prototype, showing a thorough understanding of methods which can be applied to reduce wastage.

General guidance for the section

In this section candidates are expected to provide a manufacturing specification that comprehensively addresses the needs and wants of the client that includes comprehensive technical details to allow a fully accurate interpretation by a third party. It should include detailed drawings of the finished designs full cutting lists of the materials and components required and any part drawings where appropriate. This section should also include details of manufacturing processes and where sustainability and environmental decisions are being made.

Evidence in this section is likely to include a graphical representation of a final design with working/component drawings and a breakdown of major manufacturing stages. Candidates should:

- Produce a manufacturing specification that comprehensively addresses the needs and wants of the client is presented that includes comprehensive technical details to allow fully accurate interpretation by a third party.
- Produce a sophisticated refinement of design proposals to generate a design solution that comprehensively meets the requirements of the design specification.
- Demonstrate accomplished project management including application of calculations to determine material quantities and costs related to the production of the prototype, showing a thorough understanding of methods which can be applied to reduce wastage.

Candidates should be able to demonstrate high level skills in approximately 3 - 5 sides of A3 paper (or electronic equivalent).

To achieve higher marks in this section candidaites will need to:

Produce manufacturing specification. This can be broken down into two parts:

a) Comprehensive manufacturing details to enable a third party to manufacture the design which includes a working drawing and cutting list of the design proposal should provide accurate working drawings that show all the construction details including dimensions, sizes, tolerances, quantities, finishes and costs of materials and components.

Although an orthographic drawings are commonly used to give the details of a design proposal candidates can also use other techniques to help represent the final idea such as:

- Engineering drawing and schematics
- Isometric, oblique, perspective drawing
- Computer-aided design (CAD) for parts of designs or whole designs.
- Exploded drawings to show how parts locate or fit together
- Dimensioning
- Photographs of construction models.

If any aspect is not clear, add to your working drawings with annotation to give the level of detail required.

b) A clear production plan that details the stages or sequence of operations to manufacture the prototype.

Production plans can vary a great deal but should include enough detail for manufacture. It needs to be appropriate to the scale of production for making the prototype. If the design is a one-off, the plan for production should relate to this.

- Details of the main stages / processes of production in the correct order.
- Details of any tools or equipment required.
- Details of materials required.
- Give realistic deadlines for completing the tasks.
- Where and how quality control can be used to ensure tolerance and accuracy.
- Give details about any safety requirements for the person manufacturing the prototype or other people.
- Details of any sustainability environmental issues such as extracting and processing the selected materials, the prototype manufacture, lifespan, disposal and methods to reduce wastage.

Production plans can be laid out in a number of ways but need to include the details shown above. The most important aspect is that they show clear and detailed instructions for manufacturing the prototype. They should be detailed enough so that different people could follow the plan and the final products would be identical. Examples of production plans are.

- Tables can be used to provide the detailed information but the choice of headings needs to be carefully decided to include all relevant details.
- Flow diagrams can give the sequence of operations but will need further clarification (A flow diagram alone may give a sequence of operations but may not provide enough detail and may need to be supplemented with other information in a different form).
- Gantt Charts can give the sequence of operations but will need further clarification. (A Gantt chart alone may give a sequence of operations but may not provide enough detail and may need to be supplemented with other information in a different form).

Candidates should identify the main stages of production in the correct order as these can then be broken down into specific processes/techniques that will give the required level of detail.

For example:

Stage 1

- *Manufacturing the joints at the top of the legs of the table.*

Processes

- *Mark out the mortice & tenon joint,*
- *Cut mortises on mortice machine*
- *Cut tenons by hand and adjust to fit*

Details of materials required should include a justification of the material chosen, quantities and costs.

Details of any tools or equipment required should include: Marking out, cutting, shaping, machinery, jigs, templates, patterns, finishing etc.

When dealing with quality control, it is not just about accuracy it is how quality control can be used to ensure tolerance and accuracy and are measurable aspects that will lead to accuracy every time such as the use of Jigs, templates, formers, gauges, testing equipment, settings on machines, guides, patterns etc.

Give realistic deadlines for completing the tasks and make sure candidaites give themselves enough time as there may be delays in using equipment, ordering materials or recovering from mistakes.

Give details about any safety requirements for the person manufacturing the prototype or other people such as guards, clothing, extraction, trailing wires, sharp tools etc.

Give details of manufacturing processes and where sustainability and environmental decisions are being made. Such as planning documentation to show the lay planning to minimise the waste in the cutting of components or how to source more sustainable materials.

Links to the NEA exemplar

More detailed guidance on how to achieve the higher levels including moderator comments, definitions and activities are included in the NEA exemplar.

Part 2(d): Designing a Prototype

7. Review of development and final idea

Content	Skills and Evidence
a) Critical analysis and evaluation of their own ideas and decisions while using an iterative design process leading to refinements of designs. b) Analysis and evaluation of designs and prototypes/products produced by others, including client/end user to inform design decisions. c) Analysis and evaluation of refinements to designs based on the design decisions made by others, including the client/end user, along with a consideration of the materials, components and manufacturing techniques that will be used for making the final prototype. d) Draw conclusions based on the analysis and evaluation, drawing together considerations about the appropriateness of the final prototype in meeting the needs of the specification.	**Analyse** refinements made to designs through the development process – break down or deconstruct the refinements made to prototype designs with reasoned consideration and investigation of a range of factors including materials and/or components, processes, techniques, aesthetics and contextual/historical influences supported by reference to feedback. **Evaluate** refinements made to designs through the development process - critically review information gained from analysis of prototype designs including strengths, weaknesses and all relevant information, to form independent judgments and come to balanced and supported conclusions about the appropriateness of the final prototype design in meeting the needs of the specification, taking into account the effectiveness of the iterative design process. **Analyse** designs and prototypes made by others and **make connections** between elements of the design - break down or deconstruct prototype designs of others with reasoned consideration and investigation of a range of factors including materials and/or components, processes, techniques, aesthetics and contextual/historical influences. Showing the ways in which elements and aspects of designs are related and work together as part of the overall design.
	Evaluate designs and prototypes made by others **–** critically review information gained from analysis of prototype designs of others, including strengths, weaknesses and all relevant information, to form independent judgments and come to balanced and supported conclusions which inform own design decisions. The review of development and final idea section is likely to accompany research, development of design ideas and the final design solution and may consist of a summative submission which would include a conclusion that incorporates the opinions of the client/end user evidenced through photographs, email transcripts and market research. Information should be communicated through logical and well-organised statements. There should be evidence of an objective evaluation of ideas set against the needs in the design brief and specification to ensure that designs are realistic, viable and fulfil the client/end user's needs, wants and values. Client/end user interaction could include the use of photographs, email, transcripts or market research. This section will be evidenced through any form of appropriate effective communication.

Grid 7

Level	Mark	Review of development and final idea (AO3 1a 6 marks, AO3 1b 6 marks)
	0	No rewardable material
Level 1	1–3	• Superficial analysis of the refinements made to designs through the development process with limited references to feedback made by others and consideration of materials, components and manufacturing techniques. • Limited and imbalanced evaluation of the refinements made to designs through the development process, which draw limited conclusions about the appropriateness of the final prototype in meeting the needs of the specification. • Superficial analysis of the designs and prototypes made by others, which considers a limited range of factors and makes superficial connections between elements of the design. • Limited and imbalanced evaluation of the design and prototypes made by others, which begins to inform their own design decisions.
Level 2	4-6	• Partially developed analysis of the refinements made to designs through the development process, supported by generally relevant references to feedback made by others and consideration of materials, components and manufacturing techniques. • Partially sound and partially balanced evaluation of the refinements made to designs through the development process, which is used to draw partially sound conclusions about the appropriateness of the final prototype in meeting the needs of the specification. • Partially developed analysis of the designs and prototypes made by others, which considers a generally relevant range of factors and makes partially developed connections between elements of the design. • Partially sound and partially balanced evaluation of the designs and prototypes made by others, which coherently informs their own design decisions.
Level 3	7-9	• Mostly developed analysis of the refinements made to designs throughout the development process, mostly relevant references to feedback made by others and consideration of materials, components and manufacturing techniques. • Sound and mostly balanced evaluation of the refinements made to designs through the development process, which is used to draw sound conclusions about the appropriateness of the final prototype in meeting the needs of the specification. • Mostly developed analysis of the designs and prototypes made by others, which considers a mostly relevant range of factors and makes mostly relevant connections between elements of the design. • Sound and mostly balanced evaluation of the designs and prototypes made by others, which effectively informs their own design decisions.
Level 4	10-12	• Comprehensively developed analysis of the refinements made to designs through the development process, pertinently supported by references to feedback made by others and consideration of materials, components and manufacturing techniques. • Perceptive and balanced evaluation of the refinements made to designs through the development process, which is used to draw perceptive conclusions about the appropriateness of the final prototype in meeting the needs of the specification. • Comprehensively developed analysis of the designs and prototypes made by others, which considers a comprehensive range of factors and makes comprehensive connections between elements of the design. • Perceptive and balanced evaluation of the designs and prototypes made by others, which is used perceptively to inform their own design decisions.

General guidance for the section

In this section candidaites are expected to provide evidence of continual review, evaluation and analysis throughout the process of developing the final idea. Evidence in this section is likely to include notes throughout the development and perhaps a summary page comparing the final idea to the specification but must include logical and effective communication that uses technical vocabulary and refer back to sustainability.
Credit for this section can also be found in the earlier design ideas section; as candidates will review their initial ideas by analysing their ideas against the specification and taking into account the opinions of others to inform the development.

Other evidence may also be found outside the development section as it is often more logically offered in one of the many iterative interventions throughout the whole project. Such as the analysis of the designs and prototypes made by others or the deconstruction of existing design ideas to inform their own design decisions.

Candidates should:

- Comprehensively develop an analysis of the refinements made to designs through the development process, pertinently supported by references to feedback made by others and consideration of materials, components and manufacturing techniques.

- Provide a perceptive and balanced evaluation of the refinements made to designs through the development process, which is used to draw perceptive conclusions about the appropriateness of the final prototype in meeting the needs of the specification.

- Comprehensively develop an analysis of the designs and prototypes made by others, which considers a comprehensive range of factors and makes comprehensive connections between elements of the design.

- Provide a perceptive and balanced evaluation of the designs and prototypes made by others, which is used perceptively to inform their own design decisions.

Candidates should be able to demonstrate high level skills throughout the development and at least 1-2 pages of formal review evaluating the initial and final idea.

To achieve higher marks in this section candidaites will need to:

Review is a key element of the iterative design process and can be demonstrated in all areas of the development of the design ideas and development that lead to the final idea.
Candidates need to show evidence of continually reviewing the initial ideas and throughout all development pages. Review can be added throughout the development in a variety of forms.

- *On all design pages to analyse and evaluate design elements as they progress*
- *Evaluation of existing designs and prototypes to inform design decisions*
- *A review of initial ideas making decisions for the development*
- *A Review of the final against the specification*

At each stage candidates should not be afraid to make decisions that make them re-think the solutions.
It is never too late to take a step backwards and make improvements as it all forms an iterative design process of continual improvement. As candidates evaluate against the specification they may find aspects that have been missed and need to be included.

It is important that designs are reviewed as they progress so that they can develop through an iterative process where a proposal can be made, evaluated, and continually improved.
This is a normal part of a continuous review and can be in the form of:

- *Personal comment from the candidate*
- *Feedback and discussion with the client*
- *Feedback from an expert*
- *Feedback from user groups*
- *Results of testing of materials, components, systems*
- *Present your ideas to a class group*

All reviews must be objective and relate back to the needs and wants identified in the design brief and the specification and communicated through logical and well-organised statements.

All reviews must be formative and guide the development and improve the future outcome and address the needs and wants of the client / user group.

Reviews may also ask more questions about the design and may require further research.
Such as identifying suitable materials, mechanisms or circuits to be used in the design.

When reviewing designs as they develop, think about:

- *Does it meet the specification or design brief.*
- *Does it fit the user (anthropometrics)*
- *Is it easy to use (ergonomics)*
- *Does it work and how does it work, mechanisms, movement,*
- *How could it be improved*
- *Is the construction appropriate to the material*
- *Justify the use of materials, strength, aesthetics, availability, sustainability*
- *What does mu client think*
- *How does it fulfil the safety aspects or any legislation?*
- *What are the results of the testing and how do they affect the development*
- *How does it meet the aesthetic requirements*

It is also good practice to formally compare each design back to the specification and take advice from the client / user group.

This can be in the form of a table but avoid the use of tick boxes or scores out of 10 as it is not suitable unless there is clarification on how the scores are awarded. Similarly, Yes/No decisions are not formative as there needs to be full justification of the decisions made. The quality of this review is dependent on the quality of the original specification. The review of the initial ideas should provide evidence and justification of why the design is to progress. A thorough review of initial ideas should include:

- *Use of the specification points to justify and evaluate how each design fulfils or does not meet the requirements.*
- *Use of client / user group feedback and discussion.*
- *Make conclusions about each design*
- *Make decisions on what designs or parts of each design need to be taken forward as there may be aspects of a number of designs that will make a successful idea. These positive could be highlighted.*

To review the final idea candidates need to compare the design back to your specification and take advice from the client / user group.

This can be in the form of a table but the use of tick boxes or scores out of 10 is not suitable unless there is clarification on how the scores are awarded. Similarly, Yes/No decisions are not formative as there needs to be full justification of the decisions made. The quality of this review is dependent on the quality of the original specification.

- *Use the specification points and justify how the final design meets the criteria.*
- *Use client feedback and discussion.*
- *Make conclusions and decisions on any final amendments that may need to be made before starting the manufacturing.*

Candidates should review the designs and prototypes made by others and considering a comprehensive range of factors to make comprehensive connections between elements of the design.

They should be used perceptively to inform their own design decisions in a number of ways.

- *Evaluate individual designs directly related to the design problem to establish key details about functionality, form or dimensions that will help throughout the design process.*
- *Investigate particular design styles or movements that may have been indicated by the client.*
- *Review and disassemble existing products or models to establish manufacturing techniques and material used to inform the construction decisions.*

Links to the NEA exemplar

More detailed guidance on how to achieve the higher levels including moderator comments, definitions and activities are included in the NEA exemplar.

Part 2(e): Designing a Prototype

8. Communication of ideas

Content	Skills and Evidence
a) Selection and skill in the use of traditional/manual graphical, digital techniques (CAD), written techniques to communicate designs.	**Select** and **use** communication techniques - Consider different communication techniques and make considered choices about which are most fit for purpose based on their ability to clearly and accurately convey design information and related factors. Demonstrate an ability to use the selected communication techniques accurately in order to effectively communicate all aspects of design proposals. Evidence to support the marks awarded in this section will be found in both the development of design ideas and the final design solution sections of the portfolio. Notes and annotations should provide sufficient information to enable others to interpret their design intentions.

Grid 8

Level	Mark	Communication of design ideas (AO2 6 marks)
	0	No rewardable material
Level 1	1–2	• Basic selection and appropriate use of traditional/manual graphical techniques to communicate design proposals. • Basic selection and appropriate use of computer-aided design (CAD) techniques to communicate design proposals. • Basic selection and appropriate use of written techniques to communicate design proposals.
Level 2	3–4	• Considered selection and effective use of traditional/manual graphical techniques to communicate design proposals. • Considered selection and effective use of computer-aided design (CAD) techniques to communicate design proposals. • Considered selection and effective use of written techniques to communicate design proposals.
Level 3	5–6	• Perceptive selection and accomplished use of traditional/manual graphical techniques to communicate design proposals. • Perceptive selection and accomplished use of computer-aided design (CAD) techniques to communicate design proposals. • Perceptive selection and accomplished use of written techniques to communicate design proposals.

General guidance for the section

In this section candidaites are expected to demonstrate a range of presentation techniques to communicate your design proposals. There should be a clear flow through the design process with the use of traditional and modern techniques to give a clear understanding of the design. This will include any notes and annotations that provide information to enable others to interpret the designing. The evidence for this marking grid can be extracted from any design or development activity.
Candidates should:

- Demonstrate a perceptive selection and accomplished use of traditional/manual graphical techniques to communicate design proposals.

- Demonstrate a perceptive selection and accomplished use of computer-aided design (CAD) techniques to communicate design proposals.

- Demonstrate a perceptive selection and accomplished use of written techniques to communicate design proposals.

Candidates should be able to demonstrate high level skills throughout the design ideas and development section and marks are not awarded for specific pages.

To achieve higher marks in this section candidaites will need to:

To demonstrate a sophisticated selection and use of design strategies to inform decisions.
There are not a set number of presentation techniques that would demonstrate a 'range'; but candidates should not rely on one approach as it may limit the understanding of the design ideas and access to higher marks. Presentation techniques should include the following techniques when communicating design proposals.

- *Traditional/manual graphical techniques.*
- *Computer-aided design (CAD) techniques.*
- *Written techniques.*

A range of presentation methods needs to be demonstrated.
These will vary a great deal and will depend on the strengths of the candidates but it is good to demonstrate a wide range that are selected to suit different needs and allow the client / examiner a clear understanding of the candidates' thoughts and ideas. This could include the use of.

Traditional/manual graphical techniques.

- Pictorial drawings (isometric, oblique, perspective, orthographic)
- Working drawings (1st or 3rd Angle Isometric) and schematics
- Part drawings or full designs
- Sections or cutaways to show inside of the product
- Thumbnail sketches.
- Freehand sketches in 2D and 3D,
- *Colour and shading using pencils or markers*
- Exploded drawings to show how parts locate or fit together
- Sub-systems to demonstrate construction or how a section operates.
- Use of models (2D or 3D, mechanical or electrical systems)
- Use of systems or schematic diagrams
- Cut and paste from other sources

Computer-aided design (CAD) techniques

- Computer-aided design (CAD) for parts of designs or whole designs.
- CAD rendering for life like projections
- Computer-aided working drawings.
- Computer-aided manufacture (CAM) to demonstrate construction or features
- Specialist CAD programmes to modelling such as PCB design, circuits, pneumatics and mechanical operation.
- Scanning images to develop
- Digital photography

Written techniques

- Annotation / labelling of ideas (use of arrows)
- Justification of the selection of materials or processes
- Feedback from client
- Specialist terms and technical vocabulary
- ICT techniques (word processing, spreadsheets, databases)
- Dimensioning

All of the above need to demonstrate a high degree of accuracy. ICT should be used appropriately.

For example, candidates should only spend time on complex rendered CAD images once design decisions have been made as it is a better use of time.

Modelling techniques is an important element of design and will enable candidates to test out principles, trial ideas, work out construction or make visual judgements.

These must be recorded as digital photographs so the work is credited.

Written annotation should be accurate and succinct as the graphics should be giving the bulk of the information.
There should be a flow to the work as the designs develop.

Annotation should explain design details and follow a logical order.
Technical information and specialist terms should be used so that all design thinking is understood and manufacturing intentions are understood. Each page should have enough information so that a third party would understand the ideas from looking at the pages alone. When annotating try to:

- *Explain how it meets the specification or design brief.*
- *Explain how it fit the user (anthropometrics)*
- *Explain how is it made easy to use (ergonomics)*
- *Explain how it works and achieve the functional requirements?*
- *Explain how it could be improved?*
- *Explain how it can be constructed?*
- *Justify the use of materials, strength, aesthetics, availability, sustainability*
- *Explain how it fulfils the safety aspects or any legislation?*
- *Describe the results of the testing and how do they affect the development*
- *Explain how it meets the aesthetic requirements*
- *Identify ideas that are being taken forward*
- *Explain how it is sustainable, environmentally friendly*

Links to the NEA exemplar

More detailed guidance on how to achieve the higher levels including moderator comments, definitions and activities are included in the NEA exemplar.

Part 3: Making a final prototype

9 & 10. Tools and Equipment

Content	Skills and Evidence
a) Production of a high-quality prototype that is appropriate to an advanced level of demand, meeting the requirements of the design specification. b) Selection and technical skill in application of material, range of tools, techniques, fixtures, components and finishes used in the manufacture of the final prototype. c) Demonstration of safe working practice, including for self and others with whom they may be working. d) Demonstration of an iterative approach to the manufacture of the final prototype. e) Measuring, determining, and applying of the degree of accuracy and precision required for prototypes to perform as intended.	**Select** materials, fixtures, components and fittings – Consider different options for materials, fixtures, components and fittings that can be used and make considered choices about which are most fit for purpose based on their ability to produce a prototype that is functional and meets the requirements of the client/end user and specification. **Demonstrate understanding** of material properties, the requirements of the client/end user, and the intended purpose of the prototype - show an ability to select and apply knowledge of relevant material properties, client/end user requirements and the intended purpose of the prototype through the making of a functional prototype which meets all requirements set out. **Use tools, equipment and techniques** – Carry out required operations using selected tools and equipment and techniques for the manufacture of the final prototype, applying the required accuracy to ensure it performs as intended. **Demonstrate understanding** of the need for dimensional and geometric accuracy - show an ability to select and apply accurate making techniques in order to demonstrate an understanding of the importance of accuracy in the production of a final prototype **Demonstrate** safe working practices – document the ways in which the tools, equipment, processes and techniques used during the making of prototypes were used with regard for the safety of self and others, showing control measures used to reduce hazards and risk. **Demonstrate making skills** in the production of a functional prototype – show an ability to accurately apply appropriate making processes and techniques in relation to the complexity of design problem **Produce** a functional prototype – present and fully document the physicality and functionality of a completed prototype showing how it addresses the client/end user needs and requirements of the design specification **Apply** an iterative approach to manufacture - employ a process of planning, experimenting, making, testing and reviewing, including use of input from client/end, to inform decision making, make improvements and refine prototypes at each stage of manufacture.
	As evidence of the quality of candidates' making skills (and the level of demand of their work), it is important that key stages of the manufacturing process are photographed in order to demonstrate that the prototype is an appropriate working solution to the identified client/end user needs, wants and values and is sufficiently developed to be tested and evaluated (for example, full sized products, scaled working models or functioning systems). Photographic evidence should also demonstrate that the final prototype is fit for purpose and in addition to being a working solution; addresses the needs, wants and values of the client/end user and is successful in meeting the criteria of the specification. Amendments to the final outcome are documented appropriately and are likely to be found in the evaluation section, they should include those made in consultation with the client/end user. Risk assessments should be appropriately evidenced in the portfolio of work.

9. Tools & Equipment

Level	Mark	Tools and equipment (AO2 12 marks)
	0	No rewardable material
Level 1	1–3	• Basic selection of materials, fixtures, components and fittings some of which are appropriate for the final prototype, showing a limited understanding of the intended purpose of the prototype. • Limited use of tools and equipment to prepare materials for the manufacture of the prototype, showing a limited understanding of the need for dimensional accuracy. • Demonstrate a generally adequate degree of safe working practice for self and others.
Level 2	4–6	• Adequate selection of materials, fixtures, components and fittings which are generally appropriate for the final prototype, showing a partially sound understanding of the requirements of the end user and the intended purpose of the prototype. • Some skilful use of tools, equipment and techniques to prepare materials for the manufacture of the prototype, showing a generally sound understanding of the need for dimensional or geometric accuracy. • Demonstrate a fully adequate degree of safe working practice for self and others.
Level 3	7-9	• Mostly sophisticated selection of materials, fixtures, components and fittings which are mostly appropriate for the final prototype, showing a sound understanding of the requirements of the end user and the intended purpose of the prototype. • Mostly Skilful use of tools, equipment and techniques to prepare materials for the manufacture of the prototype, showing a sound understanding of the need for dimensional or geometric accuracy. • Demonstrate a generally high degree of safe working practice for self and others.
Level 4	10–12	• Sophisticated selection of materials, fixtures, components and fittings which are fully appropriate for the final prototype, showing an in-depth understanding of material properties, the requirements of the end user, and the intended purpose of the prototype. • Accomplished use of tools, equipment and techniques to prepare materials for the manufacture of the prototype, showing an in-depth understanding of the need for dimensional and geometric accuracy. • Demonstrate a consistently high degree of safe working practice for self and others.

General guidance for the section

In this section candidates are expected to demonstrate a range of accomplished making skills at and advanced level standard in relation to a sophisticated design problem. The level of demand, range of skills and complexity in the production of a high-quality fully functioning prototype that meets the end user needs and wants but also provides a suitable level of challenge that is higher than both GCSE or AS level qualifications.

The skills should be demanding and used with skill and accuracy to produce a prototype that fully meets the design specification and be capable of being tested and evaluated in the final section.

Candidates should show:

- A sophisticated selection of materials, fixtures, components and fittings which are fully appropriate for the final prototype, showing an in- depth understanding of material properties, the requirements of the end user, and the intended purpose of the prototype.

- Accomplished use of tools, equipment and techniques to prepare materials for the manufacture of the prototype, showing an in-depth understanding of the need for dimensional and geometric accuracy.

- A consistently high degree of safe working practice for self and others.
- A sophisticated application of an iterative approach to manufacture to produce a prototype showing how candidates adapt/extend their making to solve problems as they arise.

- Provide evidence of the selection of tools and techniques.

- Photographic evidence of candidates working on the production of the prototype and documented evidence of the selection of materials, fixtures, components, tools and manufacturing techniques.

Candidates should be able to demonstrate high level skills throughout the design ideas and development section and evidenced in the photographic diary in approximately 3-4 sides of A3 paper (or electronic equivalent).

NB. It is important that candidates manufacture a final prototype that demonstrates a range of accomplished skills with a high degree of accuracy and complexity that are at **Advanced Level.**

To achieve higher marks in this section candidaites will need to:

- Follow the manufacturing specification candidates have produced in grid 6 which details the stages or sequence of operations to manufacture the prototype.

- Provide photographic evidence demonstrating the full range of manufacturing techniques used in the construction of the prototype. Candidates should keep a photographic diary that will help the examiner see where the candidate is reaching the required standard in making the final prototype. Photographs should capture that it is the candidates work and show:

    - Safe working procedures
    - Marking out with dimensional and graphical accuracy
    - Demonstrate a range of different manufacturing skills appropriate to the level of demand with skill and accuracy
    - Demonstrate a range of different manufacturing skills appropriate to the materials used with skill and accuracy
    - Appropriate quality control procedures, with the use of jigs, templates patterns etc.

- Provide photographic evidence that includes annotation to explain the stage, process, materials used, CAM, Safety, sustainability aspects, and finishes applied.

- Evidence to justify the use of the materials in the actual manufacture of the prototype and the way that materials are economically used, processed, joined and finished. This sophisticated selection of materials could already have been evidenced throughout the design section, through testing and modelling and in the planning pages.

- Demonstrate that safety has a high priority throughout the making. Plans should provide evidence of risk assessments and what procedures have been put in place to minimise the risks or what alternative manufacturing methods have been used. Photographs should clearly show safe working practices and procedures for the individuals and others working in the environment.

- Provide evidence that demonstrates the candidate's ability to use a wide range of tools and equipment and processes that are demanding and show high-level making skills. This should be in the form of photographic evidence.

- It is important that candidates consider the construction throughout the portfolio so that the design proposal has a suitable level of challenge and complexity that will require a range of demanding skills.

- Well made products that contain undemanding skills or too many repeatable skills will make it difficult to fulfil the requirements of the higher marking criteria.
- Make sure the manufacturing skills are appropriate to the manufacture of the prototype with suitable process and they are achievable to the candidate's skill levels.

- Where Computer Aided Manufacture (CAM) is used in the construction of the prototype it should not form the majority of the manufacturing techniques if there is not a sufficient level of complexity. Candidates need to ensure that the majority of the construction demonstrates the use of a range of hand tools and workshop machinery to demonstrate a wide range of skills.

- The construction is predominantly a one off construction but if the there are repeatable processes or components, candidates need to demonstrate skills that leads to repeatable accuracy by using jigs, templates, patterns etc. or methods to make identical parts such as CAM.

10. Tools & Equipment

Level	Mark	Quality and accuracy (AO2 18 marks)
	0	No rewardable material
Level 1	1–4	• Produce a prototype that demonstrates mostly adequate making skills in relation to a basic design problem. • Produce a partly functioning prototype which matches the end user needs. • Produce a prototype that superficially meets the design specification. • Basic application of an iterative approach to manufacture and to produce a prototype.
Level 2	5–9	• Produce a prototype that demonstrates some skilful making skills at an advanced level in relation to a partially effective design problem • Produce a generally functioning prototype which matches the end user needs. • Produce a prototype that partially meets the design specification. • Considered application of an iterative approach to manufacture to produce a prototype.
Level 3	10–14	• Produce a prototype that demonstrates skilful making skills at an advanced level in relation to an effective design problem. • Produce a mostly functional prototype which matches the end user needs. • Produce a prototype that mostly meets the design specification. • Accomplished application of an iterative approach to manufacture to produce a prototype.
Level 4	15–18	• Produce a prototype that demonstrates accomplished making skills at an advanced level in relation to a sophisticated design problem • Produce a fully functional prototype which matches the end user needs. • Produce a prototype that fully meets the design specification. • Sophisticated application of an iterative approach to manufacture to produce a prototype.

General guidance for the section

In this section candidates are expected to demonstrate a high level making skills that demonstrate accuracy leading to a quality prototype that is fully functioning prototype that meets the end user needs identified in the specification. Amendments to the design that have changed through the iterative process of manufacture and refining need to be documented.

Evidence in this section will be photographic evidence of candidates working on the production and the annotation of these photographs.
Candidates should:

- Produce a prototype that demonstrates accomplished making skills at an advanced level in relation to a sophisticated design problem.
- Produce a fully functional prototype which matches the end user needs that can be tested and evaluated.

- Produce a prototype that fully meets the design specification.
- Demonstrate a sophisticated application of an iterative approach to manufacture to produce a prototype.

NB. It is important that candidates manufacture a final prototype that demonstrates a range of accomplished skills with a high degree of accuracy and complexity that are at **Advanced Level.**

To achieve higher marks in this section candidaites will need to:

- Provided photographic evidence that shows where quality and accuracy is demonstrated throughout the manufacturing of the prototype. Photographs should capture that it is the candidates work and show:

    - *Marking out with dimensional and graphical accuracy*
    - *Fitting of parts and components*
    - *Quality of joints, construction, finished etc.*
    - *Appropriate quality control procedures, with the use of jigs, templates patterns etc.*
    - *The choice of material has enabled higher quality*

- Provide photographic evidence that includes annotation to clearly explain where the prototype is expertly made using advanced skills to a high level of difficulty and complexity. They should show quality and accuracy in a well finished and fully functioning prototype.

- Take photographs at every stage and then present them in a form of photo diary. Candidates should take photos on digital cameras or mobile phones in every session and these will provide a full series of pictures that can then be filtered at a later date. It is important that photos are taken throughout as these cannot be taken later.

- Use of quality control procedures is very important in this section to ensure accuracy in manufacture eliminate faults so that there is a quality prototype. Provide evidence of:

    - *Where the quality checks have been made*
    - *The level of tolerance with dimensions and marking out*
    - *Checks on tools and equipment*
    - *Use of Jigs, templates, patterns, formers, guides*
    - *Testing prior to assembly*

- Provide photographic evidence to demonstrate quality and accuracy throughout the construction but they also needs to be used to demonstrate how the prototype is fit for purpose, fully functioning and meets the needs, wants and values of the client and successfully meets the criteria of the specification.

Links to the NEA exemplar

Part 4: Evaluating own design and prototype

11. Testing and Evaluating

Content	Skills and Evidence
a) An analysis of the prototype is performed that includes testing against the specification. b) Evaluation of the prototype in meeting the needs, wants and values of the client/end user and specification. c) An analysis and evaluation of the impact on the environment, including life-cycle analysis of the final prototype.	**Analyse** the final prototype - break down or deconstruct the refinements made to the final prototype during the design and manufacturing process, with reasoned consideration and investigation of a range of factors including materials and/or components, processes, techniques, aesthetics and contextual/historical influences supported by reference to feedback, the design specification, and testing against measurable criteria. **Evaluate** the final prototype - critically review information gained from analysis of the final manufactured prototype, including strengths, weaknesses and all relevant information, taking into account the effectiveness of the iterative process during manufacture and the intended purpose of the prototype, drawing balanced and supported conclusions. **Analyse** the potential impacts of the prototype - break down or deconstruct the potential social, moral, ethical and environmental impacts of the prototype with reasoned consideration and investigation of a range of factors including impact of materials and manufacturing processes, supported by reference to feedback, the design specification, and testing against measurable criteria **Evaluate** the potential impacts of the prototype - critically review information gained from analysis of the potential social, moral, ethical and environmental impacts of the prototype, including strengths, weaknesses and all relevant information, drawing balanced and supported conclusions. Annotated photographs, written responses or represented data related to market research/field trials as evidence of testing undertaken. There should be evidence of analysis and evaluation of wider issues in design and technology including social, moral, ethical and environmental impacts. Tests should be objective and carried out by the client/end user to gather third-party feedback. There should be evidence of client/end user interaction with the final prototype.

Grid 11

Level	Mark	Testing and evaluation (AO3 1a 3 marks, AO3 1b 3 marks, AO3 2a 3 marks, AO3 2b 3 marks)
	0	No rewardable material
Level 1	1–4	• Superficial analysis of the final prototype, taking into account refinements implemented during the development and manufacturing process and the client/end user specification, showing a limited approach to testing against measurable criteria. • Limited evaluation of the prototype, taking into account the iterative design process and the intended purpose of the prototype, drawing imbalanced conclusions from testing. • Superficial analysis of the social, moral, ethical and environmental impact of materials and manufacturing processes of the prototype • Limited evaluation o of the social, moral, ethical and environmental impact of the prototype.
Level 2	5–8	• Developed analysis of the prototype, taking into account refinements implemented during the development and the client/end user specification, showing a sound approach to testing against measurable criteria. • Sound evaluation of the prototype, taking into account the iterative design process and the intended purpose of the prototype, drawing mostly balanced conclusions from testing against measurable criteria. • Developed analysis of the social, moral, ethical and environmental impact of materials and manufacturing processes of the prototype • Sound evaluation of the social, moral, ethical and environmental impact of the prototype.
Level 3	9–12	• Comprehensively developed analysis of the prototype, taking into account refinements implemented during the development and the client/end user specification, showing a perceptive approach to testing against most measurable criteria. • Perceptive evaluation of the prototype, taking into account the iterative design process and the intended purpose of the prototype, drawing balanced conclusions from testing against measureable criteria. • Comprehensively developed analysis of the social, moral, ethical and environmental impact of materials and manufacturing processes of the prototype • Perceptive evaluation of the social, moral, ethical and environmental impact of the prototype.

General guidance for the section

In this section candidaites are expected to make a full and thorough analysis and evaluation of the finished prototype by comparing back to the needs and wants of the end user set out in the design brief and testing against most aspects of the specification in section 3. Evidence in this section is likely to include annotated photographic evidence of testing and of the finished prototype. There needs to be written responses and documented

evidence of testing and justification of how the finished design meets the specification criteria. A life-cycle analysis and a critical evaluation of the social, moral and ethical impacts should be carried out.

Candidates should show:

- A comprehensively developed analysis / evaluation / testing of the prototype, (taking into account refinements and iterations implemented during the development) against:
-
  - The needs and wants of the client
  - A comprehensive range of the specification points including those which are realistic, technical and measurable in relation to a sophisticated design problem
  - The intended purpose of the prototype.

- A comprehensively developed analysis / evaluation of the social, moral and ethical impact of materials and manufacturing processes.

- A comprehensively developed analysis / evaluation of the impact on the environment including life-cycle analysis of the final prototype.

Candidates should be able to demonstrate high level skills in approximately 3-4 sides of A3 paper (or electronic equivalent)

To achieve higher marks in this section candidaites will need to:

- Candidates should analyse the specification to decide on the areas of the specification that need to be evaluated and develop a range of tests to present evidence that the final outcome is fit for purpose and fulfils the needs, wants and values of the end user. Testing could include.

  - *Performance aspects of the prototype, such as measurable factor, materials, mechanisms*
  - *Functional aspects related to the specification*
  - *Strength or dimensional aspects of the prototype*
  - *The overall look of the finished prototype*
  - *Use / interaction by the client*
  - *Questionnaire / interview with client*
  - *Fitness for purpose*
  - *Ease of manufacture*
  - *Aftercare*
  - *Quality*
  - *Relevant British Standards*

- A key element of this section is the photographic evidence. Candidates are advised to provide photographic evidence on the tests that are carried out with annotation to explain the notable areas of the testing, which may include.

- Candidates need to use the specification developed in section 3 to provide a full evaluation against most points. This should include a justification of why the points have been met, exceeded or have fallen short of the stated specification point. Remember, specification points may have been drawn from any of the areas below.

    - Purpose / Function
    - Form
    - Ease of use (Ergonomics)
    - Sizes (Anthropometrics)
    - Location
    - Sustainability
    - Budget
    - Safety
    - Materials
    - Performance requirements
    - User requirements
    - Material and component requirements
    - The scale of manufacture
    - Quality assurance / control, including tolerances
    - Life expectancy
    - Maintenance
    - British standards
    - Cultural, social and ethical issues
    - Components and construction methods

- Candidates should gather feedback from the client / user group or other third party feedback such as experts, teachers, and peers to give an objective evaluation of the intended purpose of the prototype as this will provide a range of opinions.

- Candidates need to document any deviation from the production plan and justify the reasons why changes have been made in the manufacture and how they have improved the final prototype. These may be unforeseen problems that occurred such as availability of materials, strength considerations, consultation from the client.

- Candidates need to analyse the potential impact and evaluate the impact of their prototype on the environment. An effective way of doing this is to complete a life cycle analysis of the final prototype.

A life-cycle analysis is a systematic inventory that assesses all environmental impacts related to every stage of a products life from 'cradle to grave'. Candidates need to evaluate all the costs of their prototype, including:

- *Extraction, transportation and processing of the raw materials*
- *Manufacture of the prototype*
- *The transportation or distribution of the product,*
- *The use of the product by the consumer including repair and maintenance*
- *Disposal or recovery of the product at the end of its useful life.*

By carrying out a life-cycle analysis they can easily identify what areas can be changed to improve the costs and the environmental impact.

- Candidates need to analyse the potential impact and evaluate the impact of their prototype on the potential social, moral or ethical impacts.

- After testing, evaluation and life-cycle analysis has been carried out, candidates will be in a position to make objective conclusions about the success or shortcomings of the final prototype and make suggestions about how and if the prototype could be improved. Suggestions for improvement could be based on aesthetics, manufacturing, design features, technical aspects, simplifying the design or its overall fitness for purpose.

Links to the NEA exemplar

More detailed guidance on how to achieve the higher levels including moderator comments, definitions and activities are included in the NEA exemplar.