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Engineering and Manufacturing Technologies

all you need to know.

# Sample Portfolio

## NCFE Level 2 Certificate in Engineering Studies (601/4532/8)

## Unit 01 Introduction to engineering (J/506/3765)

Issue 1 December 2015

ncfe.

# Contents

# Introduction

The material within this portfolio relates to:

Unit 01 Introduction to engineering (J/506/3765)

This portfolio is designed to demonstrate the types of evidence that could be produced for Unit 01 of the NCFE Level 2 Certificate in Engineering Studies. It's designed to provide guidance on how a portfolio could look, rather than being prescriptive.

Evidence may be submitted in a variety of forms. In this example there are written accounts and visual evidence, but the evidence could also be presented in an audio format. Where the learner has provided visual evidence (for example screen grabs, copies of research), this has been clearly annotated to give context as to why it has been included. Each piece of evidence has been presented with the assessment criteria number shown at the top of the page.

This portfolio contains manufactured evidence produced by NCFE. External Moderator guidance has been provided for each piece of evidence relating to an assessment criterion. The guidance comments on how the evidence meets the assessment criterion and what could be improved to obtain a higher grade.

The suggestions and assessment methods are not exhaustive and Teachers are encouraged to explore other methods which will support the learner to produce the best evidence that they're capable of for the unit. For further advice on the suitability of a particular assessment method, you can refer to the relevant qualification specification or contact your NCFE External Moderator.

It's strongly recommended that each unit is presented and assessed individually to allow accurate judgements about the learner's competence. This will also make it easier to award a grade for the unit. The work must then be internally moderated and made available for the External Moderator. It's accepted that a piece of evidence may be presented for more than one unit. Where this is the case, the evidence must be clearly mapped to all units and assessment criteria it applies to when presented to the External Moderator. This will enable them to make an accurate judgement about the learner's competence and overall unit grade. We would encourage the use of our Evidence and Grading Tracker document which is available on our website www.ncfe.org.uk, however any method which clearly records the evidence against the assesment criteria can be used.

# Learner evidence and external moderator commentary

## Unit 01 Introduction to engineering (J/506/3765)

**Assessment criterion:**

1.1 Explain the term 'engineering'

**Learner evidence:**

Task 1 (1.1)

Engineering is concerned with a product or process that has to be constructed or engineered from raw materials to produce the final result. This covers its design, construction, development, machining and maintenance. Engineering covers engines, machines and large scale structures. This often involves the use of machining to change the shape of materials by turning, milling or grinding. Typical examples of engineering are often named after the type of work that they cover.

Marine engineering covers work that is connected with water for example boat building or maintenance. Civil Engineering covers engineering on roads, railways and infrastructure. Mechanical Engineering includes pipework, machines, factories and production processes. Electrical Engineering includes electronics and the use of electricity to make things operate. There are other specialist areas of engineering such as nuclear and biological.

## Unit 01 Introduction to engineering (J/506/3765)

**Assessment criterion:**

1.1 Explain the term ‘engineering’

**External Moderator commentary:**

The term has been thoroughly explained.

Grade awarded for this assessment criterion - Distinction

## Unit 01 Introduction to engineering (J/506/3765)

**Assessment criterion:**

1.2 Describe different engineering sectors

**Learner evidence:**

Task 2 (1.2)

I am going to examine the following engineering sectors

- Marine
- Mechanical
- Civil

Marine Engineering

This covers engineering on or below water. Boat building, construction and maintenance are the main types of work that this sector covers. Diesel marine engines have to be designed and built to operate the worlds ships in transporting goods around the globe. Engines have to be serviced and maintained as well as the boats to make sure that they work efficiently and safely. Boats are often put into a 'dry dock' where they can be taken out of the water to be worked upon.

Mechanical Engineering

This covers machines and equipment such as pipework, manufacturing of engineered products, structural steel fabrication and other large work involving metals. Mechanical engineering machines include anything with a moving part within it. Early mechanical engineering was developed with the design, operation and maintenance of the steam engine that was used to drive a manufacturing process and then a train.

Civil Engineering

This covers heavy engineering to the construction of harbours, roads, motorways, bridges, reservoirs, tunnels and drainage and any large concrete constructed works. Civil engineering is connected with the construction of structures not machinery. Large concrete pours in civil engineering are used to form structures such as dam walls, retaining walls and the lining of tunnels through mountains, under rivers and the tube line in London.

## Unit 01 Introduction to engineering (J/506/3765)

**Assessment criterion:**

1.2 Describe different engineering sectors

**External Moderator commentary:**

The learner has described 3 sectors well, providing detailed descriptions of each.

In order to achieve a Distinction they would need to describe more sectors and there would need to be more information on each of the engineering disciplines, encompassing a broader overall picture of each sector of engineering. Sectors could include: automotive, electrical, electronic, robotics.

Grade awarded for this assessment criterion – Merit

## Unit 01 Introduction to engineering (J/506/3765)

**Assessment criterion:**

1.3 Describe the skills and qualities needed to become an engineer

**Learner evidence:**

Task 3 (1.3)

You need to be passionate about machinery, taking it apart and studying how it works. This motivates you in becoming an engineer and finding out how machines work fascinating. You need to be good at mathematics as engineers use this when they are designing their machines and structures. You need to be accurate and methodical as an engineer. The skills needed are being able to record, draw and communicate designs to others and be able to manage projects on time and to budget. Engineers are driven people with a passion for pushing the boundaries further for example Brunel. Skills needed are:

- accuracy in your workings and calculations
- mathematics in understanding engineering science
- communication in drawing and writing down your ideas
- friendly and approachable in getting things achieved
- be able to find solutions quickly
- have investigation skills in finding out what is wrong.

All of the above will make you a very good engineer.

## Unit 01 Introduction to engineering (J/506/3765)

**Assessment criterion:**

1.3 Describe the skills and qualities needed to become an engineer

**External Moderator commentary:**

The learner has achieved a Merit by evidencing critical understanding of the skills and qualities required to be an engineer. They have described the skills needed, supported by examples.

To achieve a Distinction they would need to expand their descriptions, showing critical judgement by describing the relevance of the skills and using examples to show how those skills are applied in a practical situation.

Grade awarded for this assessment criterion - Merit

## Unit 01 Introduction to engineering (J/506/3765)

### Assessment criterion:

1.4 Assess the importance of health and safety in a chosen engineering environment

**Learner evidence:**

Task 4 (1.4)
The engineering environment I have chosen is mechanical engineering within a machine workshop. There are a number of hazards in such an environment. These are:

- drilling – where swarf and entrapment can occur
- milling – where swarf can ensnare
- grinding – flying particles
- turning – entrapment
- welding – hot working.

Health and safety is therefore vitally important for these operations. The use of a risk assessment has to be in place to warn all employees about the hazards of working in a mechanical workshop. These have control measures to reduce the risks from the hazards. PPE must be worn as part of a safe system of working. Working at height while fabricating is also a risk when working off scaffolding. A health and safety policy has to be written if the environment contains 5 or more employees and an induction to the workshop ensures all know about health and safety. The HSWA 1974 ensures that an employer takes care of all the machines to ensure that they are safe to use and the workshop is safe. Engineering can be a dangerous environment to work in often within confined spaces when putting things together and using equipment that can harm if not used properly. Health and safety is therefore essential for all to understand and use correctly in this workshop.

## Unit 01 Introduction to engineering (J/506/3765)

**Assessment criterion:**

**1.4** Assess the importance of health and safety in a chosen engineering environment

**External Moderator commentary:**

The learner has provided an assessment that details the importance of health and safety in a machine shop. Although some of the examples provided are not accurate to the process described, for example milling, they have assessed the overall importance of health and safety in the chosen environment.

To achieve a Merit the learner would need to be more specific about the hazards, for example sharp tools and injury, entrapment of overalls in moving machines, flying particles from disintegrating grinding wheels entering the eyes, burns and arc-eye from welding. This could be supported with a list of the safety equipment and control measures used to reduce the risk from these hazards.

There is no Distinction grade available for this assessment criterion.

Grade awarded for this assessment criterion - Pass

## Unit 01 Introduction to engineering (J/506/3765)

**Assessment criterion:**

2.1 Describe a range of engineering organisations and a product(s)/services(s) they provide

**Learner evidence:**

Task 5 (2.1)

I have done some research and found the following engineering organisations:

1. The Institute of Mechanical Engineers
2. Haworth Castings Limited
3. Grayton Engineering
4. MRT Castings Limited

The Institute of Mechanical Engineers is the professional association for engineering. This provides a membership structure for its members who have to provide their qualifications in order to join. They educate and inform all members through activities and meetings. They provide professional registration for employers so they can attract the best people. They provide continuous professional development for their members and set a high standard for all to achieve. They are recognised across the world and give members the professional recognition that membership brings. Members who fully meet the membership rules can use IMechE after their name. This is the logo

Institution of MECHANICAL ENGINEERS

Improving the world through engineering

Haworth Castings are a UK company that specialises in the casting of aluminium parts for the engineering industry that are cast using sand moulding techniques. They make specialist aluminium lightweight parts for automotive engineering and other mechanical engineering operations. This business uses skilled operatives to produce precision castings using the sand moulding process.

Grayton Engineering is a specialist mechanical engineering company that provides engineering services to the cement, steel, chemical and petro chemical industries. They are specialists in the engineering of conveyors, pipework fabrication and installation, structural steelwork, tanks and ducting and servicing rotating equipment. They have a large workshop for fabrication of engineering components. They also fabricate duct work for air moving systems.

## Unit 01 Introduction to engineering (J/506/3765)

**Assessment criterion:**

2.1 Describe a range of engineering organisations and a product(s)/services(s) they provide

**External Moderator commentary:**

A range of engineering organisations are identified, meeting the Pass criteria. A detailed description is given for two of the organisations, meeting the Merit standards. The description on Haworth Castings does not add any detail or information that is not in the other organisations.

In order to achieve a Distinction each of the 3 descriptions needs to be more comprehensive in explaining the organization and the product or service they provide.

Grade awarded for this assessment criterion - Merit

## Unit 01 Introduction to engineering (J/506/3765)

**Assessment criterion:**

2.2 Compare manufacturing processes for the chosen engineering organisations

**Learner evidence:**

Task 6 (2.2)

I am going to compare the casting processes from MRT and Haworth which uses two different processes which are as follows

- Sand casting
- Die casting

The two processes produce the same product but are different in how they achieve this.

Sand Casting
Sand casting uses a process that involves firstly making a 'pattern'. This is a model of the finished engineered component. Patterns are produced to the accurate size required for the finished component. A sand box is used and a layer of sand placed in the bottom of the mould and compacted. The sand is a specialised casting sand that compacts and leaves an impression of the pattern in the sand. The pattern can either be dissolved out of the mould by the molten metal or the sand box made in two halves with the pattern split and removed then the sand boxes are reassembled. Hollow tubes are placed through the sand down into the casting in order to pour the molten metal down and then allow air to escape which would weaken the finished casting. Hot metal is melted within a specialist furnace and then carried and poured into the moulds. This is then allowed to set and cool then the sand box is tipped out the sand and vibrated off the casting. Excess metal is removed by cutting off the feed and the vent and feed tubes and grinding flat. Further machining can be undertaken to the finished casting.

Die Casting
This is a different process that does not use sand. A specialist die is formed in hardened steel that is the reverse image of the piece to be cast. This is made in two halves which separate. These are called dies. When the die is closed hot metal is poured into the die which is cooled to form a solid casting. When the die opens up the casting can be removed and further finishing processes completed. This is a mass manufacturing process which several hundreds of castings produced a day all identical to each other. The process is accurate and automated and is safer than the sand casting process as it can be better controlled. It is a faster process as no sand mould has to be built and a casting can be formed in minutes that is accurate and with a good quality standard of finish.

## Unit 01 Introduction to engineering (J/506/3765)

**Assessment criterion:**

2.2 Compare manufacturing processes for the chosen engineering organisations

**External Moderator commentary:**

The learner has achieved a Merit because the description compares the processes of 2 organisations in sufficient depth to show critical understanding, although there are some errors.

In order to achieve a Distinction the learner would need to demonstrate critical judgement by describing where the individual processes would be used and why.

Grade awarded for this assessment criterion - Merit

## Unit 01 Introduction to engineering (J/506/3765)

**Assessment criterion:**

2.3 Describe the advantages and disadvantages that the product(s)/service(s) has on society

**Learner evidence:**

Task 7 (2.3)

There are many advantages for our society in the UK for using die casting.

The benefits include the following:

- With aluminium products all of the waste materials can be recycled and used again.
- The die after its useful working life can be recycled.
- Employment opportunities with a local manufacturer or supplier.
- Environmental benefits in terms of saving energy and finite fuels.
- Multiple copies can be made that saves resources and makes the process efficient.

The disadvantages are:

- The emissions to air from the furnace melting of the aluminium.
- Dirt and noise from the processes involved.
- Transportation of the finished components by heavy goods vehicles causes other environmental issues.

## Unit 01 Introduction to engineering (J/506/3765)

**Assessment criterion:**

2.3 Describe the advantages and disadvantages that the product(s)/service(s) has on society

**External Moderator commentary:**

The learner has described the advantages and disadvantages of the product/service on society.

There is no critical judgement needed to achieve a Distinction. For example the offset of the amount of carbon emissions against the employment and prosperity that engineering projects bring to a community or more detail on the effect of the advantages and disadvantages on society.

Note the plurality of the verbs used within the assessment criterion where more than one product or service can be evidenced.

Grade awarded for this assessment criterion - Merit

## Unit 01 Introduction to engineering (J/506/3765)

**Assessment criteria**

3.1 Describe the use of science in engineering
3.2 Describe the use of technology in engineering
3.3 Describe the use of maths in engineering

**Learner evidence:**

Task 8 (3.1) (3.2) (3.3)

Science is very important in engineering. The science behind heat in terms of expansion during engineering processes has to be carefully considered and controlled especially in welding operations. The science behind metals and their properties is essential when designing and constructing an engine or machine. The resistance of a metal and its strength properties have to be considered so it won't fail during its life cycle.

The properties in terms of the science associated with tension, shear and compression have to be considered often along with the stress and strain of an engineered material. Structural steel has to resist bending and the science of bending moments has to be calculated by the engineer to ensure that a factor of safety is built into the final product.

Steel expands when it is warmed and so the details of how steel is connected is important to allow for such expansion and movement. Science allows us to find out how far a piece of steel will expand when it is warmed or contract when it is cooled. The science associated with welding steel together is also important. Some metals will not weld by this method and others will not join to a different metal.

Technology is now playing a very important part in engineering assembly. Robots are now welding and assembling engineering processes. Robotics is now an established part of engineering processes.

Computer aided design using CNC machines now allows a designer to upload their design onto a machine that will cut out the shape produced. The operator pushes a button and the whole process is automatically produced.

## Unit 01 Introduction to engineering (J/506/3765)

The use of 3D ink printing has enabled the engineer to print out an actual copy of their idea to see if it works in reality.

Source: http://www.covpress.com/facilities/facilities.php?id=3

Source: http://www.3dquickparts.com.au/rapid-prototype

Here a 3D print of the canopy to a football stadium has been used to check it works correctly.
3D virtual welding can now be used to training operatives in welding without actually using any hot welding materials or equipment.
3D laser scanners now allow precise measurements to be taken of an engineering survey prior to manufacturing a new structure.

## Unit 01 Introduction to engineering (J/506/3765)

Here is a 3D scanner been used to map a railway line so engineers can then plan a new junction or connection.


Source: http://www.severnpartnership.com/case_study_item/tamper-train-3d-modelling-2/#sthash.F3FBrppb.dpbs

## Unit 01 Introduction to engineering (J/506/3765)

**Assessment criterion:**

3.1 Describe the use of science in engineering

**External Moderator commentary:**

Although the learner has given a detailed answer they have not described the use of science in engineering.

They have provided examples of where science is used but there is no generic description. For example science is used in engineering to produce new materials, research new technologies etc. The examples provided would be good supporting evidence for this but do not meet the Pass grading descriptor on their own.

Grade awarded for this assessment criterion - Not Yet Achieved

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**Assessment criterion:**

3.2 Describe the use of technology in engineering

**External Moderator commentary:**

As with assessment criterion 3.1 the learner has given specific examples of how technology can be used rather than demonstrating clear understanding through an overall outline of its use. For example achieving efficiencies, trialling before use, modelling products before manufacture, manufacturing complex components, working in hazardous environments.

Grade awarded for this assessment criterion - Not Yet Achieved

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**Assessment criterion:**

3.3 Describe the use of maths in engineering

**External Moderator commentary:**

The learner has not provided any evidence for this assessment criterion.

Grade awarded for this assessment criterion - Not Yet Achieved

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# Evidence and Grading Tracker

## Unit 01 Introduction to engineering (J/506/3765)

A breakdown of the grades awarded for each assessment criterion within Unit 01 is shown below in this example of our completed Evidence and Grading Tracker, which is available on the qualifications page our website.

A Not Yet Achieved grade can be awarded for the unit as a whole.

The learner has not achieved a Pass grade for the unit because they did not achieve a Pass for assessment criteria 3.1, 3.2, 3.3.

The learner is entitled to one opportunity to resubmit work for the unit to obtain a higher grade.

| Assessment criteria | Not Yet Achieved | Pass | Merit | Distinction | Evidence (including portfolio page number and type) |
|---|---|---|---|---|---|
| **1.1 Explain the term 'engineering'** | | | | X | Task 1 page 4 |
| **1.2 Describe different engineering sectors** | | | X | | Task 2 page 6 |
| **1.3 Describe the skills and qualities needed to become an engineer** | | | X | | Task 3 page 8 |
| **1.4 Assess the importance of health and safety in a chosen engineering environment** | X | | | No Distinction grade for this AC | Task 4 page 10 |
| **2.1 Describe a range of engineering organisations and the product(s)/services(s) they provide** | | X | | | Task 5 page 12 |

| Assessment criteria | Not Yet Achieved | Pass | Merit | Distinction | Evidence (including portfolio page number and type) |
|---|---|---|---|---|---|
| **2.2 Compare manufacturing processes for the chosen engineering organisations** | | | X | | Task 6 page 14 |
| **2.3 Describe the advantages and disadvantages that the product(s)/service(s) has on society** | | | X | | Task 7 page 16 |
| **3.1 Describe the use of science in engineering** | X | | | | Task 8 page 18 |
| **3.2 Describe the use of technology in engineering** | X | | | | Task 8 page 18 |
| **3.3 Describe the use of maths in engineering** | X | | | | Task 8 page 18 |

# Summative feedback

**I confirm this is all my own work.**

Learner signature

Teacher/Assessor comments: (please continue overleaf if necessary)

Well done with this assessment, you have produced some good work, much of it at Merit or Distinction standard.

Remember to include both generic descriptions and specific examples in your answers, especially for the assessment criterion you have not yet achieved and to apply critical judgement where possible.

You have not yet provided any evidence for assessment criterion 3.3.

**I confirm I have graded this work against the grading descriptors for the qualification.**

**Overall unit grade:**

**Teacher/Assessor Name:**

**Signature:**

**Date:**