Criteria for the Diploma Qualifications in Manufacturing and Product Design at Levels 1, 2 and 3

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Contents

The criteria

Introduction

1. The purpose of this document is to record a full set of criteria for principal learning for the Diploma in Manufacturing and Product Design at levels 1, 2 and 3. This document should be read in conjunction with the Ofqual document *Criteria for Foundation, Higher and Advanced Diploma Qualifications* which defines the overarching criteria for all Diplomas at levels 1, 2 and 3.

2. All references to guided learning hours (GLH) within this document are for the purposes of ensuring that there is sufficient content specified at each level to enable the design of qualifications. GLH are not intended to indicate final unit sizes or design.

Aims

3. The general aims of the Diploma are identified in Section 2 of the document *Criteria for Foundation, Higher and Advanced Diploma Qualifications*. The Diploma in Manufacturing and Product Design is for all learners, and has particular relevance to learners who are 14–19 and who seek to acquire knowledge and develop skills in the broad context of manufacturing industries. The purpose of the Diploma in Manufacturing and Product Design at levels 1, 2 and 3 is to introduce learners to the world of manufacturing.

Themes

4. The Diploma in Manufacturing and Product Design is structured around the same three integrated themes at each level.

Theme A: Business and enterprise

5. Manufacturing is responsible for a large portion of the wealth generation in the global economy. This theme will introduce a range of business and enterprise activities to enable learners to gain practical experience of how the manufacturing industry works. In principal learning, learners will explore a range of business activities in manufacturing and consider the importance of these businesses to the local, national and global economies. Through specialist learning, they will be able to further develop their understanding of this theme.

Theme B: Product design and materials science

6. Future product development can only be successful with a deep knowledge of manufacturing technology. It is the combination of both design and science associated with materials and manufacturing principles that leads to innovation and the introduction of new products. The theme will consider all aspects of sustainable manufacturing. In principal learning, learners will explore the design of products for assembly and manufacturing. They will also learn how to investigate and test the properties and characteristics of materials, and develop an understanding of the scientific principles behind them (including new materials). Through specialist learning, learners will be able to further develop their understanding of the product design and development process and the properties, characteristics and scientific principles within a manufacturing sector.

Theme C: Production systems

7. This theme will look at implementation and improvement of manufacturing and processing techniques and the development of production methods for the manufacturing of a range of products. Central to the theme will be implementation of quality assurance and continuous improvement techniques. In principal learning, the focus will be on exploring and taking part in production; while in specialist learning the emphasis will be on developing understanding of production and processing within one or more manufacturing sectors.

Structure

Structure of Diplomas in Manufacturing and Product Design			
Level	*Foundation*	*Higher*	*Advanced*
Total GLH	600	800	1,080
Principal learning (GLH)	240	420	540
Generic learning (GLH)	240	200	180
Additional/specialist learning	120	180	360

Sectors

8. Within the following criteria the following words or phrases are used to indicate the breadth of learning and allow for learners to explore the manufacturing sector within their local area. An 'exemplar' – is used to indicate learning about an example of, for example, a product or manufacturing enterprise.

   A 'sub-sector' – is used to refer to the five main sub-sectors of manufacturing:

- food;
- apparel and textiles;
- processing;
- chemicals, polymers and pharmaceuticals;
- engineering materials.

Each sub-sector includes different types of manufacturing.

Foundation level

Summary of topic titles

Topic no.	Title	GLH
	Theme A: Business and enterprise	
1.1	Introduction to manufacturing	30
1.2	Dealing with customers and suppliers	30
1.3	Introduction to working practices	30
	Theme B: Product design and materials science	
1.4	Introduction to product design and development	60
1.5	Introduction to materials science	30
	Theme C: Production systems	
1.6	Manufacturing a product	60

Flexibility at level 1

Learners taking the level 1 Diploma in manufacturing and product design must take the following three topics.

- Topic 1.1 Introduction to manufacturing;
- Topic 1.3 Introduction to working practices;
- Topic 1.6 Manufacturing a product;

PLUS one of the following options:

- Topic 1.2 Dealing with customers and suppliers;
- Topic 1.5 Introduction to materials science;

OR:

- Topic 1.4 Introduction to product design and development.

Learners taking a level 1 Diploma in another line of learning may select any topic or topics that add up to 60 GLH.

Topic 1.1: Introduction to manufacturing (30 GLH)

Purpose

The purpose of this topic is to enable learners to understand:

- manufacturing as a business;
- the range of sub-sectors involved in manufacturing and the products they produce;
- how price, cost and competition affect manufacturing enterprises.

This topic links to:

- Topic 1.2 Dealing with customers and suppliers;
- Topic 1.3 Introduction to working practices.

Scope of content

Learners must know and understand:

a) what the main business processes used in a manufacturing business are;

b) what the main sub-sectors of manufacturing are and what products they typically produce;

c) why wealth creation is important to the company, community and employee;

d) what social, economic and environmental issues impact on an exemplar manufacturing business;

e) what general effects world trading has on the manufacturing industry in the UK;

f) how costs and prices affect the supply of materials and labour;

g) what different types of costs a manufacturing business must consider.

Learners must be able to:

a) use basic manufacturing terminology;

b) calculate simple costs (for example cost of materials and labour within product price, sales per month).

In order to engage with this topic effectively, learners must use the following personal, learning and thinking skills (PLTS):

- independent enquirers.

Topic 1.2: Dealing with customers and suppliers (30 GLH)

Purpose

The purpose of this topic is to enable learners to understand:

- why good customer service is important both within the manufacturing business and for its customers and suppliers;

- how employees can add value to a manufacturing business by what they do and how well they do it;
- how to provide efficient and effective customer service.

This topic is linked to:

- Topic 1.1 Introduction to manufacturing.

Scope of content

Learners must know and understand:

a) why internal and external customers and suppliers are important to a manufacturing business;

b) why and how to follow customer service procedures (for example communicating with customers, personal presentation and keeping accurate customer records);

c) what manufacturers and suppliers are legally and ethically required to do when selling products and why;

d) what legal rights external customers have;

e) what quality assurance is and why it is important for customer service.

Learners must be able to:

a) present themselves to customers and suppliers in an appropriate manner;

b) deal with customers and suppliers, following customer service procedures;

c) provide accurate information to customers and suppliers;

d) use an exemplar organisational database to look up and record information about customers and suppliers.

In order to engage with this topic effectively, learners must use the following PLTS:

- effective participators;
- team workers.

Topic 1.3: Introduction to working practices (30 GLH)

Purpose

The purpose of this topic is to enable learners to understand:

- the range of job roles involved in manufacturing and what they involve;
- the key laws that apply in the workplace;
- how to work independently and, when working as part of a team, participate effectively to produce a product.

This topic is linked to:

- Topic 1.1 Introduction to manufacturing;
- Topic 1.6 Manufacturing a product.

Scope of content

Learners must know and understand:

a) what departments and job roles can be found in different sized manufacturing businesses within a sub-sector;

b) what different job roles involve and how the work of different departments or teams link in a manufacturing business;

c) what responsibilities employers and employees have to each other;

d) why effective teamwork is important in manufacturing;

e) why health and safety and environmental laws must be followed;

f) why codes of conduct must be followed;

g) what the equality and diversity requirements are for manufacturing businesses.

Learners must be able to:

a) behave responsibly in a workplace;

b) carry out their own responsibilities and support others to meet targets;

c) contribute to identifying health and safety risks and meeting environmental requirements.

In order to engage with this topic effectively, learners must use the following PLTS:

- team workers;
- self-managers;
- reflective learners.

Topic 1.4: Introduction to product design and development (60 GLH)

Purpose

The purpose of this topic is to enable learners to understand:

- how customer and client needs influence the design of products and how they are specified;
- how products are designed and developed for manufacturing;
- how to analyse product designs, gather feedback from customers or clients and describe what products need to be like (product design specification).

This topic is linked to:

- Topic 1.5 Introduction to materials science;
- Topic 1.6 Manufacturing a product.

Scope of content

Learners must know and understand:

a) the features and intended benefits of exemplar manufactured products;

b) what a product design specification is for and how it is developed;

c) why product analysis is important to the design and development process;

d) how computer-aided design (CAD), and its relationship to computer-aided manufacture (CAM), has influenced design in manufacturing;

e) what issues manufacturers must consider in the design of a product for manufacture or assembly (for example legislation, costs, aesthetics, sustainability, customer or client needs);

f) how different materials are selected for exemplar products.

Learners must be able to:

a) carry out tests to analyse whether an exemplar product is suitable for the customer or client;

b) select suitable materials for product from a range of given materials;

c) draw up a exemplar product design specification for an exemplar product.

In order to engage with this topic effectively, learners must use the following PLTS:

- creative thinkers;
- independent enquirers.

Topic 1.5: Introduction to materials science (30 GLH)

Purpose

The purpose of this topic is to enable learners to understand:

- what testing techniques can be used to investigate the different basic chemical, biological and physical properties and characteristics of materials within a sub-sector;
- how to carry out simple tests safely on different raw materials and finished products.

This topic is linked to:

- Topic 1.4 Introduction to product design and development;
- Topic 1.6 Manufacturing a product.

Scope of content

Learners must know and understand:

a) what testing and measurement methods can be used to investigate the nature and composition of raw materials and finished products in a sub-sector;

b) what basic scientific theories can be understood from the testing methods used;

c) what the results of tests can be used for;

d) what health and safety laws apply to the measurement and testing of materials.

Learners must be able to:

a) carry out basic testing and measurement techniques on a range of different materials within a sub-sector;

b) follow appropriate health and safety guidelines;

c) record, present and store the results of investigations into the main properties, characteristics and uses of materials within a sub-sector.

In order to engage with this topic effectively, learners must use the following PLTS:

- independent enquirers;
- effective participators.

Topic 1.6: Manufacturing a product (60 GLH)

Purpose

The purpose of this topic is to enable learners to understand:

- how to follow standard operating procedures to manufacture a product to a given specification;
- how to contribute safely, efficiently and effectively to manufacturing a product;
- what laws and regulations apply to manufacturing a product.

This topic is linked to:

- Topic 1.3 Introduction to working practices;
- Topic 1.4 Introduction to product design and development;
- Topic 1.5 Introduction to materials science.

Scope of content

Learners must know and understand:

a) what processes and stages are involved in an exemplar manufacturing operation;

b) what properties and quantities of raw materials are required to make a finished product;

c) what plant and equipment is required to manufacture a product;

d) what legislation manufacturers must comply with in the production of a product;

e) why product design specifications are important and what can happen if they are not followed;

f) why it is important not to waste materials, time and other resources;

g) how computers and control systems are used in process operations;

h) what would change if a product were manufactured in different quantities.

Learners must be able to follow standard operating procedures when contributing to manufacturing a product, including:

a) gathering relevant materials;

b) calculating quantities of materials;

c) using appropriate tools and equipment;

d) checking quality and meeting production targets;

e) complying with health and safety guidelines.

In order to engage with this topic effectively, learners must use the following PLTS:

- team workers;
- effective participators.

Higher level

Summary of topic titles

Topic no.	Titles	GLH
	Theme A: Business and enterprise	
2.1	Running a manufacturing business	60
2.2	The global business world	60
2.3	Working in manufacturing	60
	Theme B: Product design and materials science	
2.4	Designing and developing products	60
2.5	Materials science	60
	Theme C: Production systems	
2.6	Processing systems	60
2.7	Product manufacture	60

Topic 2.1: Running a manufacturing business (60 GLH)

Purpose

The purpose of this topic is to enable learners to understand:

- how a manufacturing business is structured and how the different functions, roles and responsibilities work together to create a profitable and sustainable enterprise;
- why budgeting, cash flow and financial management are critical to business success;
- how to complete and interpret basic financial records (such as cash flow forecast, management accounts, cost–benefit and investment appraisal).

This topic is linked to:

- Topic 2.2 The global business world;
- Topic 2.3 Working in manufacturing.

Scope of content

Learners must know and understand:

a) how different sized manufacturing businesses are structured in terms of functions and roles and what effect this has on the way they operate;

b) what laws apply to manufacturing, who sets them and how they are enforced;

c) why budgets, cash flow and financial targets are important in a manufacturing enterprise;

d) the basic categories of costs and components of management accounts;

e) how costs vary in relation to the volume of production and the ways businesses increase income and decrease costs;

f) why it is important to calculate break-even points.

Learners must be able to:

a) use basic financial terms (for example profit, loss, cash flow, margins, VAT, return on investment);

b) enter data onto a financial spreadsheet;

c) interpret basic financial documents;

d) calculate and check the accuracy of basic costs and break-even figures.

In order to engage with this topic effectively, learners must use the following PLTS:

- independent enquirers;
- reflective learners.

Topic 2.2: The global business world (60 GLH)

Purpose

The purpose of this topic is to enable learners to understand:

- how manufacturing businesses balance often competing social, economic and environmental issues to ensure sustainability;
- how the global market impacts on products and marketing;
- the relationship between the customer, the business and their suppliers;
- how products are marketed and why the approach varies across different markets and products.

This topic is linked to:

- Topic 2.1 Running a manufacturing business;
- Topic 2.3 Working in manufacturing.

Scope of content

Learners must know and understand:

a) how manufacturing businesses balance often competing issues to ensure profitability within a sub-sector (for example by managing social, economic and environmental issues);

b) what general effects the world market economy and global trading has on manufacturing industry in the UK;

c) what the links are between the business processes relating to customers, suppliers, product development and delivery;

d) how marketing is used as a tool to promote different products in different markets.

Learners must be able to:

a) interpret basic statistical data about manufacturing;

b) present information about markets and customer needs;

c) analyse marketing approaches.

In order to engage with this topic effectively, learners must use the following PLTS:

- independent enquirers;
- creative thinkers.

Topic 2.3: Working in manufacturing (60 GLH)

Purpose

The purpose of this topic is to enable learners to understand:

- the responsibilities that employers and employees have to each other;
- how employees can contribute to the success of the company by their attitudes and behaviours;
- how to work as part of a team to contribute to different stages of the production process;
- the roles, functions, career and training opportunities in manufacturing.

This topic is linked to:

- Topic 2.1 Running a manufacturing business;
- Topic 2.2 The global business world.

Scope of content

Learners must know and understand:

a) what technical and administrative support roles are needed within a sub-sector;

b) what legal, social and ethical responsibilities are placed on employers and employees;

c) how equality and diversity requirements are put into practice in the workplace;

d) what the role of trade unions and employee groups is in manufacturing;

e) what legislation and rights apply to employees in manufacturing businesses;

f) how individuals' roles, responsibilities, behaviours and actions influence the achievement of team goals;

g) why efficient and effective team-working is important in manufacturing business;

h) what careers, pre-entry and on-the-job training are available within a manufacturing sub-sector.

Learners must be able to:

a) fulfil agreed responsibilities safely, effectively and efficiently and support others to meet their responsibilities;

b) use problem-solving techniques to find ways to meet team goals;

c) report issues or problems appropriately to a responsible person.

In order to engage with this topic effectively, learners must use the following PLTS:

- effective participators;
- reflective learners;
- team workers.

Topic 2.4: Designing and developing products (60 GLH)

Purpose

The purpose of this topic is to enable learners to understand:

- how the different stages of research and development add value to products and manufacturing processes;
- the range of factors that affect product design and development for manufacturing;

- how to draw up a product design specification based on product analysis, a client brief or customer research.

This topic is linked to:

- Topic 2.5 Materials science;
- Topic 2.7 Product manufacture.

Scope of content

Learners must know and understand:

a) the basic principles of good manufacturing design and development;

b) why research, design and development are important in manufacturing and what is involved;

c) what factors may affect the design and manufacture of a product (for example cost concern for the environment or new developments in materials);

d) how social, economic and sustainability factors are taken into account;

e) the development and design of a manufactured product (for example values and beliefs of others, sustainability, fair trade and human rights);

f) what the product design specification for a manufactured product includes and why it is needed.

Learners must be able to:

a) interpret a client brief or product research;

b) develop design ideas for a prototype, using CAD where appropriate;

c) draw up a simple product design specification for a manufactured product to meet a client brief or product research;

d) analyse whether the features and benefits of a designed product meet the client's needs.

In order to engage with this topic effectively, learners must use the following PLTS:

- independent enquirers;
- creative thinkers.

Topic 2.5: Materials science (60 GLH)

Purpose

The purpose of this topic is to enable learners to understand:

- how scientific, technical developments and the chemical, biological and physical properties and characteristics of materials affect the manufacture of products;
- how to test and process exemplar materials.

This topic is linked to:

- Topic 2.4 Designing and developing products.

Scope of content

Learners must know and understand:

a) what materials, scientific processes and principles are used to manufacture products within a sub-sector and increase productivity and sustainability;

b) what testing, analysis and measurement methods are used for a variety of materials;

c) how to investigate the chemical, biological and physical properties of materials within a subsector;

d) how laboratory activities for investigating materials differ from commercial activities.

Learners must be able to:

a) use scientific terminology, symbols and units;

b) prepare materials for investigation and perform tests in line with health and safety and organisational guidelines;

c) test, analyse and measure the main chemical, biological and physical properties of exemplar materials within a sub-sector;

d) record observations and measurements;

e) analyse results and draw conclusions.

In order to engage with this topic effectively, learners must use the following PLTS:

- independent enquirers;
- self-managers;
- reflective learners;
- effective participators.

Topic 2.6: Processing systems (60 GLH)

Purpose

The purpose of this topic is to enable learners to understand:

- what manufacturing processes and systems are used by an exemplar manufacturing enterprise and how to maximise efficiency while maintaining safety;
- why quality assurance and control are central to cost-effective production;
- what aspects of production may need to be checked and how to measure quality at different stages of production.

This topic is linked to:

- Topic 2.7 Product manufacture.

Scope of content

Learners must know and understand:

a) what different processes and systems are used within a manufacturing enterprise;

b) how technology is used to maximise efficiency and effectiveness within a manufacturing enterprise;

c) how the processes and systems would differ if a product was manufactured in different quantities;

d) what may happen if health and safety legislation and guidelines are not followed;

e) what control procedures are used for the safe use of tools, equipment and plant to manufacture a product;

f) what critical control points are needed to maintain product quality during each stage of manufacture;

g) what measuring equipment is used to monitor quality of a product and the services used to manufacture it (for example heat, light or power);

h) why it is important to calibrate equipment regularly and accurately.

Learners must be able to:

a) apply control techniques safely in line with relevant legislation and guidelines;

b) use measuring equipment safely to check quality to a given tolerance.

In order to engage with this topic effectively, learners must use the following PLTS:

- reflective learners;
- team workers;
- effective participators.

Topic 2.7: Product manufacture (60 GLH)

Purpose

The purpose of this topic is to enable learners to understand:

- how to follow design specifications and standard operating procedures for manufacturing a product;
- how to work as an effective part of a production team within a manufacturing enterprise;
- what constraints there may be on working practices (such as complying with health and safety and environmental legislation and codes of practice).

This topic is linked to:

- Topic 2.4 Designing and developing products;
- Topic 2.6 Processing systems.

Scope of content

Learners must know and understand:

a) why it is important to follow product design specifications, standard operating procedures and integrate operations when manufacturing a product;

b) why complying with health and safety legislation is so important in the workplace;

c) what methods are used to maximise efficiency in the manufacturing process (for example lean manufacture and maintenance systems);

d) why it is important to consider environmental impact and cost (for example of remanufacture, recycling materials and the safe disposal of waste materials);

e) what different energy resources are used and their costs (including renewable resources);

f) how products and materials are packaged, transported and stored within a sub-sector.

Learners must be able to contribute to manufacturing a product by following a standard operating procedure, in line with the specification and agreed tolerances, including:

a) interpreting a product design specification and standard operating procedure;

b) calculating the quantities of materials;

c) setting up or calibrating equipment;

d) applying quality control methods;

e) checking work, checking progress and meeting production targets;

f) complying with health and safety and environmental guidelines.

In order to engage with this topic effectively, learners must use the following PLTS:

- team workers;
- effective participators;
- self-managers.

Advanced level

Summary of topic titles

Topic no.	Titles	GLH
	Theme A: Business and enterprise	
3.1	Manufacturing business principles	60
3.2	Customer needs and market requirements	60
3.3	Supply chain management	30
3.4	Management of resources and working practices	30
	Theme B: Product design and materials science	
3.5	Research, development and introduction of new products	90
3.6	Materials science	90
	Theme C: Production systems	
3.7	Production and processing systems	90
3.8	Management of production and processing operations	60
3.9	Quality in manufacturing	30

Topic 3.1: Manufacturing business principles (60 GLH)

Purpose

The purpose of this topic is to enable learners to understand:

- how manufacturing enterprises are structured, managed and led;
- how economic, environmental, political and social factors affect business operations and sustainability;
- what influence financial planning and cost management have on profitability.

This topic links to:

- Topic 3.2 Customer needs and market requirements;
- Topic 3.3 Supply chain management;
- Topic 3.4 Management of resources and working practices;
- Topic 3.8 Management of production and processing operations.

Scope of content

Learners must know and understand:

a) why entrepreneurship and leadership are important in manufacturing;

b) why key business structures and functions are needed in a manufacturing enterprise (for example relating to customers, suppliers, product development and delivery);

c) what key economic, environmental, political and social issues affect manufacturing (for example the world market economy, global trading and corporate social responsibility);

d) how an exemplar manufacturing enterprise seeks to meet both social and economic demands;

e) how manufacturing enterprises develop policies to make sure they comply with environmental, employment, financial and business legislation;

f) what and why financial planning techniques are used to run a manufacturing enterprise successfully (for example accounts, budgets, cost–benefit analyses and returns on investment);

g) how to evaluate risk against benefits to sustain the long-term viability of a manufacturing enterprise;

h) what techniques manufacturing enterprises use to improve performance.

Learners must be able to:

a) evaluate and recommend policies in line with strategic plans, business plans and lega l requirements;

b) interpret and construct accurate key financial planning documents.

In order to engage with this topic effectively, learners must use the following PLTS:

- independent enquirers;
- creative thinkers.

Topic 3.2: Customer needs and market requirements (60 GLH)

Purpose

The purpose of this topic is to enable learners to understand:

- how manufacturing businesses gather and use data about customers, competitors and markets to inform product development and delivery;
- how businesses respond to their ethical and legal responsibilities (for example customer protection, the environment and the Disability Discrimination Act);
- how the relationship with customers can be managed to promote sales and improve profits.

This topic links to:

- Topic 3.1 Manufacturing business principles;
- Topic 3.3 Supply chain management;
- Topic 3.4 Management of resources and working practices;

- Topic 3.5 Research, development and the introduction of new products.

Scope of content

Learners must know and understand:

a) why marketing operations, organisation and strategy are important;

b) how iconic manufacturing achievements have met market requirements and customer needs;

c) what marketing and sales structures and techniques are used to promote a product to the customer;

d) what market research techniques can be used to explore customers' needs and values;

e) what legislation and codes of practice apply to consumers, sales and marketing;

f) why quality standards are important in customer service;

g) how exemplar manufacturing businesses identify and try to meet different customer's needs and values.

Learners must be able to:

a) devise and carry out market research;

b) analyse statistical data on market growth or decline (for example political, economic, social and technological – PEST; and political, economic, social, technological, legal and environmental –PESTLE);

c) prepare a marketing strategy for a given product or manufacturing enterprise.

In order to engage with this topic effectively, learners must use the following PLTS:

- independent enquirers;
- creative thinkers.

Topic 3.3: Supply chain management (30 GLH)

Purpose

The purpose of this topic is to enable learners to understand:

- the principles of supply chain logistics;
- how supply and demand can be integrated within and across companies;
- how supply chain problems can be addressed through procurement, logistics and lean manufacturing;
- how to contribute ideas and draw up plans to solve supply chain problems.

This topic links to:

- Topic 3.1 Manufacturing business principles;
- Topic 3.2 Customer needs and market requirements;
- Topic 3.4 Management of resources and working practices;
- Topic 3.8 Management of production and processing operations.

Scope of content

Learners must know and understand:

a) how supply chain operations are structured and the relationships within the supply chain process;

b) what laws apply to supply chain logistics;

c) why cost-effective supply chain management is important in manufacturing;

d) why companies need to maintain ‘customer focus’ throughout the supply chain;

e) what the main methods are of transporting, storing, recycling and safe disposal and goods and materials in at least two manufacturing sub-sectors;

f) why it is important to compare suppliers and supply chain logistic systems (for example in terms of products, services, prices and impact on environment);

g) how raw materials and supplies are procured to meet the requirements in a product design specification and cost constraints.

Learners must be able to:

a) map and evaluate the supply chain process in at least two manufacturing sub-sectors;

b) gather data on and make decisions about potential suppliers;

c) calculate quantities of materials or supplies needed.

In order to engage with this topic effectively, learners must use the following PLTS:

- independent enquirers;
- reflective learners.

Topic 3.4: Management of resources and working practices (30 GLH)

Purpose

The purpose of this topic is to enable learners to understand:

- what key employment and operational practices apply in manufacturing;
- how supervisory skills can be used to make sure that each individual contributes to achieving organisational goals.

This topic links to:

- Topic 3.1 Manufacturing business principles;
- Topic 3.2 Customer needs and market requirements;
- Topic 3.3 Supply chain management;
- Topic 3.8 Management of production and processing operations.

Scope of content

Learners must know and understand:

a) what the entry requirements and on-the-job training opportunities are for different roles within at least two manufacturing sub-sectors;

b) what supervisory responsibilities and skills are required in manufacturing;

c) how individuals and teams work together to achieve individual, team and organisational goals;

d) why relationships are important between integrated operations in manufacturing a product;

e) what employment laws and social, ethical and legal rights and duties apply to employers and employees;

f) what roles legislative bodies play in regulating and enforcing laws within at least two manufacturing sub-sectors.

Learners must be able to:

a) carry out own responsibilities effectively and efficiently and support others to meet team goals;

b) take a lead when working as part of a team to meet organisational goals;

c) follow appropriate legislation and guidelines.

In order to engage with this topic effectively, learners must use the following PLTS:

- effective participators;
- reflective learners;
- team workers.

Topic 3.5: Research, development and the introduction of new products (90 GLH)

Purpose

The purpose of this topic is to enable learners to understand:

- what product development involves (for example market research analysis, research, prototyping and piloting) and how they are used to develop and introduce new products;
- why and how innovation, sustainability, continuous improvement, economic, ethical and environmental issues affect the design and development of new products;
- how to solve product design and development problems.

This topic links to:

- Topic 3.2 Customer needs and market requirements;
- Topic 3.6 Materials science;
- Topic 3.7 Processing and production systems.

Scope of content

Learners must know and understand:

a) why research and development are important and how the findings of market research analysis can be used to inform the design of a product;

b) how the design process, prototypes, testing and trials are used;

c) how product design and new developments in manufacturing technology can enhance sustainable manufacturing methods;

d) what legislation needs to be followed in the design of a product;

e) what detail a design specification needs to contain and how it is used in the manufacturing process;

f) how issues and principles inform the design process (for example economics, ethics, environmental impact and continuous improvement).

Learners must be able to:

a) use a range of techniques to gather customer views about a product or range of products;

b) analyse customer feedback and suggest improvements;

c) analyse and evaluate products or prototypes;

d) design a product for manufacture;

e) produce a product design specification and refine it following feedback (for example from clients, customers or the production department).

In order to engage with this topic effectively, learners must use the following PLTS:

- creative thinkers;
- reflective learners.

Topic 3.6: Materials science (90 GLH)

Purpose

The purpose of this topic is to enable learners to understand:

- how the chemical, physical and biological properties and structure of materials are exploited in different products and manufacturing processes;
- how to carry out different investigation techniques safely;
- how science and technology are being used in manufacturing to increase productivity.

This topic links to:

- Topic 3.5 Research, development and the introduction of new products;
- Topic 3.7 Processing and production systems;
- Topic 3.8 Management of production and processing operations.

Scope of content

Learners must know and understand:

a) why testing materials for characteristics is important (for example chemical composition, electromagnetic properties and the behaviour of materials on a molecular level);

b) what laws, regulations and guidelines are applied to maintain safety;

c) how to investigate the properties, structure and types of bonding found within common materials within at least two manufacturing sub-sectors using appropriate techniques (including non-destructive testing);

d) how the characteristics and properties of exemplar materials can be changed and exploited in different products and manufacturing processes;

e) how to produce a secondary material from a primary material;

f) why and how scientific principles and technology can be applied to manufacturing processes within at least two sub-sectors and to increase productivity.

Learners must be able to:

a) comply with heath and safety guidelines;

b) calibrate equipment;

c) investigate the characteristics, properties and uses of materials within at least two manufacturing sub-sectors (including 'smart' or 'modern' materials and, where appropriate, 'biomaterials');

d) test complex materials (for example a metallic artefact, biofuel, soap) and products (for example a textile, paper, cardboard, bricks);

e) calculate, interpret and present the results of tests and investigations;

f) make decisions about product design, development or manufacturing within at least two sub-sectors based on the results of tests and investigations.

In order to engage with this topic effectively, learners must use the following PLTS:

- independent enquirers;

- reflective learners.

Topic 3.7: Production and processing systems (90 GLH)

Purpose

The purpose of this topic is to enable learners to understand:

- what is involved in manufacturing a product and how manufacturing processes compare for batch, small- and large-scale production and continuous processing;
- how advanced technology and control methods are used in manufacturing processes;
- how to contribute to the efficient and safe manufacture of a product to meet customer needs, product design specification and business objectives.

This topic links to:

- Topic 3.5 Research, development and the introduction of new products;
- Topic 3.6 Materials science;
- Topic 3.8 Management of production and processing operations;
- Topic 3.9 Quality in manufacturing.

Scope of content

Learners must know and understand:

a) how an exemplar enterprise applies manufacturing principles to the processes it uses (for example right quantity, quality, cost, place and time);

b) what the key stages and features of the operations and processing systems are in manufacturing a product;

c) how production processes are planned and improved to maximise efficiency and effectiveness;

d) what effects manufacturing a product in different quantities would have (for example on cost, quality, people or utilisation of plant);

e) how advanced technology is used in a manufacturing process;

f) how control technology, control methods and safety controls are used to protect a product, the people involved on the shop floor and the environment;

g) what legislation manufacturing operations must comply with.

Learners must be able to:

a) follow standard operating procedures and product design specifications;

b) contribute efficiently and effectively to the manufacture of a product;

c) use tools, equipment and plant and dispose of resources safely in line with relevant legislation and working practices;

d) monitor quality and tolerances against a product design specification.

In order to engage with this topic effectively, learners must use the following PLTS:

- effective participators;
- self-managers;
- team workers.

Topic 3.8: Management of production and processing operations (60 GLH)

Purpose

The purpose of this topic is to enable learners to understand:

- what organisational and management principles and techniques can be used to maximise productivity and minimise waste;
- how to plan and maintain resources in line with health, safety and environmental requirements;
- how to review manufacturing operations and identify opportunities for improvement.

This topic links to:

- Topic 3.1 Manufacturing business principles;
- Topic 3.3 Supply chain management;
- Topic 3.4 Management of resources and working practices;
- Topic 3.6 Materials science;
- Topic 3.7 Production and processing systems;
- Topic 3.9 Quality in manufacturing.

Scope of content

Learners must know and understand:

a) how an exemplar enterprise manages production and processing operations to meet agreed output requirements;

b) how lean manufacture and other methods can be used to maximise efficiency and effectiveness;

c) why and when manufacturing plant and equipment need to be maintained;

d) why and how to recycle and safely dispose of manufacturing materials, by-products and waste;

e) what affect poor maintenance, wasting materials, resources and energy may have on the cost of manufacturing a product;

f) how risk assessment is used in a manufacturing workplace;

g) how solutions can be achieved using problem-solving and fault-finding techniques.

Learners must be able to:

a) monitor and record the inputs and outputs of a production process against the specification;

b) carry out risk assessments for health, safety and the environment;

c) use problem-solving techniques to find ways to improve quality or efficiency;

d) use fault-finding techniques on manufacturing plant and equipment.

In order to engage with this topic effectively, learners must use the following PLTS:

- reflective learners;
- independent enquirers.

Topic 3.9: Quality in manufacturing (30 GLH)

Purpose

The purpose of this topic is to enable learners to understand:

- why quality is important in all aspects of manufacturing business;
- what the principles of total quality management are and how quality management systems are used to maintain and improve standards;
- how to monitor the quality of a product using appropriate techniques.

This topic links to

- Topic 3.5 Research, development and the introduction of new products;
- Topic 3.7 Production and processing systems;
- Topic 3.8 Management of production and processing operations.

Scope of content

Learners must know and understand:

a) what quality means in manufacturing and how poor quality can affect profit margins;

b) what quality control processes are used within at least two manufacturing sub-sectors;

c) why tolerances are important and how they are defined in product design specifications;

d) what an internal and external audit involves;

e) how standards are implemented and monitored using quality management systems (for example ISO9000 and IIP) within a manufacturing enterprise.

Learners must be able to:

a) use measuring techniques to monitor the quality of a manufacturing process, product or service (for example heat, light or power);

b) carry out a basic quality audit (for example on a company, department or process);

c) analyse data, interpret and present results and recommendations about quality.

In order to engage with this topic effectively, learners must use the following PLTS:

- independent enquirers;
- reflective learners.

Personal, learning and thinking skills

9. Awarding organisations must design learning outcomes and assessment criteria that clearly include opportunities for the development of PLTS. At all levels of the Diploma, principal learning must include all six PLTS. These should be integrated as a minimum within the assessment criteria for principal learning to explicitly recognise the application of these skills within sector-relevant contexts.

10. Awarding organisations must also provide a clear mapping of the coverage of PLTS within their submission. This should be at the level requested under each topic within the criteria, such as 'independent enquirers', 'creative thinkers' and so on.

Advanced level: external assessment

Manufacturing and Product Design will have 120 GLH of external assessment.

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