Design & Technology - Product Dersign: Personal Leaning Checklist

Design and technology and our world				
Learners need a breadth of technical knowledge and understanding in order to make effective choices in relation to the selection of materials, components and systems. They should consider emerging technologies, environmental issues and impacts on society. They should consider the needs of future generations as well as their own, and take a broad view of the impact of design and technology activities.				
Content	Amplification			
1. The impact of new and emerging technologies on: • industry • enterprise • sustainability • people • culture • society • the environment • production techniques • systems	The focus of this content is the impact of new and emerging technologies on the areas identified below. • The impact of new and emerging technologies on industry and enterprise: • market pull – responding to demands from the market; • technology push – development in materials and components, manufacturing methods; • consumer choice – consumers wishing to own the latest technologies/products. • The Product Life Cycle. • Global production and its effects on culture and people. • Legislation to which products are subject. • Consumer rights and protection for consumers when purchasing and using products. • Moral and ethical factors related to manufacturing products and the sale and use of products. • Sustainability; meeting today's needs without compromising the needs of future generations. • Advantages and disadvantages of using computer aided design (CAD). • Advantages and disadvantages of the use of computer aided manufacture (CAM). • How CAM equipment can be used in a variety of applications: CNC embroidery, vinyl cutting, CNC routing, laser cutting and 3D printing.			
Content	Amplification			
2. How the critical evaluation of new and emerging technologies informs design decisions; considering contemporary and potential future scenarios from different perspectives, such as ethics and the environment	The focus of this content is how the critical evaluation of new and emerging technologies informs design decisions. • The importance of sustainability issues and environmental issues when designing and making. • Social, cultural, economic and environmental responsibilities in designing and making products. • The SIX R's of sustainability; rethink, reuse, recycle, repair, reduce and refuse. • Life Cycle Analysis to determine the environmental impact of a product. • Fair-trade policies and carbon footprint. • Ecological footprint.			
3. How energy is generated and stored in order to choose and use appropriate sources to make products and to power systems	• Types of renewable and non-renewable energy sources: wind, solar, geothermal, hydroelectric, wood/biomass, wave, coal, gas, nuclear and oil. • Issues surrounding the use of fossil fuels: coal, oil and gas. • The advantages and disadvantages of renewable energy sources. • The use of renewable energy sources in modern manufacturing production systems: the use of solar panels and wind turbines in manufacturing sites. • Renewable energy sources for products: wind-up and photovoltaic cells. • Energy generation and storage in a range of contexts: motor vehicles (e.g. petrol/diesel, electricity) and household products (e.g. battery, solar, mains electricity).			

Smart materials, composites and technical textiles				
The design and manufacture of products depends upon material technology and the development and implementation of materials in products. Learners need to be aware of developments in materials technology and how these impact on the design and use of products.				
Content	Amplification			
4. Developments in modern and smart materials, composite materials and technical textiles	• Electroluminescent film or wire i.e. LCD. • Quantum Tunnelling Composite (QTC) - when used in circuits the resistance changes under compression. • SMA – shape memory alloys. • Polymorph. • Smart fibres and fabrics that respond to the environment or stimuli: • photo-chromic; • thermo-chromic; • micro-encapsulation; • biometrics. • Carbon Fibre, Kevlar and GRP. • Interactive textiles that function as electronic devices and sensors: circuits integrated into fabrics, such as heart rate monitors; wearable electronics such as mobile phones or music player, GPS, tracking systems and electronics integrated into the fabric itself. • Micro-fibres in clothing manufacture. • Phase changing materials: breathable materials; proactive heat and moisture management. • Sun protective clothing. • Nomex. • Geotextiles for landscaping. • Rhovyl as an antibacterial fibre.			

Electronic systems and programmable components				
Familiar products often include the use of electronic components. Learners should be aware of the importance of electronic and programmable components to the product designer and end user and how such components are integrated into everyday products we use.				
Content	Amplification			
5. How electronic systems provide functionality to products and processes, including sensors and control devices to respond to a variety of inputs, and devices to produce a range of outputs	• Graphical conventions for communicating concepts: circuit diagrams, block diagrams and flowcharts. • The 'systems' approach – input; process; output. • Principles of a control system: • input data from a sensor: light dependent resistor (LDR), thermistor; • processing by control devices: semi-conductor, IC, microprocessor or computer; • output where a signal is received that will perform a desired function: buzzer, light emitting diode (LED). • The importance of feedback within the system. • The methods of providing feedback in different systems. • Familiar products in terms of their control system. • Control devices that include counting, switching and timing. • Analogue and digital sensors as input components.			
6. The use of programmable components to embed functionality into products in order to enhance and customise their operation	• Sub routines or macros in control systems. • Programmable microcontrollers can be used to control a range of systems. • Programmable microcontrollers can interface with other devices. • Programmable microcontrollers can be reprogrammed repeatedly. • The benefits and limitations of programmable microcontrollers. • Programmable Interface Controllers (PIC) and how they can be used to control products or systems.			

Mechanical components and devices				
Familiar products often include the use of mechanical components and devices. Learners should be aware of the importance of mechanical components and devices to the product designer and end user and how such components are integrated into everyday products we use.				
Content	Amplification			
7. The functions of mechanical devices, to produce different sorts of movement, changing the magnitude and direction of forces	• Principle of a mechanical device to transform input motion and force into a desired output motion and force. • Analyse everyday mechanical devices and how they function. • Consider mechanical systems in terms of input; process; output. • Mechanical systems which: • increase or decrease speed of movement/rotation; • change magnitude/direction of force/movement/rotation. • Simple calculations involving mechanical systems. • Analyse the function of mechanical products that have: • pulley systems, e.g. curtain rails, sewing machine; • gear systems, e.g. whisk, hand drill; • levers and linkages, e.g. scissors; • rack and pinion, e.g. chair lift; • cams, e.g. automata toys.			

Materials				
Learners need to have a broad understanding of the categorisation and properties of a range of materials. They should be aware of their source, use and application in products.				
Content	Amplification			
8. Papers and boards	• The categorisation and properties of paper, cards, boards and composite materials. Properties to be considered in terms of their strength, folding ability, surface finish and absorbency. • Papers, cards and boards can be laminated to improve strength, finish and appearance. • The standard ISO sizes of paper. • The use of grammage i.e. grams per square metre (gsm) to measure weight of paper. • The use of microns to measure thickness of card. • The use of recycled materials to manufacture papers and boards. • The aesthetic and functional properties of common papers, cards and boards: layout paper, tracing paper, copier paper, recycled paper, corrugated board, cartridge paper, mounting board and folding boxboard.			
9. Natural and manufactured timber	• The categorisation and properties of hardwoods and softwoods. • Properties to be considered: strength, grain structure, surface finish and absorbency. • Natural timber is harvested from deciduous (hardwoods) and coniferous (softwood) trees. • Natural timber is available in the following forms: plank, board, strip, square, and dowel. • Natural timber can be identified using a range of discriminators: weight, colour, grain, texture, durability and ease of working. • Natural timber is protected using different finishes and these finishes are sometimes used to improve aesthetic appeal. • Categorisation and properties of manufactured timbers. • Manufactured timbers are made from natural timbers and made from particles/fibres or laminates. • Manufactured timbers are available in standard sizes and forms: plywood, MDF (Medium Density Fibreboard), chipboard, hardboard and veneered boards. • Manufactured timbers can be protected using finishes and these finishes are sometimes used to improve the aesthetic appeal.			
10. Ferrous and non- ferrous metals	• Categorisation and working properties of ferrous metals, non- ferrous metals and alloys. • Properties of metals: hardness, elasticity, conductivity, toughness, ductility, tensile strength and malleability. • Metals are sold as sheet, bar, rod, tube and angle. • Ferrous metals: cast iron, mild steel, medium carbon steel and high carbon steel. • Ferrous metals may require a protective finish and the finish is sometimes used to improve the aesthetic appeal. • Non-ferrous metals: aluminium, copper, brass, bronze. • Alloys of metals are a base metal mixed with other metals or non-metals to change their properties or appearance. • Non-ferrous metals may require a protective finish and the finish is sometimes used to improve the aesthetic appeal.			
11. Thermoforming and thermosetting polymers	• Categorisation and physical properties of polymers. • Polymers can be made from both natural and synthetic resources. • Polymers are sold as sheet, film, bar, rod and tube. • The differences between a thermoforming (thermoplastic) and thermosetting material. • Properties of polymers: weight, hardness, elasticity, conductivity/insulation, toughness and strength. • The properties of thermoplastics: polythene, polystyrene, polypropylene and PVC. • The properties of the thermosetting plastics: UF (urea formaldehyde), MF (melamine formaldehyde), PR (polyester resin) and ER (epoxy resin).			
12. Natural, synthetic, blended and mixed fibres, and woven, non-woven and knitted textiles.	• The categorisation and working properties of fibres and textiles. • The raw materials of textiles are classified according to their source. • Natural polymers: • Animal polymers: wool/fleece – mohair, cashmere, angora, alpaca, camel (hair). • Insect polymers: silk. • Plant polymers: cotton, linen hemp, jute, rayon, viscose. • Manufactured polymers: • Synthetic: polyester, polypropylene, nylon, acrylic, elastane, lycra, aramid fibres. • Microfibres – Tactel, Tencel (Lyocell). • The properties of textiles fibres: strength, elasticity, absorbency, durability, insulation, flammability, water-repellence, anti-static and resistance to acid, bleach and sunlight. • Blending and mixing fibres improves the properties and uses of yarns and materials.			

In-depth knowledge and understanding				
This section is for natural and manufactured timber. Learners are required to develop an in-depth knowledge and understanding of:				
Content	Amplification			

Natural and manufactured timber	**1.** The sources, origins, physical and working properties of the material categories or the components and systems, and their ecological and social footprint	• The physical and working properties of hardwoods, softwoods and man-made boards: toughness, flexibility, grain structure, strength, absorbency, surface finish, colour and hardness. • Natural solid timber - strengths and weaknesses • Defects: shrinkage, splits, shakes, knots, fungial attack. • Hardwoods: beech, oak, mahogany, balsa and jelutong. • Softwoods: scots pine, western red cedar and parana pine. • Strengths, weaknesses of the following manufactured boards: • plywood, MDF - medium density fibreboard, chipboard and hardboard. • The impact on the environment of deforestation. • Ecological and social footprint. • Changing society's view on waste, encourage recycling. • Living in a greener world. • Life-cycle analysis of a material or product.			
	2. The way in which the selection of materials or components is influenced by a range of factors, such as functional, aesthetic, environmental, availability, cost, social, cultural and ethical	• Aesthetic properties of natural and manufactured timbers. • Functional properties of natural and manufactured timbers. • Responsibilities of designers and manufacturers who design using timber with respect to: • the environment; • working conditions in third world countries, low labour costs and poverty; • exploitation of employees; • recyclability and waste. • Biodiversity and deforestation. • Estimating the true costs of a prototype or product. • Comparison costs of hardwoods, softwoods and manufactured board.			
	3. The impact of forces and stresses on materials and objects and the ways in which materials can be reinforced and stiffened	• The behaviour of natural and manufactured timber under forces or under stress. • The stiffness and a strength of natural timber will depend upon the wood, the cross sectional area and the depth of the section. • Reinforcement of natural timber by laminating. • The strength of plywood will depend upon the number of layers and the wood grain being at right angles. • The strength of a timber product will depend upon how the product is jointed or what fixing method is used.			
Natural and manufactured timber	**4.** Stock forms, types and sizes in order to calculate and determine the quantity of materials or components required	• Natural timber is available in different sectional forms, various standard sizes and can have a different finish (sawn or planed). • Manufactured boards are commonly available in sheet form and in standard sizes and various thicknesses. • Calculate the costs involved in the design of products: fixtures, fittings, finishes required and the material cost.			
	5. Alternative processes that can be used to manufacture products to different scales of production	• Advantages and disadvantages of producing single, one off products. • The advantages and disadvantages of producing products in limited quantities (batch production). • The need to produce a number of identical products. • Jigs and devices to control repeat activities. • The advantages and disadvantages of high volume, continuous production. • Issues related to high volume production. • The importance of CAM in modern high volume production.			
	6. Specialist techniques and processes that can be used to shape, fabricate, construct and assemble a high quality prototype, including techniques such as wastage, addition, deforming and reforming, as appropriate to the materials and/or components being used	**Wastage/Addition** • Tools and equipment to mark out, hold, cut, shape, drill and form laminates of natural timbers and manufactured boards. • The pillar drill to drill holes to various diameters. • Jigs and formers to ensure accuracy as part of the process of drilling, bending, cutting wood materials. **Deforming/Reforming** • Material joining can be permanent or temporary. • The principles of producing wood products using the following processes: jointing, veneering, laminating and steam bending. • Classification of wood joints as frame or box construction. • Frame: mitre, dowel, mortise and tenon, halving and bridle joint. • Box/carcass: butt, lap, housing, dovetail and comb joint. • Adhesives: PVA (wood to wood), contact adhesive and epoxy resin (wood to other materials). • Temporary: screw (countersunk and round head) and knock down fittings. • Lasers. • CAM machines.			
	7. Appropriate surface treatments and finishes that can be applied for functional and aesthetic purposes	• Surface treatments of natural timber and manufactured boards to prolong life of a product: sealants and primers. • Finishes for aesthetic or functional reasons: varnish, wood stains, oils, polishes and preservative paints.			