| Year 12 Theory | Road Map | | | | |
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| In this unit you will investigate water on the land. The aims are as follows:<br>**LG1**: Knowledge<br>**LG2**: Application<br>**LG3**: Skills | Assessment Grades | | | | |
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| **Themes** | **Learning Goals/Outcomes/Content** |  |  |  | |
| What are the different scales of production? | **L1 Scales of production**<br>Knowledge (Component)<br>Students should be aware of, and be able to describe, the different scales of production giving example products and specific manufacturing methods.<br>Specific scales of production to include:<br>• one-off, bespoke<br>• batch production<br>• mass/line production<br>• unit production systems (UPS)<br>• quick response manufacturing (QRM)<br>• vertical in-house production. | | | | |
| How are computers used to automate and refine production systems? | **L2 Efficient use of materials**<br>**The use of computer systems & Sub-assembly**<br>Knowledge (Component)<br>Students must develop an awareness of the relationship between material cost, form, and manufacturing processes, and the scale of production.<br>• The development of designs which use materials economically and with regard to their characteristics.<br>• The use of manufacturing processes which increase accuracy and reduce waste.<br>• The savings to be gained when comparing bulk production with one-off production.<br>• The advantages<br>Students should be able to explain specific industrial manufacturing systems and their use in the production of given products. Specific manufacturing systems to include:<br>• modular/cell production<br>• just in time (JIT)<br>• quick response manufacturing (QRM)<br>• flexible manufacturing systems.<br>Students should be aware of, and able to explain, sub-assembly as a separate line of manufacture for certain parts of a product. | | | | |
| What are the advantages of using CAD? | **L3 Computer aided design (CAD)**<br>Knowledge (Component)<br>Students should be aware of, and be able to describe, the following:<br>• the advantages and disadvantages of using CAD compared to a manually generated alternative<br>• the use of CAD to develop and present ideas for products, including:<br>• the use of 2D CAD for working drawings<br>• the use of 3D CAD to produce presentation drawings<br>• how CAD is used in industrial applications. | | | | |
| How do you use 2D CAD to work to a high level of tolerance? | **L4 Computer aided design (CAD)**<br>Knowledge (Component)<br>Students understand how to use 2D CAD software<br>Students able to work with high level of tolerance<br>Students understand what laser kerf is and how to compensate for this | | | | |
| How can CAD be used to produce working drawings? | **L5 Computer aided design (CAD)**<br>Knowledge (Component) | | | | |

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| | Students understand the difference between first angle and third angle projection<br>Students able to use 2D CAD software to produce an orthographic drawing | | | |
| How do you use 3D CAD to produce concept drawings? | **L6 Computer aided design (CAD)**<br>Knowledge (Component)<br>Students understand how to use 3D CAD software<br>Students understand how to use rendering and snapshot tools for presenting concepts | | | |
| How is virtual modelling used and what are its benefits? | **L7 Virtual modelling**<br>Knowledge (Component)<br>Students should be aware of, and be able to describe, how virtual modelling/testing is used in industry prior to product production. Specific processes to include:<br>• simulation<br>• computational fluid dynamics (CFD) as used for testing aerodynamics and wind resistance, and flow of liquids within/ around products<br>• finite element analysis (FEA) as used in component stress analysis. | | | |
| What are the various forms of CAM and what are they used for? | **L8 Computer aided manufacture (CAM)**<br>Knowledge (Component)<br>Students should be aware of, and be able to describe, how CAM is used in the manufacture of products. Specific processes to include:<br>• laser cutting<br>• routing<br>• milling<br>• turning<br>• plotter cutting. | | | |
| How do you convert CAD files for laser cutting? | **L9 Computer aided manufacture (CAM)**<br>Knowledge (Component)<br>Understand how to prepare files for laser cutting<br>Understand how to operate the laser cutter | | | |
| What is rapid prototyping and how do you do it? | **L10 Rapid prototyping processes**<br>Knowledge (Component)<br>Students should be aware of, and be able to describe, rapid prototyping processes, including 3D printing.<br>Students should understand, and be able to explain, the benefits to designers and manufacturers. | | | |
| What is PPC and what is its benefits for the company and consumer? | **L11 Electronic data interchange**<br>**Production, planning and control (PPC) networking**<br>Knowledge (Component)<br>Students should be aware of, and able to describe, the use of electronic point of sales (EPOS) for marketing purposes and the collection of market research data, including:<br>• the maintenance of stock levels<br>• the capture of customer data, eg contact details.<br>Students should be aware of, and able to describe, the role of PCC systems in the planning and control of all aspects of manufacturing, including:<br>• availability of materials<br>• scheduling of machines and people<br>• coordinating suppliers and customers. | | | |
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| What is iterative design? | **L1 R8 Revision Skills & Iterative Design Process**<br>Knowledge (Component)<br>Students should be aware of, and able to explain, different approaches to user centred design. That in approaching a design challenge there is not a single process, but that good design always addresses many issues, including:<br>• designing to meet needs, wants or values<br>• investigations to inform the use of primary and secondary data:<br>• market research<br>• interviews<br>• human factors<br>• focus groups<br>• product analysis and evaluation | | | |

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| | • the use of anthropometric data and percentiles<br>• the use of ergonomic data<br>• the development of a design proposal<br>• the planning and manufacture of a prototype solution<br>• the evaluation of a prototype solution to inform further development. | | | |
| What are the key features of the art deco and arts & crafts movements? | **L2 Design styles and movements 1**<br>Knowledge (Component)<br>Students should be aware of, and able to discuss, how key historical design styles, design movements and influential designers that have helped to shape product design and manufacture.<br>*Design styles and movements*<br>Students should be aware of, and be able to discuss, key design styles and movements and their principles of design, including:<br>• **arts and craft movement**<br>• **Art Deco**<br>• Modernism, eg Bauhaus<br>• Post modernism, eg Memphis. | | | |
| What are the key features of the modernist, and post-modernist movements? | **L3 Design styles and movements 2**<br>Knowledge (Component)<br>Students should be aware of, and able to discuss, how key historical design styles, design movements and influential designers that have helped to shape product design and manufacture.<br>*Design styles and movements*<br>Students should be aware of, and be able to discuss, key design styles and movements and their principles of design, including:<br>• arts and craft movement<br>• Art Deco<br>• **Modernism, eg Bauhaus**<br>• **Post modernism, eg Memphis.** | | | |
| Who are Starck, Dyson and Calvert? | **L4 Designers and their work 1**<br>Knowledge (Component)<br>Students should be aware of, and able to discuss, how key historical design styles, design movements and influential designers that have helped to shape product design and manufacture.<br>*Designers and their work*<br>Students should be aware of, and be able to discuss, the work of influential designers and how their work represents the principles of different design movements, including:<br>• **Phillipe Starck**<br>• **James Dyson**<br>• **Margaret Calvert**<br>• Dieter Rams<br>• Charles and Ray Eames<br>• Marianne Brandt. | | | |
| Who are Rams, Eames and Brandt? | **L5 Designers and their work 2**<br>Knowledge (Component)<br>Students should be aware of, and able to discuss, how key historical design styles, design movements and influential designers that have helped to shape product design and manufacture.<br>*Designers and their work*<br>Students should be aware of, and be able to discuss, the work of influential designers and how their work represents the principles of different design movements, including:<br>• Phillipe Starck<br>• James Dyson<br>• Margaret Calvert<br>• **Dieter Rams**<br>• **Charles and Ray Eames**<br>• **Marianne Brandt.** | | | |
| How have socio economic issues shaped product design? | **L6 Socio economic influences**<br>Knowledge (Component)<br>Students should be aware of, and able to discuss, how socio economic influences have helped to shape product design and manufacture, including: | | | |

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| | • post WW1: the Bauhaus and development of furniture for mass production<br>• WW2: rationing, the development of 'utility' products<br>• contemporary times:<br>• fashion and demand for mass produced furniture<br>• decorative design. | | | |
| What are recent major developments in technology? | **L7 Major developments in technology**<br>Knowledge (Component)<br>Students should be aware of, and able to discuss, how major developments in technology are shaping product design and manufacture, including:<br>• micro electronics<br>• new materials<br>• new methods of manufacture<br>• advancements in CAD/CAM. | | | |
| What influence on design does sustainability, ethical issues and inclusivity have? | **L8 Social, moral and ethical issues 1**<br>Knowledge (Component)<br>Students should be aware of, and able to discuss, the responsibilities of designers and manufacturers, including:<br>**• products are made using sustainable materials and ethical production methods**<br>**• the development of products that are:**<br>**• culturally acceptable**<br>**• not offensive to people of different race, gender or religious belief**<br>**• the development of products that are inclusive**<br>• the design and manufacture of products that could assist with social problems, eg poverty, health and wellbeing, migration and housing<br>• the impact of Fairtrade on design and consumer demand<br>• designing products to consider the six R of sustainability. | | | |
| What influence on design does sociability and Fairtrade have? | **L9 Social, moral and ethical issues 2**<br>Knowledge (Component)<br>Students should be aware of, and able to discuss, the responsibilities of designers and manufacturers, including:<br>• products are made using sustainable materials and ethical production methods<br>• the development of products that are:<br>• culturally acceptable<br>• not offensive to people of different race, gender or religious belief<br>• the development of products that are inclusive<br>**• the design and manufacture of products that could assist with social problems, eg poverty, health and wellbeing, migration and housing**<br>**• the impact of Fairtrade on design and consumer demand**<br>**• designing products to consider the six Rs of sustainability.** | | | |
| What are the life cycles of products and how has this influenced their design? | **L10 Product life cycle**<br>Knowledge (Component)<br>Design introduction, evolution, growth, maturity, decline and replacement. Students should be familiar with examples of how designers refine and re-develop products in the lifecycle of specific products. | | | |
| What structure is the design processes and what does it involve? | **L11 The use of a design process**<br>Knowledge (Component)<br>Students should be aware of, and able to discuss and implement, the stages of a range of design processes in order to apply personal judgement and relevant criteria in the appraisal of products and systems, including:<br>• those used in the NEA<br>• investigations and analysis<br>• use of inspiration materials, eg mood boards<br>• ideas generation<br>• illustration<br>• development of a design specification<br>• modelling<br>• planning<br>• evaluating and testing. | | | |

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| What are prototypes and what methods are used to produce them? | **L12 Prototype development**<br>Knowledge (Component)<br>Students should be aware of, and able to discuss and demonstrate, the development of a prototype from design proposals. This knowledge should influence the development of design ideas for the NEA so that students may make high quality products that meet the needs of identified users. | | | |
| How is the iterative design process used in industry? | **L13 The iterative design process in industrial or commercial contexts**<br>Knowledge (Component)<br>Students should be aware of, and able to discuss, how different design methodologies are used by designers in the corporate world when designing products including collaborative working and the cyclic nature of commercial design and manufacture. | | | |
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| How do environmental issues impact upon design? | **L1 R8 Revision Skills & Environmental issues**<br>Knowledge (Component)<br>Students should be aware of, and able to discuss, the importance environmental issues in design and manufacture, including:<br>• the responsibilities of designers and manufacturers in ensuring products are made from sustainable materials and components<br>• the environmental impact of packaging of products, eg the use of excessive packaging and plastics. | | | |
| How can design be used to conserve energy and resources? | **L2 Conservation of energy and resources**<br>Knowledge (Component)<br>Students should be aware of, and able to discuss, the concept of a circular economy, including:<br>• how products are designed to conserve energy, materials and components<br>• the design of products for minimum impact on the environment including raw material extraction, consumption, ease of repair, maintenance and end of life<br>• sustainable manufacturing including the use of alternative energy and methods to minimise waste<br>• the impact of waste, surplus and by-products created in the process of manufacture including reuse of material off-cuts, chemicals, heat and water<br>• cost implications of dealing with waste<br>• the impact of global | | | |
| What is quality assurance and how is it applied? | **L3 Quality assurance**<br>Knowledge (Component)<br>Students should be aware of, and able to discuss and demonstrate, the procedures and policies put in place to reduce waste and ensure manufactured products are produced accurately and within acceptable tolerances, including quality assurance systems including Total Quality Management (TQM), scrum, Six Sigma and their applications to specific industrial examples including critical path analysis. | | | |
| What is quality control and how is it applied? | **L4 Quality control**<br>Knowledge (Component)<br>Students should be aware of, and able to discuss and demonstrate, quality control, including:<br>• the monitoring, checking and testing of materials, components, equipment and products throughout production to ensure they conform to acceptable tolerances<br>• specific quality control methods including the use of 'go-no go' gauges, laser or probe scanning and measuring<br>• use of digital measuring devices such as vernier callipers and micrometers<br>• non-destructive testing such as x-rays and ultrasound. | | | |
| What are the national and international standards in design? | **L5 National and international standards in product design**<br><br>Knowledge (Component)<br>Students should be aware of, and able to discuss, the importance of national and international standards in product design, including:<br>• British Standards Institute (BSI)<br>• International Organisation for Standardisation (ISO)<br>• Restriction of Hazardous Substances (ROHS) directive<br>• battery directive<br>• polymer codes for identification and recycling | | | |

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| | • packaging directives<br>• WEEE directives<br>• energy ratings of products<br>• eco-labelling:<br>• the Mobius Loop<br>• the European Eco-label<br>• NAPM recycled mark<br>• the EC energy label<br>• the Energy Efficient label and logo<br>• Forest Stewardship Council (FSC)<br>• EPA energy star. | | | |
| What are material working characteristics? | **L6 Materials and their applications 1**<br>Knowledge (Component)<br>Students are expected to be able to name specific materials for a wide range of applications.<br>They must also be able to provide detailed and justified explanations of why specific materials and combinations of materials are suitable for given applications, with reference to:<br>• **physical and mechanical properties (working characteristics)**<br>• product function<br>• aesthetics<br>• cost<br>• manufacture and disposal. | | | |
| What makes a material suitable for its application? | **L7 Materials and their applications 2**<br>Knowledge (Component)<br>Students are expected to be able to name specific materials for a wide range of applications.<br>They must also be able to provide detailed and justified explanations of why specific materials and combinations of materials are suitable for given applications, with reference to:<br>• physical and mechanical properties (working characteristics)<br>• **product function**<br>• **aesthetics**<br>• **cost**<br>• **manufacture and disposal.** | | | |
| What are the main material classifications? | **L8 Classification of materials 1**<br>Knowledge (Component)<br>Students should know and understand the classifications of the following materials and be able to name examples that belong to each category:<br>• metals (ferrous, non-ferrous, alloys)<br>• woods (hardwoods, softwoods, manufactured boards)<br>• polymers (thermoplastics, thermoset polymers, elastomers)<br>• papers and boards<br>• composites<br>• smart materials<br>• modern materials. | | | |
| How can you test materials and their properties? | **L9 Methods for investigating and testing materials 1**<br>Knowledge (Component)<br>Students should be able to describe how workshop and industrial tests are set up and what will be tested, measured and compared, including:<br>• tensile strength<br>• toughness<br>• hardness<br>• malleability<br>• corrosion<br>• conductivity. | | | |
| How can you test materials and their properties? | **L10 Methods for investigating and testing materials 2**<br>Knowledge (Component)<br>Students should be able to describe how workshop and industrial tests are set up and what will be tested, measured and compared, including:<br>• tensile strength<br>• toughness<br>• hardness<br>• malleability | | | |

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| | • corrosion<br>• conductivity. | | | |
| How can you test materials and their properties? | **L11 Methods for investigating and testing materials 3**<br>Knowledge (Component)<br>Students should be able to describe how workshop and industrial tests are set up and what will be tested, measured and compared, including:<br>• tensile strength<br>• toughness<br>• hardness<br>• malleability<br>• corrosion<br>• conductivity. | | | |
| What are the performance characteristics of papers and boards? | **L12 Performance characteristics of papers and boards**<br>Knowledge (Component)<br>Students should be able to name different types of papers and boards.<br>Students should be able to describe the performance characteristics of papers and boards, including:<br>• the ability to be scored<br>• cutting<br>• folding<br>• surface qualities for printing<br>• impact resistance<br>• recyclability and/or biodegradability.<br>Students should be able to explain why different papers and boards are suitable for different applications, including:<br>• layout paper: sketch pads<br>• cartridge paper: printing<br>• tracing paper: copying images<br>• bleed proof paper: marker rendering<br>• treated paper: photographic printing<br>• watercolour paper: painting<br>• corrugated card: packaging<br>• bleached card: greeting cards and high quality packaging<br>• mount board: modelling<br>• duplex card: food packaging<br>• foil backed and laminated card: drinks packaging<br>• metal effect card: gift packaging<br>• moulded paper pulp: eco-friendly packaging. | | | |
| What are the performance characteristics of polymer based sheet and films? | **L13a Performance characteristics of polymer based sheet and film 1**<br>Knowledge (Component)<br>Students should be able to name different types of polymer based sheet and film. Students should be able to describe the performance characteristics of polymer based sheet and film, including:<br>• the ability to be scored<br>• cutting<br>• folding<br>• moulding<br>• transparency<br>• translucency<br>• flexibility<br>• recyclability and/or biodegradability. | | | |
| What are the performance characteristics of polymer based sheet and films? | **L13b Performance characteristics of polymer based sheet and film 2**<br>Knowledge (Component)<br>Students should be able to explain why different polymer based sheet and film are suitable for different applications, including:<br>• foam board: model making<br>• fluted polypropylene: signs and box construction<br>• translucent polypropylene sheets: packaging<br>• styrofoam: modelling and formers<br>• low density polyethylene sheet: wrapping, packaging and bags<br>• plastazote foam: protective packaging<br>• cellulose acetate: packaging<br>• polyactide sheet and film: biodegradable packaging. | | | |
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| What are the performance characteristics of woods? | **L1 Performance characteristics of woods**<br>Knowledge (Component)<br>Students should be aware of the different stock forms of timber, including:<br>• rough sawn<br>• planed square edge (PSE)<br>• planed all round (PAR)<br>• natural timber<br>• manufactured boards<br>• mouldings. | | | |
| What are the performance characteristics of woods? | **L2 Performance characteristics of woods**<br>Knowledge (Component)<br>Students should be able to describe the performance characteristics of woods, including:<br>• grain pattern<br>• grain direction<br>• surface defects<br>• warpage<br>• shrinkage<br>• splitting<br>• joining<br>• forming<br>• steam bending<br>• laminating<br>• machining qualities<br>• resistance to decay<br>• moisture resistance<br>• toxicity. | | | |
| What are the performance characteristics of woods? | **L3 Performance characteristics of woods**<br>Knowledge (Component)<br>Students should be familiar with the following woods and wood products:<br>• softwoods:<br>• pine<br>• spruce<br>• Douglas fir<br>• redwood<br>• cedar<br>• larch<br>• hardwoods:<br>• oak<br>• ash<br>• mahogany<br>• teak<br>• birch<br>• beech<br>• manufactured boards:<br>• plywood<br>• marine plywood<br>• aeroply<br>• flexible plywood<br>• chipboard<br>• medium density fibreboard (MDF)<br>• veneers and melamine formaldehyde laminates. | | | |
| What are the performance characteristics of metals? | **L4 Performance characteristics of metals**<br>Knowledge (Component)<br>Students should be aware of the different stock forms of metals, including:<br>• sheet<br>• plate<br>• bar:<br>• flat<br>• round<br>• square<br>• hexagonal<br>• tube:<br>• round | | | |

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| | • square<br>• rectangular<br>• hexagonal<br>• structural:<br>• H beam<br>• I beam<br>• tee<br>• channel<br>• angle. | | | |
| What are the performance characteristics of metals? | **L5 Performance characteristics of metals**<br>Knowledge (Component)<br>Students should be able to describe the performance characteristics of metals, including:<br>• hardness<br>• toughness<br>• malleability<br>• elasticity<br>• tensile strength<br>• density<br>• resistance to corrosion<br>• thermal conductivity<br>• electrical conductivity<br>• melting points<br>• ability to be alloyed<br>• ability to be joined with heat processes<br>• ability to take applied coatings and finishes. | | | |
| What are the performance characteristics of metals? | **L6 Performance characteristics of metals**<br>Knowledge (Component)<br>Students should be familiar with the following metals:<br>• ferrous:<br>• low carbon steel<br>• stainless steel<br>• high speed steel (HSS)<br>• medium carbon steel<br>• cast iron<br>• non-ferrous:<br>• aluminium<br>• copper<br>• zinc<br>• silver<br>• gold<br>• titanium<br>• tin<br>• ferrous alloys:<br>• stainless steel<br>• die steel (tool steel)<br>• non-ferrous alloys:<br>• bronze<br>• brass<br>• duralumin<br>• pewter. | | | |
| What are the performance characteristics of polymers? | **L7 Performance characteristics of polymers**<br>Knowledge (Component)<br>Students should be aware of the different stock forms of polymers, including:<br>• sheet<br>• film<br>• granules<br>• rod and other extruded forms<br>• foam<br>• powder.<br>Students should be able to describe the performance characteristics of polymers, including:<br>• toughness<br>• elasticity | | | |

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| | • insulation (thermal and electrical)<br>• UV resistance<br>• ability to be moulded<br>• resistance to chemicals and liquids<br>• melting points<br>• suitability for food packaging applications<br>• biodegradability<br>• recyclability<br>• self finishing<br>• ability to be combined with other polymers and/or additives. | | | |
| What are the performance characteristics of polymers? | **L8 Performance characteristics of polymers**<br>Knowledge (Component)<br>Students should be familiar with the following polymers:<br>• thermoplastic:<br>• low density polyethylene (LDPE)<br>• high density polyethylene (HDPE)<br>• polypropylene (PP)<br>• high impact polystyrene (HIPS)<br>• acrylonitrile butadiene styrene (ABS)<br>• polymethylmethacrylate (PMMA)<br>• nylon<br>• rigid and flexible polyvinyl chloride (PVC)<br>• Polyethylene terephthalate (PET)<br>• urea formaldehyde (UF)<br>• melamine formaldehyde (MF)<br>• polyester resin<br>• epoxy resin. | | | |
| What are elastomers? | **L9 Elastomers**<br>Knowledge (Component)<br>Students should be able to explain the suitability of elastomers for given applications making reference to relevant physical and/or mechanical properties, including:<br>• ability to be stretched and then return to original shape<br>• texture<br>• self finishing<br>• non-toxic.<br>Students should understand how elastomers are used to enhance products, for example in producing grips for improved ergonomics.<br>Students should be familiar with the following elastomers:<br>• natural rubber<br>• polybutadiene<br>• neoprene<br>• silicone<br>• Thermoplastic Elastomer (TPE). | | | |
| What are biodegradable polymers? | **L10 Biodegradable polymers**<br>Knowledge (Component)<br>Students should be able to explain the suitability of biodegradable polymers for given application making reference to relevant physical and/or mechanical properties, including:<br>• ability to be moulded into 3D products or film<br>• ability to degrade with the action of UV<br>rays (sunlight), water or enzymes present in soil.<br>Students should understand how biodegradable polymers degrade.<br>Students should be familiar with the following biodegradable polymers:<br>• corn starch polymers<br>• potatopak<br>• biopol (bio-batch additive)<br>• polyactide (PLA)<br>• polyhdroxyalkanoate (PHA)<br>• water soluble: lactide, glycolide (Lactel and ecofilm). | | | |
| What are composites? | **L11a Composites**<br>Knowledge (Component)<br>Students need to know and understand how materials are combined to make composites with enhanced properties. | | | |

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| | Students should be able to explain the suitability of composites for given application making reference to relevant physical and/or mechanical properties, including:<br>• ability to be moulded into a variety of 3D forms<br>• enhancement of physical and/or mechanical properties<br>• ease of manufacture for some uses against traditional materials<br>• improved product performance. | | | |
| What are composites? | **L11b Composites**<br>Knowledge (Component)<br>Students should be familiar with the following composites:<br>• carbon fibre reinforced plastic (CFRP)<br>• glass reinforced plastic (GRP)<br>• tungsten carbide<br>• aluminium composite board<br>• concrete, including reinforced concrete<br>• fibre cement<br>• engineered wood, eg glulam (glued laminated timber). | | | |
| What are smart materials? | **L12 Smart materials**<br>Knowledge (Component)<br>Students should know and understand the term smart material.<br>Students should be able to explain the suitability of smart materials for given applications making reference to how the material responds to external stimuli, including:<br>• changes in temperature<br>• changes in light levels<br>• changes in pressure (force).<br>Students should be familiar with the following smart materials:<br>• shape memory alloys (SMA), eg Nitinol<br>• thermochromatic pigment<br>• phosphorescent pigment<br>• photochromic pigment<br>• electroluminescent wire<br>• piezo electric material. | | | |
| What are modern materials? | **L13 Modern materials**<br>Knowledge (Component)<br>Students should know and understand the term modern material.<br>Students should be able to explain the suitability of modern materials for given applications.<br>Students should be familiar with the following modern materials:<br>• kevlar<br>• precious metal clay (PMC)<br>• high density modelling foam<br>• polymorph. | | | |
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| How do you enhance a range of resistant materials? | **L1 Enhancement of materials**<br>Knowledge (Component)<br>Students are expected to be able to describe enhancement methods for given materials and explain their suitability for specific product applications.<br>Polymer enhancement<br>The use of additives to enhance properties, including:<br>• UV stabilisers to prolong the life of polymers<br>• bio-batch materials to encourage biodegradability.<br>Students should be familiar with how additives are used in specific polymer products, eg patio furniture, food packaging and carrier bags.<br>Wood enhancement<br>The combining of natural timber with resins and lamination to give enhanced properties, eg increased strength and stability.<br>Enhancing timber products with preservatives, finishes and coatings.<br>Metal enhancement<br>Students should be aware of heat treatment methods of enhancing metals, including:<br>• case hardening<br>• hardening and tempering. | | | |

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| How do you form papers and boards? | **L2 Forming, redistribution and addition processes- Paper and board forming processes**<br>Knowledge (Component)<br>Students should be aware of the ways that paper and board can be shaped into different products such as packaging. Specific process to include:<br>• die cutting<br>• laser cutting<br>• creasing<br>• bending. | | | |
| What processes are used to form polymers? | **L3 Forming, redistribution and addition processes- Polymer processes**<br>Knowledge (Component)<br>Students should be aware of how polymers can be formed into 3D products. They should be able to describe the different forming methods.<br>They should be able to explain the suitability of the different forming methods for a range of specific products and scales of production. Specific process to include:<br>• **vacuum forming**<br>• **thermoforming**<br>• **calendaring**<br>• **line bending**<br>• **laminating (layup)**<br>• injection moulding<br>• blow moulding<br>• rotational moulding<br>• extrusion<br>• compression moulding. | | | |
| What processes are used to form polymers? | **L4 Forming, redistribution and addition processes- Polymer processes**<br>Knowledge (Component)<br>Students should be aware of how polymers can be formed into 3D products. They should be able to describe the different forming methods. Students should be aware of how polymers can be formed into 3D products. They should be able to describe the different forming methods. They should be able to explain the suitability of the different forming methods for a range of specific products and scales of production. Specific process to include:<br>• vacuum forming<br>• thermoforming<br>• calendaring<br>• line bending<br>• laminating (layup)<br>• **injection moulding**<br>• **blow moulding**<br>• **rotational moulding**<br>• **extrusion**<br>• **compression moulding.** | | | |
| What processes are used to form metals? | **L5 Forming, redistribution and addition processes- Metal processes**<br>Knowledge (Component)<br>Students should be aware of how metals can be shaped into 3D products. They should be able to describe the different forming methods. They should be able to explain the suitability of the different forming methods for a range of specific products and scales of production. Specific processes to include:<br>• press forming<br>• spinning<br>• cupping<br>• deep drawing<br>• forging<br>• drop forging<br>• bending<br>• rolling<br>• casting:<br>• sand casting<br>• die casting<br>• investment casting<br>• low temperature casting (pewter). | | | |

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| What processes are used to form metals? | **L6 Forming, redistribution and addition processes- Metal processes**<br>Knowledge (Component)<br>Students should be aware of the different permanent and temporary joining methods for metals. They should be able to describe the different methods. They should be able to explain the suitability of the different joining methods for a range of specific products and scales of production. Including addition/fabrication processes:<br>• metal inert gas (MIG) welding<br>• tungsten inert gas (TIG) welding<br>• spot welding<br>• oxy-acetylene welding<br>• soldering (soft and hard)<br>• brazing<br>• riveting<br>• temporary joining methods and fasteners:<br>• self tapping screws<br>• machine screws<br>• nuts and bolts. | | | |
| What processes are used to form metals? | **L7 Forming, redistribution and addition processes- Metal processes**<br>Knowledge (Component)<br>Students should be aware of the different wasting processes. They should be able to describe the different processes. They should be able to explain the suitability of the different wasting processes for a range of specific components and products. Specific processes to include:<br>• milling<br>• turning<br>• flame cutting<br>• plasma cutting<br>• laser cutting<br>• punching/stamping. | | | |
| What processes are used to form woods? | **L8 Forming, redistribution and addition processes- Wood processes**<br>Knowledge (Component)<br>Students should be aware of how timber can be joined to form different products. They should be able to describe the different methods. They should be able to explain the suitability of the different joining methods for a range of specific products and scales of production. Including:<br>**• addition/fabrication processes**<br>**• traditional wood jointing:**<br>**• dovetail joint**<br>**• comb joint**<br>**• housing joint**<br>**• half-lap joint**<br>**• dowel joint**<br>**• mortise and tenon**<br>• component jointing:<br>• knock down (KD) fittings<br>• wood screws<br>• nuts and bolts<br>• coach bolts. | | | |
| What processes are used to form woods? | **L9 Forming, redistribution and addition processes- Wood processes**<br>Knowledge (Component)<br>Students should be aware of how timber can be joined to form different products. They should be able to describe the different methods. They should be able to explain the suitability of the different joining methods for a range of specific products and scales of production. Including:<br>• addition/fabrication processes<br>• traditional wood jointing:<br>• dovetail joint<br>• comb joint<br>• housing joint<br>• half-lap joint<br>• dowel joint<br>• mortise and tenon<br>**• component jointing:** | | | |

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| | • **knock down (KD) fittings**<br>• **wood screws**<br>• **nuts and bolts**<br>• **coach bolts.** | | | |
| What processes are used to form woods? | **L10 Forming, redistribution and addition processes- Wood processes**<br>Knowledge (Component)<br>Students should be aware of how timber can be formed into 3D products. They should be able to describe the different processes. They should be able to explain the suitability of the different wasting processes for a range of specific products. **Specific processes to include:**<br>• **laminating**<br>• **steam bending**<br>• machine processes:<br>• turning between centre<br>• use of the chuck and faceplate<br>• milling<br>• routering to produce slots, holes and profiles. | | | |
| What processes are used to form woods? | **L11 Forming, redistribution and addition processes- Wood processes**<br>Knowledge (Component)<br>Students should be aware of how timber can be formed into 3D products. They should be able to describe the different processes. They should be able to explain the suitability of the different wasting processes for a range of specific products. Specific processes to include:<br>• laminating<br>• steam bending<br>• **machine processes:**<br>• **turning between centre**<br>• **use of the chuck and faceplate**<br>• **milling**<br>• **routering to produce slots, holes and profiles.** | | | |
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| What are jigs and fixtures? | **L1 Jigs and fixtures**<br>Knowledge (Component)<br>Students should be aware of how jigs and fixtures can be used to aid the manufacture of products. They should be able to describe them and explain their suitability for accurate and repeated manufacture of products. | | | |
| How do you design & make a jig or fixture? | **L2 Jigs and fixtures**<br>Knowledge (Component)<br>Students should be aware of how jigs and fixtures can be used to aid the manufacture of products. They should be able to describe them and explain their suitability for accurate and repeated manufacture of products. | | | |
| How do you finish paper or board? | **L3 Paper and board finishing**<br>Knowledge (Component)<br>Students should be aware of the ways that paper and board can be finished to enhance their appearance or for improved function. Specific finishes to include:<br>• laminating<br>• embossing<br>• debossing<br>• varnishing, UV varnishing and spot varnishing<br>• foil blocking. | | | |
| What are the main types of printing processes and what are their suitability for scales of production? | **L4 Paper and board printing processes**<br>Knowledge (Component)<br>Students should be aware of the different types of printing processes and their suitability for specific products and scales of production. Specific processes to include:<br>• screen printing<br>• flexographic and offset lithographic printing<br>• digital printing. | | | |
| What are the most common ways to finish polymers? | **L5 Polymer finishing**<br>Knowledge (Component)<br>Students should be aware of the ways that polymers can be finished to enhance their aesthetics or for improved function. Students should be aware | | | |

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| | that some polymers are self-finishing and that this should be considered as a polymer finish. Specific finishes to include:<br>• acrylic spray paints<br>• thermoplastic elastomer.<br>Students should understand how pigments can be added to polymers in the moulding process, including:<br>• gel coats when laminating GRP<br>• smart pigments such as thermochromic or phosphorescent. | | | |
| How are metal paints applied dependent on scales of production? | **L6 Metal finishing**<br>Knowledge (Component)<br>Students should be aware of the ways that metals can be finished to enhance their appearance or prevent corrosion. Including applied finishes:<br>• **cellulose paint**<br>• **acrylic paint**<br>• electro-plating<br>• dip coating<br>• powder coating<br>• galvanising<br>• sealants<br>• preservatives<br>• anodising<br>• plating<br>• coating<br>• cathodic protection. | | | |
| How are polymers used to finish metals? | **L7 Metal finishing**<br>Knowledge (Component)<br>Students should be aware of the ways that metals can be finished to enhance their appearance or prevent corrosion. Including applied finishes:<br>• cellulose paint<br>• acrylic paint<br>• electro-plating<br>• **dip coating**<br>• **powder coating**<br>• galvanising<br>• sealants<br>• preservatives<br>• anodising<br>• plating<br>• coating<br>• cathodic protection. | | | |
| What other forms of barrier protection are used to finish metals? | **L8 Metal finishing**<br>Knowledge (Component)<br>Students should be aware of the ways that metals can be finished to enhance their appearance or prevent corrosion. Including applied finishes:<br>• cellulose paint<br>• acrylic paint<br>• **electro-plating**<br>• dip coating<br>• powder coating<br>• **galvanising**<br>• **sealants**<br>• **preservatives**<br>• **anodising**<br>• **plating**<br>• **coating**<br>• **cathodic protection.** | | | |
| How are varnishes applied dependent on scales of production? | **L9 Wood finishing**<br>Knowledge (Component)<br>Students should be aware of the ways that woods can be finished to enhance their appearance or prevent decay. Specific finishes to include:<br>• applied finished:<br>• **polyurethane varnish**<br>• **acrylic varnish**<br>• water based paints | | | |

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| | • stains<br>• colour wash<br>• wax finishes<br>• Danish oil<br>• teak oil<br>• pressure treating | | | |
| How are water based paints and stains applied dependent on scales of production? | **L10 Wood finishing**<br>Knowledge (Component)<br>Students should be aware of the ways that woods can be finished to enhance their appearance or prevent decay. Specific finishes to include:<br>• applied finished:<br>• polyurethane varnish<br>• acrylic varnish<br>• **water based paints**<br>• **stains**<br>• **colour wash**<br>• wax finishes<br>• Danish oil<br>• teak oil<br>• pressure treating | | | |
| What are alternative forms of finishing woods? | **L11 Wood finishing**<br>Knowledge (Component)<br>Students should be aware of the ways that woods can be finished to enhance their appearance or prevent decay. Specific finishes to include:<br>• applied finished:<br>• polyurethane varnish<br>• acrylic varnish<br>• water based paints<br>• stains<br>• colour wash<br>• **wax finishes**<br>• **Danish oil**<br>• **teak oil**<br>• **pressure treating** | | | |

**Links:**
LG1:
LG2:.
LG3: