

# Year 10 and 11 Design Technology Curriculum Map 2018-19

## Level 1 / 2 Awards- Materials Technology

### AQA (3740)

#### Unit 1: Skills and associated knowledge

##### 1. Preparing materials and selecting hand tools for marking out, cutting and shaping

- Ability to prepare materials in preparation for marking out: • plane a straight edge and face on a piece of timber in order to get a datum point • degrease a piece of sheet steel • measure the thickness of a piece of acrylic with vernier callipers.
- Knowledge of different types of equipment and techniques for preparing and marking out materials: • scribe for marking out on metals • layout fluid • rule for measuring • try square and engineer's for marking lines at 90 degrees and for checking that work is square • mitre square for marking out at 45 degrees • combination square for a range of marking out and measuring functions • sliding bevel for marking out at other angles • dividers • marking gauge for marking out lines parallel to an edge on timber • mortise gauge for marking out parallel lines on timber • odd leg calipers for marking out lines parallel to an edge on sheet metal • centre punches to mark out on metals • an awareness of templates/guides • vernier caliper/micrometer.
- Knowledge and understanding of common hand tools used for cutting and shaping: • sawing using a range of specialist saws for appropriate cuts on relevant materials (tenon saw, coping saw, hacksaw, piercing saw) • chiselling, including using a cold chisel to cut metals, horizontal and vertical paring with a wood chisel, cutting a mortise with a mortise chisel • shearing metal sheet with tinsnips and a guillotine • planing to create a flat surface, and to clean up wood prior to applying a finish • filing metals and plastics including cross filing and draw filing • thread cutting using a tap and die.

##### 2. Forming, bending or laminating

- Learners should be able to demonstrate knowledge and understanding of forming, bending and laminating techniques including: • forming wood by: • kerfing (creating saw cuts on one side of timber to allow it to curve) • laminating veneers or bendy ply layers around a former to create curved wooden shapes • steam bending timber and temporarily clamping it to a former whilst it cools, to retain its shape • forming metals by: • bending bar and/or rod round a former to create curved shapes • folding sheet metals using folding bars and a mallet, and a folding machine • beaten metal including hollowing using a hollowing block and blocking hammer or sandbag and bossing mallet; raising using a stake and planishing hammer • rolling sheet metals into cylindrical shapes by hand in a vice and using a metal rolling machine • vacuum forming to produce complex 3D shapes from thermoplastic sheet and creating successful moulds which are tapered, rounded, and where appropriate have counterbored vent holes • press forming using a yoke and plug to shape materials such as 3mm acrylic • forming polymers by line bending using a strip heater to create bends and curves in thermoplastic polymer sheet.
- Understanding the stages of manufacture of these processes.
- Understanding the advantages and disadvantages of each in order to select the most appropriate method for the chosen material.

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#### 3. Casting or moulding

- Learners should be able to demonstrate knowledge and understanding of casting and moulding techniques including: • die casting including pewter casting into multi part moulds eg made from MDF • sand casting using a pattern in a 2 part moulding box; understanding the importance of draft angle on the pattern, and an allowance for shrinkage • hot glue injection with a hot glue gun to replicate the commercial practice of injection moulding; creating/using a mould for the process • laying up glass reinforced plastic including the use of an accurate polished mould, application of a gel coat, polyester resin stippled into glass fibre matting • blow moulding using a vacuum former to create polymer domes.
- Learners should understand the stages of manufacture of these processes.
- Learners should understand the advantages and disadvantages of each in order to select the most appropriate method for the chosen material.

#### 4. Permanent and non-permanent joining techniques

- Learners should be able to demonstrate knowledge and understanding of permanent and non-permanent joining techniques. Permanent • Welding including arc, MIG and spot welding techniques. • Brazing steel parts together including thorough surface preparation and application of an appropriate flux. • Soldering including soldering electronic parts with a soldering iron, and silver soldering techniques (as used in jewellery making). • Glueing selecting the appropriate adhesive for the materials, and using the correct techniques to achieve the bond, including using PVA, Cyanoacrylate, liquid solvent cement, epoxy resin, contact adhesive. • Riveting including round head, flat head, countersunk, bifurcated and pop-riveting. Non-permanent • Nuts and bolts. • Screwed fastenings and nails. • Knock down fittings.
- Understanding how to apply these techniques to a range of materials.
- Understanding the advantages and disadvantages of each in order to select the most appropriate method for the chosen material.

#### 5. Machining and the use of power tools including the use of Computer Aided Manufacture (CAM)

- Learners should be able to demonstrate knowledge and understanding of machining, the use of hand held power tools and CAM for the processes of: • drilling using cordless and pillar drills, CNC routers • cutting using bandsaws, jigsaws, fret saws, vinyl cutter, laser cutter • turning using wood and metal lathes, CNC lathes • routing using power router and CNC router • milling using horizontal and vertical milling machine and CNC mill • 3D printing.
- Understanding the stages of manufacture of these processes.
- Understanding the advantages and disadvantages of each in order to select the most appropriate method for the chosen material.

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#### 6. Quantity production including quality assurance and quality control

- Learners should be able to demonstrate knowledge and understanding of techniques used to ensure accuracy when manufacturing in quantities.
- Learners need to understand and use a range of quality assurance techniques including:
  - jigs to assist with repeated tasks eg drilling holes in parts
  - moulds eg vacuum forming moulds and moulds for casting parts
  - templates to assist marking out parts
  - fences to guide machinery, eg to guide a power router, to make a parallel cut on a bandsaw
  - stops to limit the depth of a hole or cut
  - formers including those used to achieve consistent curves and bends in acrylic sheet
  - working to tolerance.
- Learners need to understand and use a range of quality control techniques including:
  - sampling
  - visual inspection using gauges and measuring equipment.
- Understanding the benefits of each technique in order to select the most appropriate.

#### 7. Using finishing techniques

- Learners should be able to demonstrate knowledge and understanding of a range of finishing techniques (and the steps needed to achieve high quality finishes) including:
  - surface preparation appropriate to the material eg filling, sanding and planing wood, filing metals, degreasing steel sheet, etching, priming
  - staining timber surfaces
  - spraying metal and wooden surfaces
  - painting by brush and roller to achieve gloss, matt and silk finishes
  - plastic dip coating of metal parts
  - varnishing wooden surfaces
  - preservatives used to repel water, eg oils for hardwoods and decorative preservatives for sheds and fencing
  - polishing
  - waxing.

#### 8. Teamwork

- Knowledge and understanding of the key elements of teamwork and how these can be applied in real contexts.
- Working to create an outcome as a member of a team.
- Participation and collaboration with others, communication, following instructions, time management
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## Unit 2: Extended making project

### 1. Selecting and justifying appropriate materials

- Learners should know and understand the properties of materials to enable them to select appropriately. Learners must study a range of materials and consider their suitability in the environment they will be used.

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- Learners should be able to discriminate between a range of materials according to their working properties and cost.

#### **2. Selecting and justifying appropriate processes**

- A range of different processes to enable them to select appropriately.
- Learners must study a range of processes and consider their suitability for the manufacture of a specific product.
- Learners should be able to discriminate between a range of processes according to their suitability for materials and the intended environment for the product, time and cost.

#### **3. Selecting and justifying appropriate joining techniques**

- Learners should know and understand a range of joining techniques to enable them to select appropriately.
- Learners must study a range of joining techniques and consider their suitability for the manufacture of a specific product.
- Learners should be able to discriminate between a range of joining techniques according to their suitability for materials and the intended environment for the product, time and cost.

#### **4. Selecting and justifying appropriate finishes**

- Learners should know and understand a range of finishes to enable them to select appropriately.
- Learners must study a range of finishes and consider their suitability for the manufacture of a specific product.
- Learners should be able to discriminate between a range of finishes according to their suitability for materials and the intended environment for the product, time and cost.

#### **5. Planning for manufacture**

- Learners should be able to:
  - draw upon and recognise the needs of the client when planning for manufacture
  - select the most appropriate processes and techniques to make a high quality practical outcome
  - generate a manufacturing specification that includes measurable constraints to help guide them through the manufacture of their practical outcomes
  - understand and use appropriate materials, quantities, sizes and tolerances
  - plan a sequence to enable manufacture
  - develop and adapt existing working drawings and plans using 2D and 3D CAD packages
  - to ensure a high quality outcome is produced.
- Learners should be able to produce and interpret the following elements of a manufacturing specification:
  - flow diagrams
  - working drawings
  - parts list
  - cutting

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list • material costings • assembly diagrams/exploded diagrams • plan of manufacture.

#### 6. Health and safety issues

- Learners should know and understand: • how to use tools, equipment and machinery safely • the risks associated with materials and processes and measures to minimise hazards.
- Learners should know and understand the importance of the following: • Control of Substances Hazardous to Health (COSHH) • Safety symbols/workplace signage • Personal Protective Equipment (PPE)

#### 7. Communication skills

- Learners should be able to communicate their decisions effectively using a range of techniques appropriate to the audience.
- Learners should have knowledge and understanding of the following skills: • verbal • written (including electronic documents and data, activity logs, meeting minutes) • effective listening • respect for others' opinions • negotiation • assertiveness • providing feedback.

#### 8. Communication skills

- Learners should be able to communicate information using technical drawings including CAD.
- Learners should have the knowledge and understanding of: • sketching in isometric and orthographic projections • sectional and exploded sketches • the use of 2D and 3D representations using CAD software.

### Unit 3: Fundamentals of materials technology

#### 1. Metals and alloys.

- Learners should know and understand: • the physical properties and working characteristics of metals and alloys • the advantages and limitations of metals and alloys • how metals and alloys can be combined to make best use of several desirable properties • common products manufactured from metals and alloys and the rationale for choosing these materials.
- Learners must study the following metals and alloys and know their classifications: • ferrous metals: • cast iron • low-carbon steel • medium-carbon steel • high-carbon steel • non-ferrous metals: • aluminium • copper • zinc • gold • silver • tin • stainless steel • brass • bronze.

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#### 2. Timber and timber-based composites.

- Learners should know and understand:
  - the advantages and limitations of timber and timber based composites
  - physical properties and working characteristics of timber and timber based composites
  - how materials can be combined to make best use of several desirable properties
  - common products manufactured from timber and timber-based composites. Learners must study the following timber and timber based-composites and know their classifications:
    - hardwood: • beech • oak • ash • mahogany • teak
    - softwoods: • spruce • pine • cedar
    - manufactured board • MDF • plywood • particle board • hardboard • OSB board.

#### 3. Polymers and polymer-based composites.

- Learners should have knowledge of:
  - the advantages and limitations of polymers and polymer based composites
  - physical properties and working characteristics of polymers and polymer based composites
  - how materials can be combined to make best use of several desirable properties
  - common products manufactured from polymers and polymer based composites.
- Learners must study the following polymers and polymer-based composites and know their classifications:
  - Thermoplastics: • Acrylic (PMMA) • High-Density Polythene (HDPE) • Low-Density Polythene (LDPE) • High-Impact Polystyrene (HIPS) • Polypropylene (PP) • Acrylonitrile Butadiene Styrene (ABS) • Polyethylene Terephthate (PET) • Polyvinyl Chloride (PVC) • Polylactic acid (PLA).
  - Thermosetting plastics: • Melamine Formaldehyde (MF) • Urea Formaldehyde (UF) • Polyester resins • Epoxy resins.
  - Elastomers: Silicon Rubber
  - Composites: • Carbon-fibre reinforced plastics (CFRP) • Glass reinforced plastics (GRP).

#### 4. Properties and working characteristics of:

- - metals and alloys
  - timber and timber-based composites
  - polymers and polymer-based composites.
- Learners should have knowledge of the following properties and working characteristics:
  - hardness
  - toughness
  - impact resistance
  - ductility
  - malleability
  - thermal and electrical conductivity
  - chemical resistance
  - corrosion resistance
  - durability.

#### 5. Processes and manufacture

- Learners should be able to select the appropriate preparation process for specific materials and understand the stages involved. Learners should study the following preparation processes:
  - seasoning
  - conversion
  - planning
  - cutting
  - degreasing.

#### 6. Marking and measurement.

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- Learners should understand the importance of accuracy when marking out material and the importance of working to tolerances.
- Learners should understand the appropriate use of the following equipment for marking and measuring: • rule • try square • dividers • marking gauge • mortise gauge • mitre square • scribe • punches • layout fluid • an awareness of templates/guides • vernier caliper/micrometer.

#### 7. Using hand tools, power tools and machinery.

- Learners should be able to select the appropriate tools, equipment and machinery to produce high quality practical outcomes. • they should be able to identify appropriate manufacturing processes to create a desired outcome when using specific materials.
- Learners should know and understand the following processes: • cutting • thread cutting • under 'cutting' • drilling • shearing • shaping • forging • punching • turning • routing/milling • forming • folding/rolling/bending • press forming • vacuum forming • line bending • laminating • steam bending.

#### 8. Casting and moulding.

- Learners should be able to: • select the appropriate tools, equipment and machinery to produce high quality, practical outcomes. • identify appropriate manufacturing processes to create a desired outcome when using specific materials.
- Learners should know and understand: • additive/subtractive/redistribution methods of manufacture • the following specific processes: • die casting in pewter • sand casting in aluminium • injection moulding • blow moulding • Glass Reinforced Polymer (GRP).

#### 9. Heat treatment.

- Learners should know and understand that working characteristics of materials can be changed by heat treatment.
- Learners should know and understand specific heat treatments including: • annealing • hardening • tempering.
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#### 10. Computer Aided Manufacture (CAM).

- Learners should be able to: • understand Computer Aided Manufacture (CAM), its benefits, associated problems and appropriate use • select the appropriate tools, equipment and machinery to produce high quality practical outcomes • identify appropriate manufacturing processes to create a desired outcome when using specific materials.

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- Learners should know and understand the appropriate use of the following equipment: • vinyl cutter • laser/plasma cutting • turning • milling/routing • 3D printing.

#### 11. Joining, components, adhesives and finishes

- Learners should know and understand: • how to prepare material and select the most appropriate joining method to produce a practical outcome • permanent and non-permanent joining methods.
- Learners should know and understand the following joining techniques: • soldering (soft/hard) • brazing • riveting • welding Wood joints • carcass: • housing • rebate • dovetail • comb • butt • dowel • frame joints • mitre • mortise and tenon.

#### 12. Components.

- Learners should have an awareness of commonly used, knock-down fittings.
- Learners should know and understand the appropriate use of the following components: • nuts • bolts • washers • screws • nails • hinges • rivets • knock-down (KD) fittings

#### 13. Adhesives.

- Learners should be able to select an appropriate adhesive for a material and understand the most effective methods of material preparation and application.
- Learners should know and understand the appropriate use of the following adhesives: • Polyvinyl Acetate (PVA) • cyanoacrylate • liquid solvent cement • epoxy resin • contact adhesive.

#### 14. Finish.

- Learners should be able to: • select an appropriate finish for a material and understand the most effective methods of material preparation and application • understand that a material's durability and aesthetics can be altered by applying a particular finish • understand that a manufactured board can have a laminate or veneer applied.
- Learners should know and understand the appropriate use of the following finishes: • surface preparation • application of finish. Metal: • primers • paints • dip coating • galvanising • anodising • polishing • enamelling. Wood: • stain • preservatives • polishes • varnish • oils • wax • undercoat • paint • veneers • laminates. Plastic (polishing)

#### 15. Commercial practice

- Learners should have knowledge of a range of different commercial manufacturing process.



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- Learners should be familiar with the following commercial manufacturing processes.
  - Timber based materials: • laminating • steam bending • CNC routing • spray finishing.
  - Metal based materials: • CNC turning • CNC milling • sand casting • die casting • robotic welding • powder coating • galvanising • anodising • robotic spray painting.
  - Polymers: • line bending • vacuum forming • injection moulding • blow moulding • extrusion • compression moulding • calendaring • over moulding • rapid prototyping.

#### 16. Quality control.

- Learners should know and understand:
  - the measures that can be taken to ensure accuracy when manufacturing in volume
  - that products can be tested throughout manufacture and before use to provide customer reassurance.
- Learners should understand the appropriate use of the following to ensure accuracy in manufacturing:
  - jigs
  - moulds
  - templates

#### 17. Testing and inspection.

- They should understand that the quality of a product can be affected by the initial material selection, eg faults in wood and variation in material thickness.
- Learners should know and understand the appropriate use of the following for testing purposes:
  - go/no go gauges
  - sampling
  - measuring to working tolerances
  - non-destructive testing.

#### 18. Commercial use of CAM.

- Learners should know and understand:
  - the role that CAM plays in commercial manufacture
  - the processes needed to turn a Computer Aided Design (CAD) drawing into a file capable of being read by a CAM machine with an awareness of feed speeds and power settings where Computer Aided Manufacture (CAM) outputs are being used.
- Learners should know and understand the following uses:
  - CNC Centre lathe
  - CNC Milling machine
  - CNC Plasma cutter
  - laser cutter
  - 3D Router
  - 3D Printer
  - vinyl cutter.

#### 19. Scales of production.

- Learners should understand that products are produced to meet differing volumes of demand.
- Learners should be familiar with the following scales of production:
  - one-off
  - batch
  - continuous

#### 20. Commercial manufacturing systems.

- Learners should understand how efficiency of manufacture is related to scale of production
  - they should be familiar with the scales of production and be able to identify the most appropriate method of manufacture for common products.

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- Learners should be familiar with the following commercial manufacture systems: • just in time • lean manufacture • cell production • assembly lines.

#### 21. Safe working practices.

- Learners should understand how to observe health and safety regulations when working with materials, components and machinery.
- Learners should know and understand the importance of the following: • maintenance of machinery and tools • Portable Appliance Testing PAT testing • well-ordered workspace • Health and Safety Executive (HSE) guidelines • control of substances hazardous to health.
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#### 22. Sources of material.

- Learners should understand the environmental and sustainability issues associated with the sourcing of materials and manufacturing products.
- They should be familiar with the following sources of materials: • sustainable sources of material: Forest Stewardship Council (FSC) timber • stock forms • boards, planks, mouldings, dowels and veneers • rod, strip, tube, bar, angle and sheet.

#### 23. Product Life Cycle Learners should be aware of:

- Measures being taken to limit the environmental impact of manufacturing products • the need for products to be constructed to consider maintenance in order to increase their lifespan.
- Learners should be aware of the following considerations in commercial manufacture: • source • manufacture • disposal • environmental impact.

#### 24. Careers opportunities

- Career opportunities and employment in materials technology.
- Learners should understand that there are a variety of opportunities to work in areas related to materials technology.
- Learners should have an understanding of the different roles.