# A Level Bridging Work 2020-2021

## *A Level Product Design*

The tasks below are designed to support you as you prepare to start A Level *Product Design*.

These tasks have been developed to build on your GCSE knowledge and help with the transition into sixth form, using your time wisely over the coming months to ensure you maintain a level of education that will be needed to be successful in your subject when you enroll into the sixth form in August/September.

Please use this document to research areas that will benefit you when you are studying your A Level courses both Product design and Engineering

**(P511) Manufacturing Primary Forming Processes**

**Metal moulding processes**

- Casting processes:
  - Sand casting, including:

Characteristics, e.g. Suitable for high melting point alloys, complex geometry, rough surface finish

    - Applications, e.g. Engine blocks, pump housings and valves
  - Die (gravity, pressure) casting, including:

Characteristics, e.g. Good dimensional accuracy, smoother surface finish and improved mechanical properties

    - Applications, e.g. Cylinder heads, brackets and gas turbine engine parts
  - Investment casting, including:
    - Characteristics, e.g. Suitable for most metallic materials, complex geometry and smooth surface finish applications, e.g. Exhaust manifolds, turbine blades and brass connectors.
- Metallic materials applicable to process, including:
  - Ferrous, e.g. Carbon steels, stainless steels, cast iron
  - Non-ferrous, e.g. Aluminium, copper, brass, zinc, titanium, alloys.
- The function of additives, e.g. Pig iron, scrap, ore, ingots, recycled material, metal composition, trace elements, coke, limestone.
- Mould features, including patterns, cores, dies, moulding parts (boxes, sand, reinforcements, releasing agents, runners, risers, sprues).
- Component removal and finishing, including knock out, ejection and fettling.
- Sustainability of casting processes, including use of coal fired or electric furnaces, water contamination, fumes and particle release and raw material extraction.

| Sand casting | | | | | | |
|---|---|---|---|---|---|---|
| Image of the process | Images of the types of products made using this process | How you can tell that the product has been made using this process? | Step by step description of the process in bullet point form | Advantages | Disadvantages | Any health and safety aspects relating to the process |
| | Turbo charger housing  Pipe support bracket | A sand casting looks rough and grainy because the aluminum is poured into a hole dug into sand or similar material Describe how you could tell by looking ant or touching a product how it was made | 1. Make a pattern for the product that you a wanting to make<br>2. Place a pattern in sand to create a mold.<br>3. Incorporate the pattern and sand in a gating system.<br>4. Remove the pattern.<br>5. Fill the mold cavity with molten metal. | • Inexpensive<br>• Complex shapes can be made<br>• Large components can be made | • Sand moulds can only be used once<br>• Surface finish not always good<br>• Labour intensive<br>• Slow production rate | • There are fume hazards from the metals, alloys and fluxes used to melt and pour into the **sand**.<br>• The binders in the **sand** may be quite toxic, and when hot metal hits them, can generate toxic fumes,<br>• Hot molten meta |

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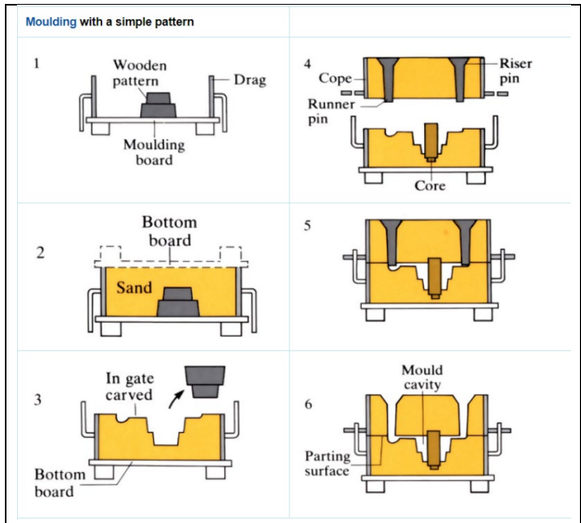
|  |  | | 6. Allow the metal to cool.<br>7. Break away the sand mold and remove the casting.<br>Imagine that you were telling someone who the process is carried out | | | • Moisture in the sand can make the mold explode when molten mettle is poured in<br>Heavy materials<br>This is not extensive but an outline of at least 5 key health and safety areas |

**Ceramic moulding processes**

- Sintering, including:
  - Characteristics, e.g. Suitable for high melting point ceramics, complex geometry,
- Good dimensional accuracy
  - Applications, e.g. Gears, carbide tip tools and driveshaft's
- Injection moulding, including
  - Characteristics, e.g. Excellent batch to batch repeatability, high surface finish quality,
- High hardness and mechanical strength
  - Applications, e.g. Diagnostic equipment, surgical instruments and bearings.
- Ceramic materials applicable to process, e.g. Metallic carbides, nitrides, oxides.
- Powder metallurgy (pm), including blending and compacting.
- Secondary process operations, including infiltration, sizing, coining, machining,
- Impregnation, plating, heat treatment.
- Sustainability of ceramic moulding processes, including use of coal fired or electric
- Furnaces, water consumption during processing, particle release and raw material extraction.

| Sintering | | | | | | |
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| Image of the process | Images of the types of products made using this process | How you can tell that the product has been made using this process? | Step by step description of the process in bullet point form | Advantages | Disadvantages | Any health and safety aspects relating to the process |
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**Polymer moulding processes**

- Compression moulding, including:
  - Characteristics, e.g. Low-cost tooling, suitable for thermoset materials, Suitable for small manufacturing volumes
  - Applications, e.g. Wellington boots, seals and gaskets

| Compression moulding | | | | | | |
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| Image of the process | Images of the types of products made using this process | How you can tell that the product has been made using this process? | Step by step description of the process in bullet point form | Advantages | Disadvantages | Any health and safety aspects relating to the process |
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- Transfer moulding, including:
  - Characteristics, e.g. High cavity count, design flexibility, short manufacturing cycle
  - Applications, e.g. Rubber face seals for gas valves and connector seals for spark plug leads

| Transfer moulding | | | | | | |
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| Image of the process | Images of the types of products made using this process | How you can tell that the product has been made using this process? | Step by step description of the process in bullet point form | Advantages | Disadvantages | Any health and safety aspects relating to the process |
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- Injection moulding, including:
  - Characteristics, e.g. Suitable for mass manufacturing, good dimensional accuracy,
  - Complex geometry
  - Applications, e.g. Refuse bins, chair seats and toolboxes

| Injection moulding | | | | | | |
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| Image of the process | Images of the types of products made using this process | How you can tell that the product has been made using this process? | Step by step description of the process in bullet point form | Advantages | Disadvantages | Any health and safety aspects relating to the process |
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- Rotational moulding, including:
  - Characteristics, e.g. Suitable for the manufacture of large hollow products,
  - Minimal material wastage, multi-layered products are possible
  - Applications, e.g. Large storage tanks, toys and leisure craft

Rotational moulding

| Image of the process | Images of the types of products made using this process | How you can tell that the product has been made using this process? | Step by step description of the process in bullet point form | Advantages | Disadvantages | Any health and safety aspects relating to the process |
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- Blow moulding, including:
  - Characteristics, e.g. One piece construction is achieved, suitable for low and
  - High manufacturing volumes of hollow products
  - Applications, e.g. Containers, drinks bottles and toys.

| Blow moulding | | | | | | |
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| Image of the process | Images of the types of products made using this process | How you can tell that the product has been made using this process? | Step by step description of the process in bullet point form | Advantages | Disadvantages | Any health and safety aspects relating to the process |
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- Polymer materials applicable to process:
  - Thermoplastics, e.g. Acrylonitrile butadiene styrene (ABS), polymethyl methacrylate
  - (acrylic), polystyrene, polyethylene, nylon, and polypropylene
  - Thermosetting plastics, e.g. Bakelite, melamine formaldehyde, epoxy resin,
  - Polyester resin and urea formaldehyde.
- The function of additives, e.g. Stabilisers, flame retardants, fillers (cotton flock, fibres, mica, graphite, wood flour), plasticisers, antistatic, colorants, lubricants.
- Mould features, including two plate, three plate, combination/composite, split, unscrewing.
- Moulding parameters, including temperature, pressure, speed/timings, distance, flashing, short shot, distortion, burning, colour deviation.
- Sustainability of polymer moulding processes, including use of electricity, refining of petroleum, recycling materials and recovering energy through waste incineration.

**Metal deformation processes**

- Extrusion, including:
  - Types, e.g. Direct, indirect, and impact
  - Characteristics, e.g. Elongated grain structure, good dimensional accuracy and high geometric change of work piece
  - Applications, e.g. Box section, tubing and window frames

| Extrusion | | | | | | |
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| Image of the process | Images of the types of products made using this process | How you can tell that the product has been made using this process? | Step by step description of the process in bullet point form | Advantages | Disadvantages | Any health and safety aspects relating to the process |
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- Forging, including:
  - Types, e.g. Drop, pressure, and upset
  - Characteristics, e.g. Uniform grain flow, low operational costs and high mechanical strength
  - Applications, e.g. Crankshafts, hand tools and golf clubs

| Forging | | | | | | |
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| Image of the process | Images of the types of products made using this process | How you can tell that the product has been made using this process? | Step by step description of the process in bullet point form | Advantages | Disadvantages | Any health and safety aspects relating to the process |
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- Rolling, including:
  - Types, e.g. Hot and cold
  - Characteristics, e.g. Wide range of material thicknesses produced, high hardness and
  - Mechanical strength
  - Applications, e.g. Lintels, flat bar and sheet material

| Rolling | | | | | | |
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| Image of the process | Images of the types of products made using this process | How you can tell that the product has been made using this process? | Step by step description of the process in bullet point form | Advantages | Disadvantages | Any health and safety aspects relating to the process |
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- Presswork, including:
  - Types, e.g. Forming, bending, deep drawing
  - Characteristics, e.g. Suitable for mass manufacturing, good dimensional accuracy
  - And use with sheet material
  - Applications, e.g. Car body panels, brackets and computer hardware panels

| Presswork | | | | | | |
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| Image of the process | Images of the types of products made using this process | How you can tell that the product has been made using this process? | Step by step description of the process in bullet point form | Advantages | Disadvantages | Any health and safety aspects relating to the process |
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- Metal spinning, including:
  - Types, e.g. Shear, internal and external tube
  - Characteristics, e.g. Low volume, low set-up costs and high surface finish quality
  - Applications, e.g. Ornaments, saucepans and musical instruments.

| Metal spinning | | | | | | |
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| Image of the process | Images of the types of products made using this process | How you can tell that the product has been made using this process? | Step by step description of the process in bullet point form | Advantages | Disadvantages | Any health and safety aspects relating to the process |
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- Metals applicable to process, including:
  - Ferrous, e.g. Carbon steels and stainless steels
  - Non-ferrous, e.g. Aluminium, copper and brass.

(P499) **Manufacturing Secondary Machining Processes**

Examine the technology and characteristics of secondary machining processes that are widely used in industry

**Traditional secondary machining processes**

Drilling:

- Machine type and batch size, including single spindle machines, e.g. Pillar
- (one-off to small batch sizes) and radial (small to medium batch sizes)
- Features of the component, e.g. Countersinking, counterboring, spot facing, taping,
- Holes (including through, blind and reamed holes)
- Accuracy of components – typical dimensional tolerances = ±0.3 mm to ±0.05 mm and typical surface texture = 6.3 µm to 1.6 µm.

| Drilling |
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| Image of the process | Images of the types of products made using this process | How you can tell that the product has been made using this process? | Step by step description of the process in bullet point form | Advantages | Disadvantages | Any health and safety aspects relating to the process |
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Turning:

- Machine type and batch size, including centre lathe (one-off to small batch size) and turret (small to large batch size)
- Features of the component, e.g. Flat faces, diameters (including parallel, stepped and tapered diameters), holes (including drilled, bored and reamed holes), profile forms, threads, parting off, chamfers, knurls, undercuts
- Accuracy of components – typical dimensional tolerances = ±0.05 mm to ±0.0125 mm and typical surface texture = 3.2 µm to 0.8 µm.

| Turning | | | | | | |
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| Image of the process | Images of the types of products made using this process | How you can tell that the product has been made using this process? | Step by step description of the process in bullet point form | Advantages | Disadvantages | Any health and safety aspects relating to the process |
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Milling:

- Machine type and batch size, including horizontal (one-off to small batch size), vertical (one-off to small batch size), universal (one-off to small batch size)
- Features of the component, e.g. Faces, steps/shoulders, slots, holes, and profile forms
- Accuracy of components – typical dimensional tolerances = ±0.1 mm to ±0.025 mm and typical surface texture = 3.2 µm to 0.8 µm.

Milling

| Image of the process | Images of the types of products made using this process | How you can tell that the product has been made using this process? | Step by step description of the process in bullet point form | Advantages | Disadvantages | Any health and safety aspects relating to the process |
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Grinding:

- Machine type and batch size, including surface (one-off to small batch size), cylindrical (one-off to small batch size), centreless (medium to large batch size),
- Universal (one-off to small batch size)
- Features of the component, e.g. Faces, slots, diameters and bores
- Accuracy of components – typical dimensional tolerances = ±0.0125 mm to
- ±0.002 mm and typical surface texture = 0.8 µm to 0.2 µm.

| Grinding | | | | | | |
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| Image of the process | Images of the types of products made using this process | How you can tell that the product has been made using this process? | Step by step description of the process in bullet point form | Advantages | Disadvantages | Any health and safety aspects relating to the process |
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**Specialist secondary machining processes**

- Presswork:
  - Machine type and batch size, including single action (small to medium batch size), Multiple action (medium batch to mass manufacturing)
  - Features of the component, e.g. Blanking, notching, piercing, cropping/shearing, Bending/forming
  - Accuracy of components – typical dimensional tolerances = ±0.3 mm to ±0.05 mm.

| Presswork | | | | | | |
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| Image of the process | Images of the types of products made using this process | How you can tell that the product has been made using this process? | Step by step description of the process in bullet point form | Advantages | Disadvantages | Any health and safety aspects relating to the process |
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- Electro discharge:
  - Machine type and batch size, including spark erosion (small to large batch size), Wire erosion (small to large batch size)
  - Features of the component, e.g. Holes, faces, forms and other features (including engraving, cavities, radii/arcs, slots)
  - Accuracy of components – typical dimensional tolerances = ±0.1mm to ±0.05mm And typical surface texture = 6.3 µm to 0.4 µm.

| Electro discharge | | | | | | |
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| Image of the process | Images of the types of products made using this process | How you can tell that the product has been made using this process? | Step by step description of the process in bullet point form | Advantages | Disadvantages | Any health and safety aspects relating to the process |
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- Broaching:
  - Machine type and batch size, including horizontal (one-off to medium batch size), vertical (one-off to medium batch size)
  - Features of the component, e.g. Keyways, holes, and splines
  - Accuracy of components – typical dimensional tolerances = ±0.05mm to ±0.01mm and typical surface texture = 6.3 µm to 0.4 µm.

| Broaching | | | | | | |
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| Image of the process | Images of the types of products made using this process | How you can tell that the product has been made using this process? | Step by step description of the process in bullet point form | Advantages | Disadvantages | Any health and safety aspects relating to the process |
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- Honing and lapping:
  - Machine types and batch size, including horizontal and vertical honing (one-off to medium batch size) and rotary disc and reciprocating lapping (one-off to medium batch size)
  - Features of the component, e.g. Holes, faces accuracy of components – typical dimensional tolerances = ±0.01 mm to ±0.005 mm and typical surface texture = 0.2 µm to 0.03 µm.

| Honing and lapping | | | | | | |
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| Image of the process | Images of the types of products made using this process | How you can tell that the product has been made using this process? | Step by step description of the process in bullet point form | Advantages | Disadvantages | Any health and safety aspects relating to the process |
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●Welding

| Honing and lapping | | | | | | |
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| Image of the process | Images of the types of products made using this process | How you can tell that the product has been made using this process? | Step by step description of the process in bullet point form | Advantages | Disadvantages | Any health and safety aspects relating to the process |
| MIG welding | | | | | | |

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| TIG Welding | | | | | | |
| Arc Welding | | | | | | |
| Brazing | | | | | | |

Technical principles

- Principles of industrial manufacturing systems across a range of scales of production to include

| Key terms / knowledge | Description | Example | Staffing needs | Advantages | Disadvantages |
|---|---|---|---|---|---|
| Mass | | | | | |
| Batch | | | | | |
| One-off | | | | | |
| Just in Time (JIT) | | | | | |
| Bought-in | | | | | |
| Standardised part assembly | | | | | |
| Prototyping | | | | | |
| Modular | | | | | |

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| Batch | | | | | |
| High volume production | | | | | |

- Health and safety

| Key terms / knowledge | Description | Example | The protection offered by each | Advantages | Disadvantages |
|---|---|---|---|---|---|
| Patents | | | | | |
| Registered Designs | | | | | |
| Design Right | | | | | |
| Registered Trade Marks | | | | | |
| Copyright | | | | | |

- Intellectual Property

| Key terms / knowledge | Description | Example | For your example what information is provided |
|---|---|---|---|
| Health and Safety at Work Act (HASAW) | | | |
| Control of Substances Hazardous to Health (COSHH) | | | |
| Personal Protective Equipment at Work Regulations (PPE) | | | |

- Needs and demands of consumers

| Key terms / knowledge | Description | Example | Advantages | Disadvantages |
|---|---|---|---|---|
| Technology push | | | | |
| Market-pull | | | | |
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- Static and dynamic forces in structures

| Key terms / knowledge | Description | Example |
|---|---|---|
| Dynamic forces in structures | | |
| Dynamic forces in structures | | |
| Tension forces | | |
| Compression forces | | |
| Torsion | | |
| Bending force | | |

- Energy sources, energy storage, transmission, and utilisation

| Key terms / knowledge | Description | Use | Example | Advantages | Disadvantages |
|---|---|---|---|---|---|
| Fossil fuels | | | | | |
| Nuclear fuels, | | | | | |
| Sola | | | | | |
| Hydro | | | | | |

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| Wind generation | | | | | |

- Materials

| Material type | Description | Properties | Structure | Used in | Example | Advantages | Disadvantages |
|---|---|---|---|---|---|---|---|
| Metal | | | | | | | |
| Mild steel | | | | | | | |
| High carbon steel | | | | | | | |
| Cast iron | | | | | | | |
| Alloys | | | | | | | |
| Stainless steel | | | | | | | |
| Nickel alloys | | | | | | | |
| Aluminum alloys | | | | | | | |
| Aluminum | | | | | | | |
| Aluminum | | | | | | | |
| Composites | | | | | | | |
| Fiberglass | | | | | | | |
| Carbon fiber | | | | | | | |
| GRP (glass reinforced plastic) | | | | | | | |
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| Plastics | | | | | | | |
| Acrylic | | | | | | | |
| Wood | | | | | | | |
| Hardwood | | | | | | | |
| Softwood | | | | | | | |
| Manufactured board | | | | | | | |
| Natural polymers | | | | | | | |
| Animal: wool | | | | | | | |
| Insect: Silk | | | | | | | |
| Plant: Cotton | | | | | | | |
| Manufactured polymers | | | | | | | |
| Regenerated: | | | | | | | |
| Viscose | | | | | | | |
| Acetate | | | | | | | |
| Synthetic; | | | | | | | |
| Polyester | | | | | | | |
| Lycra | | | | | | | |
| Microfibers | | | | | | | |
| Tactel | | | | | | | |
| Lyocel | | | | | | | |