Teachers' Notes

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Meeting the Specifications

Each of the Make Assignments is designed to take approximately one half term, or eight weeks. This is dependant upon the curriculum time allocated per week. A model of approximately four hours per week has been assumed.

In these assignments students will make engineered products. They will develop their understanding of the process of designing a product and producing it.

Students will:

- use product specifications;
- read and interpret engineering drawings and diagrams;
- select suitable materials, parts and components for a product;
- create a production plan;
- use processes, tools and equipment, including Computer Aided Manufacture (CAM), required to make an engineered product;
- check the quality of their work conforms to the standards required;
- apply health and safety procedures.

They should also bring to their projects, knowledge they have gained in other areas, such as mathematical and scientific skills. The knowledge gained from Unit 1: *Design and graphical communication* and Unit 3: *Application of technology*; should also be borne in mind throughout these assignments.

Although these assignments are based upon the requirements for the Applied GCSE in Engineering, particularly Unit 2: *Making Engineered Products*, students may produce evidence against assessment criteria for other subjects, i.e. Applied GCSE in Manufacturing, GCSE Design and Technology, Key Skills, Applied GCSE in ICT.

These assignments will also help students progress to some of the units in VCE Engineering.

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Vocational Relevance

Using a product specification

To make an engineered product, the specific requirements for all the different parts of the product must be decided upon before embarking on the manufacturing phase. This information is contained within a product specification and working drawings and/or diagrams.

Most of this information for these assignments is available in the associated Make Assignment, however it is expected that students will carry out some investigation of their own. These assignments are related to the Design Assignments, produced for Unit 1. If students have worked through the Design Assignment they will have a detailed specification for the item, or some relevant research that they can use for these assignments.

If the students have not worked through the Design Assignments, they should be provided with a product specification, or develop their own from the associated Make Assignment.

Students need to be able to understand and use the information in the product specification to make decisions about the development of a product. They must learn how to use a product specification and be able to recognise the following essential information required for a product:

- size, shape, form;
- materials, parts and components;
- process methods, where these are specified;
- quantity required, for example single unit, batch and volume production;
- timescales.

Production planning

The production plan gives all the details required to make the product. Students must be able to produce a production plan for their product. The production plan will give information about:

- materials, parts and components to be used;
- processes to be used;
- tools, equipment and machinery to be used;
- the sequence of production including critical production and quality control points;
- production scheduling including realistic deadlines;
- how quality will be checked and inspected;
- health and safety factors.

Students must be able to modify their plans as circumstances change, or if the necessary materials or processes are unavailable.

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Choosing materials, parts and components

Students must learn how to select materials and components with suitable characteristics and properties to meet a product specification.

Materials and their properties may be considered in the following groups:

- ferrous and non-ferrous metals and alloys;
- polymers, such as thermosetting polymers and thermoplastic polymers;
- ceramics;
- composites which combine the properties of different materials, e.g. bi-metal strips, carbon composites and sintered metals.

Students must learn to recognise and understand the function of mechanical, electrical/electronic and pneumatic/hydraulic parts and components and be able to select and use appropriate parts and components for the development of an engineered product, including:

- mechanical components, such as nuts, bolts, screws, springs, rivets, pins, clips, keys and drive mechanisms including gear trains;
- electrical/electronic components, such as resistors, capacitors, diodes, LEDs, bulbs, wire, cable, insulators, batteries, motors, buzzers, variable resistors, thermistors, transistors and integrated circuits;
- pneumatic/hydraulic components, such as directional and flow control valves, cylinders, reservoirs and filters.

The materials and components available have properties, characteristics and features that may affect their choice. Students must learn to appreciate these when selecting and using appropriate materials for their product(s). These properties, characteristics and features might include:

- ability to be shaped and formed, for example by hammering, casting, forging, forming, bending and coiling;
- ability to be treated, for example by heat or chemicals;
- ability to be given a surface finish, for example by painting or chrome plating;
- ease of handling, for example by being small, light, no sharp edges;
- cost, for example the relative cost compared with other alternative materials and components;
- availability, form and supply; for example by being available in standard sizes and standard values.

Using processes

For the chosen product students must be able to use the following processes and to understand their importance for functional and aesthetic reasons:

- material removal, such as turning, drilling, etching, milling and grinding;
- shaping and manipulation, such as hammering, forming and bending;

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- joining and assembly, such as crimping, soldering, adhesion, wiring, threaded fasteners, welding and brazing;
- heat and chemical treatment, such as annealing, tempering, hardening, etching, plating;
- surface finishing, such as polishing and coating.

Quality control techniques

Students must be able to inspect, test, measure and compare engineered products to their product specification to ensure that they comply with the standards required. Important features in a specification include:

- the dimensions;
- the tolerances;
- the fit;
- the finish;
- the performance;
- the quality.

Tools and equipment

Students must learn to select and use appropriate tools and equipment, including Computer Aided Manufacture (CAM), needed for producing an engineered product. Their selection should take account of availability, cost, ease of handling, properties of materials and components. Students must also learn to care for tools and equipment and to maintain them where appropriate.

Health and safety

Students must be aware of health and safety issues relating to the use of materials, components, tools and equipment required for their engineering activities. These usually include:

- taking reasonable care of themselves and others in an engineering environment;
- wearing appropriate clothing and using safety equipment as appropriate;
- carrying out risk assessments;
- following health and safety procedures and instructions;
- keeping a safe, clean and tidy workplace;
- ensuring that tools, equipment and machinery are properly maintained and fit for use.

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Wind Turbine Drive Unit

Relevant case study: Alternative Energy

Timescale

This assignment is designed to take approximately one half term to deliver.

This should be made up from approximately 30 hours of lesson time, 10 hours of homework.

The "Make Assignment" gives clear instructions on what the student needs to do as they work through the assignment.

The first week should be spent examining the product specification. This should be used as the basis of the production plan, so it is important that the specification is clearly understood. They should spend a further two weeks developing their production plan. This will involve deciding upon materials and components, processes and equipment to be used and a sequence of production. They will also need to consider quality checks and tests.

The production plan should be checked by the teacher, and then followed through the manufacturing process.

Students should spend approximately three weeks making their solution, the assignment notes give RS component catalogue numbers, these items should be made available to the students.

Preparation and preparatory teaching

This assignment concentrates on the production of a working electronic generator. It is therefore important that students have had experience of assembling and disassembling generators. They should be familiar with the components of the turbine system.

It is expected that students will have worked through the "Alternative Energy" design assignment, however it is possible for a student to work on this assignment, using a pre-prepared product specification.

As this assignment is based around the making of the wind turbine it will need workshop facilities. Therefore students will need to be familiar with workshop safety and the use and application of tools and equipment:

- Measuring and marking out;
- Cutting and finishing materials;
- Drilling;
- Mechanical fixings - nuts and bolts, screws;
- Adhesives;
- Joining using heat.

Students will need knowledge of the appropriate electrical components for the generator section, such as how an electrical motor can be used to generate electricity. Although this is dependant upon the application of the turbine.

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Practical hints

The components listed in the assignment should be made available prior to starting the manufacture of the turbine.

Students may wish to work together to manufacture the turbine, perhaps developing different turbines, but testing on one generator.

Other generator units can be used, e.g. Lego, Fischer Technic.

The output from the generator should be measured using a multimeter, however connecting a 6 V bulb to the output from the motor will give immediate visible feedback, to show that the system is working. Higher quality tests should then be carried out.

Using the gearbox and motor unit as a generator will allow the student to see a real electrical output, however the friction in the gearbox may mean that the scale of the turbine will be important. It may be advisable that some testing is done using pulleys to investigate the effectiveness of the turbine.

These tests could be used to compare the efficiency of different propellers - three blade, four blade, different diameters etc.

Various materials should be made available for manufacturing the turbine, in suitable cross-sections. Many of these materials can be gathered from off-cuts, or samples from suppliers.

This assignment could be adapted to give students a variety of possible outcomes:

- Lifting equipment
- Pumps

The project could be set in the context of a developing country's need, to raise water, or as an electrical generator for a medical centre.

Each variation will involve the student developing the turbine, and then fitting it to some form of gearbox, so that the wind energy can be harnessed.

Useful Websites:

http://www.eere.energy.gov/wind/feature.html

http://www.westwind.ie/smallwind.htm

http://users.aber.ac.uk/iri/WIND/TECH/WPcourse/

http://www.bwea.com/you/siting.html

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Bike Reflector

Relevant case study: Bicycles

Timescale

This assignment is designed to take approximately one half term to deliver.

This should be made up from approximately 30 hours of lesson time, 10 hours of homework.

The "Make Assignment" gives clear instructions on what the student needs to do as they work through the assignment.

The first week should be spent examining the product specification. This should be used as the basis of the production plan, so it is important that the specification is clearly understood. They should spend a further two weeks developing their production plan. This will involve deciding upon materials and components, processes and equipment to be used and a sequence of production. They will also need to consider quality checks and tests.

The production plan should be checked by the teacher, and then followed through the manufacturing process.

Students should spend approximately three weeks making their solution, the assignment notes give RS component catalogue numbers, these items should be made available to the students.

As part of this assignment involves the accurate forming of a flat strap by bending, the practical time will need to be increased if the students develop their own forming jig. This will be particularly relevant if they are to investigate manufacturing a batch of the brackets.

Preparation and preparatory teaching

This assignment concentrates on the production of a bike reflector and associated fixing bracket. The components are relatively standard, however students must have had experience of practical workshop practices;

- Measuring and marking out;
- Cutting;
- Drilling;
- Bending;
- Finishing.

It is expected that students will have worked through the design assignment "Bikes", to give them experience of working with bicycle components. However this is not essential, they could work through this as a "stand-alone" activity. They would then need to be given the product specification.

If students are to make a single unit, it would not be necessary to provide a jig, however if they are to produce a number of the reflector units, they should be either provided

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with a jig, or given the opportunity to manufacture their own. This could be in the form of a base with specifically located pins. The metal strip could then be formed around the pins. Alternatively, if facilities are available, the students could make a press mould. This could be used in conjunction with a "fly-press", it is not recommended to use bench vices, as they are not designed to be used to form materials.

Practical hints

Due to the nature of this assignment it is likely that students will work individually to produce the reflector. However this could be restructured so that students are involved in a batch production system. Students could then be given particular roles and responsibilities in the production process.

The bracket could be manufactured from most metals, however it is recommended that aluminium, or thin mild steel be used. Due to the application of the bracket, a suitable finish should be considered.

Although the development of the production plan is the student's responsibility, it should be pointed out that the bracket should have all holes drilled prior to bending. This will make the production much safer, however this then adds further complications, such as elongated holes, following the bending!

This assignment could be adapted to give students a variety of possible outcomes, all utilising the idea of a bracket supporting a lightweight item:

- Point of sale display
- Coat pegs
- Lighting brackets

Useful websites:

http://www.compusmart.ab.ca/nuprod/bicycle_reflector.htm

http://www.halfbakery.com/idea/Bicycle_20Radar_20Reflector

http://www.welljoin.com/bi-3.htm

http://www.bikemagicflasher.cwc.net/

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Electronic Component Box

Relevant case study: Surveillance

Timescale

This assignment is designed to take approximately one half term to deliver.

This should be made up from approximately 30 hours of lesson time, 10 hours of homework.

The "Make Assignment" gives clear instructions on what the student needs to do as they work through the assignment.

The first week should be spent examining the product specification. This should be used as the basis of the production plan, so it is important that the specification is clearly understood. They should spend a further two weeks developing their production plan. This will involve deciding upon materials and components, processes and equipment to be used and a sequence of production. They will also need to consider quality checks and tests.

The production plan should be checked by the teacher, and then followed through the manufacturing process.

Students should spend approximately three weeks making their solution, the assignment notes give RS component catalogue numbers, these items should be made available to the students.

However, if students have the opportunity to develop an injection mould the time needed to successfully complete this assignment will need to be increased.

NOTE: *This Make Assignment could be linked to the next assignment, PCB for Intercom, If this is the case, students could work together, to manufacture the box and the PCB, to produce a complete intercom unit. Preferably two!*

Preparation and preparatory teaching

This assignment concentrates on the production of a container for a PCB (printed circuit board). Students should therefore be familiar with this type of container. Many electronic component suppliers sell suitable containers, the majority of which are injection moulded ABS, or similar. Students should, therefore be familiar with the manufacturing processes used to make these commercially available containers.

It is unlikely that many centres will have the facilities to produce injection moulded ABS containers, so the design of the students version will need to be modified to allow for manufacture using the centres facilities. This may mean;

- Vacuum forming;
- Sheet bending;
- Carcass construction using discreet panels.

If students are to be encouraged to manufacture a number of containers of similar dimensions, they should have the opportunity to use a forming machine with some sort

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of mould or pattern, thereby allowing for consistency.

Moulds can be manufactured from a variety of materials. In the case of vacuum forming, complex profiles can be attained through the use of modelling clay, such as plasticine, placed in a freezer for a period of time to "harden". The sheet can then be formed and the plasticine removed. If the profile does not allow for draft angles, the plasticine mould can be destroyed on removal, making replication impossible.

Industrial injection moulding equipment use metal dies, often cast and finished. This is impossible to do in schools, however male and female moulds can be constructed using layers of sheet materials, cut using a CNC mill or engraver. The layers are then locked together to achieve a simple mould, into which a molten polymer, such as polythene, can be injected.

It may also be possible to utilise a pre-purchased container and have the student design and construct an appropriate lid and wall or table top fixing.

Practical hints

Due to the industrial manufacturing processes involved in making containers of this sort, it may be advisable to limit the construction to a simple, box type, container. The student could then concentrate on developing the "lid". This will need to have holes for speakers, microphones, switches and other components as well as being detachable for maintenance.

Appropriate sheet materials could be used, with suitable finishes applied. For example:

- Acrylic sheet
- High Impact Polystyrene Sheet
- Aluminium sheet
- Thin sheet steel

The polymer sheets could be cut and joined, or bent using a line bender, or vacuum formed. The metal sheets could be folded and soldered, however the design must allow for "safe edges" to be incorporated.

If a pattern of holes is to be drilled for the speaker or microphone - rather than marking each hole, a piece of "verraboard" can be used as a drilling jig - stuck onto the surface to be drilled with tape, then a 1.5 mm drill can be used to pierce the material through the verraboard, giving a regular pattern.

"Letraset" lettering can be applied to give a professional look to the device.

If the student is constructing the container, the fixing of the PCB should also be considered. Commercially available boxes often use slots or rails for the PCB to slide into. These will be very difficult to mimic, so sticky back PCB holders could be employed. These will require locating holes to be drilled in the PCB and then the holder mounted in the box, the PCB then clicks into place on the holder.

This assignment could be adapted to cater for any number of electronic projects:

- Portable radios

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- Alarm systems
- Electronic dice
- Personal stereo speakers

Useful websites:

http://www.tekoenclosures.com/enclosures/enclosures.html

http://www.rapidelectronics.co.uk/cases_30-0600.htm

http://www.maplin.co.uk/?tn=1689&userid=arm_wsr

http://www.bowood-electronics.co.uk/index.php/cPath/11_75?PHPSESSID=1fb7a32255ba76045c5a738ea6d30d15

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PCB for Intercom

Relevant case study: Surveillance

Timescale

This assignment is designed to take approximately one half term to deliver.

This should be made up from approximately 30 hours of lesson time, 10 hours of homework.

The "Make Assignment" gives clear instructions on what the student needs to do as they work through the assignment.

The first week should be spent examining the product specification. This should be used as the basis of the production plan, so it is important that the specification is clearly understood. They should spend a further two weeks developing their production plan. This will involve deciding upon materials and components, processes and equipment to be used and a sequence of production. They will also need to consider quality checks and tests.

The production plan should be checked by the teacher, and then followed through the manufacturing process.

Students should spend approximately three weeks making their solution, the assignment notes give RS component catalogue numbers, these items should be made available to the students.

The assignment notes could be adapted to other electronic project ideas, however, this will mean that the students will need the circuit details altering to match the new requirements.

NOTE: *if this assignment is linked to the previous assignment "Electronic Component Box" the whole project should be given approximately one term.*

Preparation and preparatory teaching

This assignment concentrates on the production of the circuitry needed for a portable intercom device. Students should be familiar with the safe production of a PCB:

- Use of a mask on photo etch board;
- Etching of copper clad board
- Surface mounting;
- Soldering equipment.

In industry, these types of PCBs would be manufactured using miniature components, fixed in place by robotic equipment, however these facilities are not available in schools, students should be made aware of these differences. This could be done through the use of video or a visit to an electronic production centre.

To test the intercom device, students should be encouraged to produce a pair - a sender and a receiving unit. It may be advisable for students to work together to produce a pair of functioning devices, with both send and receive circuits in each.

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The completed circuit should be housed in a suitable container, either from the previous assignment, or a pre-purchased item.

Practical hints

If the students are set this assignment as is, the components required should be distributed as a set - each student receiving a bag of components, alongside the circuit diagrams and mask.

As the circuit is to be surface mounted, it may be possible to add some detail to the mask, such as student initials, to avoid confusion if more than one student is making the boards.

It may be cost effective to etch a number of boards at once, preferably before cutting the copper clad board, however, the etching process may be prolonged depending upon the quality of the etchant. It is advisable to mark "cut lines" on the board, prior to etching, to allow students to know the maximum size of the board, thereby helping them to develop the container.

It is essential that a chip holder is used for the Integrated Circuit, as heating the legs of the IC will destroy the internal circuitry.

Microphones and speakers should be attached by flying leads, the position of the mounting for these should be investigated through experimentation, as they may cause interference or feedback, if they are located too close together.

The circuit has been designed around a 9 V supply, for testing purposes the battery attachment can be replaced with a low voltage DC supply, however it is essential that the recommended voltage is used, as higher or lower voltages will damage the components.

Following construction of the devices, students should be encouraged to investigate the working limitations of the intercom; range; volume; battery life.

They will also need to consider adaptations that would be made for a larger batch. They could also be encouraged to investigate other processes that could be utilised for manufacturing PCBs, such as automated production lines.

This assignment could be adapted to cover a number of circuits, as mentioned in the previous assignment.

Useful websites:

http://www.accorde-esprit.com/manufacturing.htm

http://www.garnerosborne.co.uk/index.html

http://www.pcb-pool.com/html_uk/uk_angebot_1.htm

http://www.pcbuk.com/

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Pizza Box

Relevant case study: Food Packaging

Timescale

This assignment is designed to take approximately one half term to deliver.

This should be made up from approximately 30 hours of lesson time, 10 hours of homework.

The "Make Assignment" gives clear instructions on what the student needs to do as they work through the assignment.

The first week should be spent examining the product specification. This should be used as the basis of the production plan, so it is important that the specification is clearly understood. They should spend a further two weeks developing their production plan. This will involve deciding upon materials and components, processes and equipment to be used and a sequence of production. They will also need to consider quality checks and tests.

The production plan should be checked by the teacher, and then followed through the manufacturing process.

Students should spend approximately three weeks making their solution, the assignment notes give an indication of the type of card to be used, however other materials could also be investigated for suitability; corriflute (corrugated plastic sheet), HIPS (High Impact Polystyrene sheet).

Preparation and preparatory teaching

At first glance this may seem a relatively simple assignment, however, it is essential that the student achieve an accurate outcome. This may prove difficult due to the nature of the materials.

It is important that students have had experience of cutting and folding materials, in a safe manner - more accidents are caused through the unsafe use of knives than any other workshop tool!

It is advisable that students are able to investigate a range of similar packages, prior to making their own, so that they can be sure of the construction details - direction of folds, etc.

Pizza boxes are used, not only to transport the pizza safely, but also to advertise the pizza company. This advertising is often applied to the surface of the box using a screen printing process. If students are producing a small number of boxes, they would probably not develop a screen print, but apply any "decoration" by hand. However they should be aware of the screen printing technique utilised for larger batches.

They may also consider applying "sticky-back" graphics produced through a CAD (Computer Aided Design) system.

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Practical hints

The student will be producing a single or small number of the pizza boxes, it is therefore likely that each will be cut individually, from a sheet of material. In practice a large number of sheets will be cut simultaneously. This may be done using a special fine bladed saw, or laser cutter, or a specialist guillotine or stamp could be used. As these facilities are unlikely to be available to the students, they should be explained to them, either through video or visits to a manufacturer.

The orientation of the package needs to be considered prior to cutting from a sheet - as there is a "grain" to the corrugation of these materials that should be utilised to achieve a strong outcome.

Corrugated materials are difficult to bend or fold, it may be easier to score and bend. For folds along or across the grain it may be easier to score the outside of the fold, but this may weaken the material. Students should be encouraged to experiment with different folding methods and investigate other packages that use similar materials.

They may consider applying "sticky-back" graphics produced through a CAD (Computer Aided Design) system, rather than painting straight onto the material.

Following construction, students should be encouraged to test the pizza box for thermal protection of the pizza, as well as, strength and robustness.

Although this assignment is based around pizza boxes, it could easily be altered to facilitate students working on a variety of different themes:

- Perfume bottle packaging
- Toy packaging
- Medical goods packaging

Or for the more adventurous:

- Red Cross food packages for famine food drops
- Emergency medical supplies for a war zone
- Waterproof foodstuffs for sailing accidents

Useful websites:

http://www.pizzapastanet.co.uk/pr0268.htm#start

http://www.bby-biz.com/pbmpizzabox/

http://www.smurfit-stone.com/content/Pizza_Boxes.asp

http://www.pizzaboxesinc.com/newhome.html