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Power generation is more efficient during periods of heavy rainfall. At other times, water is pumped back up to the top of the reservoir when the demand for electricity is low. The flow of water through the turbine is easily controlled, making it simple to alter the power being produced depending on the demand at different times of the day.

**Q7** What might be the impact on the natural environment and wildlife of constructing a dam at the end of a valley and flooding the valley to create a reservoir for a hydroelectric power station?

**Q8** List as many positive factors for hydroelectric power as you can.

### Biofuel

The production of **biofuel** is becoming a viable way of producing energy for our transportation and heating needs. Oil- and starch-producing crops are grown, harvested and refined into a number of products, including biodiesel. The process is commonly known as **biomass** energy production. The term biomass can include other solid biofuels such as wood chips and farm waste.

In 2016, only about 3% of fuel for the UK’s transportation system came from biodiesel, according to the Department of Transport. A growing number of companies and private users are recycling spent cooking oil, (a waste product from the catering industry) and converting it into biodiesel by refining it independently.
Shape memory alloy

Most materials have some form of memory, meaning that they will try to resist deformation or spring back to their original shape. **Shape memory alloys** (SMA) take this a step further; they can remember a preset shape and return to it despite being dramatically reshaped. The stimulus for returning to the preset shape is heat or electricity.

**Nitinol**, an alloy of nickel and titanium, is the most commonly used SMA. To program its shape memory, the nitinol must be held in the desired position and heated to around 540°C, then allowed to cool. It can then be deformed to a different shape. When it is heated to around 70°C, it will spring back to its programmed shape. This can also be achieved by passing an electric current through it. It can be re-programmed by reheating it to 540°C.

<table>
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<th>Appearance</th>
<th>Image</th>
<th>Characteristics</th>
<th>Uses</th>
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<td>Shape memory alloy (Nitinol)</td>
<td>Mid-grey metal wire of varying thickness. Also available in sheets</td>
<td><img src="image" alt="Shape Memory Alloy" /></td>
<td>A shape can be programmed when heated to 540°C; it can be deformed and will return to the memory shape when reheated to 70°C</td>
<td>Frames for glasses, dental braces, self-expanding stents used in surgical procedures to open capillaries, fire sprinklers</td>
</tr>
<tr>
<td>Heat or electricity</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**SMA used as a self-expanding surgical stent**

Nitinol can also be used as **muscle wire**. The wire is first stretched and then, when an electrical current is passed through it, it will contract approximately 5% of its length. This is used in dental braces.

Q5 Explain how a piece of shape memory alloy could be used in a fire detector controlling a sprinkler system.
9. Explain one reason why Kevlar is an appropriate choice of material for the firefighter protective gloves shown below.

10. Give two applications for microencapsulated fabrics.

11. (a) Draw the correct circuit symbol for a PTM and a PTB switch.

   (b) Describe one operational difference between a PTM and a PTB switch.

12. Use notes and sketches to show the difference between an analogue and digital electrical signal.

13. (a) Name the type of motion shown below:

   (b) Give one application or machine which exhibits the type of motion you have named in your answer to (a).

14. Identify the class of lever shown below for the car foot pump.

15. (a) Describe the action a follower goes through when following a snail shaped cam.

   (b) Name two types of cam follower.

16. Explain one reason why an idler gear is used in a gear train.
Non-woven textiles

Non-woven fabrics are made directly from fibres without being spun into yarns. The most commonly available non-woven fabrics are bonded fabrics made from a web of fibres held together with heat or adhesive. Common uses of non-woven fabrics include disposable products such as garments worn by surgeons and crime scene investigators, dishcloths and interfacings. Non-woven fabrics can be given special treatments such as flame resistance to make head rest covers on trains and aircraft.

Felt is a mechanical process which has traditionally been done by hand, but is now mainly machine produced. It involves matting together wool or synthetic fibres using a combination of heat, pressure, moisture and movement to mesh the fibres together in a random way. Felt can be formed into shapes when wet (see drape formed hats in Chapter 37), but it does not have any elasticity and will not drape well when dry. It is not strong and can pull apart under tension, but unlike woven fabric, will not fray when cut.

<table>
<thead>
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<th>Appearance</th>
<th>Image</th>
<th>Characteristics</th>
<th>Example uses</th>
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<td>Bonded fabric</td>
<td>Random laid fibres are visible in the fabric, it can have small holes or a textured surface</td>
<td>![Bonded fabric image]</td>
<td>Fabrics lack strength, they have no grain so can be cut in any direction and do not fray</td>
<td>Disposable products such as protective clothing worn for hygiene purposes, tea bags, dish cloths and dusters</td>
</tr>
<tr>
<td>Felted fabric</td>
<td>Matted fibres randomly interspersed, wide range of colours and thicknesses</td>
<td>![Felted fabric image]</td>
<td>Can be formed with moisture and heat; once dry it has no elasticity or drape, and can pull apart easily. Woollen varieties can be expensive</td>
<td>Hats, handicraft, pads under furniture to prevent scratching, soundproofing and insulation</td>
</tr>
</tbody>
</table>

Q5: What might happen to woollen felted products if they are washed in hot water?
Chapter 38 – Commercial manufacturing, surface treatments and finishes

Objectives

- Know and understand how textile based materials are selected and processed for commercial products
- Understand why aids are used to judge quality and accuracy before and during processing
- Understand how surface treatments and finishes affect the functional and aesthetic properties of textile products

Textiles for commercial products

Commercial textile production has developed significantly over the last 50 years owing to new materials being invented as well as new industrial manufacturing methods and higher levels of computer driven automation. Both ‘technology push’, in the form of new materials and ‘market pull’ with demand for greater performance of fabrics, have contributed to a huge and expanding industry.

The introduction of stretch fabrics has transformed aerodynamics, especially seen in cycling and swimming, enabling items of clothing to fit tightly thus reducing drag yet allowing for freedom of movement by the wearer. Wicking fabrics have also been of huge benefit to athletes and outdoor adventurers by allowing perspiration to evaporate quickly, keeping the wearer dry.

Sportswear and outdoor apparel have gone through more changes than many other areas of textiles over the last few decades owing to constant developments in new technologies, giving a greater range of physical and working properties to use. These fabrics can also take advantage of microencapsulation. (See Chapter 10 for more detail.)

Q1 How have developments in commercial textiles helped to improve comfort and safety in motorsport apparel?

Commercial developments in the area of home and business furnishings have led to a greater range of choice through colours, styles and levels of quality. Furnishings cover a multitude of interior, and increasingly, exterior quality textiles, including carpets, rugs, upholstery fabrics, curtains, cushions and many more. These products all form part of our living and working spaces and are chosen for many different reasons. Aesthetics are very important to most people, but the physical and working properties may well be of equal or greater concern to a customer.
Section 5 Exercises

Exercises in this section are generic so that answers may be given in context that apply appropriate techniques, knowledge and understanding from any of the material areas.

1. Choose one of the materials in the table below.

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<td>Solid white board</td>
<td>Ash</td>
<td>Low carbon steel</td>
<td>Acrylic</td>
<td>Cotton</td>
</tr>
</tbody>
</table>

Name one surface finish or treatment that can be applied to the material to enhance the functional or mechanical properties.

Use notes and/or sketches to explain how the surface finish or treatment can be changed to improve or enhance its properties. [5]

Name of material: _________________________________________________________

Surface finish or treatment: ____________________________________________

2. Describe two ways that materials can be shaped or formed.

Give examples in your answers. [4]

3. Five materials are listed in the table below. Choose one material:

<table>
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<th>Materials</th>
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<td>Corrugated card</td>
<td>Plywood</td>
<td>Low carbon steel</td>
<td>Polyvinyl chloride (PVC)</td>
<td>Wool yarn</td>
</tr>
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(a) State one raw primary source material of your chosen material. [1]

(b) Give one stock form in which the material is likely to be available. [1]

(c) Describe the manufacturing process(es) used to turn the raw primary source material into a stock form. You may include sketches in your answer. [3]

(d) Describe two ways that one of the materials can be modified. [4]

4. Choose one product or component from the table below and describe two features that make it suitable for mass production. [4]

<p>| | | | | |</p>
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<td>Aluminium drink can</td>
<td>PET water bottle</td>
<td>Foil lined board</td>
<td>Cotton skirt</td>
<td>Pine roof truss</td>
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Designer investigation:

**Philippe Starck 1949–present**

The truly multi-faceted French designer, Philippe Starck was born in Paris where his design studio is based to this day. His father was an aeronautical engineer and it is said that young Starck had a passion for design from an early age, hence attending Ecole Nissim de Camondo, a school of product design and interior architecture in Paris. He started by designing inflatable furniture and, although not a great success, it gathered much needed attention.

Starck was offered a job as an artistic director with Pierre Cardin which was a good stepping stone but he preferred much simpler designs than the flamboyance of Cardin. Having successfully created interior designs for Parisian nightclubs he launched Starck Products in 1979. His big break came in 1982 after being selected to work on the private residence of the then French President. Since then he has worked on numerous projects from simple mass produced items for brands such as Alessi and Microsoft to furniture, electrical goods and a number of top end hotels. He is involved in all aspects of design and has even produced motorbikes, electric vehicles and yachts.

Starck is a prolific and innovative designer who has produced many iconic products; some that have already become modern classics such as the ‘Juicy Salif’ lemon squeezer. He is considered by some to put form ahead of function, making some of his products beautiful but impractical to use. He often utilises organic forms which are sleek, simplistic and streamlined. Much of his work can be quirky and humorous; he readily confesses that he likes to inject mystery, magic and quirkiness into his designs. Starck likes to work at reducing the amount of materials used in manufacture and packaging, selecting energy efficient and sustainable options where possible.

*The Juicy Salif lemon squeezer, by Philippe Starck*
Drawing techniques

There are three main types of 3D drawing styles that you are likely to use within your portfolio. These vary in their level of complexity to produce and have different advantages and disadvantages.

**Oblique projection** uses a 45-degree angle to draw lines that represent the depth of the side (end) and the top (plan) of the drawing. The front of the drawing is face on to the viewer which actually creates a visual lie. It is impossible to see the front of a cuboid straight on and also see the side and the top.

Oblique projection is a technique that can get an idea across quickly and simply. It can be very useful in the early stages of developing ideas.

**Isometric projection** uses a 30-degree angle and is much more realistic. For a basic cuboid, all of the height, width and depth lines follow the 30-degree isometric grid lines. Dimensioning can be done accurately and, by using simple techniques, complex shapes can be constructed or carved out of the main cuboid.

Isometric projection is very good for design ideas that have a geometric shape. With some practice, it is also good to convey ideas quickly and to show where components and parts fit in relation to others.

**Two-point perspective** uses two vanishing points that are set to the outer edges of the page. The main construction lines that create the width and depth are all projected back to the two vanishing points.

Two-point perspective gives the most realistic view as it emulates the way the viewer’s eye sees perspective, meaning that things get smaller the further away they are. It is great technique to give a realistic view of what a product or prototype might look like. It is not so easy to add dimensions, in comparison to isometric projection.

**Q4** Which 3D drawing technique would you choose if you were intending to make an accurate prototype of a product?
Chapter 48 – Material management and marking out

Objectives

- Understand how effective design planning can minimise waste
- Be aware of how design adaptations and use of tessellation can save time and materials
- Understand how to calculate the surface area and quantity of required materials
- Understand the value of using measurement and marking out to create an accurate and quality prototype
- Understand the use of datum points and coordinates
- Be able to recognise and characterise the appropriate tools and methods to mark out a range of materials to create prototypes

Planning

The key to material management is to plan ahead. Working out the best way to fit the required parts of a product onto the material efficiently is not as straightforward as one might imagine. Material tends to come in specific sizes, depending on the type of material. Papers and boards come in ‘A series’ sizes, for example A4 sheets are 210mm x 297mm. These A series sizes are all rectangular, so if you wanted to cut a square shaped section from the sheet you would automatically have waste. However, if you wanted a number of identical squares you could get a much larger sheet and divide it up, producing less waste than using a number of smaller sheets.

Q1

Using the standard A series paper sizes (covered in Chapter 25) answer the following questions.

(a) Calculate the waste if you cut a 210mm square from a sheet of A4 paper.
(b) Calculate the waste if you cut a 195mm square from a sheet of A4 paper.
(c) Which larger size of A series paper would be the most economical to use if you wanted to produce 66 squares at 195mm x 195mm?

As the majority of materials come in rectangular or other specific shapes and sizes there are a few basic rules to follow in order to use materials efficiently. For example, starting from the most effective edge or corner of a sheet and not somewhere in the middle, means that the material remaining is as large as possible and is in its most useable form. If cutting discs from a rectangular sheet consider the following options:

![Diagram of waste pieces A and B](image)

Extra circles cut from otherwise wasted material
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### 3.1 Core technical principles

**New and emerging technologies**

| 3.1.1 | New and emerging technologies | ✔ |

**Energy, materials, systems and devices**

| 3.1.2 | Energy storage and generation | ✔ |
| 3.1.3 | Developments in new materials | ✔ |
| 3.1.4 | Systems approach to designing | ✔ |
| 3.1.5 | Mechanical devices | ✔ |

**Materials and their working properties**

| 3.1.6 | Materials and their working properties | ✔ |

### 3.2 Specialist technical principles

**Common specialist technical principles**

| 3.2.2 | Forces and stresses | ✔ |
| 3.2.3 | Ecological and social footprint | ✔ |
| 3.2.7 | Scales of production | ✔ |

**Specialist material areas**

| 3.2.1 | Selection of materials or components | ✔ |
| 3.2.4 | Sources and origins | ✔ |
| 3.2.5 | Using and working with materials | ✔ |
| 3.2.6 | Stock forms, types and sizes | ✔ |
| 3.2.8 | Specialist techniques and processes | ✔ |
| 3.2.9 | Surface treatments and finishes | ✔ |

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**Materials covered in Units 5A-F**

- ✔ Papers and boards
- ✔ Timber based materials
- ✔ Metal based materials
- ✔ Polymers
- ✔ Textile based materials
- ✔ Electronic and mechanical systems

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The content in each section of the textbook covers the same specification points as the corresponding downloadable teaching unit, e.g. Section 1 complements Unit 1.
3.3 Designing and making principles

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This book provides detailed and concise coverage of all the topics covered in the new AQA 8552 Design and Technology (9-1) specification, written and presented in a way that is accessible to teenagers and easy to teach from. It can be used both as a course text and as a revision guide for students nearing the end of their course.

It is divided into 12 sections covering every element of the specification. Sections 5A to 5F of the textbook cover each of the specialist technical areas. These sections would complement practical classroom experience. Each chapter contains relevant questions and exercises from past papers, which can be set as homework. Answers to all these are available to teachers only, in a Teachers Supplement which can be ordered from our website.

www.pgonline.co.uk

About the author
Mike Ross has 16 years’ experience teaching Design and Technology in secondary schools in the state and private sectors. He has been Head of Technology for 13 years and has taught and overseen all Design and Technology disciplines at GCSE as well as A level Product Design for both Resistant Materials and Graphics specialisms. He has also taught Electronics at GCSE and A level. He has a BEd degree in Secondary Design and Technology Teaching.

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‘Stony Sunrise’
Paper and acrylic on masonite, 90x45x3cm © Amy Genser 2015
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This book has been approved by AQA.