

Design and Technology - Investigating benches

Teachers' notes

This year 9 project aims:

- to bring the 3 areas of Design and Technology, Science and Mathematics together in a way to show how mathematics and science underpin the design of objects where forces will be exerted on them.
- to take an established activity and put an engineering focus on it. By investigating the different types of forces which a bench must be able to withstand for safe seating we aim to show a similar process for building structures and elements such as bridges, lintels over windows, floor joists etc.

The activity described below has been based on a project where furniture, in particular – park benches, will be designed for a specific purpose*. The materials provided will be in support of a product analysis activity and will show the links between school-based design and technology and structural engineering. The process exemplified closely follows that of Structural Engineers when they begin to analyse a similar structure. This process supports the aim of the National Curriculum to link the curriculum to the wider world and demonstrate that what is being taught in the classroom has direct relevance within the world of work.

*This activity can be used to support on the QCA unit of work Year 9(ii) Selecting materials. It supports activities on page 5 – focused practical tasks, although there is less emphasis on mathematical modelling within the QCA.

Learning Objectives from the National Curriculum

Design and Technology

1. Learning objectives – pupils should be taught:

Developing, planning and communicating ideas

- a. identify relevant sources of information, using a range of resources including ICT;
- e. consider aesthetics and other issues that influence the planning

3. Evaluating processes and products:

c. identify and use criteria to judge quality of other people's products including the extent to which they meet a clear need, their fitness for purpose, whether resources have been used appropriately, and their impact beyond the purpose for which they were designed.

4. Knowledge and understanding of materials and components

- a. to consider the physical and chemical properties and working characteristics of common and modern materials;
- c. that materials and components can be combined, processed and finished to create more useful properties and particular aesthetic effects.

6. Knowledge and understanding: Structures

- a. to recognise structures and how to support and reinforce them;

- b. simple tests and appropriate calculations to work out the effects of loads;
- c. that forces of compression, tension, torsion and shear produce different effects.

Science link:

2. Investigative skills

- a. use scientific knowledge and understanding to turn ideas into a form that can be investigated, and decide on an appropriate approach.

Physical Processes:

Forces and Motion – Force and linear motion

- 2c. that unbalanced forces can change (the speed or direction) of the movement of objects and that balanced forces produce no change in movement of an object.

Forces and Motion – Forces and rotation

- e. that forces can cause objects to rotate about a pivot;
- f. the principles of moments and its application to situations involving one pivot.

Mathematics Link:

Equations, formulae and identities

Pupils should be taught to:

- a. distinguish the different roles played by letter symbols in algebra, knowing that letter symbols represent definite unknown numbers in equations, defined quantities or variables in formulae, general, unspecified and independent numbers in identities and in functions they define new expressions or quantities by referring to known quantities.

Equations

- d. set up simple equations; solve simple equation, by using inverse operations or by transforming both sides in the same way;

Linear equations

- e. solve linear equations, with integer coefficients, in which the unknown appears on either side or on both sides of the equation; solve linear equations that require prior simplifications of brackets, including those that have negative signs occurring anywhere in the equation, and those with a negative solution.

Formulae

- f. use formulae in maths and other subject; substitute numbers into formula; derive formula and change its subject.

Design Brief:

Design and make a park bench to be sited next to a local tourist attraction and able to seat a person safely. The bench must be aesthetically pleasing.

Part of the designing side (product analysis) of the project will entail making a simple mathematical model of the bench which will predict its behaviour.

The making side of the project will entail students constructing a bench 1/5 the scale of the real bench. It is expected that the material will be 5mm thick softwood for the seat of the bench. This represents a scale factor of 1/5th of the thickness of wood used in the calculated example below. However other materials can be used, but will need research into their bending stress capacity.

The rest of the project would follow a similar course to a normal Design and Make activity.

The Teaching Materials:

Product Analysis Session 1

 5 Minutes

Introduction: Aim of the lesson: To analyse how a bench can fail, the science and maths needed to model this failure without building the bench and testing it to destruction. (Mathematical modelling)


The link to Structural Engineering

The process that structural engineers undertake when assessing the strength of a structure is:

- 1) to consider all the possible ways in which the structure might fail. Each is called a *failure mode*.
- 2) For each failure mode, to calculate the *effects of the loads* when the structure is just about to fail.
- 3) Then to calculate the *load capacity* of the element that is about to fail.
- 4) Lastly, for a safe structure, to ensure that the load capacity exceeds the effects of the loads by an appropriate margin.

The following notes should be read together with the sheet they refer to.

Sheet 1: How could this bench break?

 10 minutes

This unit examines a park bench, which is a very simple structure. There are numerous failure modes, for example:

- i) failure of the seat at its central position, in bending
 - ii) failure of the back at its central position, in bending
 - iii) sideways collapse of the bench, with both supports falling over sideways
 - iv) crushing of the supports
 - v) overturning of the whole bench, backwards
- and there are several others.

Give each student/pair of students this sheet to complete the activity. Get them to annotate the sheet with their ideas.

Sheet 2: Taking one failure mode. Teacher to explain process. 🕒 20 minutes

We take the first failure mode in the list above. We then *simplify* the structure undergoing this type of failure to turn it into a mathematical model that can be *analysed* using calculations. The simplifications include:

- a) turning the bench from a 3-dimensional object into a 2-dimensional one. The simplification requires that if a thin vertical slice were cut from the seat plank, the slice can represent the behaviour of the whole plank and of all other similar possible slices.
- b) discarding parts of the bench that do not influence the failure mode: the back planks, the upper parts of the supports, the ends of the seat that protrude beyond the supports.
- c) simplifying what remains: narrowing the supports to a single point and representing the weight on the seat as a load at a single point. This simplification includes discarding any strength obtained because the seat plank is fixed rigidly to the supports.

Generally, simplification of a structure is done *conservatively*, i.e. it makes the simplified structure weaker or at least no stronger than the original item. Engineers can then be confident that if they can demonstrate that the model is strong enough, the original item will also be satisfactory.

The *principle of equilibrium* states that if an object is not accelerating, the forces on it must be in balance. Also, if an object is not spinning at an increasing rate, the moments on it must be in balance. (A moment is a force acting about an axis of rotation).

When the seat plank is just about to fail, the forces and moments acting on it are in balance. We need take only half the plank, which will give us information about what is happening at the central point of the plank when it is about to fail. The half-plank must be in equilibrium.

Sheet 3: Teacher to explain process. 🕒 15minutes

We can *resolve forces vertically*, i.e. state that the downward vertical forces must be equal to the upward vertical forces. We can *take moments about an axis*: the axis can be anywhere and will not affect the result, but it is convenient to choose an axis at the top of the support. We find that for equilibrium there must be a *bending moment* in the centre of the plank equal to $\frac{1}{4} WL$. (NB this is true for any value of W). British Standard BS5268 Part 2 contains a table of permissible bending stresses in different types of timber. The basic figures are modified for factors such as duration of load, thickness of wood etc. The quoted bending stress of 10N/mm^2 is approximately what could be carried by a good quality pine timber. Hardwoods such as oak or teak can carry higher stresses.

Sheet 4: Students to calculate a & b, Discuss other options.  25minutes

The relationships between the capacity of the seat plank and the various ways of solving the problem are:

- a) Thicker wood: capacity increases approximately as the (thickness)² [squared]
- b) Wider wood: capacity increases linearly with width
- c) Stronger wood: capacity increases linearly with strength
- d) Weight: capacity reduces linearly with increased weight
- e) Closer supports: capacity increases linearly with decreased distance
- f) Extra support: for the simplified model, the capacity of the seat increases indefinitely because if the extra support was placed centrally under the seat, the point load would go directly into the support and the seat would not have to bend at all.
- g) Different material: capacity changes as the proportion
(bending stress for different material $4 \times 10 \text{ N/mm}^2$)
- h) Lower gravity: weight decreases, so capacity increases linearly with reduced weight.

The use of thicker wood is the most efficient answer unless an extra support is allowable.

How could this bench break?

Think of all the different ways this bench might break (fail)¹ when someone sits on it. Annotate the drawing with your ideas.



¹ Fail means to break or otherwise not do the job it was meant to do.

Sheet 2 - Design and Technology - Investigating a bench



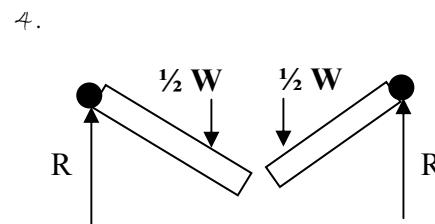
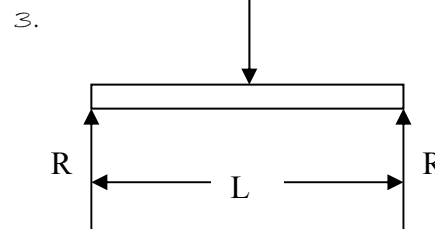
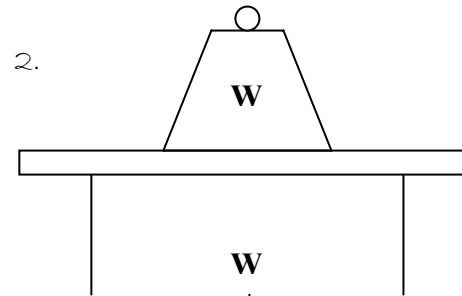
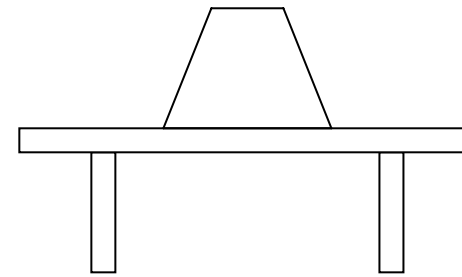
To help understand why the bench has failed in this way, we need to simplify the structure. We discard all the parts of the bench that are not important in the type of failure.

The back slats and the back supports are not important if the seat fails, so we can leave them out of our diagram. (diagram 1)

We can go a step further by reducing the thickness of the legs. For this type of failure the legs only have to resist downward forces and we can show them as single lines. (diagram 2)

The next step is to leave off the ends of the seat because they have no importance in this type of failure. (diagram 3)

We also show the forces acting on the seat as arrows. (diagram 4)

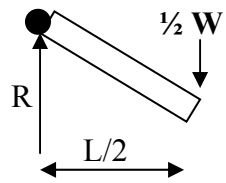


Weight W can be represented as a point load acting at the middle of the seat.

When the bench just breaks, we can show the forces acting on each half like this.

● - pivot for rotation at the tops of the supports.

Sheet 3 - Calculating the strength of the seat

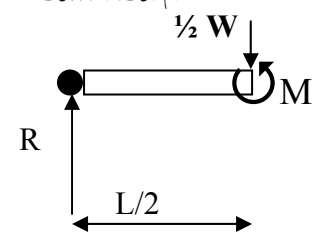


When the seat is just about to break it is still in equilibrium.

Equilibrium
This means that the forces acting on an object are in balance.

The vertical forces are in balance therefore $R = 1/2W$. But, the rotational effect of the force is not in balance.
If we take the moments about a pivot at the top of the support:
Clockwise moment $\curvearrowright = 1/2W \times 1/2L = 1/4WL$.
Anticlockwise moment $\curvearrowleft = \text{zero}$ (from external forces).

So to be in balance there must be a moment in the seat itself:



$$M = 1/4 WL$$

If W was 100kg (=1kN) and L was 1.0m M would be $0.25 \times 1 \times 1 = 0.25 \text{ kNm}$

Is the seat strong enough to carry this?

The bending moment in the seat causes bending stresses. From British Standards we can find the highest bending stress that wood can carry is 10 N/mm^2 (10Pa).

We use an equation: $M = fZ$ to find the bending stress caused by moment M .

f = the stress Z is a geometric property of the seat where $Z = bd^2/6$.
 b is the width of the wood, d is the thickness of the wood.

$$\text{So } f = M/Z = M/(bd^2/6) = 6M/bd^2$$

Convert everything to N and mm.

Suppose $b = 200 \text{ mm}$, $d = 25 \text{ mm}$, then
 $f = 6 \times 0.25 \text{ kNm} / (200 \times 25^2) = 12 \text{ N/mm}^2$.

This is more than the timber can carry (10 N/mm^2) so the timber breaks.

What can we do?



Sheet 4 -Solving the problem by modelling with mathematics.

We can.....

- a. use thicker wood – how much thicker would it need to be?
- b. use wider wood – how wide? Will this have an effect on the comfort of the bench?
- c. use stronger wood – what effect will this have on the final product? in terms of resources, cost and sustainability?
- d. stop people weighing more than a certain weight sitting on the bench. What do you think would happen?
- e. move the supports closer together – how much closer? Will this have an effect on other parts of the bench?
- f. put another support under the bench.
- g. use a different material for the bench – what would we need to do to check this would work.
- h. put the bench on the Moon or somewhere else where gravity is lower!

What would you do?

Benches to evaluate



Buildings to use as a design influence



Gateshead Millennium Bridge



The British Airways London Eye



David L. Lawrence Convention Center, USA



The Eden Project, Cornwall

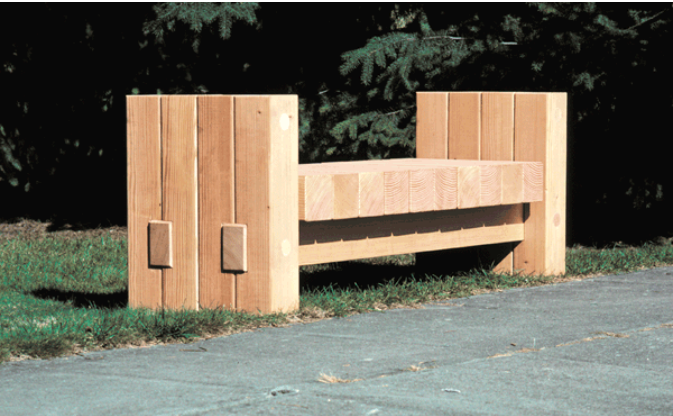


City of Manchester Stadium



London Millennium Footbridge

Benches for public spaces



Appendix 2: QCA Design and technology Unit of work 9(ii) Resistant Materials: selecting materials

Unit 9A(ii) Selecting materials

Focus: resistant materials

About the unit

The main aim of this unit is for pupils to apply their understanding of the properties of materials when designing.

In this unit, pupils tackle a design and make assignment (DMA) on the theme 'Fold it up'. They identify a need for a folding structure, selecting the materials they will use according to their characteristics, and matching them to appropriate making processes. The optimum use of materials should reconcile a number of criteria, including the working characteristics, production processes, environmental and social issues, costs and aesthetics.

Pupils gain the knowledge, skills and understanding they need to carry out the DMA successfully through product evaluation activities and focused practical tasks. They:

- understand that the properties of materials, *eg strength, durability*, influence what they select for a design
- select materials and match them to appropriate making processes
- learn how to use heat treatment and other processes to change the working properties of materials
- learn about the diversity of one product, *eg tool racks*, and the influence of lifestyle
- consider minimising environmental damage, use materials sympathetically, and find out about the importance of reuse and recycling issues
- conduct fair test procedures using qualitative and quantitative measures
- learn about the uses of modern materials, *eg composites*
- consider different structural designs to withstand greater loads
- redesign products to distribute the forces of tension, compression and shear more evenly throughout a product

Where the unit fits in

This is one of three resistant materials units that focus on understanding materials: one in year 7 on using and understanding materials; one in year 8 on exploring materials in greater depth; and this one in year 9 on critically selecting materials. These units ensure progression in understanding about materials.

This is part of a series of three units in year 9 on selecting materials; there are equivalent units, with similar learning outcomes, on food and textiles. Together these units are expected to take 10–15 hours. It is important that the department plans as a team so that pupils are able to draw on knowledge, skills and understanding from across the units to reinforce their learning and avoid unnecessary repetition.

Some of the optional activities are also suitable for later in year 9.

If you choose not to teach this unit, then plan to include the essential activities identified by the symbol ■ as part of another unit.

Expectations

At the end of this unit

most pupils will: understand the physical and chemical properties and the working characteristics of a range of common and modern materials; classify materials and components according to their properties and working characteristics, using a range of sources of information; take account of the characteristics and properties of materials when deciding how and when to use them; reconcile those decisions, taking account of aesthetics, time and cost; combine, process and finish materials and components to create more useful properties and particular aesthetic effects; select tools and equipment to shape and form materials safely and accurately, and to finish them appropriately; understand whether resources have been used

appropriately, and the impact of resources beyond the purpose for which they were designed (including their global and environmental impact and whether they are sustainable)

some pupils will not have made so much progress and will: consider aesthetic characteristics as they design, exploring the use of materials and describing their attributes; understand how the working characteristics of materials affect the way they are used; combine and mix materials to create useful properties; measure, mark out, cut, shape and form a range of materials safely and with some accuracy; carry out appropriate tests before putting any improvements into practice; recognise that the quality of a product depends on how well it is made and how well it meets its intended purpose, *eg how well a product meets social, economic and environmental considerations*

some pupils will have progressed further and will: use a range of industrial applications when working with common materials and processes, where appropriate; cut, shape and form materials to specified tolerances; combine processes or materials to create more useful properties, and know how the ability to change materials is exploited in industry; take account of a wider range of issues, *eg product maintenance, safety, the degree of accuracy required in production*; devise tests to check the quality of their work at critical points; know how to ensure that their products are of a suitable quality for intended users, *eg how well a product meets moral, cultural and environmental considerations*, and suggest modifications that would improve their product's performance, if necessary

Prior learning

It is helpful if pupils have:

- applied their understanding of the properties of materials
- considered more complex finishing processes, including their potential environmental impact and health hazards
- used thermoforming processes
- identified methods of using the structural properties of metals when reinforcing and strengthening frames

Pupils should have gained the above knowledge, skills and understanding in year 8, through unit 8A(ii) 'Exploring materials (resistant materials)', or similar projects.

Language for learning

Through the activities in this unit, pupils will be able to understand, use and spell correctly words relating to:

- materials, *eg composite, component materials, laminate, layer, shape memory alloy, thermoreactive, reuse, recycle, tension, compression, shear*

Speaking and listening – through the activities pupils could:

- ask different sorts of questions to extend thinking and refine ideas, *eg Does that imply that...? Does that mean...? Would we need to...?*
- discuss and evaluate conflicting evidence to arrive at a considered viewpoint

Reading – through the activities pupils could:

- recognise the author's standpoint and how it affects the meaning

Writing – through the activities pupils could:

- organise content into complete text with the relationships between points/paragraphs clearly signalled, *eg therefore, nevertheless*
- structure paragraphs to develop points, by using evidence/additional facts
- write closely-argued text where precise links and connections are made within sentences

Resources

Resources include:

- a case study of a new material and technology
- modern materials for practical investigations, *eg shape memory alloy, composites*

- examples of a composite and a laminate
- useful websites, eg www.destech.mit.edu; www.materialise.com; www.tep.org.uk

Future learning

Pupils could go on to further work in year 9 in which they apply their understanding of materials when designing and making. This unit also acts as a foundation for key stage 4. Pupils will learn that to achieve the optimum use of materials they need to take greater account of the relationship between material, form and the intended manufacturing processes.

In key stage 4, pupils will learn:

- 1e) to match materials and components with tools, equipment and processes, taking account of critical dimensions and tolerances when deciding how to manufacture the product
- 2b) to use a range of industrial applications when working with familiar materials and processes
- 4a) how materials are cut, shaped and formed to specified tolerances
- 4b) how materials can be combined and processed to create more useful properties, and how these changed materials are used in industry
- 4c) how materials are prepared for manufacture and how pre-manufactured standard components are used
- 4d) about a variety of finishing processes, and why they are important for aesthetic and functional reasons
- 4e) that to achieve the optimum use of materials and components, they need to take into account the relationships between material, form and intended manufacturing processes

(Extracts from the D&T key stage 4 programme of study)

Out-of-school activities and homework

Pupils could:

- carry out a life-cycle analysis of a product to explore the impact on the natural environment of the extraction, production and disposal of the materials used, eg *plastics*
- collect recyclable materials and develop a design idea for an interesting product that could be made from the materials
- find out what is meant by 'composites', 'laminates', and 'smart materials' and find examples of each

- consider how a range of products is made, used and disposed of, and identify their impact on users, other people and the environment

Links with other subjects

- Science: learning about the extraction and use of fossil fuels for the production of some modern materials links with learning about different sources of energy (unit 7I 'Energy resources'). There are also links with unit 7K 'Forces and their effects' in the focused practical tasks, and with unit 9K 'Speeding up'.
- Mathematics: when investigating the effects of loads on test structures, pupils use number and algebra, breaking down complex calculations, using alternative approaches to get results and selecting techniques for calculating forces.
- Sustainable development: considering how a product affects the environment and discussing the ethical use of materials will underpin learning in the citizenship programme of study. Pupils will be taught about the world as a global community and the economic and environmental implications of this. They will be taught to think about moral, social and cultural issues by analysing information, and to justify orally and in writing their personal opinion about such issues.

DESIGN AND MAKE ASSIGNMENT (DMA)

- to design and make a product in which the optimum use of materials reconciles a number of criteria, including the working characteristics, production processes, environmental and social issues, costs and aesthetics, by applying the knowledge, skills and understanding they developed during the product evaluation activities and focused practical tasks

- Set the pupils a DMA in which they:
- select materials according to their characteristics and match them to appropriate making processes
 - evaluate the materials chosen by using fair test procedures with qualitative and quantitative measures
 - explore the uses of modern materials, and use them sympathetically

The DMA should also give the pupils an opportunity to discuss how we are all responsible for the wellbeing of others.

Example

This example DMA has been written so it can be copied and given directly to pupils. Further details and contexts can be added, as appropriate.

Fold it up

There are lots of situations in which you might use temporary structures – in the workshop, on the beach, by the river, in a tent or caravan, in the garden, or after an accident. Identify a need and then design and make a useful structure to fulfil that need. Your structure should fold up or be easy to take apart, so that it doesn't take up too much space. Think carefully about suitable materials, bearing in mind whether your structure will be used indoors or outside.

- draw up a design specification and criteria that reflect users' needs
- combine ideas from a variety of sources
- refine a single idea from a range of ideas and draw up a manufacturing specification
- match and select materials, considering their fitness for purpose and environmental impact
- specify and justify the exact types and grades of materials, and give details of processing methods in the specification
- prioritise and reconcile decisions on materials, time and production
- use materials sympathetically
- evaluate their product against the original design criteria and assess how well the users' needs have been met
- write an account of the evaluation

Language for learning when writing evaluations

- Remind pupils that a written account of an evaluation could include:
 - an introductory paragraph that explains the assignment and the design issues
 - a paragraph for each design criterion
 - evidence of evaluation
 - a summary of success
 - a concluding paragraph that includes an overall evaluation, suggestions for future improvement, and a comment on what they have learnt during the DMA

PRODUCT EVALUATION			
	<p>Organise a range of activities that give pupils an opportunity to:</p> <ul style="list-style-type: none"> – learn about the diversity of a product – consider possible recycling and disposal of the materials used – explore the use of modern materials 		<p>Language for learning when evaluating products</p> <ul style="list-style-type: none"> • Ask pupils to work in small groups to discuss a set of needs that products might be designed to meet. They could use a flip chart to list questions that users might want to ask about any product, then rephrase these into criteria. It would be helpful if the teacher gives an example of this process initially. Group presentations to the whole class will allow for further discussion and refinement of criteria.
<ul style="list-style-type: none"> ■ to explore the diversity of one product, <i>eg benches</i>, and the influence of lifestyle on new product development 	<ul style="list-style-type: none"> ■ Ask the pupils to compare different examples of one product that are intended to meet similar needs. Ask them to identify how designing for the user and for manufacture can conflict with other design criteria, <i>eg the cost of materials</i>, and to suggest ways to minimise resulting problems. 	<ul style="list-style-type: none"> ■ put together criteria and questions that they can use to evaluate products and suggest improvements ■ appreciate the conflicting demands faced by designers and product makers, and reach a practical outcome, <i>eg reconciling function and aesthetics with the cost of materials</i> 	
<ul style="list-style-type: none"> ■ the practical applications, working characteristics and uses of modern materials 	<ul style="list-style-type: none"> ■ Organise some practical investigations that enable the pupils to explore the uses of modern materials, <i>eg to compare the characteristics and uses of composite materials such as glass-reinforced polyester with other materials.</i> 	<ul style="list-style-type: none"> ■ describe the working characteristics of one type of modern material, <i>eg composites</i>, and suggest what it could be used for 	

PRODUCT EVALUATION (Cont.)

■ about the uses of modern materials, *eg composites, shape memory alloy (smartwire)*

■ Ask the pupils to explore how the development of new materials and technologies has allowed designers to achieve things that were not possible before, *eg we can now make materials with the properties that we want, and in the future we are likely to see materials made to measure for a huge range of applications*. Ask the pupils:

- *What areas of research should we focus on?*
- *What products might be made?*
- *Who will benefit?*

Case studies could be used to illustrate the discussion, *eg*

- *car manufacturers can improve the properties of existing materials by processing, and use new materials and components that are ‘smart’ (responsive), to produce a car that is cheaper, lighter, saves fuel, has better performance and is 90% recyclable*
- *trains, aircraft, racing cars can be made faster, safer and lighter by using carbon-fibre reinforced composites, advanced electronic materials, intelligent guided vehicles*
- *computers can be made easier to use with flexible polymer roll-up display screens, speech recognition, and materials to improve battery life and printing*
- *medical breakthroughs include biomedical implants, intelligent wound dressings, artificial tissues, personal health monitors*
- *houses can be improved with wall coverings that change on demand and intelligent appliances, such as a fridge that reorders food and suggests meals according to contents, a self-cleaning floor covering, smart glass to control light*

■ know where new materials come from and what they might be used for, and express an opinion about why research on materials might be directed at particular types of products and needs

PRODUCT EVALUATION (Cont.)			
<ul style="list-style-type: none"> ■ the importance of reusing and recycling when designing ■ how to minimise environmental damage when selecting materials, eg by disposing of plastics, cutting coolants 	<ul style="list-style-type: none"> ■ Ask the pupils to consider the wider implications of choosing a particular way of meeting a need or solving a problem. They could think about whether meeting the need is worth the resources required, and whether the proposed solution has other consequences that should be taken into account, eg <i>environmentally damaging by-products from the manufacturing process, difficulty in the safe disposal of manufacturing by-products</i>. Ask the pupils to discuss as a class: <ul style="list-style-type: none"> – <i>What happens to the product after use?</i> – <i>How long will it last?</i> – <i>What factors might limit or lengthen its lifespan?</i> – <i>How easily can it be recycled?</i> – <i>Who will pay the cost of recycling?</i> – <i>What materials have been used and why?</i> – <i>Where do the materials come from?</i> – <i>Are the resources likely to run out?</i> – <i>Is there a problem with side effects, eg waste disposal and pollution?</i> ■ Divide the pupils into groups and give each group a product. Ask them to brainstorm the possible benefits, resources, costs and other consequences, and to come to a group view of the balance of factors. Ask them to report back as a group on their particular example. 	<ul style="list-style-type: none"> ■ discuss a range of resource issues when designing, eg <i>what happens to a product after it has outgrown its usefulness?</i> and use materials sympathetically 	<p>Language for learning when reviewing texts</p> <ul style="list-style-type: none"> • Ask pupils to discuss objectivity and bias in texts, eg <i>the author's standpoint and its effect on meaning</i>. They could review information from a production company and a consumer group on a contentious issue, eg <i>the use of non-renewable energy sources</i>.
<ul style="list-style-type: none"> ○ how technological advances and the use of local and global resources change the materials available for products 	<ul style="list-style-type: none"> ○ Discuss with the pupils why the materials used for products today, eg <i>plastic</i>, are different from those used when their grandparents were young. Ask the pupils to consider <i>Why will the materials used to make products in the future be different from those we use today?</i> 	<ul style="list-style-type: none"> ○ describe how the materials used in one product have changed over time and predict how materials may change in the near future, eg <i>the materials used for tool racks</i> 	

PRODUCT EVALUATION (Cont.)			
<ul style="list-style-type: none"> ○ what is meant by ‘composites’ and ‘laminates’, common examples of these and their properties 	<ul style="list-style-type: none"> ○ Discuss with the pupils what is meant by ‘composites’ (where different materials are used together to make a new combined material, <i>eg glass-reinforced polyester</i>). Explain that these have different properties from their constituent materials, usually combining the properties of each. Together they are often better than any of the component materials on their own. Explain to the pupils that products made of layers are called ‘laminates’, and ask them to find some products made from composites and laminates (they should include both resistant materials and textiles). Ask them to explain what properties the component materials provide and why they have been used. 	<ul style="list-style-type: none"> ○ describe a ‘composite’ and a ‘laminate’, and give two examples of composite and laminate materials 	
FOCUSED PRACTICAL TASKS (FPTs)			
	<p>These practical tasks should focus on the knowledge, skills and understanding outlined in ‘About the unit’. They should give pupils an opportunity to practise any new skills they will need during the DMA, <i>eg when considering different structural designs</i>.</p>		
<ul style="list-style-type: none"> ■ to consider different structural designs to withstand greater loads ■ to redesign products to distribute the forces of tension, compression and shear more evenly throughout the product ■ how to carry out fair test procedures using qualitative and quantitative measures and how to use appropriate vocabulary when they are testing, <i>eg durability, elasticity</i> 	<ul style="list-style-type: none"> ■ Ask the pupils to compare the structures used in a range of products, <i>eg folding structures such as tents and chairs</i>, and to identify criteria for choosing different structures for different purposes. They should investigate the effects of loads on test structures of different kinds, varying the materials used, and testing samples of materials to compare their flexibility or their relative strength under load. They should also test different shaped sections of materials to compare their weight, torsional rigidity, flexional rigidity and strength under load. 	<ul style="list-style-type: none"> ■ describe different structural designs to withstand loads ■ explain how products can be designed to distribute the forces of tension, compression and shear ■ carry out simple fair tests and use appropriate vocabulary, <i>eg durability, elasticity</i> 	

FOCUSED PRACTICAL TASKS (FPTs) (Cont.)			
<ul style="list-style-type: none"> ■ that working properties can be altered by heat treatment and by combining materials ■ how to use the working characteristics of different materials and components when designing products 	<ul style="list-style-type: none"> ■ Ask the pupils to experiment with different combinations of materials for different purposes, <i>eg to laminate wood with plastic to give it a hard-wearing surface.</i> 	<ul style="list-style-type: none"> ■ alter the working properties of materials by combining and processing them, <i>eg laminating</i> 	
<ul style="list-style-type: none"> ■ to use their knowledge of the properties of materials, <i>eg strength and durability</i>, to influence what they select for a design ■ to test materials against a specification before going into production, <i>eg to check raw materials for flaws, faults or degradation</i> 	<ul style="list-style-type: none"> ■ Discuss with the pupils how to select materials for their working properties, functional characteristics, aesthetic quality, cost, and appropriate processes. Discuss how selecting materials often involves reconciling conflicting demands, <i>eg strength versus overall weight of a product.</i> Discuss methods of testing those materials, <i>eg making a scale model or using computer software to undertake testing of materials.</i> 	<ul style="list-style-type: none"> ■ consider conflicting demands when selecting materials, <i>eg to choose the material within a price range that best meets the function and aesthetic qualities required</i> 	