1. Year Groups
Years 3/4

2. Aspect of D&T
Structures

Focus

Shell structures using computer-aided design (CAD)

4. What could children design, make and evaluate?
gift boxes   desk tidy   lunchboxes   packaging   cool boxes   party boxes   mystery boxes   toy car body shell   moneyboxes   other – specify

5. Intended users
themselves   siblings   parents   relatives   friends   younger/older children   party guests   shop customers   community group   neighbours   other – specify

6. Purpose of products
packaging   storage   protection   marketing   presentation   display   celebration   postage   other – specify

7. Links to topics and themes
Shape and Space   Shopping   Going Green   Festivals   Celebrations   Healthy Eating   Our School   Toys and Games   other – specify

8. Possible contexts
home   school   shopping   culture   enterprise   local community   wider   environment   other – specify

9. Project title
Design, make and evaluate a _____ (product) for _____ (user) for _____ (purpose).
To be completed by the teacher. Use the project title to set the scene for children's learning prior to activities in 10, 12 and 14.

16. Possible resources
collection of shell structures for different purposes and users

card, squared paper, coloured paper, adhesive tape, masking tape, PVA glue, glue spreaders, acetate sheet, pencils, felt-tip pens, rulers, right/left handed scissors

computer with computer-aided design (CAD) software such as Techsoft 2D Primary or Microsoft Word, printer

17. Key vocabulary
shell structure, three-dimensional (3-D) shape, net, cube, cuboid, prism, vertex, edge, face, length, width, breadth, capacity

marking out, scoring, shaping, tabs, adhesives, joining, assemble, accuracy, material, stiff, strong, reduce, reuse, recycle, corrugating, ribbing, laminating

font, lettering, text, graphics, decision, evaluating, design brief design criteria, innovative, prototype

3. Key learning in design and technology

Prior learning
- Experience of using different joining, cutting and finishing techniques with paper and card.
- A basic understanding of 2-D and 3-D shapes in mathematics and the physical properties and everyday uses of materials in science.
- Familiarity with general purpose software that can be used to draw accurate shapes, such as Microsoft Word, or simple computer-aided design (CAD), such as 2D Primary by Techsoft.

Designing
- Generate realistic ideas and design criteria collaboratively through discussion, focusing on the needs of the user and the functional and aesthetic purposes of the product.
- Develop ideas through the analysis of existing shell structures and use computer-aided design to model and communicate ideas.

Making
- Plan the order of the main stages of making.
- Select and use appropriate tools and software to measure, mark out, cut, score, shape and assemble with some accuracy.
- Explain their choice of materials according to functional properties and aesthetic qualities.
- Use computer-generated finishing techniques suitable for the product they are creating.

Evaluating
- Investigate and evaluate a range of shell structures including the materials, components and techniques that have been used.
- Test and evaluate their own products against design criteria and the intended user and purpose.

Technical knowledge and understanding
- Develop and use knowledge of nets of cubes and cuboids and, where appropriate, more complex 3D shapes.
- Develop and use knowledge of how to construct strong, stiff shell structures.
- Know and use technical vocabulary relevant to the project.

10. Investigative and Evaluative Activities (IEAs)
- Children investigate a collection of different shell structures including packaging. Use questions to develop children's understanding e.g. *What is the purpose of the shell structure – protecting, containing, presenting? What material is it made from? How has it been constructed? Are the materials recyclable or reusable? How has it been stiffened i.e. folded, corrugated, ribbed, laminated? What size/shape/colour is it? What information does it show and why? How attractive is the design?*
- Children take a small package apart identifying and discussing parts of a net including the tabs e.g. *How are different faces of the package arranged? How are the tabs used to join the 'free' edges of the net?*
- Evaluate existing products to determine which designs children think are the most effective. Provide opportunities for the children to judge the suitability of the shell structures for their intended users and purposes. Discuss graphics including colours/impact of style/logo/size of font e.g. *What do you prefer and why? What style of graphics and lettering might we want to include in our product to meet users' preferences and its intended purpose? Which packaging might be the best for…?*

11. Related learning in other subjects
- **Science** – discuss the properties and suitability of materials for particular purposes.
- **Mathematics** – compare and sort common 2-D and 3-D shapes in everyday objects. Recognise 3-D shapes in different orientations and describe them.
- **Spoken language** – ask relevant questions to extend knowledge and understanding. Build their technical vocabulary.

12. Focused Tasks (FTs)
- Demonstrate simple drawing software such as Techsoft 2D Primary or Microsoft Word. Ask children to explore the interface and drawing tools to practise drawing and manipulating shapes such as rectangles, squares, ellipses, trapezoids and triangles.
- Ask children to use the software to open existing drawings including nets and to draw nets of their own, using gridlines and pre-shaped tools.
- Let the children explore and be guided to try out different fill and font tools to become familiar with the graphic design aspects of the available software to achieve the desired appearance of their products.
- Practise making nets out of card, joining flat faces with masking tape to create 3-D shapes. Experiment with assembling pre-drawn nets in numerous ways using scoring, cutting and assembling techniques. Allow children to construct a simple box and show how a window can be cut out and acetate sheet added.

13. Related learning in other subjects
- **Mathematics** – use a ruler to measure to the nearest cm, half cm or mm. Draw 2-D shapes and make 3-D objects using modelling materials.
- **Computing** – design and create digital content on screen, creating nets for their products and combining text with graphics.

14. Design, Make and Evaluate Assignment (DMEA)
- Develop a design brief with the children within a context which is authentic and meaningful.
- Discuss the uses and purposes of their shell structure e.g. *What does the product need to do? Who is it aimed at? How will the purpose and user affect your design decisions?* Agree on design criteria that can be used to guide the development and evaluation of children's products *e.g. How will we know that we have designed and made successful products?*
- Ask the children to develop a design using computer-aided design (CAD) software to create nets, addressing the needs of the user and the purpose.
- Using computer-aided design (CAD) software ask the children to print out their nets to develop prototypes in order to evaluate and refine their ideas e.g. *What will you need to include in your design? How can you improve it? What materials will you use? How will you make sure your product works well and has the right appearance?*
- Ask children to identify the main stages of making and the appropriate tools and skills they learnt through focused tasks. Encourage the children to work with accuracy, using their computer-aided design (CAD) skills as appropriate.
- Evaluate throughout and the final products against the intended purpose and with the intended user, where safe and practical, drawing on the design criteria previously agreed.

15. Related learning in other subjects
- **Spoken language** – ask relevant questions to extend knowledge and understanding. Build technical vocabulary.
- **Art and design** – use and develop drawing skills.
- **Writing** – write for real purposes and audiences.
- **Computing** – design and create digital content on screen using computer-aided design (CAD) software, creating nets for their products and combining graphics with text.

18. Key competencies
problem-solving   teamwork   negotiation   consumer awareness   organisation   motivation   persuasion   leadership   perseverance   other – specify
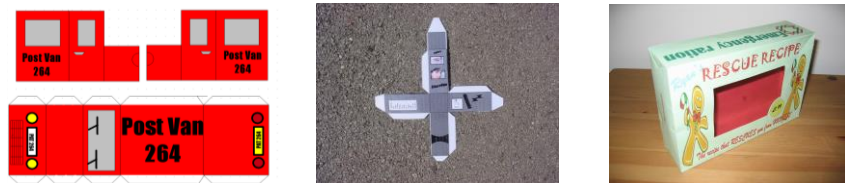
19. Health and safety
Pupils should be taught to work safely, using tools, equipment, materials, components and techniques appropriate to the task. Risk assessments should be carried out prior to undertaking this project.

20. Overall potential of project

Structures
## Shell structures using CAD
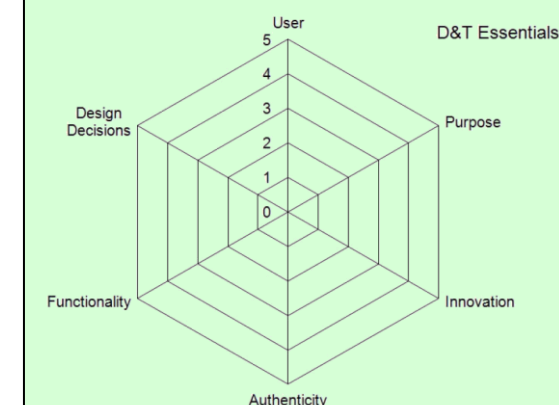
Instant CPD

Tips for teachers

- ✓ Please also refer to the Instant CPD guidance in 'Year 3/4 Structures – shell structures' when carrying out this project
- ✓ Many software packages have demonstration versions with tutorials that you can try out without paying a charge.
- ✓ Visit a local shop or supermarket to investigate different types of card packaging.
- ✓ Make a collection of shell structures of various shapes and, where possible, flatten them to show the nets and for storage.
- ✓ Put together an image board of packaging so children can see the range of fonts and consistency with a brand.
- ✓ Discuss environmental issues relating to the wastage of materials when packaging items including the three R's - reducing, recycling and reusing.
- ✓ If children are designing and making packages for a food product, they will need to choose materials appropriate for direct contact with food.
- ✓ You may want to restrict children to using particular standard shapes when designing their nets and final products.
- ✓ Ensure that the children include sufficient tabs in their drawings for assembling their nets.
- ✓ Use the options in Microsoft Word and other software to display rulers and grids that can help with generating nets and other items.
- ✓ Using copy and paste will ensure that objects are of a consistent size.
- ✓ Ensure that the children have a good understanding of the associated vocabulary and of 2-D and 3-D shapes in maths before carrying out this project.

Useful resources at www.data.org.uk

- · Primary Subject Leaders' File Section 5.9
- · Banish broken biscuits! Box them brilliantly
- · Desk Tidy
- · Working with Materials
- · Packaging – with links to Maths
- · Nets for packaging

Using Microsoft Word
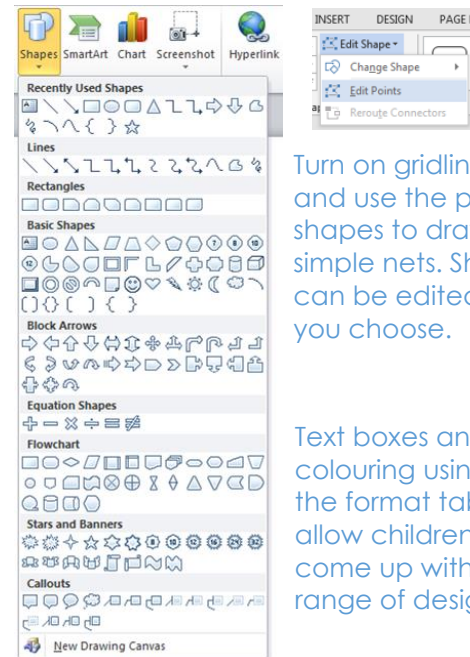
Turn on gridlines and use the pre-set shapes to draw simple nets. Shapes can be edited if you choose.

Text boxes and colouring using the format tab will allow children to come up with a range of designs.

Microsoft Word has many features that allow children to draw and manipulate accurate shapes, import or paste in graphics and print the final designs without having to use dedicated CAD software.
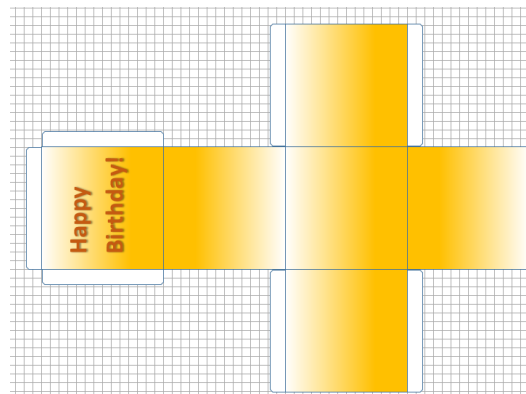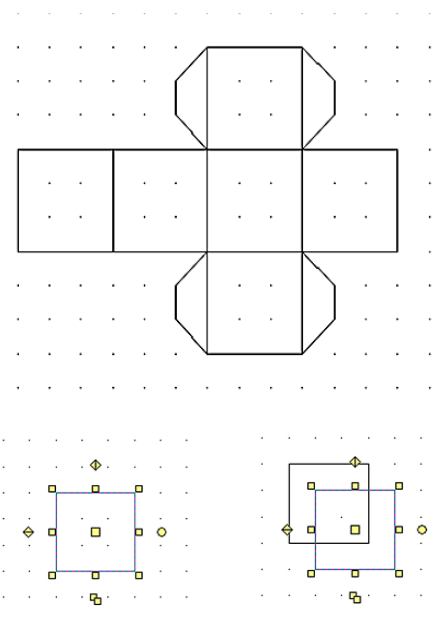

Using TechSoft 2D Primary
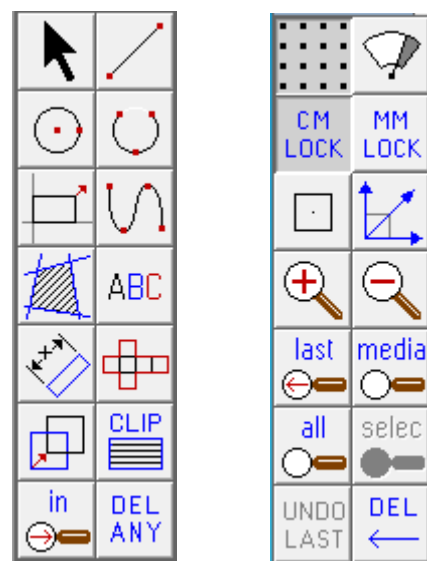
Explore and use the different drawing tools and zoom, grid and locking tools to help ensure accurate drawings.

Demonstrate how to draw a simple net and ask children to practise using the copy and move 'handles'.
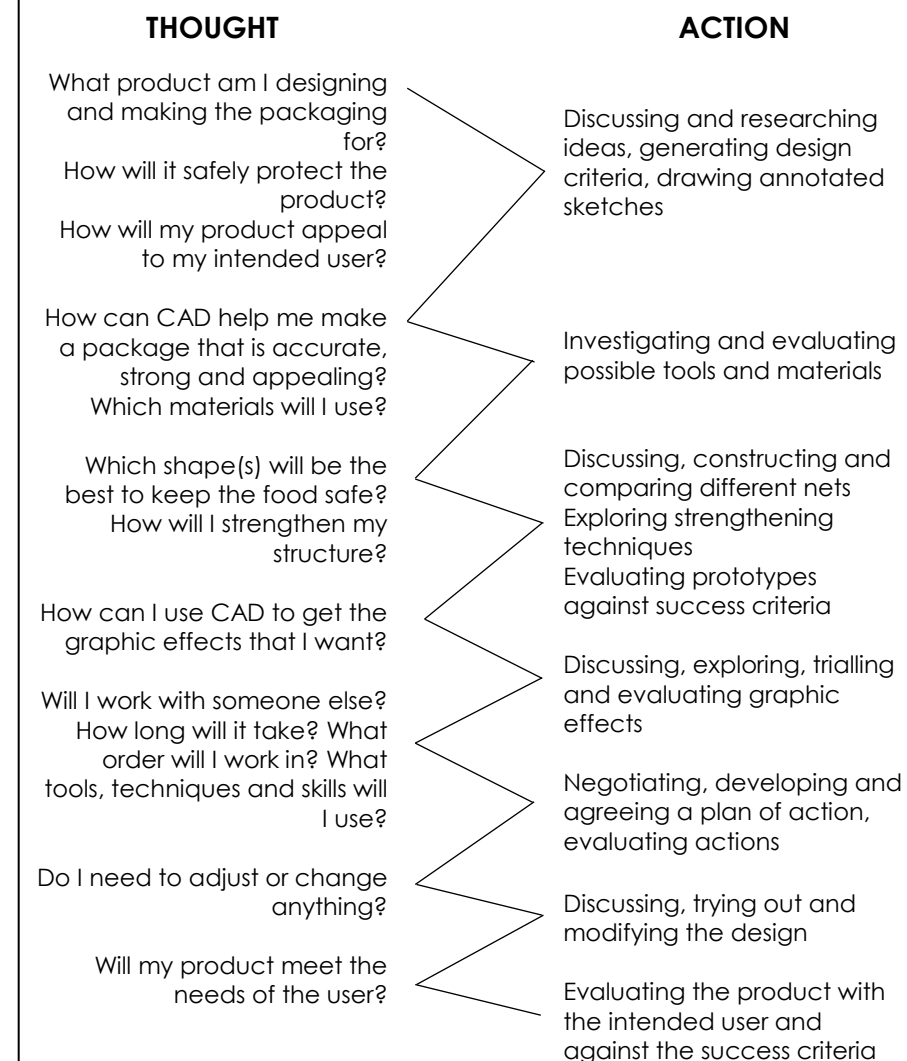

When to use CAD

- When children understand the value of using it to improve the accuracy and appearance of their products
- Where it achieves learning objectives more efficiently
- Where children have been taught and practised the necessary computing skills
- Wherever possible, to design the functional and aesthetic features of a product

When not to use CAD

- When children do not have sufficient understanding of the product they are designing
- As a substitute for practical activities with actual materials and components
- When a project can be delivered as effectively without it

Designing, making and evaluating CAD-based packaging to protect and display a food product for sale

An iterative process is the relationship between a pupil's ideas and how they are communicated and clarified through activity. This is an example of how the iterative design and make process *might* be experienced by an individual pupil during this project:

THOUGHT	ACTION
What product am I designing and making the packaging for? How will it safely protect the product? How will my product appeal to my intended user?	Discussing and researching ideas, generating design criteria, drawing annotated sketches
How can CAD help me make a package that is accurate, strong and appealing? Which materials will I use?	Investigating and evaluating possible tools and materials
Which shape(s) will be the best to keep the food safe? How will I strengthen my structure?	Discussing, constructing and comparing different nets Exploring strengthening techniques Evaluating prototypes against success criteria
How can I use CAD to get the graphic effects that I want?	Discussing, exploring, trialling and evaluating graphic effects
Will I work with someone else? How long will it take? What order will I work in? What tools, techniques and skills will I use?	Negotiating, developing and agreeing a plan of action, evaluating actions
Do I need to adjust or change anything?	Discussing, trying out and modifying the design
Will my product meet the needs of the user?	Evaluating the product with the intended user and against the success criteria

Glossary

- **CAD** – computer-aided design.
- **Shell structure** – a hollow structure with a thin outer covering.
- **Edge** – where two surfaces meet at an angle.
- **Face** – a surface of a geometric shape.
- **Vertex** – the corners of a geometric shape where edges meet.
- **Font** – a printer's term meaning the style of lettering being used.
- **Net** – the flat or opened-out shape of an object such as a box.
- **Cuboid** – a solid body with rectangular sides.
- **Prism** – a solid geometric shape with ends that are similar, equal and parallel.