1. Year Groups
Years 3/4

2. Aspect of D&T
Structures

Focus

Shell structures

4. What could children design, make and evaluate?
gift boxes/containers   desk tidy
disposable/recyclable lunchboxes   packaging
cool boxes   party boxes   keep safe boxes
mystery boxes   other – specify

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

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

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

8. Possible contexts
home   school   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, 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.

Designing
- Generate realistic ideas and design criteria collaboratively through discussion, focusing on the needs of the user and purpose of the product.
- Develop ideas through the analysis of existing products and use annotated sketches and prototypes to model and communicate ideas.

Making
- Order the main stages of making.
- Select and use appropriate tools 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 finishing techniques suitable for the product they are creating.

Evaluating
- Investigate and evaluate a range of existing 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 how to construct strong, stiff shell structures.
- Develop and use knowledge of nets of cubes and cuboids and, where appropriate, more complex 3D shapes.
- 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)
- Children use kit parts with flat faces to construct nets. Practise making nets out of card, joining flat faces with masking tape to create 3-D shapes. Experiment with assembling in nets in numerous ways.
- Demonstrate skills and techniques of scoring, cutting out and assembling using pre-drawn nets. Then allow children to practise by constructing a simple box. Show how a window could be cut out and acetate sheet added.
- Demonstrate how to use different ways of stiffening and strengthening their shell structures e.g. folding and shaping, corrugating, ribbing, laminating. Provide opportunities for the children to practise these and to carry out tests to find out where their structures might need to be strengthened or stiffened.
- Children discuss and explore the graphics techniques and media that could be used to achieve the desired appearance of their products.
- Practise using computer-aided design (CAD) software to design the net, text and graphics for their products according to purposes.

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 shapes using modelling materials.
- **Computing** – design and create digital content on screen, creating nets for their products and combining text with graphics.

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.

14. Design, Make and Evaluate Assignment (DMEA)
- Develop a design brief with the children within a context which is authentic and meaningful.
- Discuss with the children the uses and purposes of their shell structures 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 use annotated sketches and prototypes to develop, model and communicate their ideas for the product 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 computer-aided design (CAD) where appropriate.
- Evaluate throughout and the final products against the intended purpose and with the intended user, 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.

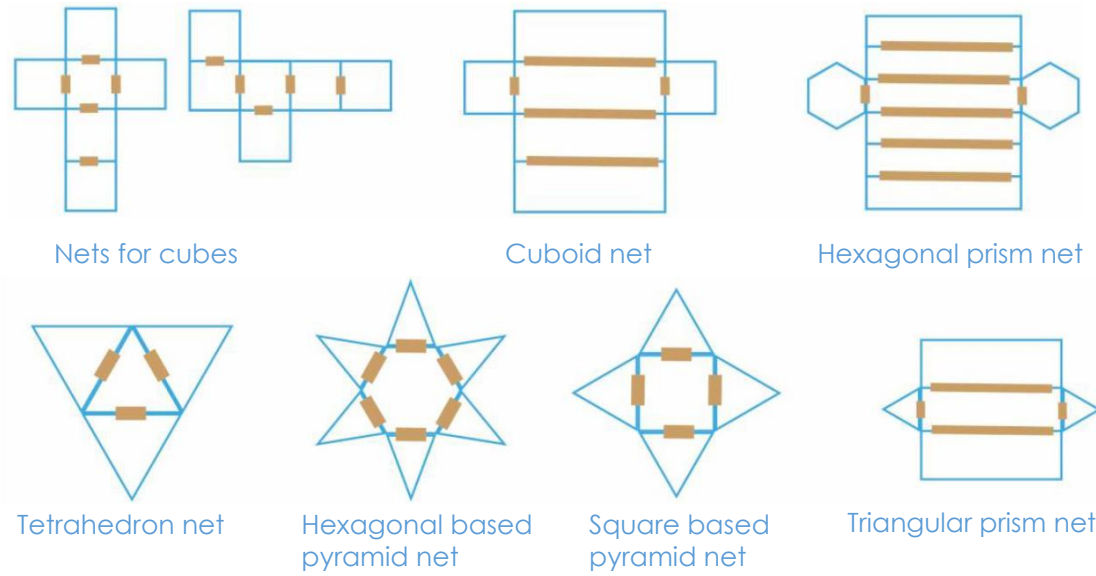## 20. Overall potential of project
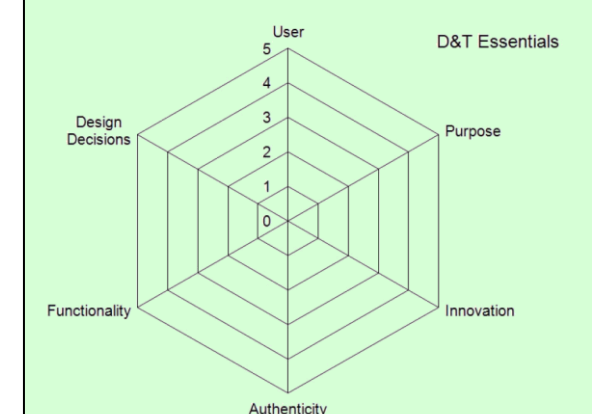
Instant CPD

Tips for teachers

- ✓ Make a collection of boxes of various shapes and flatten them for storage.
- ✓ Discuss environmental issues relating to the wastage of materials when packaging items including the three R's – reducing, recycling and reusing.
- ✓ Visit a local shop or supermarket to investigate different types of card packaging.
- ✓ The use of an empty ball point pen together with a safety rule is ideal for scoring.
- ✓ The use of standard shapes as templates will help children design their own nets.
- ✓ Ensure that the children have sufficient tabs for assembling their nets.
- ✓ Consider the use of enlarge and reduce facilities on the photocopier when copying 2-D nets for the children as examples.
- ✓ Display technical vocabulary to encourage the children to use it when discussing, designing and making their product.
- ✓ Divide your class into teams and assign children to specific jobs within their teams e.g. Resources Manager, Sustainability Officer, Design Director, Tools Manager, Process Controller, Graphics Director.
- ✓ The use of computer-aided design to draw nets and graphics for the children's products could be practised in computing lessons.
- ✓ Ensure that the children have a good understanding of 2-D and 3-D shapes in maths before carrying out this project.
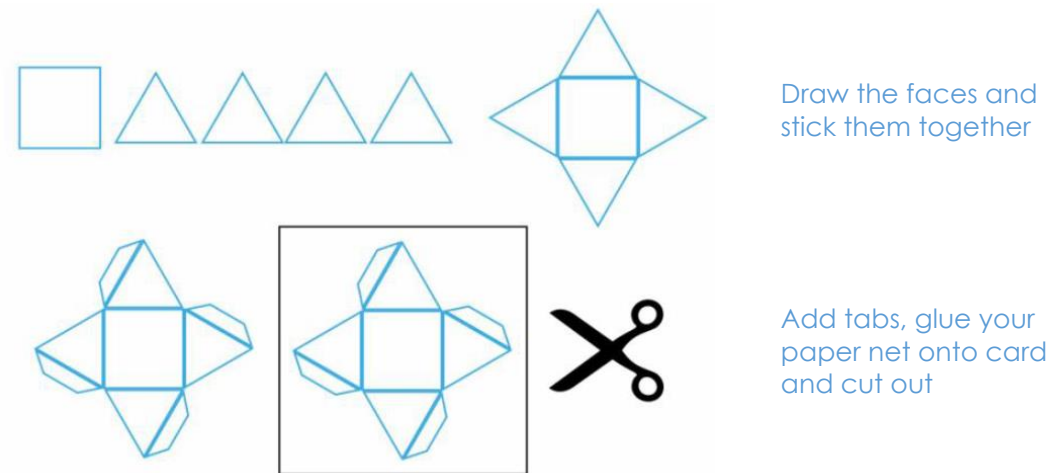
Useful resources at www.data.org.uk

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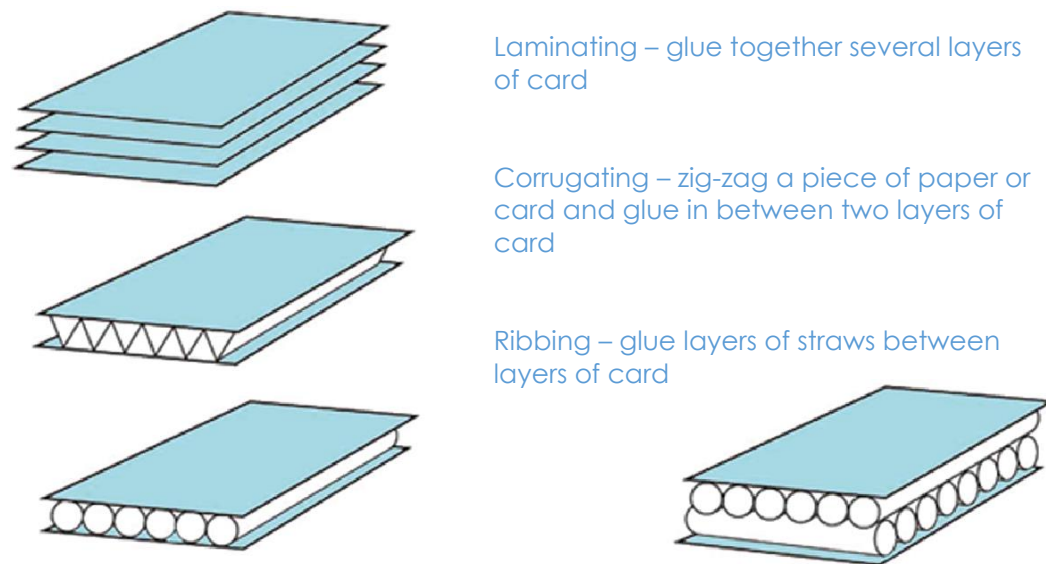- Nets for packaging helpsheet
- Door hinges helpsheet

Assemble and evaluate 3-D shapes using standard sized card squares, rectangles, equilateral triangles, isosceles triangles and hexagons, joined with masking tape.

Nets for cubes   Cuboid net   Hexagonal prism net

Tetrahedron net   Hexagonal based pyramid net   Square based pyramid net   Triangular prism net

Creating the net for the product you are designing and making without using computer aided design:

Draw the faces and stick them together

Add tabs, glue your paper net onto card and cut out

Stiffening and strengthening sheet materials:

Laminating – glue together several layers of card

Corrugating – zig-zag a piece of paper or card and glue in between two layers of card

Ribbing – glue layers of straws between layers of card

Designing, making and evaluating packaging for a gift for a family member

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 type of shell structure shall I make? What will be the purpose of my product? How will my product appeal to my intended user?	Discussing ideas, drawing annotated sketches, generating design criteria.
Which materials will I use to make it?	Investigating and evaluating possible materials.
Which shape will be the best for my structure? How will I stiffen and strengthen my structure?	Discussing, constructing and comparing different nets. Exploring strengthening techniques. Evaluating prototypes against success criteria.
What graphics techniques will I use to achieve a desired visual effect and purpose?	Discussing, exploring, trialling and evaluating different graphics 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

- **Cuboid** – a solid body with rectangular sides.
- **Edge** – where two surfaces meet at an angle.
- **Face** – a surface of a geometric shape.
- **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.
- **Prism** – a solid geometric shape with ends that are similar, equal and parallel.
- **Scoring** – cutting a line or mark into sheet material to make it easier to fold.
- **Shell structure** – a hollow structure with a thin outer covering.
- **Vertex** – used to refer to the corners of a solid geometric shape, where edges meet.