

## 2 The Design Cycle

D&T is about more than just making models. Children should be given opportunities to design products for a specific purpose. They should understand that great inventions may have gone through many changes before they were really fit for purpose. Children should learn to consider how well their own products meet the design brief and what refinements may help to improve them. During D&T lessons children should also be learning new practical skills. They should become familiar with tools and how to use them safely and they should learn about materials and their properties.

Children should experience a whole design process from first ideas to evaluation of a finished product. This process is often depicted as a cycle rather than a linear route, in order to emphasise the importance of continually evaluating and refining the product design. This is known as the Design Cycle.

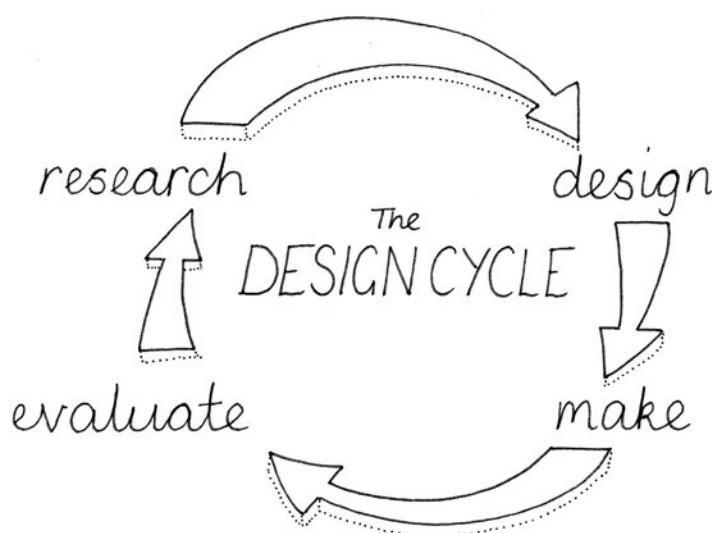


Figure 2.1

The lesson plans in this book follow the Design Cycle. It is important that during each school year, the children experience every part of the design process from research to evaluation, but at some points it may be appropriate to focus on practical skills (sawing, sewing, mechanisms) rather than on designing and making a particular product.

### RESEARCH

Research can take several forms. For young children, taking apart mechanisms from toys can help to give them an understanding about the means by which the toys can be made to move. A collection of moving toys (bath toys are particularly useful) and common mechanical items which the children can unscrew and take to pieces will be

a popular addition to any classroom. It is important to avoid injury, so children should be supervised and it is wise to avoid electrical items which may remain charged even after they are unplugged or the battery removed. The knowledge children gain from this type of research can help them when they come to design their own products, because they should have some idea about the shapes and arrangement of components.

Research also covers use of the Internet and reference books to gather information. As children may not be designing an innovative product, they can use research to give them ideas about style, decoration and size. This research will also teach the children about the inflated costs of products. It is educational to see that while, for example, leading pet shops sell expensive plastic dens for rabbits and guinea pigs, pets are just as happy in something made from an old cardboard box that has cost nothing and can be made bespoke to suit the needs of a particular animal.

As the children reach upper KS2 they should be starting to consider the needs of the consumer. They should talk to potential users, discuss their particular requirements and then use this information to inform their design. This market research can help the children to focus their designs on the actual needs, rather than the assumed needs, of the user. To help the children to formulate appropriate questions, teachers can set the scene when introducing the project, so that children understand the reasons for the design project. This could involve the teacher choosing an appropriate scenario and perhaps preparing some background information in advance (e.g. making a tool to be used by astronauts) or using a real-life situation where the potential users can be interviewed (e.g. planning a meal for the class picnic taking allergies and food preferences into account).

Having surveyed the available products and thought about the needs of the user, and perhaps already drawn out a preliminary design, children should make some decisions about the materials they will use in the construction of the product or the ingredients they will use to make a particular dish. Research here could cover the properties and manufacture of various materials and perhaps their cost. The seasonality and locality of ingredients can be researched too, as well as various recipe ideas.

In all situations, the children should be expected to build a research portfolio of ideas and information. The portfolio might include:

- photos or diagrams of mechanisms
- information about products available already
- pictures or samples of products or raw materials
- records of interviews
- results of surveys
- preliminary design ideas based on research

This portfolio may well be added to or annotated as children discover that they need further information or ideas. This is an example of the iterative nature of the design process because moving from the research stage to the design stage does not prevent the designer from returning to do more research if the need arises.

In many cases, research can be linked to the other curriculum areas. For example, the properties of common materials are covered in the science curriculum; geographical skills can be used to consider food miles when investigating ingredients; following the development of a particular product over time fits neatly into the history syllabus.

## DESIGN

Design is perhaps the hardest process within D&T. While children may have many ideas, they do not always find it easy to convert these ideas into workable designs. Encourage the children to come up with several different designs including a very simple one. If they meet insurmountable problems with their chosen (and usually ambitious) design, then they will have a fall-back position available.

A design is more than just a drawing and should include information about:

- the materials chosen
- the processes to be used
- the equipment required
- how the product will be finished

There should be detailed drawings of structures and/or mechanisms within the product. These may be shown best as cross-sectional drawings (Figure 2.2) or as an exploded view picture (Figure 2.3).

Drawing 3D representations of structures can be made easier with the use of isometric paper (Figure 2.4) which allows the children to accurately draw the angles required for a 3D solid shape, such as a cube.

If the structures are to be made from a folded net, then a diagram to show the net should be included. A supply of nets for different shapes is an invaluable resource as many children, and some adults, find it hard to visualise the net for a particular shape.

Children should be encouraged to produce a story board, in words or pictures, with details of the practical steps towards the finished product (Figure 2.5). As children become more experienced, they will gain a good understanding of the best order in which to do things. Thus, while a KS1 child might assume that decorating the product is the final step in the process, by the end of KS2, children should have realised that it is sometimes easier to add decoration *before* the product is assembled.

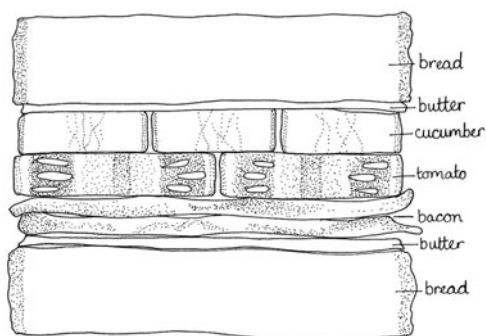


Figure 2.2 A cross-sectional drawing

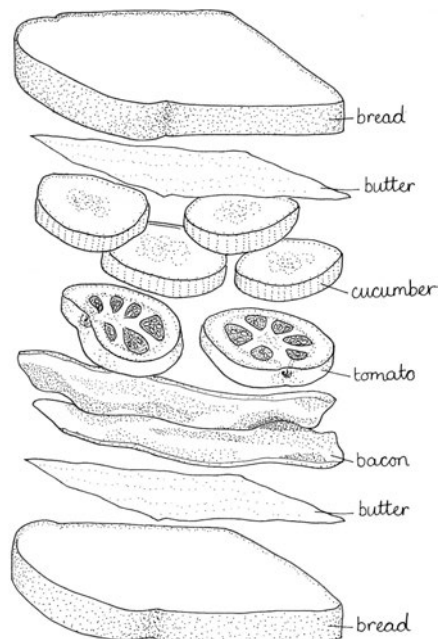
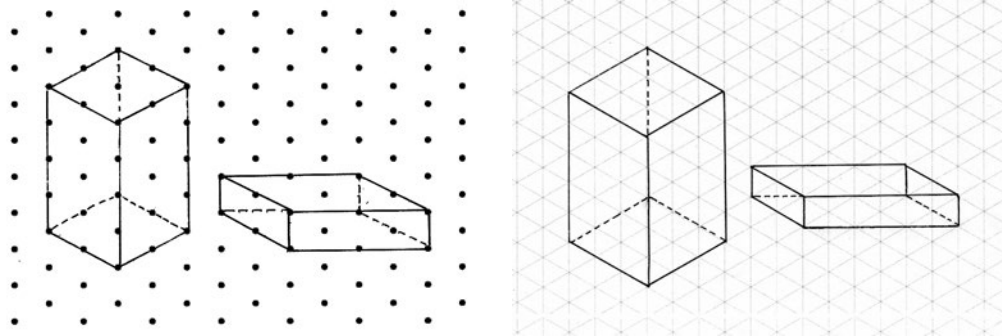
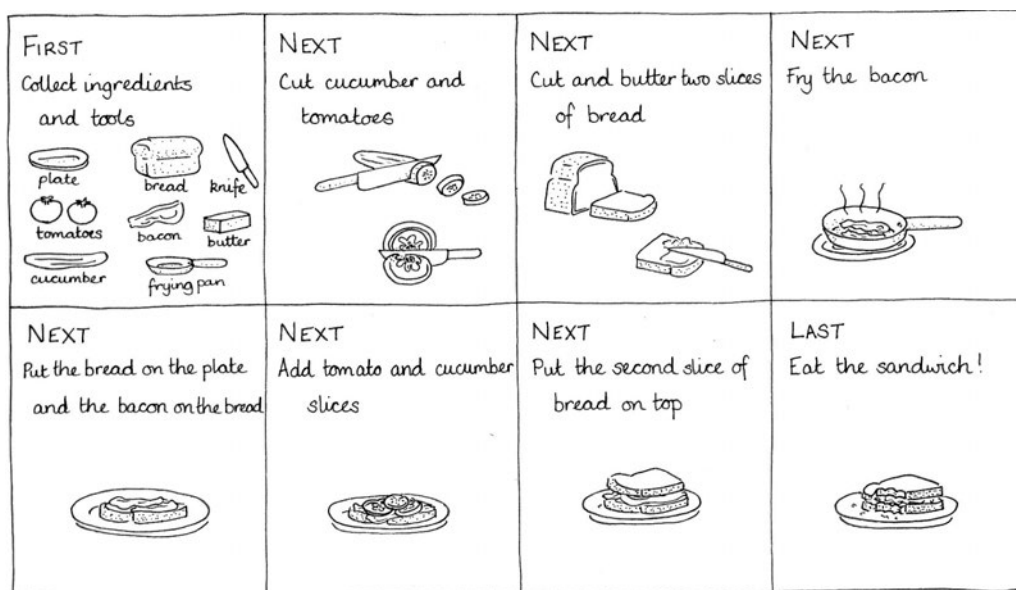


Figure 2.3 An exploded view drawing



**Figure 2.4**



**Figure 2.5** A story board showing the steps in producing a sandwich

The National Curriculum states that the design process should be iterative. In simple terms, this means a continuous cycle of thinking and doing. Thus, an original idea may look good until the child comes to consider the materials to be used. The properties of the materials chosen may not lend themselves to the structure of the product, leading to a re-think about shapes. Once the shape has been modified to suit the materials, there may be problems with the mechanism, which perhaps no longer fits inside the structure. The children will have to consider alternative arrangements and so on. As the product is manufactured, the children may see ways to improve on an already successful design. The end product should have gone through many stages of thought and action before it is finished. The iterative process can be seen at work when a child plays with a construction kit. They often make a vehicle which, after a bit of thought and play, they will alter. They might change the shape of the vehicle, add a place for a passenger to sit, add weapons or rocket launchers, find a propeller that they would like to incorporate and so on. In this way, the original car eventually becomes something more exciting. As young children will continually re-make a model in this way, encourage them to draw or photograph the model at each stage. This way, they will have a record of the changes they made.

An iterative process of design does not lend itself to neatness, as things will be crossed out, annotated or added to continually. A good design, therefore, may be rather confused. While this is to be expected and encouraged, it will sometimes be helpful for a neat copy of the finished design to be produced for construction purposes.

In most D&T lessons, children will probably be working in groups. Group work in D&T, as in all subjects helps children to learn the skills of discussion and compromise. They should also realise that, as everyone one has different skills, working as a team means that a higher quality product can be produced. During the design process the children should learn to listen to and consider the other team members' ideas and start to combine the good parts of each idea to produce a whole plan. This process may need to be modelled by the teacher several times before the children use it successfully.

## **MAKE**

The majority of the chapters in this book are concerned with the making part of the Design Cycle. Each chapter contains subject knowledge to help teachers and children to understand the theory behind the various processes. The chapters also include various ideas for making small models, toys and gadgets. These projects offer a way for the children to learn skills which they can then use in their own designs. For example, it is no use asking children to design a moving machine before they have learned what the various mechanisms can do. By making a small cam card or a moving picture using levers and linkages, they start to understand the mechanisms and see how they produce movement. This knowledge then can be transferred to their own designs later on. These focused practical tasks (FPTs) formed part of the QCA scheme of work for the pre-2014 D&T curriculum. Although they are not included in the 2014 curriculum, there is no harm in continuing to use FPTs in D&T lessons. In addition, some D&T lessons may be entirely concerned with learning and practising various techniques such as sewing or sawing. Once again, children cannot be expected to make a decent product using fabric or wood if they do not know how to cut and join it. In these cases, it is also possible for the practice to lead to the production of a small article or toy, but not necessarily one that the children have previously designed.

Another step to the understanding of the techniques involved in the making process is to make a mock-up or prototype. A mock-up is a model of the product which can be made from any material but which doesn't function. Commercial mock-ups are often decorated to show how the final product will look but not how it will work. Mock-ups are used at KS1 when the children might build a model of their product with a construction kit to show the shape and size of their design. The prototype is introduced at KS2 and is a properly working model, although it may not be full size. A prototype is used to test the functionality of the product with the expectation that problems will be found which can be fixed before the final product is manufactured. For example, during a textiles session, KS2 children can use newspaper to make a prototype of their garment design to check that it fits the user and that the pattern pieces fit together effectively. The prototype can then be disassembled and the pieces used to adjust the pattern if necessary.

As with all practical activities, children will work at different speeds and with different levels of success. It is important for the children to realise that he who finishes first has not necessarily made the best possible product, but also that taking days to carefully cut one component may result in the rest of the process being rushed and unsatisfactory. Spending one D&T session on FPTs can help the teacher to identify those children who are confident and able to cope with the task and those who may need extra assistance. When it comes to making the designed product, resources and

assistance can be deployed accordingly. Children who finish quickly generally find that, on testing, their product doesn't work as effectively as they'd hoped, so they are then able to use the extra time to refine and fix any problems. Children who are struggling with the early stages of manufacture may need to be encouraged to simplify their designs in order to produce a finished article within the allotted time. While it may be disappointing to have to do this, it is more disheartening to fail to make anything at all during the sessions.

The nature of D&T work can mean that the classroom is noisy and dusty. It is helpful to have the room zoned so that all the noisy or messy processes (sawing, gluing, blending) are kept in one area. Some tables need to be available for delicate work and there should also be space for the children to be able to lay out their designs and the various components they will be using. A named tray or box for each group can help to provide some organisation in the chaos. For cookery activities, the tables and work surfaces must be clean. There should be nothing on them but the ingredients and equipment which are required for the task. This is obvious for a food-handling situation, but there is no harm in introducing it as the way all D&T projects should be carried out. During practical sessions children may work best standing up; it allows more room for the children to work and makes access round tables easier for teachers.

Resources for D&T are expensive so it important to consider how to make the most of the resources and not waste them unnecessarily. Here are a few tried and tested suggestions:

- Put small components into labelled containers to prevent spillage and loss.
- Provide each table or group with a kit of useful items such as pens, pencils, scrap paper, scissors and glue sticks to reduce the need to be looking for them during the lesson.
- Where possible, cut A3 size card and paper down to A5 size. Felt and other fabrics can also be cut to a suitable size before the lesson. This can help to avoid the irritation of a child taking a huge piece of card or fabric and cutting out a tiny circle *from the middle!*
- Give expensive consumables directly to the pupils; make sure they put their names on them immediately. Use a permanent marker to write on motors and plastics.
- Keep back a supply of the essential but common components so that when something is unaccountably lost, you can replace it quickly.
- Having resources set out for each table can be a great time saver in a lesson; however, if the children are going to struggle not to fiddle it may be best to hand them out when they are required.

## **EVALUATE**

When evaluating their product, children should not only be considering whether the product does what it was designed to do and whether it is aesthetically pleasing, but also be recording the changes they made to the design during manufacture and the reasons for these changes. By doing this, the children begin to gain an understanding of design as an iterative process, rather than a process which follows strict and non-flexible conditions. This can be demonstrated by considering the development of mobile phones when, as soon as a new version is released, another, better one is already being designed. The rapid advances in microprocessor technology, programming and materials mean that each phone, while still allowing the user to make a call, should be better than the previous models. Software designers often take note of feedback from users to design updates for their products. Giving the children some criteria to measure

their product against can lead to more effective evaluation than simply asking them to decide what went well and what could be improved.

At KS1, evaluation can be kept simple. The children can consider how well they have met the design brief by discussing what they set out to do and thinking about how pleased they are with the end result. It is important to consider whether they had to make changes to their original ideas and what they might do differently next time. Recording the children's initial discussions on a flip chart or digital equivalent can help to remind the children of what they discussed several weeks earlier. For KS1 the 'Two Stars and a Wish' evaluation process can be sufficient. The children decide on two things they like about their product or design and one thing they would change or do better if they were to do it again. Seeing the other finished products can help with the Wish part of the process, as the children may be impressed by someone else's design ideas. The children can compare their original drawings and ideas with the finished product and try to highlight places where they have deviated from the original design. They should be encouraged to explain why they did so.

At KS2, evaluation should become a more rigorous process. If a product has been designed for a specific purpose, the children must decide whether it has met the design criteria. This might be done by asking someone else to use/try their product. The feedback from these trials can be used as part of the evaluation. So, if all goes well and the machine works as expected in a novice's hands, or if the food is eaten with enjoyment, then the children can consider that their design has met some of the criteria. The next step is to confirm that the product is doing what it should. This might involve a trial run or some analysis of the product. For example, a fruit salad may taste delicious but not offer a properly seasonal selection of fruit. The children should refer back to the design brief and check that all parts of the brief have been met. It might help to break the design brief down into various different questions. So, a brief to *Design a moving toy which can be operated by a small child using his/her foot* can be broken down into four questions:

- Does it move?
- Can it be operated with a foot?
- Could a small child operate it?
- Is this something a small child would enjoy using?

Additional questions can then be asked for each step. For the example above, the children could consider the strength of construction, the ease of use, the attractiveness of the product and the novelty of the toy (was it an original idea or was it copied from a moving toy they had seen before?)

These questions can be answered with a simple yes/no response or, as the children become more experienced in their evaluations, they could design a sliding scale of success from one (poor) to five (excellent). Anything not reaching the top level can be considered as having potential for improvement or redesign.

Asking children to design their own evaluation tool will help them to consider the design brief in detail. They could design the evaluation tool at the start of the design process to help them to focus on the important points, or they could wait until the product has been made and design an evaluation tool which takes into account some of the problems they encountered. These tools can be used by the children to inform their designs and plans for their next D&T project too. So, if they consider that their product worked well but was messily constructed, then they have a target ready-made for the next project, whether it is food or textiles or an electrical system.

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