CHAPTER 1

What is Design and Technology?

Just the words Design and Technology (D&T) make some people nervous. What comes to mind are enormous machines in factories, personal computers, helicopters, holograms, photocopiers, robots, space stations, mobile telephones and televisions. But we tend to overlook the enormous number of familiar things we have around us that are neither complicated nor expensive: brooms, forks, egg whisks, pencils, erasers, sticking plasters, torches, toys, paper weights, mitts, mixed fruit drinks, buttons, teabags, rubber boots, safety rulers, spinning top: no book is long enough to list them all. Children can understand things like these. What is more, they can design and make simple things like these themselves and solve practical problems with a small number of tools and materials. D&T need not be complex and doing D&T does not have to involve rolls of blueprints or machines. So, what is it?

Inventions that solve practical problems

Design and Technology is the process of inventing or improving things to satisfy practical needs and solve practical problems. Think of a ball of wool in a shop window. The shopkeeper wants to attach a price tag. The problem is that some ways of attaching a tag could damage the wool. Then no one would buy it – think of those annoying holes that some tags make in garments. But, if the tag is not attached firmly, it could drop off. What is the solution? One solution is to cut out a rather broad, blunt arrow-head from thin card. The 'pointed' end is pushed into the ball of wool and the price is written on the piece that sticks out. Being V-shaped, the card does not fall out and, made from thin card, it does not damage the wool. This is just one solution and you could probably think of others. Simple practical problems like these that can be solved in many different ways are very useful in the classroom. They give the children the opportunity to be creative and solve the problems in their own way.

Here is another practical problem. Think about a pile of loose sheets of paper on your desk. Someone walks past and the papers fall to the floor and become mixed-up. How can you prevent that happening? You might, for instance, put the sheets in order and push a pin through one corner. This was how papers used to be attached to letters and, of course, you would probably catch a finger on the pin as you took the letter from the envelope. The pin is a solution, but not an ideal one. Something cheap that can hold a few pages together without injuring those who handle them is needed. The improvement is, of course, the wire paper clip, invented by the Norwegian, Johan Vaaler in 1899.

Ideas can come from anywhere. Temporary fasteners for items of clothing are an obvious need and the button and the zip are two solutions. In the 1950s, George de Mestral was walking in the countryside in Switzerland and noticed that burdock seed heads – burrs – clung to his clothes. A microscope showed him how they did it. Each spine ended in a tiny hook. This hook solves the problem of seed dispersal for the plant but de Mestral went on to use it to make another solution to the problem of fastening clothes, Velcro®. This has tiny plastic hooks on a strip of fabric. Another strip has tiny loops. When the two are pressed together, hooks and loops engage and keep the strips together.

Often, inventions do not solve a new problem but improve upon an existing solution. Take clothes-pegs, for example. Originally, these were split twigs bound at one end, but after a while, the binding becomes loose. An improvement was to make a one-piece wooden peg, but these have a tendency to split so there was still room for improvement. The next step was a peg with two wooden legs held together by a spring. After that, the wood was replaced by a plastic material. This peg would not split but it is still not perfect. Sunlight and use weaken plastic pegs and they tend to snap. New designs for clothes-pegs continue to appear.

Inventions in history and everywhere

Inventing things to solve practical problems or make things work better is not something new. People have done it for thousands of years. Remarkable evidence of this comes from the frozen, 5000 year old remains of a man found in the mountains on the Austrian–Italian border. He was wearing a fur cap, a cape and leggings. Around his waist was a belt with a pouch to hold his fire-making materials. His leather shoes were lined with hay to keep his feet warm and he wore a cloak made from grass over his clothes to shed rain like a thatched roof. He had a flint knife in a plaited sheath, a bow and some arrows and, like a modern hill-walker, a backpack. He even carried a medicine kit containing a fungus that could be used to deal with infected wounds. These are solutions to some of the most fundamental problems we all face: keeping dry and warm, collecting and preparing food, carrying things and keeping healthy. Amusement and entertainment, though not essential for survival, are also needs that people seek to satisfy. It was no different long ago. For instance, a toy crocodile made from wood was found in an ancient Egyptian child's tomb. Its lower jaw was held in place by a simple hinge and when a string was pulled, the jaw would snap shut. We can easily imagine this child pestering her brothers and sisters with her snappy crocodile, just like a modern child would do. In China, at much the same time, people were playing flutes made from hollow bones and in the Middle East, they were making lute-like instruments using natural fibres for the strings.

All people face practical problems and try to solve them, no matter when or where they live. For example, enormous waterwheels were constructed in India centuries ago. They were used to irrigate fields by lifting water from rivers. The Greeks and Egyptians constructed water clocks because sun dials do not work at night and cannot indicate small intervals of time clearly. The Chinese made a clever earthquake detector that rocked to and fro in response to a tremor. The motion made balls fall into the mouths of metal frogs. Nor is ingenuity confined to adults; children all over the world use what is to hand to make their toys.

Inventors: men and women

Customs, past divisions of labour and the way history is written can give the impression that inventing is something done mainly by men. This is not the case and probably never was. Men and women solve problems in whatever they do. For instance, if your life is centred on domestic affairs, you will tend to meet domestic problems. In 1893, Josephine Cochran invented the dishwasher. Presumably, she saw the tiresome drudgery of washing dishes by hand. In 1904, Annie England patented a spoon that would hook over a treacle-tin so that it dripped into the tin, rather than made a mess on the table. Perhaps she had had enough of mopping up sticky treacle when using a conventional spoon. In the same year, Sophia Turner patented an ear-flattener. When asleep, children may lie on their ears in a way that makes them stick out. The ear-flattener was intended to prevent this. Presumably, she had noticed the problem when caring for children and set out to solve it. A more noisome problem is that of washing nappies. Whoever deals with that soon wants an improvement and in 1951, Marion Donovan invented the disposable nappy. Such concerns arose from domestic problems. When your concerns are elsewhere, so is your inventiveness. For instance, in 1870, Margaret Knight, a shop assistant in Boston, invented a satchel-bottomed paper bag, still used today. Presumably, she saw the need and how such bags would make life easier.

At about that time, Stanley Webb, a butcher, patented 'Webb's Improved Skewer'. Being a butcher, he would need something to display the price of his products. His solution was a thick wire spike with a curly top to hold the price ticket. Men have a problem with the daily growth of beard hair. For many years, the solution was to scrape off the hair with a 'cut-throat' razor, an implement which is hard to use, hard to keep sharp, and scary. K.C. Gillette solved the problem in a better way, with the disposable razor blade fitted into his safety razor. If you spend a lot of your time dealing with paper, your problems will often be paper-related. There will have been times when you had a mug in one hand, a biscuit in the other and found you needed a third hand for your papers. Dominic Skinner recently solved that problem by making a mug with a biscuit shelf so you need only one hand for your coffee and biscuit.

The point is that the situation makes the need. Sooner or later, someone will have a go at solving the problem or satisfying the need. If women had beards, K.C. Gillette might have been a woman. If Stanley Webb had worked with treacle, he might have invented the hooked spoon. If Margaret Knight had worked in Webb's shop, she might have invented the price ticket skewer. If men had been the ones to wash nappies, it could have been a man who invented the disposable nappy. The practical problems you meet are determined by your situation. Change it and you meet different problems, some of which you may solve.

This is not to say, however, that boys and girls do not develop their own interests and ways of responding to the tasks you set. These can even support what you are trying to achieve. For instance, some girls may care enormously about the appearance of their design plans. As a consequence, the drawing and written work they hand in can look good. But take care not to think in stereotypes. Do not assume that all girls are like this or that no boys are like this.

Solving practical problems can also be the concern of businesses. They look for opportunities and seek to make a product that satisfies a need (or desire) and fills a vacant niche in the market. So, for instance, we have washing machines for the household market, electric hand drills for the DIY market, paving blocks for the building industry and self-service restaurants at motorway stops.

But invention and innovation are not the exclusive preserves of large companies. Mary Phelps Jacob, prompted by the appearance of her corset under her gown, invented a 'backless brassiere' in 1913 and sold the idea to a corset company. Ladislao Biro, working independently, invented the ballpoint pen in the 1930s. Working as a secretary, Bette Graham saw the need for a paint to cover typing errors so she invented Liquid Paper then, in the 1950s, manufactured it herself, eventually selling the business to a larger company. More recently, James Dyson spent years working alone on his 'cyclone' vacuum cleaner before it appeared on the market. At the same time, the products people create are not always devices that you pick up and use in the conventional sense of the term. Arthur Wynne, for instance, was a journalist who had the problem of providing something to entertain people in the 1913 Christmas issue of his paper. His solution was the crossword puzzle.

Not all inventions are successful or serious but inventing them can be fun

Inevitably, we are surrounded by inventions that are successful. Think of the sweeping brush, the eraser, pens and pencils, bed springs, and the mass of other items we often take for granted. Those that do not make it just disappear. Some years ago, Clive Sinclair invented the C5, an open-topped buggy for getting around town. It used a battery-powered washing machine motor to propel a lightweight body big enough for one. On the surface, this affordable, electrically-propelled buggy sounds like a good idea yet very few people bought it. Compared with the conventional car, it could not compete so that was the end of it. The patent records are full of ideas that never made it. Children, however, do not know of these and so have a distorted image of invention. They may think that all inventions are good and make it onto the market.

In Japan, there is the Art of Chindogu. A Chindogu is an invention that solves a problem but it is more effort than it is worth or creates another problem or is simply not something we would want to do. For example, if a baby has reached the crawling stage, why not put him or her to good use as a mop? Sew mop heads onto her romper suits and set her free on the floor. Why struggle with an umbrella? Fit one to your hat. Never burn your tongue again. Use a plastic tongue-cover. A Chindogu is an invention that simply amuses you. Inventing can be a lot of fun.

D&T and children

What does D&T have to offer children? First, the made world is a very significant part of life for most children and adults. Through D&T, children can begin to understand the made world and have well-founded confidence in dealing with issues in it. They can, for instance, think about what makes a good product, choose wisely from competing products and begin to learn what influences designing and making. Second, learning to solve practical problems benefits from practice and guidance. In D&T, the child can learn to handle ill-defined problems that have many acceptable solutions. People with this capability have a certain kind of independence and autonomy. Third, D&T gives opportunities to acquire or supplement various life skills, such as working co-operatively and communicating effectively. Fourth, because D&T can draw on knowledge from any area of experience, it can serve a useful function in tying knowledge together for the children, making it more concrete and meaningful and memorable. Fifth, learning about D&T and engaging in it prepares the way for further learning and, in the longer term, employment for some. But children cannot acquire all of this at once. It has to be staged.

The 3 – 5 stage

An early stage relates to children between 3 and 5 years of age. This tends to be referred to as the early years, pre-school, or foundation stage. In practice, this stage overlaps with the period of compulsory schooling in the UK so that it includes children in the reception or first class of the primary school. There are various guidelines for practice in this stage. For instance, in England, these organize the curriculum into six ‘learning areas’: personal, social and emotional development; communication, language and literacy; mathematical development; knowledge and understanding of the world; physical development and creative development. In Wales, the areas are similar with the addition of bilingual and multicultural understanding. In Scotland, expressive and aesthetic development is included while in Northern Ireland, ‘early experiences in Science and Technology' is a specific inclusion. Broadly speaking, these curricula are not subject-centred but prepare the children for what they will do later. For consistency, this stage will be referred to as *the early years stage* or by reference to the age range it encompasses (*3 – 5 stage*). The children in it will be decribed as *very young children* if describing them otherwise would be ambiguous.

D&T-like activities can make a useful contribution to any of the learning areas of the early years stage. It can, for instance, help the very young child acquire new ways of working and confidence in working independently and with others (as when using scissors to cut out shapes for a greetings card and sharing them with others). It can provide opportunities to explore, predict and experience the satisfaction and pleasure of simple problem-solving and making activities (as when finding a way to help Winnie the Pooh move a large box). It can provide opportunities to describe, explain, discuss and use pictures for ideas to support their thinking (as when choosing an animal to make). There are opportunities for learning ways of doing things, like how to make copies of the same shape (as when making ladybird 'wings' from card), counting, and measuring by comparison. Both through the contexts used and what is made, children can add to their knowledge and understanding (as when they find that ladybirds have six legs and are harmless to people). Practical activities are opportunities for very young children to increase their planning and manipulative skills and hand-eye co-ordination (as when making a tail that will wag for a shoe box dog and the children have to work inside and outside the box at the same time). Open parts of activities give children the opportunity to make decisions and try out their ideas (as when deciding what the picture on a greetings card will be).

The 5-7 stage

The next stage applies to children between 5 and 7 years of age. These are firmly in the period of compulsory schooling. In England and Wales, these children in state schools are subject to the Key Stage 1 requirements of the National Curriculum, of which Design and Technology is one subject. (In Wales, by 2008 the term, 'Foundation Phase', will describe the period 3 – 7 years of age and a revised curriculum will apply). The requirements in Northern Ireland and the National Guidelines for Scotland include technology as an aspect of The World Around Us and Environmental Studies, respectively. This period of schooling will be referred to as the *5 – 7 stage*. The children in it will be decribed as *younger children* if describing them otherwise would be ambiguous.

How the children's day is organized is for the school to decide but, even where subjects are specified, this does not mean that younger children will have subject-centred lessons. A single, interesting topic may be used to achieve goals in a variety of subjects. Often, a topic will provide a meaningful context for D&T and younger children may not notice the move from one subject to another.

The exercise and development of thinking skills is also generally expected in the 5 – 7 stage. These include:

- information-processing skills (D&T can contribute here when, for instance, you have children search through pictures of playgrounds to find a range of play equipment to model);
- reasoning skills (as when you ask children to explain how a given toy works);
- enquiry skills (as when children test their ideas for how they will make a tall, thin vase stand up even when it has very large flowers in it);
- creative thinking skills (as when, for instance, children have a bright idea about how to make a model roundabout turn, or turn better, or work with fewer parts or how to make it look good);
- evaluation skills (as when you ask the children how the wheels performed on their buggies and how they might do things differently next time).

Practical problem-solving can practise these and more and some curricula list problem-solving as a skill in itself.

Other aspects of learning that are expected include financial capability, enterprise education and education for sustainable development. There are times when D&T activities can contribute to these (as when you have children 'buy' the materials they need using a fixed amount of money in the form of plastic coins and when you take opportunities to have children solve practical problems to do with avoiding waste and caring for their environment).

The 7 – 11 stage

The next stage is for 7 – 11 year olds. In England, Wales and Northern Ireland, this is commonly referred to as Key Stage 2 in state schools. Again, communication, number, co-operative working and problem-solving are to be developed across the curriculum and D&T teaching is required in England and Wales. As in the earlier stage, technology features in The World Around Us and in Environmental Studies in Northern Ireland and Scotland, respectively. This stage will be referred to as the *7 – 11 stage*. The children in it will be decribed as *older children* if describing them otherwise would be ambiguous.

This is a long stage and, to begin with, many of the children can be quite like those in the earlier stage. They affiliate readily with you and look to you for affirmation and support. As yet, their skills are often unrefined. Because they lack well-digested experience, practical problems can be difficult to understand. The oldest children in this stage, however, are often more skilled. They know more of the world and of D&T and can address more open problems. They may also tend to look more to their peers for affiliation, affirmation and support. Between 7 and 11 years of age, an increasing emphasis is often placed on the teaching of distinct subjects. Contexts for D&T, however, often arise in other areas of the curriculum. Taking these opportunities can make D&T meaningful for the children. Just as important is what it can do for learning. It can develop and integrate children's knowledge and make it more durable. Science will often inform and lead into D&T activities and a practical problem in D&T can lead to an investigation in science. Take advantage of this symbiotic relationship and of those everyday events that point to a need or problem to solve. As you are also expected to foster problem-solving skills, D&T has a significant role to play in helping you do that. You are also expected to foster creativity. Again, D&T provides opportunities for that as children search for novel solutions.

As before, the development of thinking skills is expected. In this stage, this can mean:

- information-processing skills (as when children produce a guide book using ICT to find information and when they use a programmable switch to operate traffic lights);
- reasoning skills (when you ask children to explain why a particular bridge fell down);
- enquiry skills (when children investigate how much cannot be seen from a car driver's seat);
- creative thinking skills (when you ask the children for ideas for making a buggy's wheels turn without using a motor or elastic band);
- evaluation skills (when you have the children try out their model land yachts in a breeze and comment on design improvements).

In these three stages, D&T provides opportunities to develop certain useful tendencies and skills. These include:

- an inclination to generate ideas;
- an inclination to suggest ways of doing things;
- an inclination to consider alternatives;
- an inclination to plan ahead;
- an inclination to select appropriate tools;
- the skill to mark out shapes (for example, using a template, using a ruler, using compasses);
- the skill to shape materials (for example, by folding, tearing, crushing, rolling; moulding, cutting using safe tools along lines, using pastry cutters);
- the skill to join or combine materials (for example, using adhesive tape, safe glue; stapling, paper clips and fasteners, treasury tags, sewing, nailing, pegging);
- an inclination to assemble loosely or model some part of what they will make in paper or card to check it works as expected;

- an inclination to consider matters of hygiene and safety of self and others, unprompted;
- an inclination to seek out information or investigate to find the information, as needed;
- an inclination to consider the appearance of products and to finish them well (for example, by applying colour, fabrics, glitter, sand, water-based paint, wax polish, PVA glue as a glaze);
- an ability to describe and explain what they are doing;
- an ability to demonstrate what they will do or have done;
- the skill to test products in simple ways;
- the skill to work with others and help others.

Of course, some of these will develop before others.

Children may develop these tendencies and skills working with materials such as:

- papers of various kinds;
- card (strictly speaking, a kind of paper);
- cooking foil;
- flexible plastic sheet;
- reclaimed materials (for example, card tubes from the kitchen, card boxes);
- foodstuffs;
- fabrics/textiles;
- wood;
- clay and similar modelling materials;
- simple construction kits;
- electrical components and electronic devices.

How these are used will, of course, depend on the stage and skills of the child.

D&T and science

Some say that D&T is the appliance of science. Science produces knowledge and understanding of the world. At times, this can be very useful as when we use our knowledge of electrical circuits to help us construct a model lighthouse or use the fact that a hollow box can amplify sound when making a musical instrument, or that a lever can magnify movement to make a card rabbit pop up. But you will need to remember that just because you have 'done it' in science, it does not follow that the children will be able to use it in D&T. For example, circuits neatly set out in science using a kit are one thing; making your own circuit from a roll of plastic-covered wire, a bulb without a holder, and a battery without clips to keep the wires in place is another. In the same way, translating the tests you did on a strip of wood balanced over a pencil like a see-saw into something that will make a cardboard rabbit pop up out of a hole, is another. Bridging the know-how gap becomes a problem in itself. The children are likely to need your help in bridging from science knowledge to what is sometimes called 'device' knowledge. When successful, however, the benefits are enormous because what you taught in science becomes more meaningful and memorable.

At times, you can bring science and D&T close together. For instance, suppose you set the children the challenge of building a bridge from paper that would be strong enough to take a certain toy car. Which shapes are likely to be the strongest ones they could use to support the bridge? In science, the children make tubes of various cross-sections and test them. They then immediately use what they find in their D&T. Solving a problem in science (Which shapes are the strongest?) provides the knowledge to be applied to solve a problem in D&T (How do I make a bridge strong enough to take that toy car?).

Just as D&T is not Science, D&T is not Art or Craft. Art is about expression and aesthetics. D&T may draw on Art skills because we want things to be functional and look, feel or sound good. At times, however, it may be hard to distinguish between D&T and Art. For example, if you had to design and make a wrapper for a new, chewy, dried fruit bar, would it be Art or D&T? You have to ask why the wrapper was needed. Is it to solve a practical problem? A dried fruit bar probably needs a wrapper for the sake of hygiene but the manufacturer would also want people to recognize the product from its wrapper and that is a practical problem solved, in part, by drawing on artistic knowledge and skills. That makes it D&T. Of course, the expression and beauty of the wrapper may make it a collector's piece and like Toulouse Lautrec's posters, an object of art. If that was also your intention, then it is also Art.

Craft is about developing practical skills. D&T involves craft skills but is more than these alone. You may, for instance, develop craft skills by following instructions or a recipe or by copying the actions of an expert. But this does not mean you exercise your imagination to create a design for a new product. That should happen in D&T.

D&T and ability

Problem-solving is generally seen as exercising higher level thinking. As such, how can it be suitable for all children? The experience of designing and making is a valuable one but it is worse than pointless to give children tasks that are beyond them. How is D&T to be made accessible to all?

Most of the challenges or problems we set the children are open to a variety of solutions. Take, for instance, the flashing lighthouse problem. The light can be made to flash by repeatedly pressing one of the wires onto the battery terminal. It could be made to flash by constructing a switch and pressing it repeatedly. Alternatively, cooking foil could be used to make a 'comb' with a pattern to its teeth so that, when a wire is dragged over it, the light flashes according to that pattern. And it could be made to flash using a ready-made box of electronics. Such a task lends itself to solutions with different degrees of complexity and demand. There is a level for just about everyone.

Problems also have various levels of openness. For example, 'Design and make something that will help ships know where they are and avoid rocks', is more open than 'Design and make a model lighthouse with a flashing light'. The former is less focused on a particular solution. This adds to the demand because the child has to grasp the general problem and explore what it means in order to solve it. Of course, in the process, the child's solution may not be a lighthouse. You can present a problem at different levels to tune the demand to the child's abilities. Nevertheless, at times you will have to support some children more than others and help them develop their thinking and doing. You may, for instance, point the way to a solution. For example, suppose you draw the children's attention to the way everyone seems to trip over the doormat. You might ask, 'How can we warn people about the doormat?'. This directs thoughts to warning signs. For others, you might ask, 'What can we do about it?'. This directs thoughts towards doing something to repair the mat. Do not forget, however, that the aim is to help children make progress. Always keep them working at a level that is sufficiently challenging to exercise thought and action in more proficient and complex ways, whatever their abilities.

Summary

This chapter has described Design and Technology from a practical problem-solving point of view. People have always invented solutions to such problems, wherever and whenever they lived. The problems we tend to think about are those around us. Put us in a different context and we will notice different problems and respond to them. Stereotypes can develop when men and women are assigned to different contexts. Care is needed to ensure that children see these stereotypes for what they are. Working with wood is not just for boys and working with food and textiles is not just for girls. D&T has a lot to offer the primary school child, not least being how to manage thought and action in more or less ill-defined situations. D&T can be a demanding subject but it can also be motivating and accommodating. Nevertheless, you will need to think about what you will do to ensure that all children make the most of the learning opportunities it offers.