An examination of the contribution of the 'Starting Point Approach'(*spa*) to Primary Design and Technology

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A dissertation submitted in partial fulfilment of the Doctorate in Education of the University of Greenwich

July 2009

ACKNOWLEDGEMENTS

Special thanks to supervisor Francia Kinchington for her valuable advice and tremendous support during the data gathering and writing of this thesis. Thanks also to first supervisor Dr. Neil Hall, for his teaching during the EdD and guidance during the thesis stage. The researcher would also like to thank Dr. Angela Ingham for her kind hospitality and advice when it was too late to travel home after EdD evenings. Thanks to my grown-up daughters Dr. Anna and Kelly for their encouragement and ICT help. The researcher acknowledges the advice of the Avery Hill campus television studio manager, Garry Bodenham. Thanks also to the leader and children of Greatstone Cub Scouts who helped with trialling the warm-up activity for this research. Particular thanks to the Greenwich children for the ideas, enthusiasm and cooperation that made this study possible. Heartfelt thanks to Sue Ferguson for her invaluable help with the final preparation of this document. I dedicate this thesis to my late father, Harry Good. He may well have inspired the *spa* when he had the imagination to turn the same pieces of wood into different toys for me when I was a child.

ABSTRACT

The starting point approach (*spa*) to design and technology education presented in this thesis, is intended to stimulate children's ideas and to allow projects with different purposes to be designed and made in one class. The projects all originate from a common starting point. The approach is intended to promote creativity and individual choice whist being manageable for the teacher.

Data were collected during a *spa* session taught to a group of 10-11 year old children in London. They were introduced to the pressure pad switch that was to be the starting point for their designing. The activity was initiated by the group brainstorming existing uses for pressure pads and ways to operate the switch prior to making their own. Each child went on to on to develop a project with a purpose selected by them. A transcript derived from the video of the above was subjected to analysis by means of coding and a specially devised grid. Children were also observed working and data were gathered using questionnaires, video recording, dictaphone, field notes, interviews and digital pictures of the final artefacts.

The study was qualitative in nature and based on an interpretative paradigm. The data were considered in two phases. Phase 1 of the study examined whether the children could do what the *spa* required. Phase 2 concentrated on examining in more detail what occurred when the *spa* was used.

The research showed that children following the *spa* were able to design and make products with different purposes within a single class. It is argued that an advantage of the *spa* is that it reconciles the often conflicting demands of teaching skills and knowledge with encouraging individual creativity. The starting point approach is a

pedagogical tool and process that can be used to motivate children through allowing them to decide the purpose of their individual project as well as its design.

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CHAPTER 1

BACKGROUND TO THE STUDY

Introduction

The starting point approach (*spa*) to teaching design and technology is intended to encourage individual choice and offer scope for creativity. This research examines the *spa* and its contribution to fostering children's creativity in design and technology education. It is postulated that the *spa* can play a significant role in promoting pupil creativity. This is achieved through modelling a process that actively encourages the development and articulation of ideas and a personalised response in the choice of projects. Crucially the *spa* process offers individual choice of project while remaining manageable for the teacher. It is underpinned by a premise that pupil motivation and creativity are enhanced where there is greater choice.

NOTE: The terms used to refer to design and technology in this document

The term design and technology is used in the body of this thesis. However, this was abbreviated to DT on the pre-*spa* questionnaire and in the transcript. The subject was given its full title of design and technology when the children were talked through the questionnaire and otherwise spoken to. They used the terms interchangeably, sometimes abbreviating to DT for convenience. On this basis, it is maintained that the use of the term DT had no effect on the children's understanding.

Professional context: creativity in design and technology

Creativity should arguably be at the heart of design and technology education, though this is not always apparent in practice. There is much rhetoric from government based organisations to the effect that creativity in education is 'a good thing' whilst some government edicts militate against this. The National Advisory Committee on Creative and Cultural Education (NACCCE) published its report in 1999. This was entitled: All Our Futures: Creativity, Culture & Education (DfEE 1999a). Despite this apparent endorsement of creativity, many in the field of education, including Ofsted, comment on the poverty of designing in schools. This is explored further in the review of literature.

According to Sternberg, Todd, Kaufman and Pretz (2005), the exponential increase in the pace of change makes creative thinking ever more important to individuals, education and society. Children need experience of developing new responses to new situations as preparation for an unpredictable future. There has been a developing interest in creativity in design and technology as is evident in papers by Kimbell, (2001) and Spendlove, (2003). In 2004, the Design and Technology Association's (DATA) International Research conference had creativity as its focus. The need to improve creativity and innovation in the design process in schools was highlighted in Ofsted findings (2003) which reported that the teaching of designing continued to be weaker than the teaching of making. Part of this was an insistence on pupils recording their ideas on paper before being allowed to do any making. Ofsted regarded this as a particular problem. One significant feature of the *spa* is that it avoids this problem by starting with designing through making, rather than designing on paper. Ritchie (2001:69) writes: 'Manipulation of materials can provide another way of stimulating ideas for young and old alike'. Davies and Howe also recommend starting with making as a means of stimulating ideas (2005:182). 'In order to develop their creative ideas, children may find it helpful and motivating to get their hands on materials as soon as possible'. The *spa* gives pupils concrete experience and actual physical starting points for designing that they make themselves. These starting points are intended to act as a springboard for the children's ideas. Ofsted have made moves in the direction, of designing through making, Ofsted (2001/02:6).

> The teacher immediately started the pupils making their puppets by joining a stick to a large diameter paper ball – the head. The pupils then had something to feed their imagination, even start the performance.

In the *spa* however, the initial making is closely specified but the purpose of the project is decided by the pupil.

The paucity of designing in design and technology was highlighted again in the primary Ofsted report for 2003/2004 (Ofsted, 2005) and yet again in that for 2004/2005 (Ofsted, 2006). Benson (2004:141) identifies designing as one of the two key areas 'not being taught effectively'. She points out that Ofsted have identified designing as an area of weakness for over ten years. In 2002, a major government funded project to help teachers improve 'designerly thinking' at foundation stage was approved (Benson, 2003). This was further recognition of the need to develop designing.

Creativity and the issues surrounding it, are an important part of the context for the *spa*. World changing big C creativity (Gardner, 1999) also known as high creativity (Boden, 2001), will be considered as part of examining the concept. However, the *spa* is primarily concerned with the promoting of what Craft (2002) refers to as little c creativity that is arguably within the reach of all children, especially if they are given what Benson (2004:140) calls 'relevant knowledge inputs'. Benson (2004:138) observes that while teachers may have a future Picasso or Freud in their class, it is more likely that they will have children who have 'an original idea or solution that is original to themselves and not necessarily totally original'. However, a very small minority of children will go on to demonstrate what the NACCCE report (DfEE, 1999) describes as world-changing creativity and historic originality. The levels of creativity available to most children are nonetheless worthy of development. Teachers do not give up teaching a child creative writing because they will not be capable of winning the Penguin Prize for Children's Fiction. This research has proceeded on the basis that all children are capable of some degree of creativity, and that fostering this in their design and technology work is crucial for the individual and society. Creativity is explored in greater depth in Chapter 2.

Why the study was initiated

This study was initiated because the researcher's professional experience indicated that the *spa* might make a contribution to promoting creativity in design and technology. Prior to the research, the researcher had been using the *spa* increasingly in his work with children, students and serving teachers in the UK and in Europe.

The Qualifications and Curriculum Authority (QCA, 1988) scheme is currently used as the basis for design and technology in 'over 90% of primary schools in England' (DATA, 2005:18). This led to considerable improvements when introduced but not all teachers are making best use of the scheme or any updates as Benson (2004:142) points out:

> Many schools have taken published materials such as the QCA (1998) and paid little heed to adapting the units of work to ensure that they are appropriate for the needs of the children in their school.

There is clearly a need for more flexibility and the teacher's adaptation of given projects could go a long way towards this. However, the *spa* offers a different kind of flexibility within a class by allowing individual children to adapt the common starting point to their own needs and interests. The *spa* is not intended to replace other approaches but to add to the options available to teachers.

This thesis is intended to contribute to the body of research into primary design and technology. Kimbell et al. (1996) commented on the comparatively small amount of attention given to the subject in the research literature. More than a decade later, Benson (2006) believed that the relative paucity continued. This thesis contributes to two of the four key areas that she identifies as needing to be researched. These are: designing and appropriate learning and teaching strategies. Examining the *spa* within a research framework was intended to allow professional practice previously guided by experience and intuition to be systematically examined. The research presented in this study focuses on articulating and examining the *spa* model. It is anticipated that this will inform future teaching and further research in addition to enhancing understanding of the *spa* model and process.

Two phases of analysis were undertaken. The first phase asked three questions aimed at ascertaining the extent to which children understand and can use the *spa*.

Phase 1

1. Are the children able to find existing uses for the starting point (in this case the pressure pad) in the world around them?
2. Are the children able to generate a wide range of ideas for turning the pressure pad on in different ways?
3. Are the children able to find possible uses for the pressure pad switch?

Phase 2

This sought to examine in greater depth what happened when the *spa* was used by the researcher with a group of children.

A description of the *spa* process

The *spa* is a process model which requires each child in a class to make the same physical starting point for their designing. This is then developed by them to result in an individual response to a problem of their choosing. Projects with many different purposes result within a class. This is made feasible for the teacher by the common starting point.

Stages in the spa

1. A stimulus/input is given by the teacher– showing some technology that is the starting point for the children's designing. They are told from the outset that they will be required to develop their own project based on this.
2. Group brainstorming (for example identifying where the technology is already used);
3. Making of the physical starting point for their designing;

4. Each child uses the preceding stages as a basis for an individual project, the purpose of which is decided by them.

The main feature that distinguishes the *spa* model from others, is that in the latter, the teacher usually specifies a project with the same purpose for the whole class. Unit 4D: Alarms from the QCA (QCA, 1998) will serve as an example of the most widely used approach. This designing and making assignment involves an alarm system to protect an artefact which has been brought into the classroom. This is supported by investigative, disassembly and evaluative activities such as 'Ask children to investigate some examples of commercially produced switches which work in different ways'. Focused practical tasks such as 'Show the children how to make simple circuits with batteries and a wide variety of different types of switches, bulbs, buzzers or bells' would also be carried out. These two kinds of activity would be quite acceptable in the *spa* project based on pressure pads used as the example in this thesis. The *spa* differs fundamentally from the QCA example in that it allows each child to decide the purpose of their own project. The common starting point ensures that the teacher knows what particular knowledge and processes need to be covered. This is important to making the *spa* manageable for the teacher. Children are not restricted by being told it had to be used to make an alarm and what that alarm had to protect. Instead, children following the *spa* would be asked open-ended questions to provoke their own ideas for using the starting point. Examples of questions from the researcher's *Exciting Electrics* book (Good, 1999a:13) include:

> How many ways are there to turn a pressure pad on? What could you turn on with a battery powered pressure pad- a light bulb, an electric motor, an LED, a buzzer or something else?

A wide range of more specific suggestions is offered as further support for those requiring it. These include 'Could you make a burglar alarm?' but this is only one of many possibilities and what needs protecting not specified. The role of questions in the *spa* session is explored at p.140. By contrast, the QCA assignment requires all children in a class design an alarm.

In the *spa*, children are introduced to a specific piece of technology. They explore where it is used and its relevance to them and the wider world. They are then shown how to make their own working example of the starting point. This would include what teachers subject to the National Curriculum for England would recognise as 'focused practical tasks' (DfEE, QCA, 1999:19). This is the starting point for their designing. Emphasis at this point is on following instructions, building confidence and gaining knowledge, skills and understanding in the process. The NACCCE report (1999:7) supports the need for teaching specifics to support creativity.

> Creativity is not simply a matter of letting go. Serious creative achievement relies on knowledge, control of materials and command of ideas. Creative education involves a balance between teaching knowledge and skills, and encouraging innovation.

The *spa* is the researcher's attempt to achieve this balance. Teaching the starting point with its associated practical tasks is intended to provide the knowledge and stimulus that form the basis for designing. Specific skills and knowledge integral to the starting point are taught. Benson (2004:143) emphasises that 'knowledge and understanding are important for the development of creativity' and this is reflected in the *spa*. Knowledge, skills and understanding in the *spa* are discussed later on. The *spa* teacher uses a range of pedagogic strategies including brainstorming and guided questioning to prompt children's thinking, enabling them to develop a wide variety of different responses. Children can within reason, design 'what they like', provided it is based on the starting point. The starting point can be developed by the children to fit in with their own experience and interests or the needs of others around them. This approach tries to reconcile the apparently conflicting demands of teaching specific skills and knowledge to a group and encouraging individuals to be as creative as possible.

Starting with part of a solution rather than with a 'design problem' is not such an unusual way of working. When a new material or piece of technology is developed to meet a particular need, it often inspires other new products. The many technological 'spin-offs' from the space race are an example of existing technologies being used to solve new problems. Williams (2006:9) notes that most design and technology education is concerned with solving problems rather than finding them:

> A survey of curriculum documentation from a number of countries confirms the thesis that the dominant paradigm for activity in technology education is problem solving.

However the *spa* emphasises problem finding where the starting point is part of the subsequent solution. This is perhaps a less obvious approach than starting with a given problem and it is not emphasised in orthodox approaches to design and technology education. Wright and Taylor (1970:427) point out that problem finding has been neglected by psychologists too. They support the importance of problem finding. The process of 'problem finding' has been relatively neglected by psychologists, although it is arguably of at least as much importance as problem solving. Ochse (1990:187) writes that 'it is often held that the most crucial aspect of creative problem-solving is finding the problem'. Robertson (2002:103) supports this view when he writes:

> But problem solving may not be the key to creativity – finding what the problem is may be the key to creative breakthroughs in science, art, design and technology.

In the *spa,* children are shown the common starting point for many possible projects and encouraged to take part in problem finding. They are not shown a finished project that the teacher 'made earlier' that they might simply copy. Robertson (ibid) believes that people easily become fixated on given examples and this restricts the range of ideas they come up with. The practical starting point is shown to the children but only as a beginning for their designing, as its name indicates. In some subjects, the teacher does have the single right answer that the child has to reproduce. Designing is a different matter, in that it requires thinking that it is productive rather than reproductive.

Designing is a play-like activity where ideas and materials are manipulated to explore what could and should be. Robertson (2002) describes an experiment where art students were observed preparing to paint a still life. When the work was judged, it was found that the highly creative artists 'played' with many more of the objects than the less creative ones. The highly creative ones picked up the objects, stroked them, shook them, tossed them into the air, smelt them- even bit into them. This handling and 'experiencing' is precisely what is encouraged in *spa* to stimulate ideas.

Arguably, one of the strengths of design and technology at its best, is that participants examine and judge their solutions for themselves against a problem. In the case of the starting points used in the *spa*, the basic question is 'What can I do with this?' Children are shown part of a solution but to a problem which they have to identify for themselves. No problem other than how to apply and develop the starting point is imposed. Students also need to establish their own criteria for a successful project as each is designed to meet different needs. The development of *spa* was motivated partly by the poverty of designing in primary schools experienced by the researcher and highlighted in Ofsted reports 2001, 2002 and others.

Considering progression

The data gathered in this research captured a single project that was designed to be representative of the *spa*. However, it is also important to give some consideration to the *spa* more generally in terms of categorising different starting points and their conceptual and practical demands. This provides a broader perspective and helps to inform a view of progression. The researcher's intention is to exemplify progression in the *spa*, rather than set out a complete scheme of work. The exemplars below are intended to be interpreted flexibly by teachers and be adapted to the needs of particular classes. Progression within the starting point in the data gathering is considered at p.192. First, it is necessary to consider the nature of progression in the subject.

Discussing progression in design and technology is not straightforward. Bold (1999:5) warns that 'capturing progression is no easy task because of the different strands within the subject'. Ritchie (2001:33) has similar reservations, noting that 'identifying the nature of progression in well established subjects such as mathematics and science is difficult, but the problems are even greater in design and technology.' Ritchie is concerned that the National Curriculum programmes of study and level descriptions lack detailed guidance on progression. However, collectively, the sources below provide a view of progression relevant to the National Curriculum and the *spa*. The National Curriculum in Action site for example, discusses progression with reference to the level descriptions, providing a framework in terms of developing, planning and communicating ideas; using tools, equipment, materials and components to make quality products, and evaluating processes and products. The Design and Technology Association (DATA, 1995) also characterises progression in terms of the complexity of the task, pupils taking increased responsibility for their own learning and a movement towards more open-ended tasks. Newton (2005) similarly includes movement to more independent working and open-ended tasks. These are particular characteristics of the *spa*.

To summarise, the literature indicates that key themes of progression relate to: developing, planning and communicating ideas; using tools, equipment and materials; evaluating processes and products; evolving knowledge and understanding; progression to greater complexity and the move towards independent working involving open ended tasks.

Progression through increasing open-endedness

In the *spa*, specific skills and knowledge integral to the starting point, provide a constraint which is intended to act as a focus and a stimulus for ideas. A *spa* project is 'closed' in the sense that the common starting point is a 'given'. This is intended to make projects with diverse purposes manageable in a whole class situation. However, the *spa* tasks have considerable open-endedness in that the children decide the purpose of their individual project, subject to the teacher's guidance. Teachers can adjust the degree of open-endedness for individual pupils. For example, children who have difficulty thinking of an idea can have the degree of open-endedness reduced by being given a context to explore. 'What about games of some sort?' is an example from the research (line 30 of the transcript: Appendix 1). Putting the suggestion in the form of a question makes it clear that it is not an instruction. Introducing constraints such as 'games' for children that need extra help, provides them with familiar contexts where they can look for ideas. For greater openness while still giving extra support, the teacher can provide a broader context such as 'helping people'. The primary teacher's knowledge of their pupils facilitates the suggestion of relevant contexts to individuals who need this. This does not however, equate with giving a specific design brief.

Progression as a move to greater complexity

Another source of guidance on progression is the National Association of Advisors and Inspectors in Design and Technology publication: 'Quality through Progression' (NAAIDT, 1998). This provides an account of progression in terms of designing and making skills, and knowledge and understanding. An example from the knowledge and understanding section is where children in years in 3 and 4 or up to level 4, use a switch in an electric circuit. In years 5 and 6 or up to level 5, they progress to using a number of switches, including, tilt and reed switches and the pressure pad used as an example in this study. As in the NAAIDT example, the children in the *spa* session would have had the opportunity to progress to more complex starting point pressure pads (Appendix 2) had there been subsequent sessions. These are explained below under the heading: Pressure pads starting point 2.

The Nuffield website also provides an example of progression as a move to greater complexity. Teachers at a continuing professional development session worked through two Nuffield P*rimary Solutions* (Nuffield Foundation, 2001) units: 'What should be stuck on your fridge?' and 'Is your creature fierce or friendly?'. The teachers' follow-up discussion, highlighted the increased demands of the second unit. Progression from the first unit was identified in terms of:

> ...the move from 2D to 3D, the larger number of structural components, and the level of constructional skill needed, all of which reflected the overall complexity of the product and the greater challenge of the design decisions needed to be made by the pupils.

Progression features in similar terms in the *spa* exemplar projects below. They too include development from the simple, essentially 2D work, to more complex 3D work with a larger number of components.

Exemplar starting points with indications of progression

The QCA scheme of work for key stages 1 and 2 (QCA, 1998) provides four units of work for each year. The researcher has provided six exemplar starting points for year 6 to show variety and progression in the *spa.* Assigning a 'focus' to each, parallels the QCA scheme. Year 6 was chosen as it reflects the year group of children in the data gathering. Progression within as well as between the starting points, allows the teacher to differentiate the work.

1. Pressure pad starting point 1 - Focus : electrical

This 'entry level' pressure pad starting point featured in the data gathering session. Construction is essentially 2D, consisting of three pieces of card and some aluminium foil which is connected to a battery snap and miniature bulb. Additional components would provide progression in terms of requiring a more complex circuit. Progression could also involve using the pad as an input device linked to a basic computer control box with input terminals. There is also the option of progressing to multiple, wandering or moveable pressure pads by reproducing the original starting point, as a child did during the data gathering. Progression within the starting point in the data gathering is explored at p.192. The texts: *Exciting Electrics* (Good, 1999a) and the *Design Challenge Teacher's Book* (Good, 2000) provide support materials (Appendix 3).

2. Pressure pads starting point 2 - Focus : electrical

This starting point builds on the one described above and incorporates a range of increasingly more sophisticated pads (Appendix 2). These provide progression within the starting point (Good, 1999a). The first of these will only go on when the top layer is rotated to the correct position. Progression from this focuses on a switch with several rotating layers, adding complexity. This creates an effect similar to a combination lock, in that all parts must be turned to the correct position. A still more complex pad requires two or more sensitive points to be pressed simultaneously (Good, 1999a). Additional technical and conceptual challenges are provided by a pad where the user can have as many sensitive places as they wish and decide their position (Good, 1999a:16). Still further progression involves designing additional middle layers. The different number and position of 'windows,' changes the sensitive places on the switch. There is also the option of more sophisticated computer control with any of these pads being used as more complex input devices than that in starting point 1. Electric motors can be added to the available output devices and these combined with other components to make more elaborate circuits than in starting point 1. Practical work would be more complex than making the basic pressure pad and the conceptual demands and design possibilities are also increased. Construction is still essentially 2D. The texts: *Exciting Electrics* (Good, 1999a) and the *Design Challenge Teacher's Book* (Good, 2000) provide support materials (Appendix 2).

3. Things that can collapse - starting point - Focus: construction

This exemplifies developing, planning and communicating ideas; using tools, equipment and materials and progression to greater complexity. The starting points consist of given structure designs made from card with a corrugated middle layer. These structures are rigid when assembled, but can be collapsed easily when required (Good, 1999c:22-23) Children decide the purpose of their individual products which must be based on the structure designs provided. The corrugated internal structure of the material, provides an opportunity to teach 'how the working characteristics of materials affect the ways they are used' (DFEE and QCA, 2004:19). There is progression from the previous starting points in terms moving from 2D to 3D construction. To stimulate their own ideas, children explore the existing applications and benefits of collapsible products such as saving space and ease of transportation. Progression includes children building on their experience of working with the given structures by creating their own collapsibles and designing uses for them. Further optional progression, involves treating the small structures as models for larger scale products, thereby introducing the concept of scale. Children can design products like survival shelters, play structures and exhibition stands. The texts: *Super Structures* (Good, 1999d) *Design Challenge Teacher's Book* (Good, 2000) provide support materials (Appendix 4).

4. Crankshaft starting point - Focus: mechanisms

This example using tools, equipment and materials and progression to greater complexity. The task builds on children's experience of using the type of card used in the previous collapsibles and the move to 3D working .The starting point introduces a single, easily made crankshaft mechanism (Good, 1999b: 6-7, 12-13). Children are introduced to folding a flat sheet into a 3D supporting structure which is progression from the simpler structures of the previous starting point. The basic oscillating movement can be enhanced in various ways by adding flexible materials such as fabrics. Textiles focused practical tasks, can be taught to encourage this. Children decide on a purpose for their starting point mechanism, stimulated partly by the way it moves. This starting point requires no gluing. This is introduced with other additional demands when mechanisms are addressed again below. The texts: *Amazing Machines* (Good, 1999b) and the *Design Challenge Teacher's Book* (Good, 2000) provide support materials (Appendix 5).

5. Moulding materials starting point - Focus : construction

This task exemplifies the introduction of mouldable materials which differ considerably from the sheet materials featured in the precious starting points. Salt dough, air drying clay and other mouldable materials (Good, 1999c) are easily formed and reformed and allow new processes such as extrusion. They facilitate the making of identical pieces and objects with compound curves. Attention to the properties of these materials stimulates the formation of ideas that exploit them. Knowledge, skills and understanding relating to circuits can be built on here if desired. Progression within the starting point could include embedding miniature bulbs in the mouldable material and stapling protruding wires to pressure pad-like foil pick-ups. These could form games pieces for example, that light up when placed on foil tracks connected to a battery or control box. In keeping with the *spa,* a wide range of projects with purposes ranging from jewellery to computer controlled games are possible within one class. The texts: *Moulding Materials* (Good, 1999c) and the *Design Challenge Teacher's Book* (Good, 2000) provide support materials (Appendix 6).

6. Mechanisms starting point 2 - Focus: mechanisms

This starting point is the most conceptually and practically challenging of those featured here. It allows knowledge, skills and understanding from all earlier starting points to be combined and builds on previous experience of making moving parts. A technique for making moving parts which was devised by the researcher is introduced. This involves gluing and rolling card around dowel to form cylinders that form the centre of pulleys and other mechanical components. This is more challenging than making the wire crankshaft in starting point 4 but allows children to use a wider range of mechanisms than previously. These include: cams, friction drive, pulleys and conveyor belts. Progression includes a need for greater dexterity than required for previous projects. There are more demands on planning skills, for example children have to decide how to progress while glue dries. The texts: *Amazing Machines* (Good, 1999b) and the *Design Challenge Teacher's Book* (Good, 2000) provide support materials (Appendix 5).

Examples of the QCA Standards site and progression

The QCA Standards site characterises progression in the subject under the following headings: an increase in subject knowledge, skills and understanding; a move from familiar to unfamiliar concepts; the meeting of needs which require more complex or difficult solutions; and an increase in a child's understanding of their learning is also included.

i) An increase in subject knowledge, skills and understanding

The 'Breadth of study' section of the design and technology key stage 2 programme of study (DFES, QCA, 2004:19) specifies that knowledge, skills and understanding be taught through assignments involving a range of materials, 'including electrical and mechanical components, food, mouldable materials, stiff and flexible sheet materials, and textiles'. All are covered by the *spa* exemplars presented earlier apart from food, though edible mouldable materials could be included in starting point 5 if desired. As in the QCA scheme, food based work would be covered in the previous year. Textiles could be incorporated into the mechanisms focused starting points 4 and 6. Progression is also provided by developing some areas further, as in mechanisms and electrics starting points 1 and 2. This provides breadth and some experience of depth in the time available.

ii) A move from familiar to unfamiliar concepts and the meeting of needs which require more complex or difficult solutions

Pressure pad starting point 1 is based on the basic concept of a switch, familiar to year 6 children from science. The children in the research also demonstrated that the basic pressure pad was a familiar to them in everyday life, if not in design and technology. The more complex switches in pressure pads, starting point 2, could be used to meet more complex needs. Mechanisms starting point 2, requires a synthesis of existing concepts with unfamiliar ones and the potential for more complex or difficult solutions.

iii) An increase in a child's understanding of their learning

An increase in the child's understanding through the progressive development of metacognitive skills occurs with each starting point. Strategies for idea generation that emerged during pressure pad starting point 1 in the research, were made explicit by the researcher. As children gain further experience of generating ideas for subsequent starting points, they would progressively be encouraged to identify strategies themselves.

Summary of progression in the *spa*

Progression in the *spa* can be provided in several ways. These include moving from 2D, to increasingly challenging 3D construction. Contexts of increasing openness can be associated with starting points, or children can identify their own. Children can progress from familiar materials to less familiar ones. Additional components can be provided to allow more complex circuits. Multiple copies of a starting point can be allowed and more sophisticated versions of a starting point introduced. Progressively more complex additional equipment, such as different control boxes, can be used. Handheld starting points can be regarded as models of much larger projects. A progressive increase in the dexterity and planning skills required by starting points, is also available to the teacher. Children can progress to modifying starting points and then developing their own versions.

Putting the *spa* in context

This section is intended to place the *spa* in context by relating it to the principle approaches currently used in primary design and technology education. Specifically, it explores the contribution that the different approaches make to enabling creative and diverse responses in the light of subject knowledge demands. The QCA scheme (QCA, 1998) is used as the basis for design and technology in 'over 90% of primary schools in England' (DATA, 2005:18). Nuffield's *Primary Solutions* in Design and Technology (Nuffield Foundation, 2001) also makes a significant contribution to the field. It must be emphasised that the *spa* is presented as a complement to these existing approaches, rather than a replacement.

Enabling creative and diverse responses in design and technology

Creative and diverse outcomes are important in design and technology and the contribution of the QCA and Nuffield schemes in this respect is acknowledged. Creativity and diversity must be enabled in ways that children and teachers can manage. To this end, these approaches provide a framework underpinned by subject knowledge. The QCA and Nuffield schemes have projects with a common purpose within each class. These are supported by the teaching of subject specific knowledge focused through practical tasks suited to the projects. The *spa* achieves manageability by all children in a class basing their work on a common starting point. This incorporates specific technology and subject knowledge. Creativity and diversity are promoted in the *spa,* by allowing children to decide on a project that is individual to them and their interests. The making and handling the starting point is intended to help stimulate creative applications for it. All three approaches seek to enable creativity and diversity with manageability in their own way.

The central question is to what extent these approaches enable the creative and diverse responses that are so important in the subject. The NACCCE report, All Our Futures, (DFEE, 1999:29) encourages us to look for creativity in the form of 'imaginative activity' producing outcomes of 'both originality and value'. Defining these terms is explored in Chapter 2. Diversity is arguably a natural result of creativity. Children working creatively, produce diverse outcomes. The implication is that identical or very similar outcomes would not meet the criterion for creativity of originality, discussed in Chapter 2. Critically, in requiring the child to identify the purpose of their project and its solution, *spa* encourages both creativity and diversity of response. Barlex (2004:106) observes that 'The instrument of children's creativity in design & technology is the designing and making assignment'. QCA Unit 6D Controllable

Vehicles (QCA, 1988) provides a good example of this in action. He reports that 'The teacher asked the pupils to work through an activity where they developed their understanding of how toys can be driven by electrical energy'. There were opportunities for creativity and diverse responses as children 'developed their designing skills by using their own ideas and experiences'. The project clearly promoted diversity in that pupils could make different types of vehicle. The QCA teachers' guide encourages flexibility (QCA, 1988:3) when it describes teachers: 'amending, adding to or reducing material, as appropriate, to meet the needs of the children'. Although in this example all the projects would be vehicles, this by no means precludes creativity. Barlex (2004:107) writes:

> Even if the type of product is identified for the pupils, there are still many opportunities for making design decisions in the other areas.

He describes a class working on a picture frames project (QCA Unit 3D) where 'the conditions for creativity were to a large extent met' and 'No two frames looked alike although several opted for similar solutions'.

Both QCA and Nuffield approaches include the teaching of specific skills and knowledge to prepare children for designing and making. As well as being of practical use, knowledge, skills and understanding provide children with the means with which to be creative. The QCA scheme does this through 'focused practical tasks that develop a range of techniques, skills, processes and knowledge' (DfEE, and QCA, 1999:19) reflecting the National Curriculum terminology. In the *spa,* specific skills and knowledge are taught through the starting point. The Nuffield approach uses a series of 'Small Tasks' that enable children to be successful in the 'Big Tasks,' which are designing and making assignments. The *Primary Solutions* literature reflects a strong concern for promoting creativity when it emphasises the importance of making design decisions (Nuffield Foundation, 2001:17):

> Making design decisions lies at the heart of capability in design & technology. Each decision involves choosing between possible options. Making these decisions requires the knowledge and skill that children learn through the Small Tasks.

The 'What should be on your fridge' unit for example, provides several Small Tasks, one of these helps the teacher by listing some of the design decisions the children can make. Another small task teaches practical construction methods. This would help to stimulate ideas by making the challenge more tangible. Another small task: 'Developing ideas for fridge magnets', is designed to enable creative and diverse responses directly. A list of suggested themes is provided to 'begin with'. Suggestions such as 'What about bird shapes, or insects, or reptiles?' are offered. These are suggestions, not limitations and serve to stimulate creative and diverse responses. Extensive evidence of the creativity and diversity enabled by the QCA and Nuffield schemes is presented on their respective websites, providing a valuable resource for teachers.

Supporting teachers who lack of subject knowledge

An important issue in design and technology education is Ofsted's concern relating to primary teachers' lack of subject knowledge. The 2004/2005 Ofsted report states:

> Many teachers continue to lack the subject knowledge to teach the full spectrum of D&T with confidence.

Consideration is given here to how the *spa* and the QCA (1998), support teachers in this respect. Unit 6D Controllable Vehicles, is used to exemplify QCA support. The pressure pad starting point serves as an exemplar of how the *spa* supports teachers. In the *spa* example, teachers need the knowledge, skills and understanding needed to make a simple pressure pad, using card, foil, a battery snap and a miniature bulb. Teachers who cannot gain experience of making this or other starting points through initial teacher training or continuing professional development with the researcher, are supported through the *Design Challenge* books (Good, 1999a, 1999b, 1999c , 1999d) and the *Design Challenge Teacher's Book* (Good, 2000). Pages 12-13 of the researcher's *Exciting Electrics* book (Good, 1999a) (Appendix 3) describe and illustrate how to make the starting point in this example. In addition to this subject specific guidance, teachers can draw on their knowledge of science, art, ICT when the starting point is developed. The *spa* is presented as an approach, rather than a fully developed scheme as provided by the QCA. Support for the *spa* is not as extensive as for the QCA scheme, but support is available.

The QCA scheme shows how the National Curriculum programmes of study for primary design and technology can be translated into manageable units of work. The *spa* support materials by contrast, are not specific to the National Curriculum in that they do not refer directly to the programmes of study section numbers and letters. In this respect, the QCA scheme has advantages over the *spa*. Teachers can extrapolate from the QCA units what subject knowledge they will need to teach specific units. Like all QCA units, 6D Controllable Vehicles, provides an overview before going into detail. 'About the Unit', alerts teachers to what they will need to know and highlights knowledge they may need to acquire.

The ‘prior learning’ section of the QCA unit, indicates knowledge that the teacher might need to revisit, for example, simple electrical circuits. The vocabulary section provides further detail, particularly under the sub-heading ‘knowledge and understanding’. Although this is presented as vocabulary, teachers are also being alerted that they need to have the knowledge associated with specific terms. The checklist of resources indicates that teachers need to know about related items and their purpose. The expectations section sets out the understanding children will have gained through completing the unit. Implicit in this section are expectations of the teacher's subject knowledge. The second and third of the three pages of each QCA unit focus on the breadth of study section of the National Curriculum covering pupils’ knowledge, skills and understanding, specifically, investigative, disassembly and evaluative activities, focused practical tasks and design and make assignments. For each of these, the teacher is provided with possible teaching activities and learning outcomes that the children should achieve.

Investigative Disassembly and Evaluative Activities in a QCA Unit

The investigative, disassembly and evaluative component of Unit 6D, gives examples of what the teacher might provide; things they might ask the children to observe and technology they could investigate. Disassembly no longer features explicitly in the 2004 version of the programmes of study, but this is not precluded. The unit also provides many questions that the teacher might ask the children. Questioning also played an important part in the data gathering *spa* session. It is acknowledged that teachers would be further supported by being provided with specific questions to ask.

Focussed Practical Tasks and the Design and Make Assignment in the QCA Unit

The programmes of study feature focused practical tasks that 'develop a range of techniques, skills, processes and knowledge' (DFES, QCA, 2004:19). In the *spa* session these were taught through the introduction and making of the starting point. This aspect of the QCA units is particularly important for teachers with limited subject knowledge. It sets out what the teacher needs to know and be able to do, so that they can teach the children. In Unit 6D Controllable Vehicles for example, activities include incorporating a motor and adding a small pulley to the motor spindle. Teachers are also provided with a list of tools, materials and components that children might need to use.

> Ask the children to use construction kits to make models of vehicles incorporating motors. *How can the attached axle be made to turn faster or slower?*

The *spa* starting points similarly involve the teaching of focused practical tasks that are explained in the *Exciting Electrics* pupil's book pages (Good, 1999a:12-13) A list of the tools, materials and components needed are also provided. The construction of the pressure pad is illustrated and explained step by step. The *Design Challenge Teacher's Book* (Good, 2000) provides further support in terms of guidance on safety, computer control and making circuits successfully. Support materials for the QCA scheme (QCA, 1988) are extensive and have a usefulness beyond the project for which they are specifically intended. The 'Planning into Practice' help sheet for Unit 36, (DATA, 1997) has material on pulleys that would help with the vehicle project mentioned earlier. The Unit 37: 'Alarming systems' help sheet (ibid) for QCA Unit 4D Alarms, is relevant to some children's projects that feature in the data gathering, such as Libby's alarm/welcome mat, Figure.7.5. Suggested activities such as 'investigating switches' would be relevant to all projects in the data gathering session. The design and make assignment section of each QCA unit specifies the purpose of the children's projects. It also gives a list of activities that are classified as essential or optional. This would help inexperienced teachers to prioritise. Ritchie (2001:158) reports a particular case of a teacher who had taught Unit 2A: Vehicles (QCA, 1998). As well as other learning, the teacher commented: 'I also increased my own subject knowledge greatly'. The QCA scheme (QCA, 1998) clearly supports this primary teacher's design and technology subject knowledge. The *spa* based *Design Challenge* materials provide subject knowledge and practical tips for the teachers although this is outweighed by the substantial materials produced by the Design and Technology Association for every QCA unit. These include illustrated help sheets (DATA, 1999b), and lesson plans, providing invaluable help to teachers with limited subject knowledge. This level of support is not available for the *spa,* but specific knowledge, skills and understanding are taught through the starting points. It is acknowledged that further *spa* related resources would help to support the many teachers with limited subject knowledge. Although the QCA units do not actually provide technical knowledge, they do indicate very clearly what is required, and support materials provide it. The widespread adoption of the QCA scheme endorses the view, that with its associated support materials, it meets teachers' subject knowledge needs.

CHAPTER 2

CREATIVITY IN DESIGN AND TECHNOLOGY

Creativity is central to the *spa,* making it necessary to explore the concept. Many writers on creativity such as Boden (1996), Casti (1997), Hintikka, (1997), Fisher (2004) and Dakers (2004), begin by acknowledging that the concept of creativity is elusive and difficult to define. Brinck, (1997:36) describes creativity as 'a notoriously evasive concept'. Davies, Howe and Ritchie, (2001:11) make the point that creativity may quite justifiably be defined in many ways and confusingly described as a process, an attribute, or ability in making connections. Harnad (2006:1) also recognises the scope for debate:

> What is "creativity"? Is it a stable cognitive *trait* that some people have and others do not? Is it an occasional *state* that people sometimes enter into? Or is it defined completely by its *products*: "creativity is as creativity does"? There is probably some truth in all three notions of what creativity is.

Spendlove (2003:100) writes that 'Creativity is ultimately a difficult and slippery concept as definitions are wide ranging'. He sounds a cautionary note to those attempting a definition: 'the term is over-used, often over-simplified, misrepresented and frequently interchanged inappropriately for related terms' (Spendlove, 2005:10). Duffy (1998) points to the importance of avoiding definitions that are restrictive, such as limiting creativity to the arts or to the production of an artefact. The fact that creativity occurs in many fields may partly explain some of the difficulty of arriving at an over-arching definition. In Schooler and Melcher's view (1995:98), discussions on creativity have been hampered not only because the subject matter is elusive but also 'because the domain of creativity is conceived so broadly'. In fields such as psychology, there are also different views on creativity. Ochse says that in the psychological literature alone, creativity has been 'defined in literally hundreds of ways' (Ochse, 1990:2). May (1975) suggests that a study of creativity has been generally avoided in academic psychology as among other things: un-scientific, mysterious, disturbing, and corruptive of the training of graduate students. Winch and Gingell (1999:43) offer a more optimistic view from the field of philosophy of education, observing 'The analysis of the concept of 'creativity' is one of the success stories of the philosophy of education'. Such encouragement is rare in the literature. It must also be said that Winch and Gingell do qualify their enthusiasm by saying that the success mentioned shows the limitations of the field. Some writers believe the concept of creativity is beyond difficulty. Bohm goes so far as to say that creativity is 'impossible to describe in words' (Bohm, 1998:1). Schooler and Melcher (1995:96) support this view when they describe the 'non-reportability of creative processes'. Indeed they hypothesise that trying to describe some creative processes may actually be counterproductive: 'if certain processes cannot be adequately captured in words, then attempting to articulate such processes may actually be disruptive'. It is often impossible to say where an idea came from. This is part of what Schooler and Melcher call the 'ineffable quality of creativity that has often elicited mystical views'. Davis (1992), notes that this view of creativity originates with the early Greeks who attributed creativity to inspiration from their gods. Difficulties in defining creativity are not for want of it being studied. Saari and Saari (1997:79) believe that 'we know so much about the topic without having the slightest idea what it is'.

The defining characteristics of creativity

Some writers believe that central features of creativity can be identified. Eysenck (1994:200) gives some encouragement with regard to identifying these characteristics.

> There is a good deal of agreement on what we mean by "creativity". Creativity denotes a person's capacity to produce new or original ideas, insights, inventions or artistic products, which are accepted by experts as being of scientific, aesthetic social, or technical value.

Eysenck's criteria of acceptance by experts, indicates a view that creativity must be domain changing rather than the everyday kind. The concept of there being different levels of creativity is explored later. Although popularly associated with the arts, Eysenck points out that creativity is possible in many fields. It is possible to identify differences and similarities in creativity between fields, as is explored below. However, as a starting point it is useful to consider whether there are fundamental factors that characterise the concept of creativity.

Creativity and deliberate acts

In this thesis, creativity will be understood to involve deliberate acts that result in various outputs of originality and value. Craft (2001:49) supports this view. When asked whether an accidental but highly edible food combination would count as creative, she is in little doubt:

> Here I would want to draw a line and to suggest that for an outcome to be judged creative there must have been some conscious intention involved in its creation.

Craft's view is that intention distinguishes creativity from dreams and fantasies. One might add that it is also distinguishes creativity from patterns and other things that occur in nature. Like many issues surrounding creativity, the notion of intention is not completely straightforward. It is a common experience that ideas sometimes come unbidden, perhaps from the unconscious. Mandler (1995:11) observes:

> If a particular goal exists, then the act of creation is deliberate in the long term, though it may be non-deliberate at the moment of production.

The NACCCE report (DfEE, 1999:29) also supports the element of intention when it includes the word 'fashioned' when defining creativity as: 'Imaginative activity fashioned so as to produce outcomes that are both original and of value'. These terms are discussed below.

Originality or newness

Originality or newness is often cited as an essential element in creativity. Edward de Bono writes: 'There is, of course, the element of 'newness' because repetition – no matter how valuable – is not seen as creative' (De Bono, 2007:5). Karlqvist (1997:105) writes that 'creativity is the capacity to create new things'. Brown (1997:38) observes: 'Essentially, creative activity is the forming of new concepts in the mind of an individual'. Any activity which 'involves imagination and originality can be regarded as creative' (Fisher, 1990:32). Newness has long been accepted as a criterion for creativity, Torrance (1965) says that it is included in virtually all definitions by those who have studied creative behaviour. Bowers, Farvolden and Mermigis (1995:27) mention originality: 'Creativity by and large implies that a novel form or product has been generated'. Mandler (1995:10) points to novelty being socially determined: 'A creative act, the production of something novel, exists in a social context that defines a degree of novelty'. The social aspects of creativity will be explored later but however determined, newness alone is not enough.

Creativity and value

The concept of 'value' is crucial when considering creativity. To his previously quoted statement on the importance of 'newness' to creativity, De Bono (2007:5) is quick to add the criterion of value: 'We hasten to add that what has been brought into existence must have value'. New ideas are not all truly creative they may be irrelevant to the intended purpose, faulty or otherwise useless. As the NACCCE, (1999:30) report puts it: 'the outcome of imaginative activity can only be called creative if it is of value in relation to the task at hand. Value here is a judgement of some property of the outcome related to the purpose'. Although one can create havoc, the term creative usually carries a positive value judgement. Ochse also cites the criterion of value, as do other writers (Finke, 1995:311, Brinck, 1997:5). Buzan (2001) lists fluency, originality and flexibility among the attributes of 'creative intelligence'. The weakness of Buzan's list is that it does not seem to place any importance on the quality of ideas. Yet quality must be a consideration. Accepting any merely 'different' idea as creative would devalue the term and play into the hands of those who see creativity as mere self-indulgence. Dakers (2004) asserts that creativity involves bringing something into being that is original and also valuable - useful, good, adaptive, appropriate. Boden (1996:75) supports the need for originality but also mentions that value is required: 'The novel combinations must be valuable in some way, because to call an idea creative is to say that it is not only new, but interesting'. This is supported by other writers including Gardner (1999: 116) who says that as well as standing out in terms of novelty 'the acid test of creativity is simple: In the wake of a putatively creative idea, has the domain subsequently been changed?' Gardner's domain changing, big C Creativity is considered in more detail later.

Creativity and value are so closely associated that value is implicit when something is described as creative. Boulden (2002:7) provides an example when she writes: 'The ability to find creative solutions to problems is essential for the well-being of the human race'. Accepting originality and value as part of a working definition is helpful at this point. This admittedly raises questions such as how to define originality and how value is decided and by whom. Writers in this field such as: Ochse (1990), Martindale (1994), Dakers (2004) and Boden (1994) take the view that like newness, value is culturally determined. This is reasonable in that value is usually determined by those knowledgeable or expert in a given field. Who counts as an expert is culturally determined. Creative output does not exist in a vacuum, it is both an important part of the culture and judged in the context of that culture. In Martindale's view, 'creative productions occur in structured social contexts rather than in isolation' (Martindale, 1994:159). Ochse (1990:53) asserts that creativity actually 'depends on enculturation'. Dakers (2004:33) writes that creativity must be 'assessed within a social-constructive framework'. Whether something is valued as well as being original, is culturally determined. It is perhaps paradoxical that while creativity is often linked with individuality, it is also bound up with approval by the wider, collective culture. As Boden (1994:2) points out: 'No psychologist, however interested in individuals' thinking or personality, need deny the pervasive effects of cultural style and social evaluation'. The label 'creative' is a 'socially sanctioned honorific' (Boden, 1994:2). Csikszentmihalyi (1990) also puts forward the idea that what is deemed creative is a product of judgements made by society within a domain and not purely the province of the individual. Sternberg, Lubart, Kaufman and Pretz (2005:351) sum up this view:

'Creativity may be viewed as taking place in the interaction between a person and the person's environment'. It is the domains which provide the means for judging, preserving and transmitting creative products (Lubart, Kaufman and Pretz, 2005). It is hard to imagine characterising creativity without reference to the surrounding culture. This is essential if value and newness are to be judged. High level creators may produce work of amazing originality within existing traditions (Gardner, 1990) but sometimes they will change the rules, setting new standards. High level creators and their products spring from existing culture but they may also change it.

Big C creativity

High level or big C creativity (Gardner, 1993a) is the kind that changes whole domains in important ways, Einstein's work in physics for example. Boden (2001:46) uses the term 'high creativity' to indicate 'the extraordinary creativity of the genius, in any particular field' 'those who 'change domains of knowledge or create new ones'. The NACCCE report (DfEE, 1999:30) uses the term 'historic creativity'. It is significant creativity that is 'original in terms of anyone's previous output in a particular field: that is, it may be uniquely original'. Although the terms differ, they all refer to creativity that is field changing and recognised as such by experts in that field. Novelty is certainly not enough for something to qualify as big C creativity. There must be recognition and acceptance by experts in a given field (Gardner:1993a). These experts are the gatekeepers who assign big C creativity status. Gardner (1993b:52) postulates that:

> Creativity is a characterization reserved to those products that are initially seen to be novel within a domain but that are ultimately recognized as acceptable within an appropriate community.

This means that some great creators may not be recognised in their day and the longer view must be taken. A considerable amount of literature on creativity features big C, 'high' creativity and those that are or have been capable of it. Examples include: Ochse (1990), Eysenck (1994), Boden (2001 (Gardner) (1993a), Craft (2002). Ochse (1990:4) concentrates on 'people who have been recognized by expert opinion as having contributed something of original value to the culture'. From the 1950s, the main focus of research into creativity as a psychological domain was on the factors that determined creative genius in individuals (Spendlove, 2005). The study of creative geniuses features Michalko's *Cracking Creativity* (2001) where he tries to show how methods used by eminent creators might be used by ordinary mortals.

High creativity is sometimes associated in popular culture with eccentricity or worse (Davis, 1983). The stereotypical 'mad professor' is one example. Robertson (2002:87) describes a study of sixty-nine people affected by a dementia. Although impaired in other ways, twelve of those studied 'either showed a preservation of creative ability – artistic or musical – or astonishingly, developed quite new talents in these areas'. Ochse (1990:116) considers the three main views on creativity and madness to be: that there is a positive relationship between creativity and psychopathology, a negative relationship or none at all. He concludes that on balance, the literature indicates that 'creativity is indeed related to psychopathology'. He qualifies this by saying that even if one accepts the relationship, the question remains whether they have common origins or one leads to another. If there is a relationship, does the creativity lead to the madness or the madness to the creativity? Furthermore, many highly creative people are not mad or even eccentric, so an inevitable link is not proven. Some writers even take the view that creativity is therapeutic (Ings, 2004:16). Kavaler-Adler (1996:3) believes that artists seek 'emotional healing' through their creative work. She asserts that the creative process should be seen as 'totally positive for psychological growth'.

> The creative process must be explored not as the product of sickness, but as representing the highest degree of emotional health as the expression of the normal people in act of actualising themselves.

Gardner (1999:122) suggests that some kind of 'obstacle or anomaly that makes a person marginal within his or her group' is a factor associated with high creativity. 'Averageness' or 'total normality'; on the other hand is offered as a negative factor. According to Papanek (1985:152) there are many wishing to cut down the non-conformer.

> We live in a society that places high value on conformity, our creative responses have been blunted or stifled-frequently, an innovative reaction will be dismissed as mere eccentricity.

Creative people need to think differently from the rest, but this may only be within aspects of their own field. The originality and sometimes unconventionality of creative people may lead some to regard them as eccentric when they are simply 'marching to the beat of a different drummer'.

Little c creativity

While acknowledging the importance big C or 'historic' level creativity, it is important to note that some writers assert that creativity is not the exclusive domain of geniuses. Gardner (1999) describes the everyday order of creativity as 'little c creativity'. Brown (1997:36) asserts that 'creativity is certainly present in all people to varying degrees'. Ward, Finke and Smith (1995:7) also support the view that creativity is a 'natural part of being human'. Our ability to imagine what could be and what should be, has been crucial throughout our history. Csikszentmihalyi (1996:20) regards creativity as a crucial component in what makes us human:

> We share 98% of our makeup with chimpanzees. What makes us different – our scientific understanding, and technology – is the result of individual ingenuity that was recognised, rewarded and transmitted through learning. Without creativity, it would be difficult indeed to distinguish humans from apes.

Hope (2004:116) characterises little c creativity as: 'making products that are useful, rather than to turn the status quo up-side-down'. Although both levels of creativity require newness and value, these are on dramatically different levels. Boden (2001:49) draws attention to ordinary creativity which 'focuses on the resourcefulness and agency of ordinary people' rather than 'the extraordinary contributions and insights of the few'. Everyday creativity such as finding a novel way to carry a package while leaving the hands free, happens often. Schank and Clearly (1995:229) write about 'immense social cost' of undervaluing everyday or 'little c' creativity.

> These small acts of creativity, though they differ in scope, are not different in kind from the brilliant leaps of an Einstein. Creativity is common in cognition, not an esoteric gift bequeathed only to a few.

Although there are different views on the nature of creativity, there is widespread acknowledgement of its importance. It is arguable that it is creativity in many fields that has resulted in the development of human civilisation. Those of us living in the present can be considered to be riding on the shoulders of our creative antecedents. We benefit from and build on the creations of our forbears. This began with those who created tools from stones and made paintings with the natural materials around them.

Davis (1992:11) asserts that 'civilisation is a history of creative ideas building on each other'. Fritz (1991:4) believes that the creative process has had more impact than any other in history. He attributes the entire technological age, the arts, sciences, popular culture and more, to the existence of the creative process.

Differences between creativity in the arts and sciences

Creativity in the apparently polar opposites of art and science is now considered. It is acknowledged that there is not the space in this review to explore creativity in every field as any one of these could be a major study. These major domains will be taken as examples through which to explore the differences and similarities between fields. Some of the difficulty of defining creativity may stem from the differences between the fields.

Creativity arguably occurs in most if not all areas of human endeavour. Theorists recognise different kinds of creative contribution (Sternberg, 1988, Weisberg, 1993). May (1975: 43) noted that 'Creativity must be seen in the work of the scientist as well as that of the artist, in the thinker as well as in aesthetician'. There appear to be clear differences between creativity in the arts and the sciences. This is not surprising when one considers other differences between these fields. The creative outputs of artists and scientists are very different. The use of the single term 'creative' to describe such diversity, may contribute to its lack of clarity. This is highlighted by De Bono (2007:5): 'In the English language there does not exist a separate word to distinguish the creativity of new ideas from the creativity of art'. He believes that ''idea creativity' can be taught, learned and developed in a formal way'. White (2002:128) describes artists as 'makers of objects, paintings, symphonies, poems'. He goes on to say that 'creative' scientists are creative not because they have made something but because they have had original ideas. Ward, Fink and Smith (1995:205) write that: 'Art appeals to our emotions, whereas science deals with logic and mathematical relationships'. The artists work in a continually open-ended, risk laden situation. They have plenty of opportunities to develop new forms and in a sense, create worlds with rules of their own or none at all. The scientist on the other hand is governed by strict rules and external reality. As Karlqvist (1997:111) puts it: 'Creativity in Science is very much a matter of interaction with rules and constraints'. Theories created must work within the rules of the scientific community. If the theory shows an inadequacy in the rules, new rules must be created to accommodate this. Martindale (1996:160) points out another difference between art and science: 'In science or technology, there is often a clear problem to be solved, but the problem to be solved in art is unclear'. The difference between art and science is also highlighted by the fact that very few high level creators can perform as such across both domains. This indicates that creativity is domain specific. Winch and Gingell (1999:45) write that creativity 'does not seem to be a general ability... but rather a characteristic which is developed within a particular sphere and may not travel far from that sphere'.

Ochse (1990:53) discusses the claim that artistic achievements are more creative than scientific ones, making the case that the artist is less dependent on the prior achievements of others. He does concede however that: 'Even highly creative art is to some extent a re-assemblage of ideas taken from others'. A stronger claim for the greater creativity in art is that a scientific discovery could be made by different, gifted people but the same is not true of works of art. The scientists are in a sense discovering what already exists, so the artist might be able to claim greater originality. The scientist might counter that is not the phenomena that are their main claim to originality but rather their theory explaining it.

Similarities between creativity in art and science

Although creativity in art and science are different in important respects, it is possible to identify similarities also. Both domains for example, share the fundamental requirements of originality and value discussed earlier. Something that creative scientists and artists have in common is a degree of mastery in their respective disciplines. Another aspect that art and science share is the acknowledgement that mastery alone does not necessarily result in high creativity. Deshimaru (1982:77) refers to creativity going beyond technique:

> Great works of art are created beyond technique. In the world of technology and science as well, great discoveries transcend principles and technique.

Ward, Finke and Smith (1995:205) do not deny the importance of mastery but they believe that more is needed: 'Expertise is necessary but not sufficient for making creative contributions to art or science'. They acknowledge the differences between Art: 'wild and fanciful' and Science: 'rooted in reality'. Nevertheless, they maintain that there are 'some important similarities between art and science' such as similarities in the cognitive approach to thinking creatively in these diverse spheres (Ward, Finke and Smith 1995: 207). Koestler (1964:144) writes that the reports of scientists and artists on their sources of inspiration and methods of work 'often display the same contradiction'. Claxton (1997:3) makes the point that 'Poets have always known the limitations of conscious, deliberate thinking' and have sought to cultivate 'mistier ways of knowing'. He goes on to write that 'Even scientists themselves, or at least the most creative of them, admit their genius comes from layers of mind over which they have little or no control'. Casti describes the importance of the unconscious mind to the work of the mathematician Poincaré. The solution to a longstanding problem that he had set aside came to Poincaré as he was stepping onto a bus. Casti (1997:121) comments on this: 'It appears that his unconscious mind continued to grind away at the problem, even after his conscious mind had dropped it in favour of other concerns'. The role of insight and the unconscious mind are common if rather mysterious factors across disparate fields.

Some writers have tried to understand creativity by studying the highly creative individuals discussed earlier, across different fields (Michalko, 2001, Ochse, 1990, Gardner, 1994). These writers believe that there are factors common to artists and scientists. They look for common elements across fields rather than examine each in isolation. Gardner writes that 'to understand the concept of creativity in its full-blown sense, one must look at people who have clearly affected domains'. Studying outstanding creators across fields is not a new approach (Terman, 1947, Thurnstone, 1952). Michalko (2001) searched for factors shared by thinking styles that produced the Mona Lisa and the theory of relativity. He identified productive rather than reproductive thinking as a common feature and that in both fields, work is judged by those regarded as experts. Another factor common to artists and scientists is that they often draw inspiration from the surrounding culture. They must also make reference to it when assessing the originality of their work. Ochse (1990:51) makes this point:

> Although the Humanists suggest enculturation might be inimical to the spontaneous expression of creativity, it seems a good measure of enculturation is vital to all creative production.

In the case of both artists and scientists, creativity occurs in the interplay between the individual and their surrounding culture.

Childlike thinking and creativity

Childlike thinking has connotations of curiosity and open-mindedness unfettered by preconceptions. Smith (1997:31) makes the point that creative people retain the benefits of their child's open mind but bring their knowledge to bear on this.

> These [creative] people are definitely not children or infantile adults. They look upon the world with fresh, unconventional childish eyes but correct what they see with more knowledgeable adult eyes.

Children are often regarded as naturally creative and models for adult creativity. Einon (2002:7) writes:

> Small children have the curiosity and confidence to try new things. They are not self-conscious or afraid to try new things. Creative people hang on to these skills throughout life.

Gardner (1997) observes that high creators display childlike qualities. The virtues of an uncluttered mind feature in Zen philosophy and the Japanese martial arts where the childlike mind is often described as 'beginners mind'. Bolt (1997:6) writes that:

> The ultimate beginner's mind is that of the child. Children learn so rapidly because they are neither afraid of not knowing nor convinced that they already know what they don't' and 'only an empty cup can be filled.
>
> .

Curiosity and the confidence to try new things are among the childlike qualities that some writers associate with being creative (Craft, 2001, Davis, 2002, Maltz, 2002, Cowley, 2004). Michalko (2001:114) is another writer who draws parallels between a child's thinking and that of the genius:

> Like the highly intelligent child with pailfuls of Lego building blocks, a genius is constantly combining and recombining ideas, images and other various thoughts.

Smith's empirical work (Smith, 1987:31) leads him to believe that 'the creative adult person harbours a child within herself' and that 'Growing into an adult very often means losing your creativity'. He does acknowledge however that many people do remain creative in old age. An uninhibited, child-like mind not overburdened by preconceived solutions, would certainly be an asset to a creative person. However, an open mind is not the same as an empty one. When Einstein asserted that imagination is more important than knowledge, he was not saying that knowledge is unimportant. The importance of a childlike mind is to be found in disparate contexts. The 'Dragons' Den' television programme is based on inventiveness and entrepreneurship. In his BBC book associated with the programme, Davis (2005:32) writes:

> It is true however, that some of us have lost-or, more accurately, mislaid-the ability to think creatively. All children possess that ability. Sadly, it is often diluted on the road to adulthood and discouraged through education.

Ochse (1990:86) makes the same point: 'education may inhibit creativity by causing the person to become over-committed to the traditional manner of approaching the problems inherent in the discipline'. On the other hand, creators working within a field need at least some mastery of it and education can provide this. Ochse gives examples of high level creators who were well disposed towards their formal education and also those who were not. It may be that the effect on the child's mind and the child-like mind depends on the kind of education provided. While education may sometimes inhibit creativity, it can also contribute to the crucial knowledge and skills base of the genius and the everyday creator.

Although there are different views on the nature of creativity, there is widespread acknowledgement of its importance. It is arguable that creativity in many fields has resulted in the development of human civilisation. Those of us living in the present can be considered to be riding on the shoulders of our creative antecedents. We benefit from and build on the creations of our forbears. This began with those who created tools from stones and made paintings with the natural materials around them. Davis (1992:11) asserts that 'civilisation is a history of creative ideas building on each other'. Fritz (1991:4) believes that the creative process has had more impact than any other in history. He attributes the entire technological age, the arts, sciences, popular culture and more, to the existence of the creative process.

Creativity in education and society

Since this thesis is concerned with the field of education and particularly design and technology education, creativity in this area will be emphasised below. However, education does not exist in isolation from industry and other aspects of society. As in the wider literature considered above, writers in the field of education, acknowledge the difficulty of defining creativity. The NACCCE report (NACCCE, 1999:27) suggests three difficulties:

> The problems of definition lie in its particular associations with the arts, in the complex nature of creative activity itself and in the variety of theories that have been developed to explain it.

Promoting creativity is an important part of the *spa* so it is necessary to attempt a working definition of creativity in education, despite the difficulty of doing so.

Political and technological events in society have increased the importance of creativity in education. In 1958, Harding made a plea for more emphasis on creativity in education in the U.S.A.. In his view, the Soviet's success with Sputnik has 'made us 'painfully aware' of the lack of 'able, ready and willing problem solvers' (Harding, 1958:5). White (2002) also describes the stimulating effect that Sputnik had on creativity in the West. This concern has grown exponentially in the developed world since. The NACCCE report (1999:13) stresses that employers demand more than high academic standards. They want people who can 'adapt, see connections, innovate, communicate and work with others'. In the business section of modern bookshops, there are many self-help books with titles such as such as 'Thinking Creatively' (Boulden, 2002) and 'The Creative Thinking Plan' (Claxton and Lucas, 2004). Still more books for the business world include a chapter on creativity, 'Thinking for a Change' (Maxwell, 2003) is an example. Another of many possible examples is Cook's 'Best Practice Creativity' which is particularly concerned with developing 'organisations where creativity is valued and systematically encouraged' (Cook, 1998:3). He states at the outset that:

> Success in product and service innovation depends on creativity. Without a healthy and continuous supply of ideas, organisations would cease to exist.

Creativity then is important to commerce, as well as being crucial to education. According to NACCCE (1999:27), the exponential increase in the pace of change makes creative thinking ever more important in our society and in education.

> There are few areas of life where the nation's priorities for education, health, employment and industry are not dependent on the development and application of creative practical skills.

More recent government rhetoric continues the endorsement of creativity for economic reasons. This is evident in the foreword of the government's response to Paul Roberts' Report on Nurturing Creativity in Young People where Lammy and Adonis (2006: 2) note:

> We know that if Britain is to retain its competitive advantage in the future, then it will need a creative workforce. That is as true of science and engineering as it is of broadcasting and design. So we need to ensure that our education system continues to do all it can to give children and young people the creative skills they need.

It is sensible to accept degrees of originality in the context of education. The NACCCE report (1999:30) distinguishes between three different 'categories', one might say degrees of originality. These are individual, relative and historic. The first category describes work as original in relation to the child's other work. In the second category, the work is original compared with that of the child's peers. The final category comprises work that is original in terms of all known output in a given field. Children may only rarely if ever achieve 'historic originality' though some might go on to do so. This does not mean the first two categories are not worth pursuing. Excellence and Enjoyment (2003:5) stresses that 'Learning must be focused on individual pupils' needs and abilities'. Teachers are often required to judge those abilities including the creativity of children's ideas and we need to be extremely careful about dismissing ideas too readily. Is the idea irrelevant, or have we failed to see the relevance? Most fields have their experts or 'gatekeepers' that pronounce on the extent to which original ideas are valuable. Experts of course often disagree and the value of each idea or product to a given field or situation must be debated on it merits. In the field of education, the teacher is usually the most immediate gatekeeper. There are of course other gatekeepers such as examination boards and Ofsted inspectors. Children's own evaluation of their ideas is also an integral part of design and technology. Creativity is arguably central to the subject but the NACCCE report (1999:6) asserts that: 'creativity is possible in all areas of human activity'. This suggests that there is at least the potential for creativity in all areas of the curriculum. In places, the National Curriculum for England appears to encourage creativity. The DfEE,QCA Handbook (1999:22) features 'creative thinking skills' as a requirement across all compulsory subjects, describing them as follows:

> These enable pupils to generate and extend ideas, to suggest hypotheses, to apply imagination and to look for alternative innovative outcomes.

The importance of creativity is also recognised in other countries. The Finnish government's Committee for the Future (2002:66) reports:

> In an information society, citizens are expected to be creative and capable of intuitive thinking, due to the fact that expertise is based on knowledge and the creation of new knowledge.

Japanese society is sometimes associated with conformity but their National Curriculum Council endorses 'allowing schools to show ingenuity in developing unique educational activities' (Itoh and Yamazaki, 2001). This does not necessarily mean that schools will promote their pupils' creativity.

From the above one might think that creativity in education is always seen as a good thing and widely applauded and promoted. This is by no means the case and there is no shortage of contemporary writers discussing the barriers to creativity in education (Joubert, 2001 and Kimbell, 2000a). Although some of the contemporary barriers may be new, barriers to creativity in education have existed for a long time. For some, creativity has connotations of threatening non-conformity. Torrance (1965:10) wrote that some educators see creative thinking in school as 'threatening and dangerous'. De Bono's (1972:9) view is that 'transfer of knowledge' has always been seen as the main function of education and that examinations soon bring dissenters to their senses. Dow (2004:64) makes the point that 'teacher control has traditionally taken precedence over pupil autonomy'. The transmission model of learning in which the 'expert' teacher breaks down knowledge into manageable chunks which the children learn in a sequential manner, is still in many cases considered the most effective way to learn.

Even when teachers want to foster creativity in their classrooms, there are forces working against them. In England, the pressures of the National Curriculum often result in creativity being marginalised. Cowley, (2004:140) a writer on thinking skills and a serving teacher, expresses this:

> School does seem to have a tendency to knock much of the creative, imaginative and adventurous spirit out of us. I suppose I can understand why this has to be – there's simply so much to get done, so many topics to cover, so many skills to learn.

The perceived lack of time is a matter of priorities. In a rapidly changing society, nurturing children's creativity is important in preparing them to meet new and unforeseen situations. The inventor Trevor Bayliss, (2000:321) recognises the potential of design and technology to promote inventive ideas but wants more emphasis given to innovative thinking. He observes that 'If there is room in the syllabus for 'media studies', 'leisure studies', and 'sports studies', why not courses on 'invention studies'?'.

Creativity is often associated with risk taking and experimentation. Indeed Craft (2001:57) believes that risk is essential and that an act cannot be called creative 'if a risk that matters to the agent, has not been taken'. Howe, Davis and Ritchie (2001:27) share this view: 'Risk taking is an intrinsic part of creative behaviour'. While government supposedly endorses creativity, Ofsted and government policies arguably penalise unsuccessful experiments in the quest for raising standards. Some innovative ideas will not work out and there has to be allowance for this. Unfortunately, by the time Ofsted and examination boards have exerted their influence, 'the resulting ethos is not supportive of creative risk taking in the classroom' (Kimbell, Stables and Sprake, 2002:105). Indeed the educational climate has been described as one of coercive and authoritarian governmentality (Shore and Wright, 2000). Davies (1999:101) also supports this view: 'In the current political climate, there is caution about how much freedom should be given to schools, teachers and learners to be creative'. Paradoxically, it was the relaxation of National Curriculum requirements for primary education in 1998 that resulted in less time being given to the obviously creative subjects. A further paradox is that this 'relaxation' was done to allow concentration on the government's targets for literacy and numeracy. Politicians appear to endorse creativity, not least for its economic spin-offs. However, they are only in favour when the creative process produces a 'winner every time'. This is perhaps one of the main inhibitors of creativity in all subjects. Kimbell (2000) stresses the importance of creativity to design and technology but argues that the DfEE, QCA gives mixed messages about this. Kimbell mentions the discouragement of risk taking by punitive Ofsted inspections as one of the factors that militate against creativity. The same point has been made more recently in the Roberts report (2006:28):

> it too often feels like a risk to headteachers to place creativity at the heart of a SEF [self evaluation form] form. We need a much clearer policy steer from Ofsted and the DfES about the significance of creative engagement for young children's learning.

Kimbell goes on to question government's sincerity: 'There is lots of political puff about creativity in schools - but that is all it is'. He believes that the NACCCE (1999) report has already 'disappeared in to a DfEE black hole'. If this is the case it is very unfortunate for like Kimbell, the report promotes the view that it is important to eliminate factors which inhibit the creative activity of teachers. The report also comments on the unusually high levels of prescription in relation to teaching methods and content. Wragg (2004: 137) stresses the importance of creativity and imagination among teachers:

> Teaching as a profession should be for people with imagination. The ability to create and invent is precious, the badge of the true professional. It must be protected like the Crown jewels.

Teaching creatively is not the same as teaching for creativity in the children. However, the creative teacher is likely to value to creativity in the children and needs opportunities to set an example.

There have been some positive initiatives since the NACCCE report and the setting up of Creative Partnerships in 2002 is one of these. This government initiative was overseen by the Department for Culture, Media and Sport (2007). It aims 'to give young people in disadvantaged areas across England the opportunity to develop their creativity and ambition by building partnerships between schools and creative organisations, businesses and individuals'. Craft (2005:106) suggests the reason behind such initiatives:

> the relationship between creativity and the marketplace has been one of the drivers behind government initiatives the world over to inject greater creativity into the curriculum.

Castleden (2007:12) also writes about the link between society, inventiveness and the marketplace:

> Societies need to allow individuals a certain level of independence of thought and action as a precondition for invention. Certain archaic societies have such rigid and inflexible structures that mindsets and inventiveness are constrained. In a free-market economy and what we might call a free-thinking society, inventions are likely to happen all the time.

Given that this is the case, it is all the more surprising that our governments do not take more care to avoid inhibiting creativity in education with heavy-handed interventions. Arguably, these have included an emphasis on examination, including the inspection of children as young as five. As Craft (2005:98) points out, the prevailing political climate influences creativity beyond the classroom too:

> Clearly, the wider cultural/political context may affect a person's experiences of creativity and their ability to manifest it.

The effects could of course be positive or negative. Craft (ibid) takes a cautiously optimistic view of the likely effects in our society.

> At a macro-political level, we might say that a region or country that embraces democratic values and freedom of speech would perhaps be more likely to support the promotion of creativity in policy and practice.

Politicians in the UK have more influence on education than ever before. The effects they have on creativity in education and their motives for endorsing it need to be considered critically. To what extend are they driven by the importance of nurturing individual creativity? How much are they motivated by a commitment to relentless, unsustainable economic growth at the expense of our planet? An advertising campaign by a well known furniture store exhorted us to 'Chuck out the chintz' - which they had previously sold us and replace everything with their latest products. Should creativity that can be crucial to solving real problems and sustaining individuality, be trivialised by a rampantly consumerist society? Educators need to prepare children to take part in the debate.

Creativity in design and technology

Design and technology education does not exist in isolation and all the above is pertinent to this thesis. However, there are issues specific to the subject which will now be considered. Creativity is central to design and technology although this is not always apparent in the classroom. Davies and Howe (2004:54) report the parlous state of creativity in schools as experienced by their student teachers. Collectively, these would have experienced a considerable number of primary schools. They report that 'few trainees appear to have found the D&T they have observed in schools recognisable as a creative activity'.

It could be argued that no subject has more potential for developing innovative thinking than design and technology. Designing, making and testing ideas against tangible problems allows children to judge their ideas against external reality. In arts education, whether an idea is judged valuable is comparatively more subjective. Design and technology work may have an aesthetic as well as a functional aspect but even then, there is usually a functional requirement against which work can be tested.

Design and technology can be described as human innovation and problem solving in action (McCormick et al., 1996). Problem solving should relate to children's real life environment (Schwarz, 1996), allowing them to make appropriate and meaningful connections. Moreover, the opportunities given should enable them to explore and pursue their own needs and wants, as well as those of others. According to Adams (1991) and Lindh (1997), children should be encouraged to notice problems and deficiencies in their everyday environment. They should then be given opportunities to apply technological knowledge and skills they have acquired in previous problem-solving situations.

Baynes (1992:19) observes that 'without an imaginative spark design and technology is reduced to copying what has been made already'. In fact, Baynes understates the case, because merely copying what has been made already is not design and technology at all, it is merely making things. Although non-statutory, the foreword to the National Curriculum programmes of study for design and technology (DfEE,QCA, 1999:15) says that children should 'think and intervene creatively' and become 'autonomous and creative problem solvers'. They are to 'intervene creatively and become innovators'. In this thesis, it will be argued that through *spa*, children could be given much more than the usual opportunity to do all these things.

To achieve the National Curriculum level descriptions for design and technology, children are required to generate ideas, clarify their ideas and use appropriate strategies to develop appropriate ideas (DfEE, QCA, 1999). The National Curriculum level descriptions recognise that this will happen on various levels but phrases such as 'their ideas' or 'pupils generate ideas,' feature frequently. Unfortunately, what goes on in the subject does not always justify the rhetoric. Some reasons for this are explored below.

The need to increase and support creativity in design and technology

The terms originality, innovative or creativity are not actually used in the current National Curriculum programmes of study for design and technology (DfES, 2004:5) level descriptions. Neither do these terms feature in the level descriptions to which teachers must turn when assessing their pupils. The level descriptions give emphasis to things like recognising that designs have to meet a range of different needs (level 3) and taking user's views into account (level 4). Even the 'exceptional performance' category concentrates on pupils who show discrimination in their use of information and work from formal plans. These criteria have some value but those who have brilliantly innovative and creative ideas are still waiting for a level description to be written for them. 'Their ideas' features but creativity or innovation do not feature in the level descriptions as such. The National Curriculum Handbook for primary teachers in England (DfEE,QCA, 1999b:11) mentions creativity under the heading of promoting skills across the National Curriculum but these fine words are non-statutory and not specific to design and technology:

> The curriculum should enable pupils to think creatively and critically and to make a difference for the better. It should give them the opportunity to become creative, innovative and enterprising.

This is hardly sufficient encouragement for teachers interested in creativity and it does not compel those who are not. The lack of an explicit obligation to promote and reward creativity in the design and technology programmes of study is a serious omission. Perhaps the situation in England is not quite as dire as this omission suggests. Teachers are good at finding their way around the limitations of official strictures and creative work happens in some schools. There is some scope for the teacher who values creativity to reward innovation. However, the problem is that teachers with other priorities may be able avoid or marginalise it. Nevertheless, all levels require the pupil's own ideas to be assessed. It would however be good to see degrees of creativity explicitly mentioned and rewarded. The Design Council (DfEE, 1999:83) believes that: 'The more prescriptive a curriculum, the greater the need to be explicit about creativity and not leave it to chance'.

Many other countries have looked to the English National Curriculum as a model for their technology education. Now however, it may be time to learn from them. The South Australian Curriculum Standards and Accountability framework has the development of a sense of the power of creativity, among its key foci (Keirl, 2001). Teachers assess what they value, or increasingly what they are told to value. The explicit rewarding of creativity in design and technology is important. Torrance (1965:1) makes the point: 'What is honoured in a country will be cultivated there'. Teachers must value creativity highly in design and technology if the subject is to deliver its promise in this important area.

Davies and Ritchie (2001:13) writing about primary technology, agree with the NACCCE view mentioned earlier, that not only the highest order of creative achievements is of value. They 'refute the idea that the majority of people cannot be creative'. The design and technology teacher's role is to create a climate and provide the stimulus that will encourage children to have creative ideas. All too often projects such as 'design a desk tidy that will hold six pencils and a ruler using the material provided,' limit the scope for innovation in an arbitrary way. If there is no good reason to specify that it should hold six pencils or indeed any pencils, then the restriction should not be imposed. The main motivation for desk tidy type projects is often that they enable certain processes to be carried out. Tasks need to encourage creative and innovative responses. The Ofsted (2003) report for primary design and technology also indicates the need to develop designing. The report is concerned that the teaching of designing remained weaker than the teaching of making. The majority of teachers still insist that pupils of all ages record their design ideas on paper before they start making. At worst, children are given their design assignment and with little or no further stimulus and told to draw six ideas. The dominance of drawing and treating it as synonymous with designing, are seen as a particular problem by Ofsted (2003). Hope (2006: 52) values drawing for the right reasons but comments:

> Unfortunately, teachers often formalise this [drawing] so that all children have to draw their ideas before they are allowed to start making anything. This can be counter-productive as the children will see drawing merely as a 'permission ticket' that they have to complete before being allowed to get on with the real business of designing.

Nicholl (2004:154) reports a similar problem from his own observations:

> Faced with a blank sheet of paper pupils would often copy football club or corporate logos, or products from the Argos catalogue.

Morris also highlights the problems associated with making children draw ideas first. He also identifies a problem which the *spa* can help to alleviate:

> when children are forced to design in detail before they experience the concept physically, they often struggle to create a design, create a design which bears no resemblance to the finished product; or cannot move beyond the suggestions made by the teacher and will copy these without really understanding the underlying concept.

The *spa* avoids this catalogue of problems through the children 'experiencing the concept physically' by making the practical starting point at the outset. Another barrier to creativity occurs when the teacher sets a challenge where the only problem is to guess the single right answer that the teacher holds. Such activities are more like puzzles than genuine design problems. An example of such an impoverished activity is unfortunately put forward by Slavin, (1997: 294) as 'creative problem solving'.

The use of information and communication technology (ICT) in design and technology is required by the National Curriculum (DFEE and QCA, 2004). The ease with which ideas can be experimented with and changed on a computer means that ICT has great potential to support creativity. The danger is that the need to be creative may be overlooked or taken for granted. There is a risk that like 'motherhood and apple pie,' the apparently self-evident 'goodness' of using ICT will be enough in itself. Children learning to use a computer control package are in fact learning ICT. The researcher would argue that they are only involved in design and technology when they apply this knowledge creatively as part of their designing and making. Using new technology does not guarantee that it will be used to create new things. Use of the latest software may blind some observers to when the child's output is no more creative than the proverbial pipe rack project of the past. Kimbell, Lawler, Stables and Balchin (2002) point out that there are many different styles of designing and there is danger in the implicit assumption that there is a standard way of designing and presenting ideas. They point out that computer aided drawing programmes lend themselves to working in a particular way. Their concern is that if this is becomes 'the' way, many pupils will be disadvantaged. (Kimbell et al. 2002:29) note that. 'There are many pathways to salvation in design. Some students are better at working with drawings, some with words and some prefer to make models and mock-ups'. The risk is that teachers and students might be seduced by high-tech presentation, so that other ways of exploring ideas are effectively disallowed. There are signs of more awareness of the need for more creativity in design and technology. One indication is the increase in papers in this area in DATA, the main UK journal in the subject. Examples include: 'What stimulates the creative process' (Joyce, Franklin and Neil, 1998); 'Creativity, Risk and the Curriculum' (Kimbell, 2000); (Davies, 1999), 'Taking Risks as a Feature of Creativity in the Teaching and Learning of Design and Technology'. The Design and Technology Association's journal features 'Creativity in Education: A review' (Spendlove: 2005). This is not necessarily reflected in the classroom where risk does not sit well with improving a school's position in the government's league tables. As Norman (2005) puts it, 'It is ironic that the sum total of pressures for change has been conservative'. Creativity is seen as a good thing by politicians, educators, industrialists and others. Despite this there are many factors working against creativity in design and technology. Some are from outside the subject but perhaps of most concern are those from within. Although there are attempts to stimulate children's ideas in design and technology, at its worst this involves issuing paper and asking for 'three ideas'. Secondary school and secondary initial teacher training often place great emphasis on making skills, using new software and smart materials. Following the latest industrial practices in design and technology is also seen as a good thing at secondary level.

However, the crucial but more elusive creative design skills are often neglected. The next part of this review considers using strategies for generating ideas rather than leaving it to chance. These are seen as vital in business and industry but relatively little used in design and technology education. The National Curriculum programmes of study for design and technology require that children generate ideas but give no real indication of how this might be done. This part of the chapter considers the current situation with regard to idea generation and how this might be developed. This is a matter of finding ways to 'shake the tree' of ideas, rather than waiting for 'an apple to fall'. De Bono (1992:56) is among the many that think strategies can help. 'We can use our natural thinking ability and that will serve us quite well. But if we develop structures, methods and notations we can do very much better'. It would be helpful if there was an accurate and reliable way of measuring creativity across different fields. Gardner (1993:170) however says that attempts at such tests 'cannot predict which individuals will be judged as creative on the basis of their productions within a domain'. So it is for improvements in the creativity of design and technology work that we should look to when deciding whether strategies help. This of course begs a number of questions but the fluency originality and value of design ideas should be among the factors. The climate in the classroom where strategies are implemented will have an influence on their effectiveness. A broader social climate where functional, design and technology type creativity was more highly valued, would also help. Britain is notorious for giving inventive people a difficult time. James Dyson's company is one of relatively few that is active in school design and technology. The title of his autobiography, 'Against the Odds' (Dyson, 1997), sums up his experience of developing innovations in the UK. Bayliss (2000) has established an academy of inventors but so far there no evidence that it has had an impact in education.

Teachers may find it difficult to improve the climate for 'ideas' creativity in society but they do have opportunities within their design and technology lessons. Many writers on education comment on the importance of the right setting for creative thinking. Beetlestone (1998) mentions the need to allow time for reflection and the exploration of ideas. Thanks partly to literacy and numeracy initiatives time is in notoriously short supply. Ofsted warned of 'serious narrowing of the primary curriculum' (Ward, TES, 28th June, 2002). Given the familiar 'pendulum' effect in educational policy, perhaps, just perhaps, children will get more time to think about design ideas. Costello (2000) writes that a prerequisite is that teachers themselves are given opportunities to engage in creative thinking. Bowen (2000:23) asserts that children need a 'well-organised, supportive environment'. However, an over-organised, restrictive environment needs to be avoided.

The NACCCE report (DfEE, 1999) stresses a balance between teaching knowledge and encouraging innovation. Boden (1997:1) reminds us that 'people sometimes speak as though knowledge has little to do with creativity or even prevents it'. A lack of 'constraint' may be helpful in some fields but in the *spa*, knowledge of the starting point is intended to provide the stimulus for creativity. Mandler (1995:9) makes the point that 'The mental products that we call novel, and the creative acts that produce novel thoughts and actions, need a prepared mind'. In the *spa*, the practical starting points are designed to play a key part in such preparation. Bowen (2000:23) also found that 'because the children had subject knowledge to work with, this allowed for creative responses'. 'Focused practical tasks' (DfEE, QCA, 2004:17) in the design and technology programmes of study provide knowledge and skills that allows creative responses, as Boden suggests. Unfortunately, some teachers have seen focused practical tasks as ends in themselves. Above all perhaps, children need a climate where their ideas are valued and never dismissed or ridiculed. It is all too easy for a teacher to dismiss a child's idea however kindly, because it does not fit the lesson plan or some other agenda. Design and technology work must allow room for children's ideas rather than confining them to working out the teacher's answer as they have to in many areas of the curriculum. Unless this principle is followed, there is little point in finding good strategies for generating rich ideas only to dismiss them.

Factors working against creativity within design and technology

Kimbell and Miller's research (2000:116) indicates that a perceived 'lack of creativity' in the subject is working against the recruitment of teachers who value creativity. Thus we have a vicious circle, where the negative experiences of those most needed to improve teaching, are deterred from joining the profession. According to Dow (2004:64), some professionals already working within design and technology education fail to recognise the importance of creativity, misconceive it or hold counter-productive views. She warns of a self-fulfilling prophecy when she writes:

> a design and technology teacher whose implicit theory about creativity is that it is a special quality present only in a tiny percentage of the population, will easily overlook evidence of creativity in all but a small number of pupils taught.

Such a teacher only recognises Craft's big C creativity mentioned earlier. Saari (1997:56) agrees that children usually fail such a teacher's test 'because most of them are not sufficiently sophisticated to match this measure of utility'. This harks back to the subject's origins in the wood and metalworking industries. In the era before computer controlled manufacture, the vast majority of workers were employed to mechanistically produce designs created by an elite. Dow (2004:65) is right to emphasise the need to get design and technology teachers to discuss their views on creativity so that unhelpful assumptions can be challenged. Seeman (2006:38) supports the view that teachers need to take a position on the role of innovation and by implication, creativity.

> Technology educators are facing and unprecedented crossroad: to either attempt to ignore and resist embracing the new culture of innovation education or to fully embrace it into new syllabus design, pedagogy, research and practice in the classroom.

Educator attitude is crucial and there is no shortage of teachers turning away from creativity at that crossroads. Salem (2006: 40) for example, cheerfully describes a complete unit of design and technology work at her school which allows no creativity:

> This unit of work is a Focussed Practical Task (FPT) with no design work required. Pupils are shown examples of what is required at the outset and practical work is marked on accuracy of measurements, quality of finish and function.

This is particularly disturbing because the work was disseminated in DATA's own curriculum publication under the heading of 'effective practice'. For those concerned with promoting creativity in the subject, this woodwork project is rather disturbing.

Technology familiar or new can be used to stimulate creativity. Relatively new technology like the ICT mentioned earlier, and 'smart' materials, have filtered into design and technology education from industry. This is arguably less so in the case of strategies for idea generation. Strategies used in business and industry may not always be directly transferable to school but there is a need find out which can. There may be particular problems with finding or developing strategies for use with young children.

They are furthest removed from the adult using strategies in business. Roden (1997:14) notes that 'little is known about the problem-solving strategies young children bring to design and technology tasks and how these might be expected to develop in the classroom'. Children have years of experience of giving the teacher the responses they want. However, young children are renowned for their imagination and so might well be amenable to adopting helpful strategies.

Promoting creativity in the subject is not helped by the concept being difficult to pin down, as was discussed earlier. When testing for creativity is carried out, it is almost entirely confined to verbal and pencil-and-paper tasks (Child, 1993). These may not capture all the creativity found in a design and technology class. Assessing something well does not in itself increase it but it might help to identify factors that do. Before seeking measuring instruments, we need to recall Gardner's view mentioned earlier that universal tests cannot predict creative achievement in a domain (1993:170). We need to look for more ways to determine and promote creativity in design and technology and this can involve looking back. Torrance (1965) tried to measure creativity by asking subjects to find unusual uses for objects within their experience. Respondents were for example asked to think of as many uses as possible for a brick. In the *spa*, a similar strategy is used to stimulate ideas rather than measure them. In the case of the *spa* research, a pressure pad starting point replaced Torrance's brick and children developed their ideas into finished products. The *spa* is based on children devising their own applications for the technology provided by the teacher.

Group and individual idea generation and techniques other than spa

Assuming the right climate where ideas are valued, we may need to consider the effects of children working in groups and working individually. The guidance notes for the key stage 2 design and technology programme of study in the DfEE, QCA Handbook (1999:94) indicates that pupils should 'work on their own and as part of a team on a range of designing and making activities'. Some strategies may require a group but the need for one can also be assumed. Brainstorming involves the rapid and initially uncritical generation of ideas where one idea often provokes another. Sloane (2006:117) writes that 'good brainstorms remain one of the best ways of generating fresh ideas'. This is a well known strategy for idea generation where a group is often seen as essential. Whittaker (1995:71) describes brainstorming as 'generating ideas in a group'. Fisher (1990) and Arnold (1962) are among the others who describe brainstorming as a group activity. Groups do have a number of advantages. De Bono (1970:131) writes that 'in a brainstorming session the provocation [of ideas] is supplied by the ideas of others'. There is a danger, however, that groups are seen as essential to idea generation. However, some writers recognise that an individual can also use brainstorming productively (Eastaway, 2007). Bold (1999:25) asserts that 'brainstorming occurs in a solitary or group situation'. Indeed, she believes that 'Designing in a group situation is the most problematic'. The term 'group' usually implies some degree of cohesiveness and collaboration between members. However, being in a group of discordant individuals that are simply sharing a room, could work against the generation of ideas. Retiring but creative people, might be overwhelmed by more assertive but less creative ones. A creative individual could be held back by less inspired group members. If a group has to produce one final idea, many equally good or better ideas could be lost. This could happen in design and technology, where one idea is normally chosen to be made. Children can benefit from designing in a group, children but they should also have experience of generating ideas of their own and on their own. We should remember Huxley's nightmarish vision of the future in Brave New World where groups were compulsory and the loner was seen as suspicious and antisocial (Huxley,1932). Bold (1999:24) notes that 'whether children design as individuals or as part of a team' is an issue. She goes so far as to say that in primary design and technology 'groups of three or more are rarely successful'. The teacher as discussion leader is an important part of the *spa* session. Dillon (1994:49) believes that most teachers would 'need development as a discussion leader'. In practice, we need to skilfully exploit the benefits of group and individual idea generation. As mentioned earlier, the National Curriculum requires both. Shallcross (1981:44) makes the point that 'Groups can be powerful forces in either positive or negative ways'. The teacher's management of groups can be a decisive influence in their effects in school.

Some consideration of idea generating techniques other than *spa* is relevant to this thesis to give a broader perspective. Another reason is that although guided brainstorming was used in the *spa* data gathering, other techniques could also be incorporated. Educators can benefit from looking to thinkers outside education for approaches to creative thinking and idea generation. Given the limited space available, what follows can only an indication of the potential. Writers like Michalko (2001), De Bono (1992), Buzan (2001) and Barez-Brown (2006) have led creative thinking workshops, seminars and think-tank sessions for governments and corporate clients around the world. Michalko (2001) contrasts reproductive and productive thinking. He describes reproductive thinking as occurring when we try to deal with a problem by fixating on what has worked with similar problems before. This tends to lead to well-worn solutions that are of little help with new problems. Productive thinking by contrast, is where one 'generates as many alternative approaches as one can, considering the least as well as the most likely approaches' (Michalko, 2001:4). Michalko's (2001:15) chapter heading: 'Seeing What No One Else is Seeing,' is encouraging if one believes in the importance of the individual as a creative entity.

Many techniques attempt to get users to get out of the 'groove' of their usual thinking so that new ideas will result. De Bono (2007) suggests many ways of achieving this, including linking random words with the problem in hand. Thus the problem of improving photocopiers, linked randomly with the word 'nose' could lead to a copier that indicates faults with different smells. De Bono (2007:17) devotes a whole book and parts of others, to the random word method which he regards as 'one of the basic tools of lateral thinking'. As indicated earlier, not all strategies suitable for adults or older students are suitable for use by young children. The random word method for example presupposes a certain level of literacy. 'Mindmapping' (Buzan, 1995) involves colourful diagrams but also requires literacy. Unless words are replaced by images, some strategies are too complicated for young children. A strategy that could be used across a very wide age range is 'bag of tricks' (Barez-Brown, 2006:208). This is similar to the random word method except random objects are produced from a bag to introduce fresh possibilities into the idea generating process.

Conclusion

The NACCCE (1999:6) says that, 'All people have creative abilities and we all have them differently'. Given what is known about individual learning styles and other differences, using a range of strategies is likely to be beneficial. Due to the pace of change, the need for creativity in education has never been greater. This is particularly the case in design and technology where creativity should be central. The NACCCE report (DfEE, 1999) gave a much needed boost to creativity in education but there is concern that it will lead to little improvement to practice. If real support for creativity is not forthcoming from government despite the rhetoric, there may be a need for a 'creative resistance movement' in design and technology and perhaps in education in general.

During this chapter, the nature of creativity and its importance have been explored. Some of the ongoing problems that beset creativity in education and design and technology education have emerged. It has been argued that there are areas where more knowledge and attitude change in relation to creativity are needed. Not all teachers realise the importance of creativity to design and technology. Research and curriculum materials resulting from this, are needed to convince, convert and support the doubters. The pressing need to look for improvements in this area was discussed in the Ofsted subject report for 2000/01 (Ofsted, 2002:6):

> The teaching of designing remains weaker than the teaching of making. A particular problem is that the majority of teachers still insist that pupils of all ages record their design ideas on paper before they start making...... This often means that pupils start a piece of work with a negative experience.

One feature of the *spa* is that it avoids the 'particular problem' mentioned above by starting with designing through making, rather than paperwork. Designing through making is important in the *spa* and Ofsted (2002:6) endorses this.

> Primary teachers with a good understanding of D&T often encourage pupils to engage in designing through making.

Perhaps an even more radical departure from the usual approach is that in *spa* the purpose of the product to be designed is decided by the child, not specified by the teacher. The *spa* arguably promotes creativity by allowing individual choice and gives children greater ownership of their work. Barlex (2007:50) writes that:

> A design activity that has personal authenticity requires the pupil to identify a need and is orientated towards clients and markets that he or she can relate to.

This can be difficult to achieve with a 'one brief fits all approach to design and technology. The *spa* could be one way of increasing personal authenticity and what Dineen and Collins (2004:56) describe as ownership and learner motivation:

> An environment which promotes creativity will also encourage learner motivation (and vice versa). Learners become motivated when offered ownership and responsibility, when their input is valued.

This is a positive note on which to end this review. With good teaching, we can stimulate children's creativity and motivate them in the process. Creativity is naturally vibrant in the young children that come to our schools and educators need to nurture it. Research is necessary to help us understand creativity in design and technology and to explore ways of nurturing it. What follows is an attempt to contribute to that process.

CHAPTER 3

METHODOLOGY

The research task

To conduct an examination of the contribution of the starting point approach to primary design and technology.

Research paradigm

The research paradigm used in this study is qualitative in nature and based on interpretative skills and inductive analysis (Mason, 2002). Glesne (1999:8) describes qualitative research as an 'umbrella term for various orientations to interpretivist research'. Parker (1994:3) writes that: 'Qualitative research is part of a debate, not fixed truth'. Denzin and Lincoln (1998:2) describe five different viewpoints on qualitative research. However, it is possible to identify common factors. They offer the generic definition that qualitative research is 'multimethod in focus, involving an interpretive, naturalistic approach to its subject matter' (Denzin and Lincoln, 1988:3). According to Cresswell (1998:14), there is broad agreement that qualitative research is carried out in a natural setting to avoid contrived findings and 'the researcher is an instrument of data collection'. There could be no suggestion that *spa* needed special facilities or conditions if it was to be relevant to the classroom. The approach was developed in school classrooms and is intended for use there. During the data gathering, the children experienced: writing, group discussion, practical work and talking about their work individually. These activities were already familiar to them in their normal school life. There was no need for artificial and intrusive formal testing

(Patton, 1990:132, Honebein et al., 1992:89). The *spa* session was not contrived for the research and would have taken place in any case. The session itself was the researcher's normal practice when working with children. This was important if findings were to be relevant to the researcher's subsequent application and teaching of the *spa*.

Cresswell's definition of qualitative research (Cresswell, 1998) emphasises exploring a human problem and building a complex, holistic picture based on the analysis of words. He writes that qualitative questions often start with how or what, in contrast with the why, associated with a quantitative study. What and how questions predominated in the research which required a 'detailed view' of the *spa*, and for it to be 'explored' (Cresswell, 1998:17). The researcher also met Cresswell's criterion of treating himself as an instrument of data collection. This was a further indicator for a qualitative approach, which suited the researcher's intentions. Taken as a whole, the nature of the research and the data that would result from a *spa* session, clearly indicated a qualitative approach.

The researcher's familiarity with the *spa*

The researcher acknowledges his long association with the *spa*, having first published teaching materials based on it in 1988 (Good, 1988). The research literature indicates that such familiarity has both benefits and risks. Sikes and Potts (2008:39) refer to relevant knowledge and experience gained before research as 'pre-understanding'. They point out that this has advantages: 'The researcher can approach the task with a detailed and rich understanding of the issue being investigated' and that there is the potential for 'a more insightful investigation and exploration'. However, they also write that there is a risk that 'too many assumptions can be made'. While this risk is acknowledged by the researcher, the opportunity to examine any accumulated assumptions was seen as potential benefit. Tindall (1994:143) writes that:

> Connection between the researcher and the research topic is often (traditionally) overlooked. However from the outset qualitative researchers recognize that they are subjectively and centrally engaged with the choice of research topic and the particular questions asked.

The researcher recognised his familiarity with teaching the *spa* from the start. Delamont (2002:46) writes of the need to 'fight familiarity' and that the 'The problem of over-familiarity is a central one in qualitative research'. 'Central features of education are so familiar that they are invisible'. However, Cohen et al. (2000:22) highlight the unavoidability of a degree of subjectivity when they describe the central endeavour of an interpretative paradigm as being 'to understand the subjective world of human experience'. Acknowledging the researcher's familiarity with the approach and repeated and detailed examination of the data were his main defences. The researcher continually explored the 'relationship between the data and emergent findings' (Ritchie and Hampson, 1996:391). Close examination was necessary to give the researcher insight into aspects of the *spa* that might otherwise have been taken for granted or overlooked. Sikes and Potts (2008:40) recommend 'seeking external supervision to provide a challenging other voice' to help realise the benefits of pre-understanding and minimise the potential pitfalls. This was acknowledged and supervision was important to the research undertaken.

The researcher as participant observer

This research was compatible with criteria for participant observation set out by Robson (2002:315) namely that it is used, 'with small groups; for events/ processes that take a reasonably short time; for activities that are accessible to observers, and, when the prime motivation is to find out what is going on'. For the purpose of this study, Robson's advice (2002:317) was followed, 'that the observer is an observer is made clear to the group from the start'. Additionally that:

> the observer then tries to establish close relationships with the members of the group. This stance means that as well as observing through participating in activities, the observer can ask participants to explain various aspects of what is going on.

Gall et al. (2007:647) characterise participant observation as 'the observer's assumption of a meaningful identity in the group being observed'. In this study, the researcher was also the teacher and so was able to comply with the criteria proposed by Acroyd and Hughes (1992:127) whereby they characterise participant observation as 'requiring researchers to involve themselves in the lives of those being studied - looking, listening, enquiring, recording and so on'. They regard participant observation as 'the most well-known observational method' and that there is 'a preference for studying small-scale worlds, small groups of many kinds' (Acroyd and Hughes, 1992:132). The researcher's participant observation gathering took place with just such a group.

Although different forms and degrees of participation are described in the literature (Burns, 2000; Robson, 2002; Yin, 2003; Burton, Brundrett and Jones, 2008), the researcher adopted the role of 'participant-as-observer' advocated by Scott (1996:145). This entailed being open about his purpose and 'seeking to experience...the activities under investigation, be they teaching [or] being taught'. Anderson and Arsenault (1998:156) describe the advantage of this: 'The value added from this perspective is associated with the opportunity to get closer to people in the study and share a common experience'. This helped the researcher to get a close-up view of children engaged in the *spa* and to experience the teacher's role in it.

It is acknowledged that acting as a participant observer during the data gathering had advantages but also potential risks of bias, distortion of judgement or unfair influence (Bell and Opie (2002:233).

In qualitative work, 'the research process acknowledges the uniqueness of the researcher's own involvement' (Payne and Payne, 2004:30). According to Anderson and Arsenault, (1998:134) the risk of bias is inherent in participant observation and qualitative research which:

> accepts the researcher as the main data collection instrument and acknowledges that he or she is attached to a set of 'baggage' that shapes and informs the researcher's opinions, attitudes and ways of looking at phenomena and interpreting findings.

Indeed Robson (2002) writes that 'the notion of the 'researcher-as-instrument; emphasizes the potential for bias'. However, Anderson, Arsenault, (1998:134) give the benefits of this form of research which 'accepts that people know themselves best and can describe, interpret and talk about their own environment' (ibid).

The literature (Bell and Opie, 2002); (Anderson and Arsenault, 1998) alerted the researcher to risks of potential bias associated with being a participant-observer, and this awareness was his first defence. The researcher sought to minimise bias by basing conclusions on close scrutiny of the data whilst acknowledging that complete objectivity is impossible 'as researchers are part of the world they are investigating'

(Cohen et al., 2007:171). This process of reflexivity is acknowledged in the writings of Bell and Opie (2002), Silverman (2004), Cohen et al. (2007) and Sikes and Potts (2008). Robson (2002:551) describes reflexivity as 'researchers reflecting upon their actions and values during the research (e.g. in producing data and writing accounts), and the effects that they may have'. The researcher has sought to be reflexive but recognises that researchers cannot set aside things of which they are not conscious. The researcher sought to minimise any unwarranted effects of his involvement while taking advantage of the benefits.

Reliability, validity and trialling

Cohen et al. (2001:120) write that:

> In qualitative methodologies reliability includes fidelity to real life, context and situation-specificity, authenticity, comprehensiveness, detail, honesty, depth of response and meaningfulness...

The researcher has tried to ensure that these criteria permeate this qualitative study and this is dealt with later when research instruments are discussed individually.

An important factor in promoting reliability was the researcher's use of digital and visual recording of lessons and transcripts. Perakyla's view (2004:285) is shared, that concerns about reliability alone are a reason for working with recordings and transcripts: 'Recordings and transcripts based on them can provide for highly detailed and publicly accessible representations of social interaction'.

Cohen et al. (2000) write that validity exists when the explanation of a particular event or issue can be sustained by the data. This is promoted by using research instruments that measure what they are intended to measure (Gray, 2004). The researcher used his professional experience of the *spa* to devise relevant ways of examining the approach but no infallibility is claimed. It was important that the *spa* process had in effect been 'trialled' informally many times by the researcher and others over some years. This meant that the process to be examined was established prior to registering for the EdD. As a consequence opportunities for development and trialling early in the EdD taught programme within the Mini-project in year 1 and the Preliminary Investigation in year 2 of the programme provided useful preparation for the actual research. The Mini-project was used to trial the warm-up activity with a convenience sample of children as an extra-curricular activity. This was a convenience sample which Cohen et al. (2000:102) describe as involving 'choosing the nearest individuals to serve as respondents'. Robson (2002) writes that there are sensible uses for convenience sampling, they are to do with getting a feeling for the issues.

The researcher's Preliminary Investigation was used to trial the pressure pad activity with Children's University participants. These children were from the same year group and range of schools as those involved in the data gathering a year later. The Children's University trial was particularly valuable as it so closely resembled the conditions for the actual research. Opie (2004:74) emphasises that a study of this kind 'can be viewed as an in-depth study of interactions of a single instance in an enclosed system. The issue of numbers.... is therefore meaningless'. Parakyla (2004) explains that although results may not be generalisable as description of what others do, they can nonetheless be generalisable in terms of what that group of children could do. Ritchie and Lewis (2003) observe that representational and other forms of generalisation can be drawn from qualitative data, whilst cautioning that 'there are however strict limits on what can be generalised'. Glesne (1999:153) writes: 'Qualitative inquirers look to the specific, both to understand it in particular and to understand something of the world in general'. Although she acknowledges that positivists would regard the 'respondent pool' as ' too limited for the development of generalizations,' the researcher agrees with Glesne (ibid) when she writes:

> The particular case you study in qualitative research however, is likely to contribute to an understanding of similar cases, such that going beyond the case in your ruminations will not be farfetched.

Denscombe (2002:150) stresses that the readers of research are not 'passive recipients'. They 'imaginatively transfer the findings to other situations, relying on their own knowledge and values in doing so'. Wellington (2000:99) also makes the point that 'a large part of the onus rests upon the reader'.

Ethical issues - a general statement

The researcher was guided by the British Educational Research Association's guidelines for ethical research (BERA, 2004). Researchers need to be aware of ethical implications for participants and themselves throughout the research progress (Tindall, 1994, Sikes, 2004, Radnor, 2002, Walford, 2001). Schostak's statement (2002:174) is pertinent to this research: 'Issues arise concerning the power of the researcher in relation to that of the research subjects'. The researcher took on the role of teacher, and acknowledged that an unequal power relationship was unavoidable, went to some lengths to ensure that the pupils were not unduly influenced.

Denzin and Lincoln (1998:168) summarise ethical concerns as revolving around key issues of 'harm, consent, deception, privacy, and confidentiality of data'. This is particularly true when the subjects of the research are children and arguably more vulnerable than adults. As an experienced teacher, the researcher was accustomed to taking care of the children in his charge. In light of earlier trialling, ethical problems were not anticipated although the researcher remained alert to their emergence. Delamont (2002:80) cautions us that 'sometimes the researcher discovers that a project has generated ethical dilemmas once it is underway'. In this research children were videoed, photographed and interviewed, however, the parents or carers of those involved had given their informed consent. Gaining children's consent is expanded further in the following section. Sykes (2004:25) reminds us that 'any research that involves people has the potential to cause (usually unintentional) damage'. He asks the reader to subject their methodologies and procedures to the following 'acid test': 'ask yourself how you would personally feel if you or your children or friends were 'researched' by means of them?' This advice was followed, since the researcher's own children were the same age as those involved in the study and he would have been content to agree to their participation. The researcher followed the advice of Cohen et al. (2000:52) by seeking and gaining permission from 'those adults responsible for the prospective subjects'. BERA (2004) and Gray (2004:59) stress the need for giving information about the research 'The key to ethical involvement is not just obtaining consent but informed consent. He suggests that explanation needs be given to 'gatekeepers' – in this case parents and carers, as well as the participants. An explanatory letter (Appendix 7) seeking consent from the responsible adults was sent home with the children prior to any recording. The request included relevant explanations from a list suggested by Gray (2004) and gave information about who would have access to the video and other data. The permission of legal guardians was also necessary to allow the future dissemination and illustration of the research in journals and for teaching purposes.

Children's consent

Ethically, the informed consent from the children as well as their parents was required (BERA, 2004). Some researchers advocate promoting objectivity by hiding the object of interest from subjects or even actively deceiving them. Rose (2001) quite rightly has ethical reservations about this. The researcher was keen to deal openly with the children and in any case, this suited the purpose of the research. In non-data gathering *spa* sessions, children are told that their ideas are of interest to the teacher and this was the case during the research. The reasons for capturing the session on video were also explained. Explaining the nature and purpose of the research on the day before data gathering was important to gaining the children's informed consent. It also allowed discussion with parents and carers. Establishing a trusting relationship with the children was part of the researcher's usual approach to a new class, but it was doubly important in this context. Radnor (2002:34) highlights this:

> The researcher as instrument transacting in the field is qualitatively dependent on the relationships initiated by the researcher with the research participants.

Two Student Ambassador helpers were involved in the *spa* session. The children got to know them during breaks when they led outdoor games. Among the other steps taken to promote psychological safety (p.133), there was a warm-up activity during the day prior to data gathering. This was a *spa* activity involving the children thinking of as many uses as possible for a given object, a bin bag in this case. This gave them positive, pre-data gathering experience of the *spa* and how their ideas would be received by the researcher. Davis (1983) recommends the use of warm-up activities. Shallcross (1981:19) writes extensively about the importance of establishing and maintaining an atmosphere of trust when trying to foster creative thinking. The children's body language showed that the prospect of being involved in the research made them feel important rather than anxious. Further evidence was the general use of the expressions: 'cool' and 'wicked'. It was clear from their demeanour that in all significant respects, the setting quickly became a natural one for them. Their opportunity to play a part in the research was explained on the day before the data gathering so that they had time to talk with their parents. It was made clear to the children that any who wished to avoid involvement in the research could do so without forgoing the activities or other penalty. In practice, all communicated verbally and non-verbally that they were eager to participate. To ensure their privacy, all children's names in this thesis are pseudonyms.

The *spa* process

The *spa* is a staged model which comprises design and technology work based on a common practical starting point but leading to outcomes with different purposes chosen by the children. This distinguishes the *spa* model from those normally used.

Introducing the spa process to the children

Before starting, the children were given an overview of the session. It was seen as important that they knew from the outset that they would be asked for ideas for using the starting point. This enabled subsequent activities to be seen as stimulus and gave maximum time for ideas to incubate. The stages are shown using a pressure pad that was the exemplar starting point used in the research.

Stage 1 - Introduction of the pressure pad

The stimulus/input involved showing the children the starting point for their designing. In the research, this was a pressure pad switch made from card and kitchen foil. The basic concept of a switch was discussed, linking with their work in science. The children were given pages about pressure pads from the researcher's Exciting Electrics book (Good, 1999a:12-13). These were intended as further stimulus and to inform the making process. The characteristics of pressure pads were discussed, for example, that they are thin, take up little space and are tough. The properties of the starting point are intended to provoke ideas that exploit them. The children were told that they would be shown how to make their own working pressure pad, and asked to think of as many uses for it as they could.

Stage 2 - Group brainstorming where pressure pads are used

Next, the children were asked to think of where pressure pads were used in everyday life and their ideas were recorded on a flipchart (Appendix 8a). This was intended to consolidate the concept of a pressure pad and allow existing ideas to provoke new ones.

Stage 3 - Group brainstorming of different ways to make the pressure pad go on

This involved children generating as many ways as possible to make the pressure pad switch go on and was intended to form part of the stimulation of ideas. As in the previous stages, ideas were recorded on a flipchart (Appendix 8b). This stage of the *spa* would be adapted according to the particular starting point.

Stage 4 - Making the pressure pad starting point for their designing

Making and handling the pressure pad was seen as part of the idea generating process. Designing through making is integral to the *spa*. This stage also allowed the teaching of the knowledge skills understanding that all would need. This made diverse outcomes manageable for the teacher as little or no individual input was subsequently required.

Stage 5 - Brainstorming ideas for using their pressure pads

During the final brainstorming, children were encouraged to generate lots of ideas for using pressure pads and these were added to the flipchart (Appendix 8c). These ideas were intended to lead them to design and make individual projects of their choice.

The flipcharts

All three flipcharts were left on display to provide ongoing stimulus and allow ideas to provoke others subsequently.

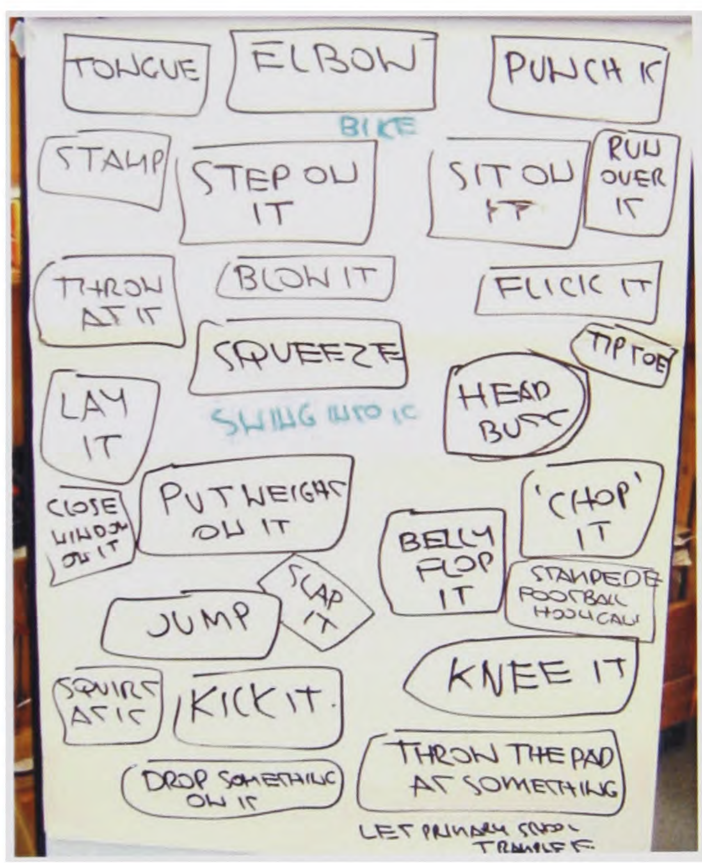

Figure 1 Example of brainstorming flipchart

The research process

Overview

There were two phases to this research.

Phase 1 involved 11 children aged 10-11 years and was intended principally to ascertain whether the *spa* could be operated successfully. The researcher was however, open to other points that might emerge.

Phase 2 considered the data from the session in more detail and additional data were gathered. This was intended to allow detailed examination of what happened when the *spa* was operated.

Data were gathered during a typical *spa* session preceded by a questionnaire and followed immediately by group and individual interviews. Particular attention was given to a focus group of six children within the class so that their reaction to the *spa* could be studied closely. Although this reduced the sample size, on balance it was decided that the benefits of concentrating on a focus group outweighed the drawbacks. Gathering data while the children were working for example, was more feasible with a focus group than trying to spend enough time with every individual in the class. Emphasising the work of a focus group also made the amount of material more manageable, allowing it to be examined more closely. As Perakyla (2004:288) puts it: 'There is a limit to how much data a single researcher or a research team can transcribe and analyse'. The teaching session followed a lesson plan designed by the researcher (Appendix 9) and was part of the Children's University for children from Greenwich.

The setting was the researcher's usual primary design and technology teaching room which was deliberately similar to a primary classroom.

Phase 1

This first phase of the research was intended to establish whether children could follow the approach. A verbatim transcription (Appendix 1) derived from the video recording of the session was studied in greater detail in phase 2. During the analysis process, irrelevant data were excluded. Examples of this included children 'talking outside of the project' (Miles and Hubermann, 1994:11).

Table 1 Research questions and data gathering methods in phase 1

Research Question 1: **Can the children operate the *spa*.**	**Data gathering methods**
1a) Can the children within the study identify the existing uses of pressure pads in the world around them?	Examination of the video and recording all existing uses suggested.
1b) Can the children within the study generate ways to turn pressure pads on in different ways?	Examination the video and identifying all ways to turn on the pressure pad that were suggested.
1c) Can children within the study find possible uses for their pressure pads?	Examination the video and recording possible uses suggested.

The video of the session was repeatedly viewed by the researcher. A transcript taken from the video recording of the brainstorming can be regarded as a primary data source. Other sources of data were: group and individual interviews, Dictaphone recordings of children working and photographs of their finished projects. These were used in the search for emergent patterns in the data. To ensure validity and credibility of the research, multiple data collecting sources and strategies were employed, applying the concept of triangulation (Miles & Hubermann, 1994: 266).

Phase 2

Phase 2 of the research examines what happened during the *spa* process and in so doing gathers data that supports the answering of question 2. The *spa* process was taught by the researcher in a lesson and captured on video, audio and in field notes. The resulting data were analysed to identify emergent themes. Dominant, preconceived questions were avoided to reduce the risk of unanticipated issues being masked, acknowledging the need to be 'open in order to discover' (Basangar and Dodier, 2004:11). The researcher taught the session himself so that he could observe aspects of the process 'from the inside'. This included interacting with the children as they worked and noting things that happened or were said 'off camera'. A Dictaphone captured the design thinking of the focus group as they worked and interacted with the researcher. The risks and benefits of being a participant observer are explored on p.71. The value of what Schön (1982:295) sees as 'a reflective conversation with the situation' central to improving professional practice, was seen as an important aspect of what occurred during the teaching session where the researcher acted as a participant observer. In examining the *spa* process, this study relates events in chronological order and the use of direct quotes from the participants to illustrate the interactions (Gall, Gall and Borg, 2007:482). The researcher gathered data by making a transcript from video and noting selected extracts from an audio recording.

Overview of data gathering in Phase 2

A pre-*spa* session questionnaire was administered. A video recording of the researcher's interaction with the children as a group was made and a verbatim transcription (Appendix 1) was derived from this. Parts of the transcript identified as being of specific interest were transferred to a coding grid for detailed examination (Appendix 10).

When the children were working individually, data were gathered using a Dictaphone in the researcher's shirt pocket to allow unobtrusive capture of the focus group children's talk as they worked. Some field notes were also made during this stage and more immediately after the *spa* teaching session. Scott and Morrison (2007:163) write that 'field notes are key elements of participant observation'. Additional data were gathered in the second phase using the instruments shown below.

Table 2 Research questions and data gathering methods in phase 2

Research questions	Data gathering methods
What was the children's experience of design and technology prior to the *spa* session?	Pre *spa* questionnaires administered to 11 children (Appendix 11) (Table 3). Group and individual interviews, relevant field notes and Dictaphone recording during individual working.
Research task: An examination of the 'Starting Point Approach (*spa*) to Primary Design and Technology	A full transcript (Appendix 1) of the researcher's teaching session derived from the video. Material from this was transposed onto a grid. (Appendix 10) for coding and analysis.
	Field notes and Dictaphone recording made during individual working.
	Digital pictures of the brainstorming flipcharts
	Digital pictures of artefacts (the products designed and made by the children)
	Group and individual interviews
	Further examination of video (including transcript) of the children engaged in *spa*.

The pre-*spa* questionnaire

The questionnaire (Appendix 11) was administered to the whole class before the *spa* activity. The children were from different schools and the researcher met them on the day before the data gathering session. As well as providing data about their pre-*spa* experience and attitudes to the subject, their responses informed the teaching of the class. The size of the sample allowed a more open and word-based the questionnaire than would have been feasible otherwise (Cohen et al., 2000:247). Since eleven children were involved, such a questionnaire could be used to 'capture the specificity of the situation' (Cohen et al., 2000:248). The questionnaire allowed for the potentially wide range of responses. The post-*spa* interview of the focus group was based on the same questions. This allowed the researcher to invite the children to elaborate on their written responses and provided an element of triangulation (Cresswell, 1998).

Table 3 Pre-*spa* session questionnaire (space for responses removed)

1. Are you a boy or girl?
2. The *best* thing about DT at school is...
3. Is there anything you don't like about DT at school?
4. Write a list of the things *you have made* in DT
5. Do you all have to make the same sort of thing in DT (e.g. slippers, puppets)?
6. Does your teacher help you to have ideas for your project in DT?
7. If yes, say how they help you
8. Do you always have to do drawings before you start making y projects?
9. Would you like to start making first and design as you go along?

Thanks for your help

Administering the questionnaire

As the children's reading and comprehension levels were unknown to the researcher, it was decided to read and if necessary explain questions before each was answered. Talking the children through the questions was also intended to keep them on task and maintain momentum. Starting with purely written work could also have had a negative effect on enthusiasm for the session. Talking through, also made the task seem less like a test and so supported psychological safety. Any queries were dealt with before moving on to the next question to help ensure the validity of the responses. The questionnaire was completed anonymously so that children could respond freely. Although this prevented any follow up, it also avoided any anxiety about whether comments would get back to their teacher. This mattered from an ethical viewpoint and also encouraged the truthful responses needed for the research.

The recording of the *spa* teaching session

Video recording played an important part in this research by enabling the *spa* process to be captured then repeatedly viewed and analysed later. Gray (2004:326) writes that 'In addition to text, photographs or other visual data such as video or film recording are also sources of qualitative data'. Silverman (2004:279) supports the use of video and 'the unprecedented access' that it gives to the 'audible and visual elements of in situ human conduct'. Video recording with good quality sound, was the principle data gathering method used in both phases of this research. Sharman, Cross and Vennis (2004:73) support the researcher's enthusiasm for the use of audio and video recording: 'They enable you to record longer periods in detail and you can repeatedly play them back in order to make your evaluation'. Some writers such as Glesne (1999:79) regard an audio record is fully sufficient for most purposes. A Dictaphone did provide audio recording during practical work when the children and researcher were moving around the room outside the range of the camera's microphone. Opie (2004:123) also supports the merits of tape recording and writes that 'the transcripts can be used to provide a check against bias or misinterpretation'. As far as video recording is concerned, he acknowledges that it has potential in helping to 'make sense of non-verbal activity'.

The researcher's experience during this data gathering leads him to the view that Opie makes too much of 'technical difficulties' of video such as focusing and ensuring good sound quality. Opie's opinion that video recording is 'more troublesome and time consuming than it is worth' was not borne out during this research. Perakyla (2004:288) advises care when he stresses that the 'technical quality of the recordings is a decisive issue,' since there is no way of recovering what is lost. The researcher overcame the potential problems of video by using a wide angle lens and a camera with an external microphone. The latter, recommended by Gray (2004), was crucial to good sound quality. This facilitated the making of transcripts. One benefit of concentrating on a focus group was that a microphone could be taped to the table where the children's contributions were made. The researcher decided that audio was insufficient for capturing the brainstorming, as previous *spa* sessions had often involved gestures to help explain ideas and objects had been shown. Walford (2001:94) highlights the limitation of audio recording: 'a tape recording only records the audio part of the conversation. It is often necessary to be able to see what is going on to interpret the words'. Video was a great help in capturing the idea generating sessions, not least because it made it easy to identify speakers. This was not a problem when working with individuals, when the advantages of the Dictaphone, outweighed its disadvantages. The video camera also had advantages and as these are now commonplace in the home and school, it was unlikely to distract. (Aldridge and Wood, 1998). However, as a precaution, the camera was also in place when the children were present on the day before the data gathering session. This was to ensure that the camera was not a novelty during the actual *spa* recording. The equipment was trialled in situ well before the data gathering. The reasons for video recording were fully explained to them. In the recorded session, non-verbal material included: the researcher showing the starting point to the children and explaining how it worked by demonstration. He also used gesture and writing on the flipchart. This is in addition to the non-verbal data that would have occurred in any non-*spa* lesson. Cohen et al. (2000:281) agree that 'it is frequently the non-verbal communication that gives more information than the verbal communication'. Had audio recording only been used, observation and field notes might have compensated to some extent. However, the researcher would have been too involved in teaching to do this adequately. Glesne (1998:57) points out the advantages of video recording:

> The density of data collected with videotape is greater than that of human observation or audio recording, and the nature of the record is permanent, in that it is possible to return to the observation repeatedly.

As well as facilitating study of the children, video offered a unique way for the researcher to observe himself teaching. It is accepted that the density of data did make it time-consuming to analyse, especially because of the need to repeatedly revisit the recording. Freebody (2003:77) emphasises the importance of this:

> Repeated viewing/listening through video - and audio taping, cross checking...are strategies used to improve the clarity and consistency of the explanatory concepts, so that they can be installed more confidently in the research account.

The video did indeed allow some beneficial repeated checking by the researcher. This was accepted as necessary and the limited duration of the *spa* session recording helped to make it feasible.

The transcript from the video

A transcript made from video recording (Appendix 1) was used to capture data for phases 1 and 2 of the research. Red and black fonts were used to identify the words of the children and the researcher respectively. Colour coding was used for immediacy of identification and to avoid the distraction of labelling.

Writers on research methods caution their readers to take care at the point of transcription. Cohen et al. (2000:281) describe it as 'a crucial step, for there is the potential for massive data loss, distortion and the reduction of complexity'. The use of video helped to ensure the accuracy of the transcript. As well allowing repeated viewing and listening, the visual element supported interpretation. First, a complete transcription of words from the video of the *spa* session was made. This put the dialogue into more tangible form, facilitating subsequent scanning, analysis and citation. Cohen et al. (2000:299) support the need for a text. 'Discourse analysis requires careful reading and interpretation of textual material, with interpretation being supported by the linguistic evidence'. Silverman (2004:201) points out that defining the term discourse analysis is 'tricky' because it is 'changing rather quickly'. Ritchie and Lewis (2003:200) emphasise a concern 'with the way knowledge is produced within a particular discourse' and the identification of 'key themes, concepts or categories', in this research the children's ideas were paramount.

The coding grid

The three brainstorming sessions in the transcript were transferred to a coding grid (Appendix 10) for more fine grained analysis in phase 2. The researcher found the grid to be a useful tool for identifying different aspects of what took place and allowing each 'item of speech' to be considered in detail. Irrelevant text from the transcript, such as children talking off task, was not transferred to the grid. The full context for the grid data can be seen on the transcript (Appendix 1). The dialogue was divided into 'items of speech'. A division was normally made when the speaker changed; much like the script for a play. Divisions were also made when there was a significant change of topic. More than one person speaking at a time was not a problem in practice. The children were accustomed to taking turns and putting their hands up to answer.

Table 4 Sample of the coding grid (Codes explained in Table 5)

Transcript from video	Cats.	Actions	Commentary
148. Yeah. OK so that's given us a few examples of where they're used ehm... now, now what we are going to do now is think about ways of turning the thing on.	inf		Drawing first brainstorming to a close. Experienced practitioner needs to judge this according to the reduction in the flow of ideas. Repetition of previous ideas would be another indication.
149. Alright, now obviously I can press it with my thumb. How else can I turn this thing on? Let's have hands up. I can press it with my thumb.	inf Qf inf	Pressing the pad is shown to reinforce the words.	This is to reinforce the explanation of what Is required.
150. Now as many ways as possible of	Qf		Quantity of ideas is stressed at this point to overcome inhibitions and to try to start the flow if ideas. Momentum seems to help.
151. Step on it.	repl		Idea 1
152. Yeah good. Yeah good. Ritchie	eval inf		Encouraging, promoting psychological safety so that others will respond also.
153. Sit on it	repl		Idea 2

A particular advantage of the grid for line-by-line analysis, was that it allowed speech to be coded and categorised. Assigning codes to various aspects of the discourse helped to 'simplify and standardize the data for analytical purposes' (Blaxter, Hughes and

Tight, 2006:203). Significant non-verbal features observed on the video could be added next to any accompanying speech. This gave a more complete picture than words alone, Cohen et al. (2000:282) write that 'it is often inadequate to transcribe only spoken words; other data are important'. They do point out that as soon as such data is noted, whether a pause is long or short or whether the speaker was happy for example, becomes a matter for interpretation. The researcher did return to the video to check that his interpretation was appropriate. In this way, the text and the video were complementary.

Although actions and other non-verbal data were noted, much of what was collected was in the form of discourse. Ritchie and Lewis (2003:200) describe discourse analysis as being 'concerned with the way knowledge is produced in a particular discourse'. Its focus on 'what is going on in an interaction' (ibid) suited the researcher's examination of the *spa* interaction. Cohen et al (2000:298) support this when they write of the discourse researcher's exploration of 'ordinary talk and everyday explanations and the social actions performed in them'. They emphasise that discourse analysis 'requires a careful reading and interpretation of textual material, and interpretation being supported by the linguistic evidence'. More than just a way to present the data, the grid also served as an analytic tool. Next to each significant item of speech a cell was provided for recording the analysis. These notes accumulated to give a detailed commentary on the brainstorming sessions.

Codes within the grid

The grid pro forma facilitated coding of the data so that themes emerging during the stages of the *spa* could be more readily identified. Different coloured fonts or highlighting were used for each of the categories. This was intended to facilitate tallying, make it easier to get an overview, and help the researcher to see any patterns that might emerge.

Table 5 Key to Codes for interaction: phase 2

red text in dialogue box - *child's speech*

black text - *researcher's speech*

Individual capital letters indicate individual children

inf	information - *usually imparted by the researcher*
Qs	shooting question- (De Bono, 2004: 79) *closed question where there are a limited number or single answer- known to the questioner*
Qf	fishing question - (De Bono, 2004:78) *an open-ended question and where the questioner does not know what answer will be given*
eval	evaluation - *comment on an idea*
met	metacognition - the *coaching of thinking skills by the researcher*
elab	elaboration - *asking for further information*
dir	directing- *telling the children what to do e.g. 'hands up'*
mod	modelling- *the modelling of desirable behaviour by the researcher*
rep	reply- *reply to a previous question or comment- not including an idea*
repI	reply with idea - *a reply from a child that includes an idea*

Cohen et al. (2000:299) write that coding 'enables the researcher to discover patterns and broad areas in the discourse'. 'With this achieved the researcher can then re-examine the text in order to discover intentions, functions and consequences of the discourse'. The occurrence of the different categories in each of the brainstorming sessions were tallied and transferred to a table (Table 9) then graphs (Figures 3-6) for ease of examination. This data and the themes emerging from it, contribute to the discussion.

Individual interviews

These interviews took place after the *spa* session and intended to allow children to talk about their own work without interruption from other children. As the interviews were unstructured, other issues, such their experience in school, sometimes emerged. Selected data from these interviews is presented and considered where it best contributes to the findings. It was acknowledged from the start that the researcher would not be passive during the interviewing. Holstein and Gubrium (2004:141) write that 'interviewers are deeply and unavoidably implicated in creating meanings that ostensibly reside within respondents'. Denzin and Lincoln (1998) point out that qualitative research is concerned with the individual's point of view and argue that it can get closer to the actor's perspective than more remote, quantitative methods. The researcher was aware that being interviewed alone might put pressure on individuals and was concerned to minimize this. Several precautions were taken for ethical reasons and to avoid unreliable 'forced' data:

- Interviews were with the focus group who had already had more contact with the researcher than the rest of the class.
- Interviews were conducted as late as possible in the Children's University period to maximise familiarity with the researcher. Aldridge and Wood (1998) stress the importance of building an effective rapport.

- Sensitive, personal issues were not involved.
- The children were asked to tell the researcher about the project they were holding as an 'ice breaker'.
- Interviews were kept short and concluded when child's demeanour suggested that they wanted to say no more. Aldridge and Wood (1998:36) point out that 'the child will be unused to talking for a length of time to a relative stranger'.

Group interview

The group interview was also conducted after the *spa* session. This allowed the children's reaction to the *spa* to be explored. Cohen et al. (2000:287) point out that there are practical as well as organisational and other advantages to the group approach:

i) Group interviews are often quicker than individual interviews and hence are timesaving and involve minimal disruption.

ii) Group interviews of children might also be less intimidating for them than individual interviews.

Gray (2004:230) writes that one result of group interviewing is that 'the chance of non-response is reduced to about zero' Gray does point out the potential risk that the 'social nature of responding may have an influence'. In practice, personal issues were not involved and the group talked freely. One contribution often provoked another. Delamont (2002:128) writes that school ethnographers have often used group interviews with children because they 'encourage them to reminisce, share experiences and even 'egg each other on'.' The researcher found this to be the case. The advantages of group interviewing include the potential for discussions to develop, providing a wide range of responses. The researcher took the points made by Cohen et al. (2000:287) into consideration:

> Group interviews require skilful chairing and attention to the physical layout of the room so that everyone can see everyone. Group size is also an issue; too few and it can put pressure on individuals, too large and the group fragments and loses focus.

The children were seated around a table and already accustomed to the researcher chairing their discussions during the *spa* session earlier. The interview was semi-structured and based on the pre-*spa* questionnaire (Appendix 11). This gave a more rounded view of issues raised in the questionnaire. As Cohen et al. (2000:147) put it: 'this enabled participants to pursue issues and matters that might not have been included in a pre-devised schedule'. The semi-structured questions provided stimulus for the children's thinking and helped to ensure that the researcher gained the data required.

CHAPTER 4

DATA PRESENTATION, FINDINGS AND DISCUSSION

1. Results and Discussion of Phase 1

Data from the Teaching Session

The findings in phase 1 of the research resulted from a *spa* lesson taught to a class of year 6 children at the University of Greenwich. The main purpose of this phase was to find out whether the children could follow the *spa* process. Questions 1a, 1b and 1c were key to ascertaining that.

Research question 1a

Can the children in the study group find existing uses for the starting point in the world around them?

Phase 1- Question 1a- Existing uses for the starting point identified by the children.
The children gave the following examples:

1. *cash point machines*
2. *light switch*
3. *mobile phone*
4. *television remote control*

Data abstracted from the video transcript

Discussion

These results show that the children were able to identify existing uses for the starting point in their normal environment. This is evident for example in references to the cash point machines and the television remote control. It is acknowledged that the mobile phone example featured in the researcher's introduction (line 25 of the transcript). However, the children were obviously familiar with these 'user interfaces' which were commonplace in their everyday lives. They were able to transfer the concept and function of cardboard pressure pad they were shown, to real world pressure pad applications. To do this they had to have grasped the pressure pad concept. This was important, as understanding of the starting point and its properties was intended to stimulate subsequent designing. Making the pressure pad reinforced understanding gained from the researcher's demonstration and explanation. De Bono (2004:109) writes that: 'One of the main values of identifying a concept is that this allows us to breed other ideas from the concept'. In the gathering session, the children were very much encouraged to 'breed' ideas from the starting point concept.

Modern technology often presents as sealed units or 'black boxes'. This part of the *spa* helped to make a common piece of technology transparent and understandable to the children. Their understanding of the technological world around them was increased. This stage of *spa* went some way to addressing the key stage 2 programme of study requirement that pupils should be taught knowledge through 'investigating and evaluating a range of familiar products' (DfEE,QCA, 2004:19).

Research question 1b

Can the children in the study group generate a wide range of ideas for turning the pressure pad on in different ways?

Phase 1- Question 2 – The children's ideas for turning the pressure pad on

When asked to think of different ways to turn pressure pad switch on, the children identified the following ideas in total:

1. *step on it*
2. *sit on it*
3. *squeeze it*
4. *pinch it*
5. *head butt it*
6. *put some weight on it*
7. *belly flop on it*
8. *elbow it*
9. *punch it*
10. *touch it with your tongue*
11. *fart on it [sic]*
12. *flick it*
13. *kneel on it*
14. *kick it*
15. *throw the pressure pad against the wall*
16. *blow on it*
17. *stamp on it*
18. *drop something on it*
19. *put some water on it (meaning squirt water on it)*
20. *slap it*
21. *run over it*
22. *tiptoe on it*
23. *close the window on it*
24. *lay on it*

Data abstracted from the video transcript.

These were added to the flipchart and some acted out by the researcher to repeat and reinforce the suggestions.

Discussion

The children were able to generate a wide range ways to turn the pressure pad on. The rich variety of ideas is evidence that the children felt free to brainstorm and express ideas in these sessions. Their ideas did not depend on knowledge gained prior to the session, as this was a new challenge for them. The ideas were their imaginative response to the provocation of the researcher's input. By generating twenty four different ways to turn the switch on, they were already demonstrating creativity.

This quantity and variety of ideas was important because it provided a fertile basis for generating ideas for using the pressure pad. Some unusual or less obvious ideas came up for example: throw the actual pressure pad against the wall, shows an interesting reversal of the normal pressing or throwing things at the switch. This child has spontaneously used a recognised strategy for generating innovative ideas. Michalko (2001:175) devotes a chapter to reversal as a deliberate strategy in his text on idea generation. 'Reversal breaks your existing patterns of thought and provoke new ones. You take things as they are and turn them around.'.

During Brainstorming 2, it was striking how quickly the children suggested ideas for making the pad go on. At times, the researcher gave up recording on the flipchart to avoid interrupting the momentum and flow of ideas generated by the children. The videoing meant that no ideas were lost. The brevity of contributions in this sample, only partly conveys the pace and energy involved:

150. What else can I do? Now as many ways as possible of turning this on yeah.

151. Step on it.

152. Yeah good. Yeah good. Ritchie

153. Sit on it.

154. Yeah good anymore?

155. Squeeze it .

156. Yeah good. Go on...

157. Pinch it.

158. Pinch it is a bit like squeezing it. Alright, anymore? Sorry Sorry go on.

159. Head butt it.

160. Yeah good. Yeah head butt it. Any others? Yeah go on the

161. Use a remote control or is that the same thing as squeeze it

162. Use a remote control what would you do throw the remote control at it?

163. No, isn't it...

164. Sorry we're now thinking of ways of turning it on...yeah

165. We reckon you could put some weight on it

166. Yeah yeah good that's good

167. Belly flop it

168. Yeah yeah belly flop it well I've never had that one before

169. Good idea

170. Why not? Yeah go on

171. Elbow it

172. Yeah yeah good we've got lots already. Doing well. Do you notice that once you get started it gets easier? Go on then

173. Punch it

174. Punch it yeah. Go on then there's still more

175. Touch it with your tongue

176. Yeah, press it with your tongue. Yeah it's possible isn't it. Now the reason we do this is any one of these might give us an idea for a project yeah. Go on then Zoe yes good – why not. Good we're doing well here. Go on then.

This sample indicates the rapid flow of ideas as well as showing the ideas themselves. Cowley (2004:60) writes that pace in itself plays a part in idea generation, and advocates working 'fast and furious':

> This helps prevent the brain from intervening and editing out any thoughts that do not seem to be relevant. By doing this you help your children to include some of the more interesting thoughts that might occur to them, but which they might feel are irrelevant and not write down.

Although Cowley is describing written idea generation, the salient point is the benefit of speed. The benefits of gestation time (Fisher, 2004) are addressed later but encouraging or maintaining momentum at the brainstorming stage in future *spa* sessions appears to be important..

Research question 1c

Can the children in the study group find possible uses for the pressure pad switch?

Applications for the pressure pad switch identified by the children

The children identified the following possible uses for the pressure pad in total:

1. *control a remote control car*
2. *under the door mat to turn on a tape recorder to scare people at a Halloween*
3. *stand a glass on the pressure pad to keep a night light on if you're scared in the dark. You could easily find your drink and you could use it as a light to help you read*
4. *an automatic door bell that no one would need to ring it and you'd know people were there... hide it under the mat*
5. *put a weight on it and it'd give you light to work in the garden at night ...use the light as a signal, they used it in the war and out at sea*
6. *a car goes over it and the bulb come on instead of speed cameras*
7. *use it to tell which model car has won as they roll down a slope*
8. *a game for children... like a play mat*
9. *when they stop a lorry, they might want the light on. When the car goes quiet.*
10. *if the driver was really tired there could be a buzzer to wake him when he drops off*
11. *a different burglar alarm so that if he comes in the window and the window shuts the buzzer would go on*
12. *when burglars put their hand in the letter box and try and push the door then when the letter box shuts the thing would go off*
13. *detecting when a dog gets out of its basket when it has been told to stay in.*

Data abstracted from the video transcript.

Discussion

The thirteen examples shown above and the transcript of the *spa* session (Appendix 1) demonstrate that the children were able to combine the function and concept of a pressure pad and various ways to close the circuit. The children's ideas can be regarded as innovative applications of the pressure pad concept. This reflects the characterisation of technology as human innovation in action (ITEA, 2000). It is important to notice that the ideas are practicable and could be a basis for actual design and technology projects. These could that lead in turn to many different designs. One child who made an impractical suggestion at line 206, was immediately corrected by another member of the group at line 208 who knew that pressure was needed.

> 206. Could you shine a light on it?
>
> 207. Sorry sorry, you were out of the room
>
> 208. It's a pressure pad

Making an apparently impractical idea feasible can be an opportunity to be creative, although it was not possible in this case. The children were encouraged not to dismiss ideas too readily. They went on to explore their basic concepts through modelling and discussion. This resulted in some being made into finished artefacts. The bringing together of a dog and the pressure pad (idea 13) and a drink and the pressure pad (idea 3) are examples of combinational creativity. Michalko (2001) devotes a chapter in his book on idea generating strategies to creating new ideas by making such novel combinations. Brown (1997:37) argues that 'creativity is not an accumulation of elements into more complex aggregates'. He writes that parts are unchanged by their recombination and that 'one might as well have a rockpile that is rearranged by an earthquake'. However, the rockpile would be a random arrangement of no value.

Components or ideas put together in a novel way that has value on the other hand, could be described as creative. The rockpile would also fail to qualify because it also lacks the deliberation normally required by the term. Industrial designers often combine things in new ways to create new and valuable products. Dyson (1997) tells how his innovative vacuum cleaner resulted from combining the existing the vacuum cleaner with the dust extracting cyclone used in wood mills. Bayliss (2000) describes how he combined clockwork with the radio to enable health information to reach people where batteries were too expensive or unavailable. The girl in this research who combined a drink with a pressure pad to create a new nightlight (Figure 7.5) was creative in a similar way, albeit at a lower level. Karlqvist (1997:105) asserts that that 'creativity is the capacity to create new things'. Newness, along with the criteria of intention and value is highly appropriate in the field of design and technology. The new nightlight meets Karlqvist's criteria of intention and value; to the girl at least. Karlqvist (1997:111) also writes that 'Many creative acts are the result of surprising combinations of knowledge from different domains'. The girl combined her knowledge of an existing situation with her knowledge and experience of the pressure pad. This idea illustrates the importance of understanding the context and rationale for a *spa* idea before it can be evaluated or properly understood. There is a need to ask children to explain the context for their *spa* project ideas if teachers are to really appreciate them. Ideas could otherwise be dismissed by an adult who does not share the child's perspective or experience. The children's ideas were often a response to personal experience or interests. It is of course also valid for children to design products needed by others. The National Curriculum for Design and Technology (DFES, QCA, 2004) at key stage 2 requires that pupils 'generate ideas for products after thinking about who will use them'. When examining existing products, they have to think about 'the views of the people who use them,' not just themselves. Some examples of ideas for products to be used by others that occurred in the *spa* session are:

6. a car goes over it and the bulb come on instead of speed cameras

9. when they stop a lorry, they might want the light on. When the car goes quiet

10. if the driver was really tired, there could be a buzzer to wake him when he drops off

These examples illustrate that designing for others sometimes occurs spontaneously in the *spa*. A class or individual could always be encouraged or required to design for others if necessary. This would still be in keeping with the *spa*.

Phase 2

The children's experience and understanding of design and technology and their attitudes to it

Sources of data were the pre-*spa* questionnaire, Dictaphone recording, field notes, and post-*spa* group and individual interviews. The questionnaire was the principle data source but the headings are also used to present data from other sources when relevant. This adds to the quantity and richness of the data and helps to give a more rounded picture than the questionnaire data alone. These data taken together, gave an insight into the experience and understanding that the children brought to the data gathering. No broader claim or generalisation is intended.

Introduction to the pre-spa questionnaire

The questionnaire (Table 3) (Appendix 11) was administered to the children to give an insight into their experience and understanding of design and technology before the *spa* session. The class provided 11 respondents. The data in this small sample are not intended to represent the views of children in general. However, the data did help to familiarise the researcher with where these children 'were' in design and technology terms. From a teaching point of view, this meant the researcher knew what knowledge, view, it skills and understanding the children had been exposed to. From a research point of view, it gave information such as what previous approaches they had experienced. The group interview included the same questions to allow the children to elaborate on their written responses and to provide some degree of triangulation (Cresswell, 1998).

Question 1- ***Are you a boy or a girl?***

This question was intended to be an easy introduction to the questionnaire. It allowed the researcher to determine whether gender was significant in subsequent responses. Analysis showed that the children's responses did not divide by gender and this was not deemed significant to the research.

Question 2 ***-The best thing about DT at school is...***

The following responses reflected the popularity of practical work:

'Cutting out and sticking things'.

'Making things with tools'.

Encouragingly one child wrote:

'Making new things that we have never heard of'.

Making featured again when the question was put during the group interview.

518. It gives you the opportunity to make things and to get better at making things.

Only two questionnaire responses specifically mentioned designing. Designing was however, represented in the group interview. Several children assented non-verbally to the following:

439. (Researcher) Right OK so what would you say the best thing about DT at school is?

440. The designing.

Question 3 - ***Is there anything you don't like about DT at school?***

Eight of the eleven children either replied that there was nothing they did not like or left this blank, which was taken to mean the same thing. This indicated the popularity of design and technology with the children. There were three highly individual responses. One child wrote:

'I don't like getting glue on my hands'.

Another response also defies analysis:

' I don't like bending wire'.

The following is from the group interview

520. Well once I was doing DT and I was decorating so what I did I swallowed a sequin.

These unlikely responses remind us that researchers sometimes get data that are difficult to anticipate or explain.

Question 4 - ***Write a list of things you have made in DT***

The children's responses confirmed that like the majority of schools (DATA, 2005), theirs were largely following the Qualifications and Curriculum scheme (QCA, 1998). Eight of the ten projects mentioned were from the scheme. The following responses are among those providing evidence this: 'We made little cars that are battery operated'. This was a reference to the QCA Unit 6D: 'Controllable vehicles'. Another response was: 'We did puppet shows'. This class would have been working on QCA Unit 2B: 'Puppets'. 'We made little houses', was a reference to the QCA Unit 1D 'Homes'.

The same question was discussed in the group interview when there was almost universal non-verbal assent when the researcher to listed examples of QCA Units. There was also the following interjection that relates to QCA Unit 2A: Vehicles:

> 444. It's just there is a list of about twenty [projects] that a lot of schools are using – there's puppets, travelling cars....
>
> 445. Yeah we did toy cars in year two.

The children's responses were evidence that the *spa* was a new experience for them. They also indicated that their previous the design and technology projects were largely chosen by their teachers. There is further evidence for this in the responses to the next question. With this in mind, these words by Howe, Davies and Ritchie (2001:127) ring a little hollow:

> The real-life scenarios and joint decision-taking potential within design and technology activity can provide just the starting points that children need to gain a sense of democratic participation, for example, in establishing shared safety rules or voting on the name of a product to improve life for a member of the local community. Design and technology is not about accepting what really exists.

The extract was from their significantly titled book: 'Primary Design and Technology for the Future' and the chapter: 'Why Citizenship'. The researcher argues that the individual choice in the *spa* session enhanced the democratic participation of the children.

Question 5 - *Do you all have to make the same thing in DT?*

Ten of the eleven children said that they all had to make the 'same sort of thing'. The remaining child could not remember what they had done. This is understandable when one considers that their most recent design and technology may have been some time in the past. In this extract from the group interview, Libby provides evidence of the teacher deciding on projects for the children.

> 472. Right so how do the people inside the class know what to make though?
>
> 473. By the teacher.

Only Conrad provides evidence that his teacher runs more than one project in the class at the same time. The projects described are: QCA Units 6A, 6B and 2B respectively. The children still had no choice of project and the purpose of each was defined for them.

> 499. Yeah our class like sometimes we split up into three groups and like one does shelters and one does slippers and the other does puppet.

At the end of Denny's individual interview, the conversation turned to his previous experience of design and technology at school. In the following extract, he has just described the projects done by his class and the researcher is summarising and checking his own interpretation:

> Right, but you all basically do the same thing?
>
> Yeah
>
> Right so you would all do slippers or whatever but they would be for the same use? [Denny confirms with a gesture captured on the video] Right, because yours is the only stick ball – the only project idea like this in the group here. OK so do you like having the choice like that?
>
> Yeah

In this extract from the group interview, Libby does mention being allowed to choose sometimes. However, the degree of choice is not specified and she clearly feels that her teacher's direction predominates.

> 501. Sometimes we are allowed to choose our own projects sometimes in my class but most of the time our teacher says OK class bla bla bla and now we are going to build a....and all of you got to do it.

Libby returned to this theme in her individual interview.

> Ehm at school I had to make a little car that I didn't want.

Responses to this question further confirmed that the children were used to working on projects with a common purpose. Question 5 developed into a comparison of the QCA approach and the *spa* in the group interview. Ritchie's comment on the choice afforded by the *spa* is significant, if not conventionally coherent.

> 505. Yeah, Yeah this way [*spa*] is better because like you don't have to copy from the paper. And you don't get the teachers saying you gotta do it this way and it's all gotta be that way.

506. See but I do that, I tell you exactly what to do but then I stop telling you and then let you have a free choice.

507 Yeah because with this whenever we got no choices then sometimes we have to do what we don't want and so if we've got lots of choices if we don't like that thing we could do another thing.

Being able to choose the purpose of their projects was commented on during some individual interviews. Jenny said:

It was fun choosing for myself. I needed a night light.

Denny commented:

My teacher wouldn't have let me make a rock home.

Responses to this question also confirmed that the *spa* way of working was new to all the children.

Question 6 - ***Does your teacher help you to have ideas for your project in DT?***

This produced a mixed response. Five of the eleven children felt that their teachers 'did not help them to have ideas' for their projects (question 6). This does not necessarily mean that the teachers did not help or were not trying to do so. The teacher's efforts may not have been recognised as help by the children. However, given the importance of idea generation in design and technology, these responses are a cause for concern. Six of the children however, said their teacher did help, see question 7. The group interview revealed that one child interpreted being helped to have ideas as synonymous with being given instructions. The next exchange followed the researcher asking the children if their teachers helped them to have ideas:

446. What I'm saying is does your teacher help you to have ideas for your project in DT ?

447. Yes, sometimes.

448. Yes does that mean that sometimes she doesn't?

449. No like sometimes like she helps us with ideas like when she puts up a project or a question that's really hard. Like when we were making our electric toy cars, she'll give us ideas how to make it.

Being given information and being given design ideas are confused. Later, the interview situation allowed the researcher to refine the question by separating these.

450. Oh yeah so like making things. Now I'm not thinking of them helping you to make the thing, I'm wondering does she help you to get the ideas for your project? Do you know what I mean?

451. Yeah yeah.

This clarification helped the children with the next question during the group interview.

Question 7- ***If yes, say how***

This question asked children who said that their teacher did help them to have ideas, to explain how they did so. This question had the potential to reveal previous experience of idea generating strategies. It also had the potential to reveal the extent to which teachers would provide an idea, rather than stimulate the children's own. Some affirmative responses are open to different interpretations.

'If you're stuck they will give an idea to you'.

'By helping us with their ideas,'

'Giving us different ideas'

'By making our ideas better'.

The worst interpretation from a creativity perspective, is that their teachers simply provided ideas. More optimistically, it could be taken to mean that they stimulated the children's own ideas. Other responses more clearly indicate that teachers are trying to develop the children's ideas. One child wrote that the teacher helped 'By making our ideas better'. Another wrote: 'They give me clues sometimes'. 'They give us a subject to concentrate on'. These responses are however, open to different to interpretations. The teachers could be providing stimulus for the children's own ideas. More disturbingly, the responses could mean that the children are being required to work out the idea that the teacher has in mind. This extract from the group interview is evidence that Libby's teacher involves her class in a deliberate strategy for idea generation.

> 455. Yeah we have our mind map book in our class but whenever .... Build a balloon buggy or something or we have to build something just or we have to build something like ....what type and how to do it we mindmap all our ideas.
>
> 456. I know what a mind map is but does everyone? Can you tell the others?
>
> 457. Like when you just have to put things like when you're brainstorming and put things in circles.
>
> 458. Circles then Right then so how many peoples teachers uses this sort of brainstorming sort of thing - everybody.
>
> 459. It's to squeeze things out. It's to squeeze things out of your brain.

At line 456, the rest of the children gave an ambivalent, non-verbal response to the researcher's first question. Once the concept was explained however, many of them acknowledged that they had some experience of mind maps. Note the child's evocative description of the purpose of mind mapping at line 458 as being 'to squeeze things out'. Buzan, (1995:154) who claims Mind Map as a registered trade mark, writes:

> The Mind Map is ideally suited to creative thinking because it utilises all the skills commonly associated with creativity, especially imagination, association of ideas and flexibility.

Like the brainstorming in the *spa* session, this is 'an organised brainstorming method' (Michalko, 2001:55). Brainstorming can be unstructured but Eastaway (2007:115) also sees benefits in some organisation: 'You need to structure the session, otherwise people will get muddled'. Another similar method is indicated by this child's comment:

465. Yeah and another word that we use we use an inspirogram.

The children's familiarity with mind maps and similar approaches in school was some preparation for their brainstorming in the *spa* session. In terms of promoting psychological safety, this familiarity meant that there was one less new thing for the children to deal with.

Question 8 - ***Do you always have to do drawings before you start making?***

Eight of the eleven children wrote that they always had to draw before they could start making. The inevitability of starting with drawing attracts criticism from Hope (2006:52):

> Drawing is a powerful means of modelling ideas. It is not, however, an essential part of every design and technology project, nor is it always the best way to start.

Ritchie supports this view (2001:67).

> While many designers do produce drawings, there is more to effective design than the working drawing. Indeed, asking young children to draw something before they make it may inhibit their designerly behaviours.

Drawing and designing are sometimes seen as synonymous by some teachers who know little of other methods. Yet Ofsted (2004/2005) emphasised that in schools where design and technology had become good, pupils designing were not restricted to producing drawings in advance of making. Primary design and technology subject leaders interviewed by Cross (2006:36) revealed a disappointment with the drawing that they had required.

> They referred to the teaching of design only if prompted. A common point was the frustration they felt when pupils designed something on paper and proceeded to make a model bearing little or no resemblance to the design.

In this case, the term model refers to the final projects rather than temporary prototypes. The following comment from the group interview indicates that the teacher concerned uses drawing to record projects as they change and develop, this might be done more efficiently using a digital camera.

> 516 Sometimes in our school half way through we'll do a ehm drawing of what it looks like now. I wish we did more drawing in our school because the only time we gotta do it was when we independently drew cars. It's because DT's fun.

One interpretation, is that the teacher found this to be the only to way to ensure that children's 'design drawings' resembled their projects. This is drawing as recording rather than designing.

What follows is a child's response to being asked in the group interview what they do at the start of a school project. The answer got rather convoluted, showing that research with children is not always a tidy or straightforward matter. At line 476, the researcher is having difficulty understanding the child's explanation, before being helped at line 478. This exchange indicates a class where some children start by drawing and others by making.

471. Well we would plan it (makes drawing motions) like what we think it's gonna look like at the end if and what we are starting it like. Well you go out in groups yeah and the person and the people have to go out in groups and start making and the people that are left inside the class are doing the drawings.

472. Right so how do the people inside the class know what to make though?

473. By the teacher. I think the teacher gives them. Well first of all everyone is in there [the classroom] and they've told everyone and they pick some people to go out of the room and start making and the rest (indicates drawing).

474. But don't they have to do drawings before they start making?

475. No.

476. I'm not quite sure how.... The rest of you you'll do drawings and then you make the thing.

477. I think what he's trying to say is two groups one stays in the classroom, one goes outside. The ones outside just start without your drawings.

478. Ahh and then you swap over.

In the end, this is another indication of the ritualistic use of drawing in design and technology by a teacher. As the second child explains, the teacher divides the class into 'drawers' and 'makers'. There is insufficient data to indicate how or why the class was divided, though some teachers do this to ease class management. Drawing is not precluded in the *spa*, but ideas are also stimulated using language and making the starting point. The making allows the children to model possible solutions in three dimensions, providing a concrete basis for their ideas.

Question 9 - *Would you like to start making first and design as you go along?*

This produced an ambivalent response from the group. Although the researcher did talk the children through this question, their reaction confirmed that they did not understand it clearly. The two children that said they did not have to draw before making, may have misunderstood the question. There was no evidence that the children had any experience of designing through making prior to the *spa* session. As already mentioned, responses to question 8 confirm that eight of the eleven children always had to start with drawing. When question 9 was revisited in the post-*spa* group interview, the children had experienced designing through making for themselves in the *spa* session.

521. So did you notice what we did we starting making fairly straight away didn't we and then Do you think having the pressure pad actually in your hand has helped you have the ideas?

[Universal and enthusiastic assent]

522. Yeah Yeah because you get to figure out what to do with it. Like a burglar alarm. Like a piece of like what looks like a door mat.

523. Yeah so do you think it helped to have it in your hand rather than in your head?

[Universal and enthusiastic assent]

Summary

The children's responses confirmed that their previous experience of design and technology was largely confined to the QCA approach. This was beneficial from the point of view of the research in that the children's reaction to *spa* as a new approach could be ascertained. The children had little or no experience of deciding the purpose of their projects before the *spa* session. Evidence for this is found in the questionnaire responses of the whole class and interview responses of the focus group. However, they had a positive view of design and technology that the researcher could build on in the *spa* session. It would have been interesting to follow up the questionnaire responses with individuals but anonymity precluded this. However, the same questions were posed during the post *spa* session group interview (Appendix 12). The extracts from the group interview are evidence that this gave extra insight into points raised by the questionnaire. The findings gave the researcher an insight into the children's prior experience, knowledge, skills and understanding and their attitude to the subject.

The three brainstorming sessions

Brainstorming is a broad term and a considerable amount has been written about its variations (Michalko, 2001, Cowley, 2004, Jones and Wyse, 2004). De Bono (1996:40) writes that during brainstorming, other people's suggestions act to 'stimulate your own ideas in a sort of chain reaction'. He sees the 'group element as essential'. This suited the researcher's intentions and the group situation of the *spa* session. The researcher's interpretation of brainstorming, allowed him to act as facilitator, chairman and scribe and to provoke with questions when necessary. The three brainstorming sessions were regarded as important to idea generation in the *spa*. The ideas generated provide evidence of this.

Table 6: Outcomes of the brainstorming sessions showing incidence of items of speech divided into categories.

KEY

red text - *child's speech* **black text** - *researcher's speech*

inf information - *usually imparted by the researcher*

Qs shooting question- (De Bono, 2004: 79) *closed question where there are a limited number or single answer- known to the questioner*

Qf fishing question - (De Bono, 2004:78) *an open-ended question and where the questioner does not know what answer will be given*

eval evaluation - *praise by the researcher*

met metacognition - the *coaching of thinking skills by the researcher*

elab elaboration - *asking for further information*

dir directing- *telling the children what to do e.g. 'hands up'*

mod modelling- *the modelling of desirable behaviour by the researcher*

rep reply- *reply to a previous question or comment- not including an idea*

repI reply - *a reply from a child that includes an idea*

Brainstorming 1- Existing uses of pressure pads

inf	Qs	Qf	eval	met	elab	dir	mod	rep	repI
20	9	2	4	0	0	2	0	4	0

Brainstorming 2 - Ways to make the pressure pad go on

inf	Qs	Qf	eval	met	elab	dir	mod	rep	repI
5	8	9	27	10	3	9	2	9	27

Brainstorming 3- Children's own uses for pressure pads.

inf	Qs	Qf	eval	met	elab	dir	mod	rep	repI
14	10	13	26	3	3	8	12	8	37

The above results combined

inf	Qs	Qf	eval	met	elab	dir	mod	rep	repI
39	27	24	57	13	6	19	14	21	64

This data were transferred to graphs to make it easier to make comparisons and see relationships (Figures 2, 3,4 and 5). This key also applies to the graphs which follow.

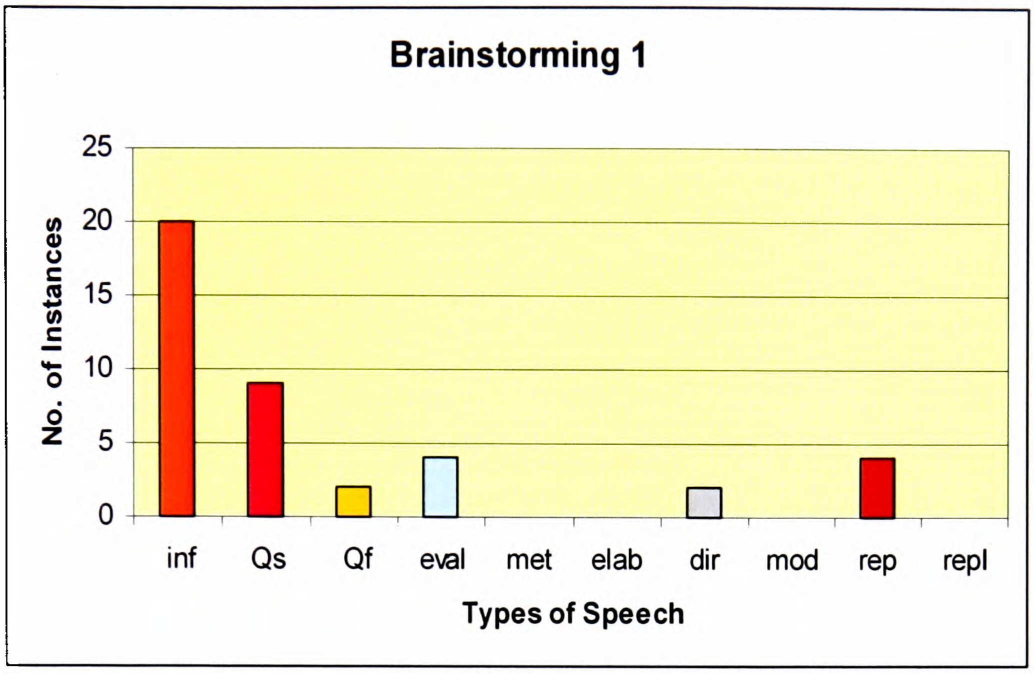

Figure 2 Incidence of categories of speech in Brainstorming 1

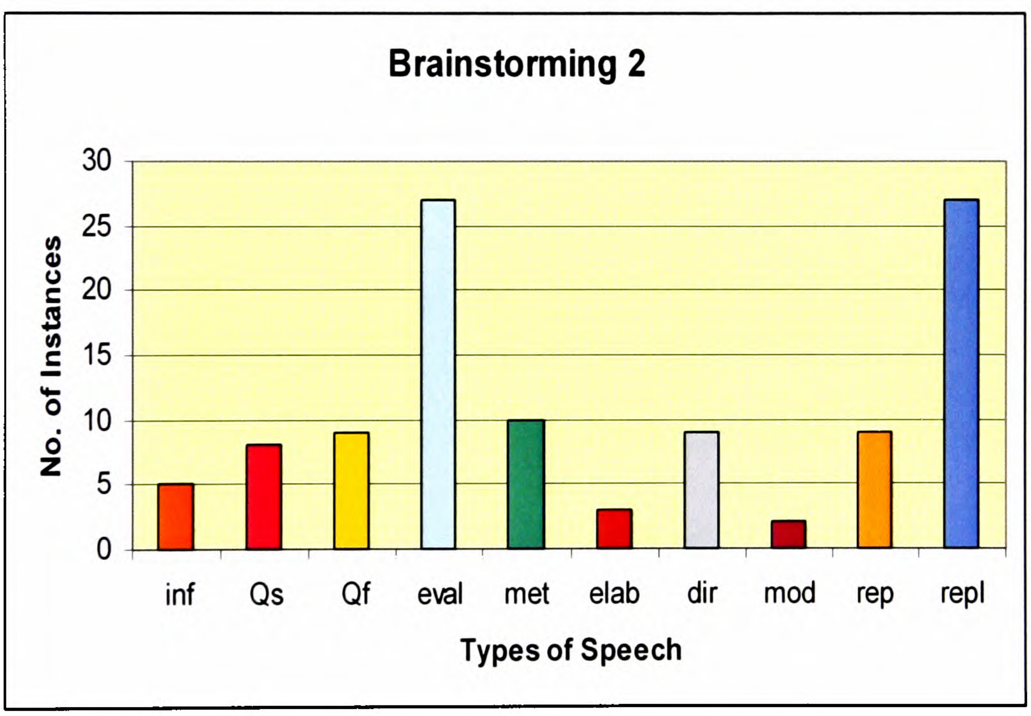

Figure 3 Incidence of categories of speech in Brainstorming 2

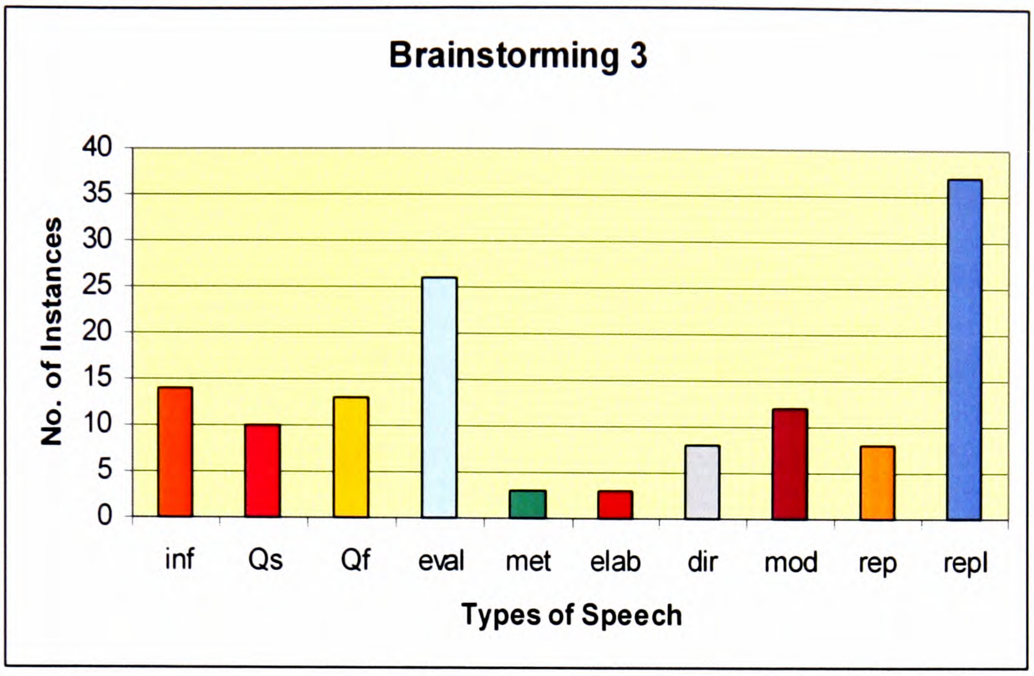

Figure 4 Incidence of categories of speech in Brainstorming 3

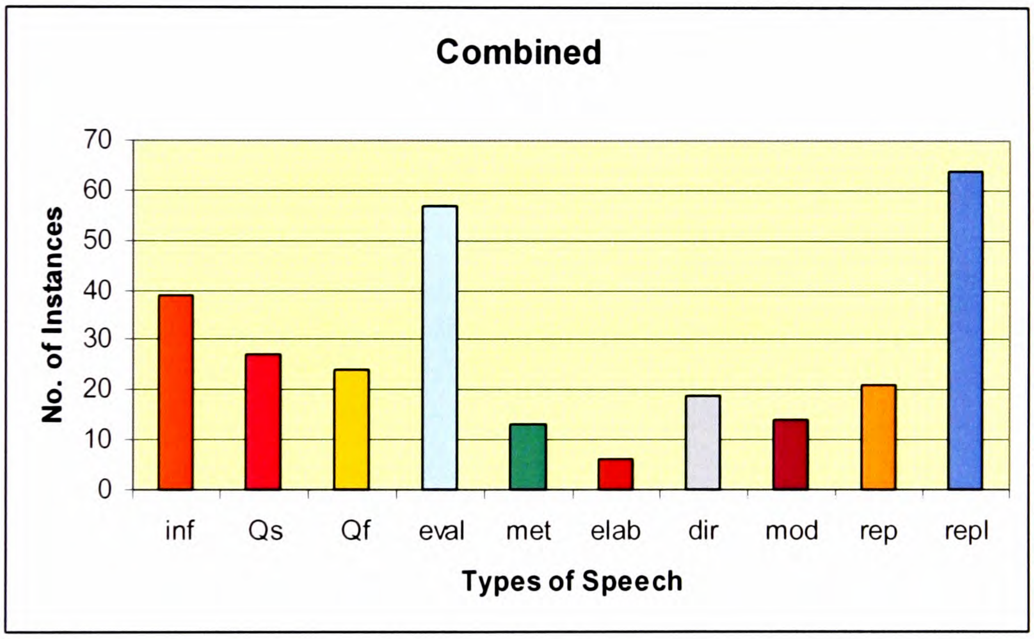

Figure 5 Brainstorming 1, 2 and 3 combined

Discussion of the brainstorming sessions

The three brainstorming sessions emerged as important in this research. It was largely through these that the *spa* model was implemented. An initial analysis of the data established just how much went on during these rather concentrated periods of interaction. In total, there were 284 contributions to the categories. As the examples below illustrate, single items of speech often involved two, three or in one instance (line 372) four different categories.

Black text indicates the researcher's speech, K is the researcher.

Red text indicates speech by children.

Two categories per item of speech feature in these examples.

7 .It's something what turns something on and off	rep
8. That's it, it's a control device. Absolutely, it switches something on and off.	**inf** **eval**

159. Head butt it.	**repI**
160. Yeah good. Yeah head butt it. Any others? Yeah go on the	**eval** **Qf**
161. Use a remote control or is that the same thing as squeeze it?	**Qs**

The following are examples where three categories per item of speech occurred.

11. OK This bit we call the 'window' and the 'window' is just to separate the layers - the top part – mine's is falling apart a bit – goes through there and when I press it what happens? Hands up.	inf Qs dir

This example above is from Brainstorming 1. The children were being given information (inf) and asked a closed question (Qf) to check their understanding and engagement. Finally, they were told or 'directed' (dir) to put their hands up to answer. The calling out of answers would have prevented the researcher from judging the understanding of the group as a whole.

172. Yeah yeah good, we've got lots already. Do you notice that once you get started it gets easier? Go on then.	eval met dir

In the above example from Brainstorming 2, the researcher was using the strategy of developing something new from an idea that has already been suggested. This could be described as 'milking' an idea for others or 'piggy-backing' (Michalko 2001:263).

378. OK that's really good so a dog control device and things that tell us where things are. Any more ideas? Anything here give us ideas?	eval Qf mod

The example above is from Brainstorming 3. The researcher gives credit to the child (eval) and summarises their idea. He also encourages the children to generate different ideas from this one through an open question (Qf). Modelling (mod) is a useful strategy that is valuable beyond this project as well as within it.

369. Dance mats.	**repI**
370. Yeah dance mats that'd be really good.	**eval**
371. If you stepped on the wrong one, a buzzer or a light would come up.	**repI**
372. Yeah yeah. Any ideas we can take from a dance mat... things that would be... Use a dance mat as the starter idea. Can we get any more ideas out of that?	**eval** **mod** **met** **Qf**

A considerable amount is happening in a short period in this example from Brainstorming 3. At line 372, the researcher encourages the child (eval), models desirable behaviour (mod) and makes the 'piggy-backing' strategy explicit (met). He then finishes with an open-ended question (Qf) to provoke further ideas. This is a good illustration of how many different categories a facilitator can include in one item of speech. The above examples indicate the richness in the items of speech occurred in all three brainstorming sessions. Further evidence of the range of categories occurring in some items of speech is to be found in Appendix 10. Examples of three categories occurring per item of speech are to be found at lines 5, 226, 237, 319, 327, 381. Communication is given as one of the key skills in the National Curriculum under heading: 'The school curriculum and the National Curriculum: about key stages 1 and 2' (DFEE and QCA, 1999:20).

> Skills in speaking and listening include the ability to speak effectively for different audiences; to listen, understand and respond appropriately to others; and to participate effectively in group discussion.

In addition to their value to the design and technology aspects of the lesson, the *spa* brainstorming sessions gave considerable experience of all the aspects of communication listed. The researcher was clearly modelling language for the children.

From the examples given above, it might be thought that the children's opportunities for sustained speech were limited. However, the researcher did allow longer responses and Libby (L) certainly availed herself of this as these examples show.

294. L- One of my friends said that she used it to set the tape recorder thing to scare people at her Halloween party by putting it under the door mat.	**repI**	Idea 4. Differences between the children (in the way they answered) emerge. Here L makes a lengthy answer. The 'story' may be made up as the idea is very similar to one mentioned by K (Researcher) earlier. L makes another lengthy answer at 361.
359. (Researcher) Anyone got any idea how you could use a pressure pad with babies?	**Qf**	K is inviting the group to start from D's idea. The tactic is to suggest a theme to provoke ideas from the group. An example of 'wasting nothing'.
360. It could tell you if a baby is wandering out of a room they're not supposed to.	**mod**	K is perhaps prompting too much here, in an effort to keep up the momentum. Skilled facilitator has to make fine judgements about when and how to intervene.
361. L- Or even you could have like the pressure pad under the mat that the baby sleeps on with loads of wires to you in another room and you'd know if the baby is gone because the light would switch off.	**repI**	L has picked up K's provocation (359) but not his specific and perhaps over-directing hint (360).
362. L. Because it's in a different room, it wouldn't bother the baby. But the batteries might run out.	**repI**	L has thought her idea through in some detail including anticipating a problem.
363. Yeah, that would be a problem.	eval	K confirms that her thinking is correct
364. L. And you might think the baby is gone but it's still in the room so you might panic but it's still in the room.	**repI**	S – shows her engagement with the ideas of others. As before, she sees the problem with another child's idea.

Libby is not the only child to give sustained answers. The following examples from Denny and Ritchie, not only include their ideas, but also how they would work. These children can clearly visualise their ideas in use. This was cognitive modelling achieved without recourse to drawing.

346. D- For a different burglar alarm so that if he comes in the window and the window shuts the buzzer would go on.	**repl**	D is revisiting the basic idea of an alarm that emerged earlier. He is *reversing* the usual *opening* of a window to trigger an alarm. This is to accommodate the pp. *Reversal* as a strategy for idea generation features p174 *Cracking Creativity*, Michalko, M.., 2001, Ten Speed Press .
347. (Researcher) Yeah if you leave your window open but if you leave the window shut you. would be stuck but yeah yeah that might work.	**eval**	K is pointing out a problem with the idea but gives qualified approval to encourage. In any case, there are often advantages to an idea that are not obvious at first. K wants to move on.
348. R - Or when you see when burglars put their hand in the letter box and try and push the door then when the letter box shut the thing would go off.	**repl**	R's idea has been stimulated by D's revisiting of the 'alarm' theme. An example of one idea provoking another.
349. Yeah the letter box sets it off. Go on then Ritchie. Anywhere, where there is pressure will make it work then.	**eval** **mod**	K reinforcing how the idea works for the benefit of the group. K reiterates the main feature of the pp. Attempting to provoke further ideas.

While long periods of speech allow the individual to develop and explain their ideas, if this goes on too long other children could lose concentration. There was some visual video evidence of this happening during Libby's monologues. The researcher did summarise ideas sometimes (lines 376 and 378) to keep all involved. The children's speech is confined to one category per item of speech, usually replying to the researcher with an idea (rep1) as at 159, 369 and 371 above. However, sometimes they ask for feedback on their idea, as at 161. This reflects that the children's main role is providing individual ideas. It also reflects their understandable lack of linguistic maturity and sophistication compared with the researcher. Although the brainstorming was 'chaired' by the researcher, there are examples of children communicating directly with each other. As the researcher's notes at line 165 suggest, this is a shared contribution. Also, notice one child commenting (eval) on another child's idea at line 169 below.

165. We reckon you could put some weight on it	**repl**	Idea 7 Although the children are apparently contributing individually, the 'we' indicated some collaboration. They were also seen to confer.
167. Belly Flop it	**repl**	Idea 8 This is probably not provoked by the previous idea as the actions involved are very different. Independent trains of thought are sometimes going on at the same time in the group. Managing this can be difficult and there is the risk that one child may give up or forget their idea if others dominate.
168. Yeah yeah belly flop it. Well I've never had that one before.	**eval**	Encouraging unusual and even outlandish ideas is important to promoting psychological safety and eliciting the more imaginative ideas. This was not the time to examine contributions too critically.
169. Good idea	**eval**	Child encouraging the others. This is to be encouraged.

Emergent themes were subsequently identified and used as the basis for the subheadings for discussion. First, some general observations about the sessions. Although all three bear the 'brainstorming' title, it is clear from the graphs that Brainstorming 1 involved a high proportion of information giving (inf). More than half the total instances (20) of information giving occurred in this one session. This was when most of the knowledge, skills and understanding (DfEE, QCA, 1999b) were taught. This also reflects the researcher's awareness of the need for a clear understanding of the starting point which was to play an important part in provoking ideas. A misunderstanding of the starting point would have led to inappropriate ideas that would not work. Information was also needed by the children in order for them to make the starting point successfully. Experience of a working starting point was also intended to be part of the stimulus for the children's ideas.

It is noticeable that four of the ten categories did not feature in Brainstorming 1. These were: metacognition (met), asking for elaboration (elab), modelling (mod) and a reply that includes an idea (rep1). This is because Brainstorming 1 is mainly concerned with establishing the starting point in preparation for making it and subsequent idea generation. In contrast, Brainstorming 2 resulted in 27 replies that included ideas (repI) and during Brainstorming 3 there were 37. Not all ideas coded and tallied in this category were equal status. Most were ideas for projects. As in:

369. Dance mats.

Others examples in this category were developments of a child's idea, as in this example:

370. Yeah dance mats that'd be really good.

371. If you stepped on the wrong one, a buzzer or a light would come up.

It is noticeable that there were also 27 and 26 instances of praise or encouragement (eval) in Brainstormings 1 and 2 respectively. This is one for every idea offered in Brainstorming 2 as in this example:

155. Squeeze it.	**repI**
156. Yeah good. Go on	**eval**

During Brainstorming 3, when uses for the pressure pad starting point were asked for, even more ideas (repI) were forthcoming; a total of 37. The high incidence of 'evals' is explained by researcher being keen to reinforce the ideas given and to reassure the children that their ideas were valued. He was encouraging more. Brainstorming 3 ideas for what might be designed included:

> Line 310. You could use it as a light to help you read.
>
> Line 312. You could use it for a bell.
>
> Line 316. Yeah you could hide it under the mat and when they stand on it....
>
> Line 318. If you're working in the garden at night, you could put a weight on it and it'd give you light to work in the garden.

These are conceptual ideas about what could be designed, rather than detailed designs for actual products. Any of the ideas might have lead to a large number of specific designs.

> Line 306. I was going to say night light so that you could easily find your drink.
>
> Line 402. I just drawed the picture and then I made some dollar signs behind and it was meant to be just a picture but then I thought to make it into a pressure pad.

In Brainstorming 3, there were fewer positive researcher's 'evals' in relation to the number of children's ideas (repI) than in Brainstorming 2, though there were still a lot. On first analysis this was surprising, as ideas were still wanted. Part of the explanation is that in Brainstorming 2 the question was simply how to turn the pressure pad on. In Brainstorming 3, suggesting new uses for the pressure pad was more challenging. As this example from the grid pro forma shows, the researcher sometimes had to emphasise information giving to get ideas back on track. This is a necessary revisiting of information given in Brainstorming 1 though it does include an 'eval', not all of which can be positive.

300. Microwave oven.	repI	Idea 6. As above at Idea 5.
301. Yeah but I'm thinking of things we could make though really. Sorry just a sec.	inf dir	K (Researcher) has noticed that the ideas (298, 300) are moving away from ideas for their projects and back to existing uses for the pp. He tries to counter this.

Importantly, when the three sessions are considered together, the largest number of items of speech by some margin, were those where the children offered their own ideas (repI). There were 64 of these and they were followed in quantity by encouragement by the researcher's 57 'evals'. Some examples are shown here:

150. Now as many ways as possible of turning this on yeah?	Qf	Quantity of ideas is stressed at this point to overcome inhibitions and to try to start the flow if ideas. Momentum helps.
151. Step on it.	repI	Idea 1
152. Yeah good. Yeah good. Ritchie	eval inf	Researcher is encouraging, promoting psychological safety so that others will respond also.
153. Sit on it	repI	Idea 2

171. Elbow it	**repI**	Idea 9
172. Yeah yeah, good, we've got lots already. Do you notice that once you get started it gets easier? Go on then	**eval** **met** dir	Encouraging but also trying to make ch. see a general point. Some' thinking about thinking' – metacognition .
173. Punch it	**repI**	Idea 10
174. Punch it yeah. Go on then there's still more	**eval**	Repeating to reinforce the answer.
176. Yeah, press it with your tongue. Yeah it's possible isn't it? Now the reason we do this is any one of these might give us an idea for a project yeah. Go on then yes good – why not. Good we're doing well here. Go on then	**eval** **met**	More encouragement and again attempting to make a general point.

Instances of information giving by the researcher (inf) came some way behind with 39 examples. This numerical comparison does not of course give consideration to the quality of the ideas but the *spa* is intended to foster idea generation in quantity and the researcher is encouraged by this result. Ritchie's (2001) view is that the best way to have a good idea is to have lots of ideas.

Psychological safety

In the context of the *spa* session, psychological safety (Klenz:1987) meant ensuring as far as possible that the children in the study were emotionally at ease. Claire (2005:160) comments that 'Much theoretical writing about creativity emphasises the centrality of taking risks in one's thinking'. The researcher needed to create the conditions where the children felt that it was safe to take such 'risks'. Hayes (2006:32) describes exactly the conditions that the researcher tried to achieve:

> The bedrock of academic success is found in creating an interactive learning climate in which pupils have self-confidence, feel relaxed in the company of other pupils in the class and enjoy an easy relationship with the teacher.

It was important that pupils were not stressed or inhibited during the data gathering. In addition to the ethical and professional reasons for this, there was an added imperative pertinent to the research itself. It was necessary for there to be what Spendlove and Hopper (2004:72) call: 'Opportunities for exploration and play without fear of making mistakes within a non-threatening environment provide the optimum creative learning experience'. Ritchie (2001:67) emphasises the need for an ethos in the classroom where children's ideas are valued and there is uncritical sharing of ideas in a group. This has been endorsed by a number of writers over time, (Fisher, 1990; De Bono, 1992; Michalko, 2001; Scottish Executive Education Department's Creativity in Education Online - SEED, 2005).

Factors that might have worked against psychological safety

While the *spa* was familiar to the researcher, it was important to remember that it was new to the children. This was confirmed by their responses to the pre-*spa* questionnaire. They also had other new things to contend with. The children met each other, the researcher and the two Student Ambassador helpers on the day before data were gathered. They came from different local schools, so had no established friends in the group. They had never been to a university campus before and were in an unfamiliar room. All this 'newness' had the potential to cause stress and inhibit the risk taking that a number of authors regard as inherent in creative activities (Adams, 1986:3; Vernon, 1970:123; De Bono, 1996; Parker, 1994; Barlex, 2003). Ings (2004:4) writes, 'In going out on a limb, the creator may well feel a sudden loneliness'. Like the researcher, Newcomb (2004) gathered data by videoing a group 'reasoning together'. He suggests a number of factors 'which tend to undermine a group's ability to work towards optimised solutions to the problem(s) they are faced with'. Among these are children's personal levels of uncertainty and their perception of their place within the group. There was clearly a need for the researcher to take precautionary steps to minimise any negative factors as far as possible. There were also opportunities to accentuate the positive aspects of the data gathering environment and this is explained below. Adams (1986) observes that creativity and change are associated with uncertainty, risk and anxiety. This had the potential to raise ethical and research problems. However, they were only potential problems and as described below, steps were taken to minimise them.

Factors that helped to promote psychological safety in preparation for the spa

Despite the possible negative effects of creative activity suggested above, Adams (1986:3) acknowledges that creativity can also be associated with 'joy, excitement and approval'. The high incidence of appreciative remarks (eval) by the researcher was intended to encourage the children to feel free to express ideas. This was evident from viewing the video of the brainstorming and the fluency with which children voiced ideas. Once the interaction was divided into categories, it was striking how often the researcher praised the children's responses. There were 57 Instances of positive 'evaluation' (eval) or praise during the three sessions. Sometimes the researcher combined praise with information giving:

Line 8. That's it, it's a control device. Absolutely, it switches something on and off.

Line 19. Yeah you're absolutely right it would stay on- so that middle layer is quite important.

The next examples are from Brainstorming 1 - Introduction of pressure pad (Appendix 10), which has a high proportion of information giving and checking understanding. The children's assent was often non-verbal as in this example:

367. Yeah, go on then Ritchie. Yeah his was on all the time that's 'because we put a staple across it. Yeah.	dir inf	R silently indicates that he relates to this.	R's pp stayed on for a different reason than that being discussed. K encourages R's non-verbal –bid as he sees a chance to warn the group of a problem to avoid. He was clearly engaged in the discussion but this was not obvious until his bid.

Such non-verbal assent was an important indicator that the children were understanding, engaged and at ease enough to respond. As Cohen et al. (2000: 281) point out, 'it is frequently the non-verbal communication that gives more information than the verbal communication'. This is an example of a number of instances where video captured data that would have been missed using audio recording alone.

Brainstorming 2: Ways to make the pressure pad go on, and Brainstorming 3 - Children's ideas for using their pressure pad, were principally where the children's own ideas were expressed. It is noticeable that the researcher used a great deal of affirmation and praise in response to encourage their ideas.

Line 152. Yeah good. Yeah good. Ritchie

Line 154. Yeah good anymore? 156. Yeah good. Go on

Line 172. Yeah yeah good we've got lots already. Do you notice that once you get started it gets easier? Go on then

Data were gathered in the naturalistic setting of a classroom, albeit not the children's usual one. Although in a university, the setting was in all significant respects, the same as a primary school classroom. The seating arrangements, equipment and other aspects of the room were familiar to the children. Primary pupils are used to being familiar to their teachers. Name stickers allowed the researcher and adult helpers to address the children by name. The stickers also allowed the children to call each other by name, which encouraged familiarity. The adults also wore name stickers to indicate that they were part of the group.

A warm-up activity was introduced on the day before the main data gathering. This involved exploring the properties of a black plastic bin bag starting point and brainstorming as many uses for it as possible. The activity was designed as an 'ice-breaker' as well as being relevant familiarisation for the main *spa* data gathering activity. The *spa* was taught in the way it had been to many new classes before the data gathering session without stress being observed. In practice, the children in this study were observed to be excited by the new surroundings and activities, rather than threatened by them. The room contained some previously completed design and technology work which the children were allowed to handle. Judging by the behaviour observed, this generated a lot of interest. The stimulating environment provided them with tangible evidence that different ideas were possible and valued. Davis and Howe conducted a design and technology research project with children of similar age on their campus. They too found that the new environment was viewed positively. 'It seemed important to them to be in a learning environment which they regarded as high status- this enhanced their own self image and gave them confidence to be creative' (Davies and Howe, 2003:22).

The researcher shared breaks with the children and the Student Ambassador helpers played games with them. This further encouraged a relaxed atmosphere conducive to idea generation. Although primary school children usually work with one teacher, they are also accustomed to working with different supply teachers and classroom assistants.

The researcher also promoted the children's confidence by linking the new *spa* work with some that was familiar to the children from school. This example is from the transcript of the video (Appendix 1).

> Line 5: Who's done switches in Science? I'm sure most, everybody's done switches – Good!

Questioning at line 6 was used to get feedback on understanding of the basic switch concept. There was a similar exchange when the children are being told how to make the pressure pad starting point at lines 99-101. Here the researcher made reference to an electrical insulator, knowing that the concept would have been covered in their National Curriculum science lessons.

A large version of the pressure pad starting point was used to support the verbal explanation of what was to be made. This was shown and demonstrated in a dramatic fashion to underline how it worked. Seeing an actual example was intended to promote confidence by leaving no doubt about what was to be done. The children were observed to be happy and confident during the demonstration. They had the reassurance of being shown precisely how to make the pressure pad through what the National Curriculum would characterise as focused practical tasks:

126. Put the stapler on the table – don't do it by squeezing it – put it on the table get your weight above it and put it down nice and tight OK. If you don't then the wires will keep falling out.

One of the children commented:

132. I know what to do.

Observation of the children provided evidence of their willingness to: interact with the researcher, voice ideas and ask and answer questions. A source of evidence is the transcript (Appendix 1), and analysis of the brainstorming sessions (Appendix 10).

The researcher's role in the *spa* session

Video recording had the advantage of capturing what took place in the *spa* session while freeing the researcher to perform his teaching role. Cohen et al. (2000:313) point out that: 'Audio-visual data collection has the capacity for completeness of analysis and comprehensiveness of material'. Audio recording was also used when the use of video was impractical (p.178).

As the researcher taught the class, the term 'researcher' is interchangeable with that of 'teacher' here. Analysis of the transcript shows that teacher's role changed considerably during the *spa* session. There were times when a didactic role was necessary. This was particularly the case during Brainstorming 1 when there were 20 instances of information giving, for example:

4. OK, So what we've got here then is a pressure pad switch, now this is very simple thing but it's very important device…

However, 'facilitator' best describes much of the researcher's role during significant parts of the session, particularly during Brainstormings 2 and 3. Sloane (2006:117) emphasises the importance of the facilitator when he writes that brainstorming 'should be chaired by an enthusiastic facilitator who encourages the flow and ensures that there is no initial criticism or judgement of the ideas'. There is evidence of the researcher conveying 'enthusiasm' in Table 6 which shows 57 instances of praise by the researcher in Brainstormings 2 and 3 combined. One of the researcher's over-arching objectives was to get a good quantity of ideas from the children. Sloane (2006:117) writes that brainstorming should 'generate a large number of ideas'. Evidence that this was achieved is

found in Table 6. This shows that 64 ideas (rep1) resulted from Brainstormings 2 and 3 combined. Michalko (2001:262) writes of collaborative brainstorming: 'Quantity breeds quality. The goal is to empty the box. Get every idea from each participant that he or she is capable of imagining'. As a child in the focus group said of brainstorming: 'It's to squeeze things out,' (line 459). The need for quantity is further endorsed by SEED (2005) which can be summarised as: the more ideas the better. Encouraging idea generation is central to the *spa*. It was apparent from repeated watching of the video and studying the transcript, that the researcher encouraged ideas in a variety of ways. Creating then maintaining a feeling of psychological safety was an important part of the researcher's role throughout the session.

The role of the researcher's questions

Lamut (2006:232) asserts that 'Questions are undoubtedly one of the most important components in class, having a remarkable impact on the learning process'. Cowley (2004:14) writes that: 'Questions play a vital role in the development of thinking' and that while answering, children develop their creativity, among other attributes. Ritchie

(2001:36) mentions the need for a teacher to ask 'the right questions at the right time' in design and technology. Benson (2003:5) also emphasises questioning skills when helping foundation stage teachers to develop 'designerly thinking'. 'The development of questioning skills was at the heart of many of the activities'. Yet Dillon (1994:78) writes vehemently against the teacher's use of questions in discussion:

> Do not put questions to students in a discussion. I explicitly recommend against questioning by the teacher. Teacher questions will foil the discussion process, turning the class into some other group talk much like recitation. Teacher questions do not stimulate student thinking and they do not encourage participation.

This is contrary to the view of the writers cited previously and the researcher's experience during the data gathering. The following question for example, resulted in 24 ideas being offered by the children.

> Line 149. Alright, now obviously I can press it with my thumb. How else can I turn this thing on?

Dillon may have heavy-handed questioning in mind, or be using 'discussion' in a specialised way. However, he does not qualify his extreme view. The video evidence and the transcript of the brainstorming, confirms the importance of questioning to the *spa*. The researcher's observations during the data gathering are in accord with De Bono's (2004:88) view that: 'Questions are a key means of interaction in any conversation or discussion'. Barlex, Welch and O'Donnell's research (2007: 10) carried out in a design and technology lesson, also mentions the importance of questioning:

> Using questioning as a strategy, Geoff [pseudonym for the teacher] originated, sustained and scaffolded dialogue that encouraged designerly thinking within a community of pupils.

The nature of the questions changed during the *spa* session but contrary to Dillon's view, that researcher found that they stimulated the children's thinking and encouraged participation. Further examples of this are to be seen next, when the role of questions in the brainstorming sessions is considered further.

Questions in Brainstorming 1- ***Introduction of the pressure pad***

Much of the interaction during this brainstorming was to check the children's understanding or get specific information from them. This is indicated by 9 closed 'shooting questions' (Qs). De Bono, 2004:80 describes the main purpose of such questions as being to check on something, where what is to be checked falls within a limited range. Shooting questions predominated in brainstorming 1 because it was important for the researcher to check that the children understood the knowledge, skills and understanding covered in the taught input. Questions to elicit feedback were frequent at this stage, especially as the researcher did not know the group well. A good understanding of the starting point was important as it formed the basis for subsequent designing. The questions were also intended to keep the children engaged and to avoid an inappropriate lecture format. The children's responses also gave the researcher as teacher, information about individuals. Ritchie (2001:36) writes about the 'level and nature of teacher intervention varying at different phases of the work' in design and technology. This is noticeable across the brainstorming sessions. The graphs (Figures 2-5) show this difference clearly. Questions in Brainstorming 1- are often quite closed 'shooting questions' (Qs) in that there is one or a limited number of answers. Examples include:

Line 6. So could someone tell me what basically a switch is? 9. Now, to make a circuit, an electrical circuit work a bulb and a battery and you know bit a wire- you know that you have to have a loop don't you?

Line 10. Yeah so what we've got, we got a switch this is where we introduce a gap but it's a gap that we can close up easily when we want to make the circuit work OK? And here you can see the gap in the circuit OK see the gap between the foil strips?

Line 11. OK This bit we call the 'window' and the 'window' is just to separate the layers the top part – mine's is falling apart a bit – goes through there and when I press it what happens?

Many questions in Brainstorming 1 are aimed at checking and reinforcing knowledge rather than directly stimulating creativity. Further examples are to be found at lines 15, 20, 21, 22, 23, 24 and 31. As Townsend and Donovan (1999:34) put it: 'Sometimes it's necessary to collect concrete information from a group and a good closed questioning technique will help you to do this efficiently'. The researcher certainly uses such questions (Qs). This does not mean that all questions in relation to making the pressure pad were completely closed.

36. OK now we're not allowed to use craft knives. So how are we going to get that hole out of the middle?

37. Any ideas?

38. Fold the piece of paper in half and cut it.

39. Brilliant, absolutely, that's perfectly good – that's one way.

This question is neither fully open nor fully closed The Qf and Qs categories are convenient, but not always clearly distinct. At first sight, the question above appears to be one of De Bono's (2004:80) 'shooting questions' in that the answer falls within a limited range. However, he also describes a shooting question as 'always to be answered yes or no'. In this case, the researcher knew of four ways to produce the hole without using a knife. The researcher praised the child's response but also indicates that there are other possibilities by adding 'that's one way'. On balance, the question is not what De Bono describes as 'a fishing question'. These are open-ended questions where the questioner does not know what answer will be given.

There was a considerable amount information (inf) giving during this brainstorming session. As Townsend and Donovan put it (1999:70), 'It's OK (for a facilitator) to teach!' Howe, Davies and Ritchie (2001:22) also endorse this:

> We are not advocating that children are just left to get on with being creative. Intervention will be required - perhaps to teach a skill, demonstrate a technique or sort out a problem. An essential skill of the teacher is to make the right intervention at the right time.

In the early stage of the *spa*, direct teaching was needed so that all children could make and understand the starting point and so have the necessary knowledge 'to design with'. The National Curriculum for design and technology requires 'that knowledge and understanding are applied when developing ideas, making products and evaluating them'. In the *spa* session, the common knowledge, skills and understanding taught, were important to making outcomes with different purposes manageable within a class. The researchers questions were used to check that the children had the knowledge they would need.

Questions in Brainstorming 2 - *Ways to make the pressure pad go on and*

Brainstorming 3 - *Children's ideas for using their pressure pad*

Brainstormings 2 and 3 are considered together, as they have much in common. Questions in Brainstorming 2 and 3 were more open than in Brainstorming 1 because the researcher's main emphasis had moved from giving information (inf) and checking that it was understood, to provoking ideas (repl). Townsend and Donovan (1999:34) describe open questions as those which have many answers. Examples of open questions from the transcript are:

> Line 149. Alright, now obviously I can press it with my thumb. How else can I turn this thing on?
>
> Line 150. What else can I do?
>
> Line 277. Right let's have some hands up then. What can we use this for?
>
> Line 302. Ehm OK, OK go on then. What else could we do? What might we use it for?

The NACCCE report (DfEE, 1999:95) strongly endorses the use of open questions: 'One of the most powerful prompts to creative thinking is the asking of open-ended questions'. Describing her creative work with children, Robson (2004:48) writes: 'The use of open-ended questions allowed speculation and extended the imagination...'. The teacher in Barlex, Welch and O'Donnell's research (2007:8) used 'open-ended questions to generate understanding of the product to be designed' in a design and technology context. Cowley (2004:15) tells teachers that as a result of using open questions: 'you should find that you end up with as many, or more, answers different answers or solutions as there are children in the class'. The *spa* also posed the children fundamental open question, 'What can you do with a pressure pad?' Very many responses were possible. To stimulate their ideas, the children were first asked to respond to another open question about how such switches could be made to go on. This was less open than the fundamental question but very many answers were still possible. The children's responses provide evidence for this and they are not exhaustive. In Brainstorming 2, the researcher used open questions to encourage ideas as endorsed by Cowley (2004:14): 'At their best, they [open questions] encourage the children to respond with creativity and by using complex, higher order thought processes'.

Questions that were direct requests for ideas

There were instances when the researcher tried to get ideas simply by asking for them:

> Line 154. Yeah, good, anymore?
>
> Line 158. Pinch it is a bit like squeezing it. Alright, anymore?
>
> Line 192. Yeah. Go on any more?
>
> Line 201. Yeah we haven't got that really have we? Good great stuff. Any more?
>
> 324. Right right anymore? Let's have some more.

However, this was the only kind of question that was asked by the Student Ambassador working with the non-focus group children in another room. Captured by Dictaphone, his questions included: 'Can you give me another idea?, 'Anything else?, 'What else could it be?', 'Is there anything else it could be?' and 'What were you thinking of making yours into?' When they result in ideas, such direct questions, elicit responses without directing or influencing them. Their limitation is that they do little to provoke or stimulate ideas when these are lacking. This can result in trying to extract ideas where none exist and the skilled facilitator needs to switch quickly to more idea provoking questions. The Student Ambassador had no previous experience of teaching. It was noticeable that his questioning lacked variety and sophistication of the much more experienced researcher. This indicates a training need that is discussed in the final chapter of this thesis.

The researcher's use of jump starting questions

Some questions were used to start or re-start the flow of ideas. Todd, Lubart and Sternberg (1995:275) use the evocative term: 'jump-starting' for questions of this kind. Examples of jump starting questions used by the researcher include:

Line 211. Are there any ideas there [on the brainstorming flipchart], that give us an idea? Well we could swing something into it couldn't we? On a rope, you know. Like that.

Line 234. We could also ride a bike over it also. Couldn't we? Yeah

Line 317. Does the way of turning it on, on the board give us any ideas?

Line 324. [in addition to the question mentioned at this line] What about games of some sort?

In the questions above, the researcher is giving areas to explore, rather than specific ideas. For example, a wide range of games could result from the second question at line 324. Similarly provocative questions were used in the 'find many uses for a black bin bag' warm-up activity on the day before the data gathering proper. When 'stuck' for ideas, children were given a context in which the bag might be useful such as a desert island. Jump starting questions were not used by the Student Ambassador with the non-focus group children.

Questions intended to get children to clarify their ideas or elaborate on them

Questions of this kind helped other children and the researcher to understand what individuals meant.

Line 279. Yeah what can we remote control with it?

Line 162. Use a remote control. What would you do throw the remote control at it?

Line 194. Throw the pad?

Line 214. Yeah how do you mean like a hose- a high pressure hose pipe on it that'd do it wouldn't it?

Line 281 On a long bit of cable kind of thing yeah?

Line 291. Yeah, if we make the toy car you mean Is that what you mean?

Line 321 Yeah good a signal light. Have you heard of Morse code? Yeah.

As well as helping collective understanding, these questions required the children to develop their ideas and bring them into sharper focus for themselves. Ideas were developed as they were explained.

The coaching of idea generating skills - modelling and metacognition

Cooper (2004:18) points out that creativity and play are areas where some think adults should not intervene at all, for fear of ruining spontaneity. Cooper's reply is that 'many children need to learn how to play – how to communicate verbally, to use material creatively, to think in divergent ways'. The children engaged in all these activities during the *spa* session and the researcher coached them as opportunities were presented. Jeffrey and Craft (2001:9) endorse teacher input when they advocate 'stimulating learners' rather than 'leaving them alone'. Fautley and Savage (2007:38) write that 'imagination is a cognitive activity that can be developed and fostered'. The NACCCE (DfEE, 1999:89) also supports intervention:

> There is an obvious sense in which children cannot be 'taught' creativity' in the way they can be taught the times tables. It is also the case that there are various techniques for facilitating creative thinking.

De Bono (2004:48) is another advocate of a proactive approach to promoting creative thinking.

> Instead of waiting for creative inspiration, there should be some thinking methods which we could learn and use deliberately. Creativity is a skill and a habit. You need to learn the skill, which them becomes a habit.

The active promotion of creative thinking was a feature of the *spa* session. The National Curriculum for design and technology at key stage 2 requires that pupils be taught the knowledge, skills and understanding necessary to 'generate ideas' (DfEE, QCA, 2004:18). Two aspects emerged on analysis of the brainstorming. The researcher modelled idea generation and also encouraged metacognition. The latter involved encouraging the children to become conscious of idea generating strategies. There were 14 instances of modelling (mod) and 13 of metacognition in Brainstormings 2 and 3 (Table 9) (Figure 5) in total. The intention was to help the children identify and use strategies when generating ideas for their pressure pads. Such strategies could also help with future tasks in design and technology and other subjects when ideas are required. According to the NACCCE report (DfEE, 1999:37), there is debate, but:

> The literature and many of the practical programmes on creative thinking certainly suggest that there are general skills that can be used across many different fields.

Modelling and metacognition did not occur at all during Brainstorming 1 (Table 9) (Figure 2). This is because the teaching of knowledge, skills and understanding was the focus and not idea generation.

Modelling idea generating behaviour

Stevens (2005:14) encourages modelling by the teacher:

> If a teacher models the process of generating ideas and adds a commentary to the process of generating ideas, then pupils will be supported, expectations will be higher and standards can be set.

The researcher modelled the kind of thinking he would do when generating ideas. Here he is identifying a context to explore for ideas:

324. Right right anymore? Let's have some more. Ehm What about games of some sort?	**Qs mod**	K (Researcher) has decided that the [previous] idea has been explored sufficiently and that it is time to move on to a new area. It is sometimes is a fine judgement to know when to do this.

The following extract from the transcript was cited previously as an example of open-ended questioning. However, it is also an example of the researcher modelling the kind of question he would ask of himself during idea generation:

> 49. Alright, now obviously I can press it with my thumb. How else can I turn this thing on? Let's have hands up. I can press it with my thumb.

The next example is from the coding grid (Appendix 10). The researcher seeks to stimulate ideas by exploring ways to make the pressure pad go on. The need for pressure to be applied in some way, was a key design consideration. The researcher suggests two ways of making the pressure pad go on. This forms a provocation with the potential to encourage thinking about other ways to apply pressure to the switch. In De Bono's terms (1992:163), a provocation is a statement put forward to 'make things happen in our minds'. Jenny's nightlight project (Figure 7.3) is based on the principle of putting a weight on the switch. Denny (7.6) also used this principle on his project initially.

319. Can we think about what's special about a pressure pad. One of the things that's special about a pressure pad is that you press it or put weight on it and it stays on so if it was a child's toy for example it would be quite useful. Go on then Ritchie.	**eval** **inf** **mod**	K (Researcher) is reminding the Ch. about the basic functioning of their starting point. Some more 'jump starting' follows. This concludes with suggesting and area to explore.

In the following example, the researcher models the strategy of 'milking' an existing idea so that it yields others.

378. OK that's really good so a dog control device and things that tell us where things are. Any more ideas? Anything here give us any ideas?	**eval** **Qf** **mod**	K (Researcher) gives some credit, summarises and wants to move on. He also encourages ch. to generate different ideas from this one. K is showing an example of a useful strategy that is valuable beyond this project. as well as within it. This shows one important role for a facilitator

In the next example, the researcher is modelling the relating the starting point to a personal hobby or interest. Cowley (2005:67) endorses teachers involving their own interests and creativity. 'Seeing their teacher working alongside them in this way can be a powerful motivator and inspiration for the class'.

188. Yeah good good. I used to do karate and I was going to make a martial art training aid with it.	**eval** **mod**	shows karate hand techniques	K trying to maintain the momentum, show involvement and also 'jump starting' the Ch's ideas. Also modelling the strategy of relating the starting point to a personal interest.
189. You can do all sort of things with this. Go on	**inf** dir		K emphasising that the preceding example was just an example- one of many possibilities.
190. Kick it	**repI**		Idea 14 This is the result of the 'jump starting' at 188.
191. Karate chop it	**repI**	hand chopping gestures	Idea 15 A further result of the 'jump starting' at 188. and more directly from the previous idea at 190.

Conrad, a child in the focus group, went on to relate his project to his personal interest in fantasy figures (Figure 7.2). A child outside the focus group linked their project to their interest in baseball. Children often know a great deal about their personal interests, making them a potentially rich source of ideas. A strength of the *spa* is that it allows children to draw on their own interests for inspiration. Other instances of modelling are to be found in Appendix 1 at lines: 188, 234, 305, 307, 313, 319, 327, 349, 360, 372, 374, 380. Modelling is encouraged by Craft and Jeffrey (2004:11) who write: 'It may also actually encourage children's creativity as teachers model the expression of their own ideas'. However, as Hayes (2006:113) points out, although modelling has value, 'it is not sufficient for adults to model behaviour and expect pupils to automatically understand what is happening and why'. The next section considers how the researcher supplemented modelling by encouraging the children to think about their thinking.

Metacognition

There is 'considerable debate about the meaning' of metacognition (Mosely et al., 2005:12). Livingston (1997) and Fautley and Savage (2007) write that meta-cognition is higher order thinking which involves conscious control over the cognitive processes involved in learning. Planning how to approach a learning task, monitoring comprehension, and evaluating progress toward the completion, are meta-cognitive. Williams (2004:31) sums up the benefits to children of a metacognitive approach: 'It helps them to be consciously aware of how to think about similar challenges in the future so that their thinking becomes more self-directed'. Sharp and Murphy (2006:43) comment on the rise of learning how to learn. 'Meta-cognition, or learning how to learn, has grown in prominence as an effective learning strategy in educational circles over the years'. The transcript of the brainstorming sessions includes thirteen examples of the researcher explicitly coaching the children's idea generating skills (met). This was done opportunistically; pointing out strategies as they emerged. Some examples are provided below. It was apparent from viewing the video, that coaching took the form of 'asides' as the researcher tried not to interrupt the momentum of the brainstorming. SEED (2005), regards this kind of active teaching as part of the teacher's role. Their view is that although a creative climate and an encouraging adult are essential, they are not enough to develop creativity. The teacher's role, goes beyond encouragement and involves intervening; actively teaching creative techniques and strategies. The following examples of metacognition occurred after a good 'flow' of ideas during the *spa* session.

Line 72. Do you notice that once you get started it gets easier?

186. Yeah we could flick it like that. Anymore, yeah, we'll probably get lots more now. Once ideas start coming they tend to come easily.

The children were encouraged to expect this next time and to exploit it. In the following, the researcher is explaining the purpose of brainstorming different ways to make the pressure pad go on.

> Line 176. Yeah press it with your tongue. Yeah it's possible isn't it.
> Now the reason we do this is any one of these might give us an idea for a project, yeah?

Again, the intention was to involve the children in the metacognitive process and encourage them to use a similar strategy in the future. While chairing the brainstorming, the researcher is also monitoring the idea generating process on a metacognitive level and feeding back to the group.

> Line 211. Are there any ideas there that give us an idea?
>
> Line 238. ...one of the things you can try to do when you are trying to have ideas is look – like we did with the bin bag – you look at what you've got already and try to squeeze a little more out of it.
>
> Line 372. Yeah yeah. Any ideas we can .take from a dance mat... things that would be. Use a dance mat as the starter idea. Can we get any more ideas out of that?

Here the researcher was encouraging the children to 'milk' ideas for further ones. SEED (2005) calls this 'piggybacking on the ideas of others' and lists it as one of the 'classic rules' for brainstorming. Michalko (2001:263) also says that the facilitator should 'Encourage freewheeling and piggybacking'. This is one of the strategies that can be used when idea generating falters. Piggybacking helps to avoid a 'cold start' after each idea. The researcher used this strategy spontaneously and then having brought it to a conscious level, taught it to the children. The enabling the children to make deliberate use of strategies was to encourage their further use in the session and subsequently. Study of the video and the transcript derived from it, showed the researcher's interventions to be very varied. Ritchie (2001:40) captures some of this range when he writes:

> In design and technology, teacher intervention may involve: asking a focused question, giving information, making a suggestion, encouraging or facilitating peer discussion, pointing out how others are tackling similar problems, demonstrating new ways of doing something, using an analogy to illustrate a similar problem and its solution, further exploration/research or reminding the child of previous learning in related area.

Arguably, the researcher did all of the above during the *spa* session. However, the list is not exhaustive: asking open-ended questions, modelling and metacognition could be added.

Ways of exploring ideas - language, graphics and the manipulation of materials

The brainstorming phases of the *spa* relied heavily on language as a means of provoking, encouraging, expressing, developing and clarifying ideas (Table 9) (Appendix 10). Yet graphic communication and exploration of ideas is traditionally regarded as paramount in design and technology. Cross (2006:36) encountered an example of this in his research: 'A system was described where the pupils were given four cards and asked to produce a design on each'. However, drawing is neither presented as paramount nor even explicitly mentioned in the design and technology programme of study for key stage 2 (DfEE, QCA, 2004:18). The requirement is that pupils should be taught to 'communicate design ideas in different ways', which can include talking. Drawing is compatible with the *spa*, but in the data gathering session other forms of idea generation like talking and modelling predominated. Other researchers have also identified the importance of language in generating design ideas.

Kimbell (2004:137) reports research which logged techniques used by designers to express their ideas at the outset of design tasks:

> The strength of verbalisation as a conceptual tool was unexpected and challenged the dominant view in the design literature of the primacy of sketching ... It is a fact that professional designers and student designers relied very heavily indeed upon verbalisation to make sense of their starting points within their respective design tasks.

The manipulation of materials to aid designing came into play during the making of the starting point. The researcher observed children manipulating their pressure pads experimentally and in some instances, discussing ideas as they did so. Some were clearly exploring how localised the sensitive area of the pressure pad was. One child wrapped their pressure pad round a tumbler to see if it would still work. Playing with the starting point, in a non-trivial sense, was clearly part of their designing. The researcher explicitly encouraged the children to design while making.

> 250. Now remember while you're doing this [making] I want you to think about uses.

Ritchie (2001:69) is among those who support the value of designing though making:

> Manipulation of materials can provide another way of stimulating ideas for young and old. While some people can visualise possibilities easily and have the spatial awareness to manipulate these images in their heads, others prefer to work immediately in the concrete world. These people will have their best ideas when handling materials: 'tinkering', fitting things together, moving parts relative to each other, dismantling, viewing things from different angles. This can be especially true of young learners who might have limited experience of a range of materials and their properties. In some ways designing literally involves 'playing' with ideas and materials.

The length of this quotation is justified by the fact that it accords so much with the early making and 'hands on' nature of the *spa*. There were indications of idea generation in the making part of gathering session, where the researcher could hear children discussing possibilities as they manipulated the pressure pad. This was not captured on the video and so is not reflected in the transcript. Children working and moving around the room generated too much background noise for the microphone to cope with. However, some of the focus group's design thinking was captured on a Dictaphone carried by the researcher as reported below. Drawing materials were available throughout the *spa* session but they were hardly used. The final artefacts are further evidence that a considerable amount of designing took place without drawing. This is testimony to the effectiveness of the discussion, modelling and manipulation methods the children preferred.

Knowledge, skills and understanding in the *spa*

Once a child has a concept based on the starting point, he or she needs a range of knowledge, skills and understanding to realise his or her ideas. This section explains where and how these are acquired in the *spa*, with illustrations from the data gathering session. The successful completion of their projects, is evidence that the children in the research had gained sufficient knowledge, skills and understanding to do so. The National Curriculum programmes of study for all subjects (DfEE, QCA, 1999b) set out children's entitlement to knowledge, skills and understanding. This section shows how the *spa* contributes to children receiving that entitlement in design and technology.

Knowledge, skills and understanding from outside school

The focus group children brought some of the knowledge, skills and understanding they needed to the *spa* session from their experience of the world outside school. After describing the ways in which key stage 2 children develop, Newton (2005:87) continues:

> At the same time, their knowledge resource grows considerably, partly through formal work in school and partly through informal experience in play and family life.

An example of this was the general non-verbal agreement among the children that they had already encountered battery snaps in toys and other electrical goods at home. One child tried to articulate this:

> 85. It's because right when you get those sorts of battery holders. When you put the batteries in they have those sorts of connector things and sort of long wire things and that's at the end of it.

Further evidence of knowledge and understanding from outside school emerged when the children were asked to give existing uses for the starting point. They cited uses such as: TV remote controls, cash machines, light switches and mobile phones. This indicates that they were able to relate their newly acquired knowledge of the starting point to the world around them. There was also evidence of prior knowledge relevant to individual projects. Jenny knew from previous experience that some materials were denser than others. This knowledge was useful when she needed something heavy but small to keep her switch on. Conrad's knowledge of fantasy figures from outside school was pertinent to his game. The researcher did not share this knowledge but it was nonetheless important to Conrad's design. This was an example of a *spa* project where the pupil's own specialised knowledge and experience was validated.

Knowledge, skills and understanding from other areas of the curriculum

The non-statutory guidance associated with the key stage 2 programme of study for design and technology (DfEE, QCA, 2004:18), encourages links with other subjects. It suggests that children 'draw on knowledge and understanding from other areas of the curriculum' (DfEE, QCA, 1999b:94). DATA research paper No.12: Cross-Curricular Links Within the Primary Curriculum (DATA, 1999a) details extensive links between knowledge, skills and understanding in design and technology and other areas of the curriculum.

Examples from the data gathering given later in this section, show that the children were able to draw on knowledge from other areas of the curriculum. However, it should be recognised that there is a body of work concerning pupils' inability to generalise knowledge from one context to another (Levinson, Murphy and McCormick, 1997). Carnell and Lodge (2002) also consider that different contexts invite differences in learning and this may influence children's ability to generalise knowledge. Job (1993:172) writes about 'the problem of transfer'. McCormick (2004) describes pupils' inability to transfer knowledge of parallel lines from a mathematical to a technological context. He goes on to say (McCormick, 2004:32):

> It is very important that technology educators realise that students' knowledge is learned in context, and that they find it very difficult to move from one context to another.

Venville, Rennie and Wallace (2004:115) found that :

> The utility of knowledge sources was influenced by the nature of the task. When students were performing open-ended tasks, they drew on a wider variety of knowledge sources than when they were performing less open-ended tasks.

The *spa* session offered the children principally an open-ended task along with the less open ended task of making of the pressure pad. In both cases there were examples of children generalising knowledge and experience from other areas of the curriculum.

The children's previous experience of using language to explore and express ideas was relevant to their work in the *spa* session. Hope (2006:2) makes an interesting connection between language and designing:

> The fluidity of language within accepted rules is in some ways parallel to the way adult design professionals use drawing to model and develop design ideas.

Howe, Davies and Ritchie (2001) also comment on the contribution of language to design and technology. There is also evidence that the children had brought more specific knowledge, skills and understanding they needed from other subjects. Denny was able to make a box based on a 'net' without help due to knowledge gained in mathematics lessons. The key stage 2 programme of study for mathematics (DfEE, QCA, 1999b:71) requires that pupils should be taught to: 'make and draw with increasing accuracy 2D and 3D shapes and patterns'. When asked in his individual interview how he knew how to make the box, he said: 'We did it like that in maths'. As well as supporting his design and technology work, making the box reinforced Denny's mathematical knowledge. All the children were involved in measurement when marking out their pressure pad starting point. The key stage 2 programme of study for mathematics (DfEE, QCA, 1999b:74) specifically mentions that pupils should be 'using mathematics in their work in other subjects'. As with other subjects, the relationship between design and technology and mathematics can be symbiotic. Work in mathematics also made a more general contribution to work in the *spa*. Robinson and

Koshy (2004:77) comment that mathematics can 'Increase children's independence by allowing them to follow their own lines of enquiry'. This would support children when they are required to develop their own projects by the *spa.*

Some of the knowledge, skills and understanding needed to make the starting point were familiar to the children from key stage 2 science. Ofsted (2003/2004) reported that applying knowledge learned in other areas such as electrical circuitry in science, is a characteristic of schools where design and technology is good. Howe, Davies and Ritchie (2001:79) 'consider the advantages of making links between science and technology to be considerable'. An example of such a link occurred in the data gathering session when the concept of a switch was raised by the researcher. There was general assent to this child's answer.

5. So it's made from three layers – as you can see. Who's done switches in science? I'm sure most everybody's done switches – Good!

6. So could someone tell me what basically a switch is?

7. It's something what turns something on and off.

Research Paper No.12 (DATA 1999:9) asserts that 'The strongest links with design and technology are within the science curriculum where there are some inevitable overlaps'. The children's knowledge from the science programme of study (DfEE, QCA, 1999b:87) was also evident when insulators and conductors were discussed. As when a switch was mentioned, there was general non-verbal assent to this child's answer.

89. What's the difference between an insulator and a conductor?

100. A conductor let's ehm electricity through.

The researcher did not assume that the children knew, remembered or understood knowledge from other subjects. In the following example, he is checking and reinforcing scientific knowledge.

> 9. Now to make a circuit, an electrical circuit work a bulb and a battery and you know, a bit of wire, you know that you have to have a loop. Don't you?

Skills and capability as well as knowledge relevant to their *spa* projects, feature in the science programmes of study. This requires that: 'Pupils should be taught: to construct circuits, incorporating a battery or power supply and a range of switches, to make electrical devices work' (DfEE, QCA, 1999b:88). This science was reinforced during the teaching of design and technology focused practical tasks (DfEE, QCA, 1999b:95) during the data gathering. The children's science education had the potential to contribute in other ways. Harlen (2000) identifies aims of primary science education that were supportive of work in the *spa*. These include prediction, planning, considering evidence and a willingness to change ideas.

The children were also able to draw on knowledge, skills and understanding acquired in their school art lessons. An example from the National Curriculum key stage 2 programme of study for art and design (DfEE, QCA, 1999b:120) is: 'Pupils should be taught about: materials and processes used in art, craft and design and how these can be matched to their ideas and intentions'. Another example requires that pupils be taught to: 'apply their experience of materials and processes, including drawing, developing their control of tools and techniques'. Howe, Davies and Ritchie (2001:92) acknowledge the differences between art and design and technology, but also see close parallels.

> In both domains there is likely to be a need or want identified...incubation and generating ideas phases involving the modelling or sketching of ideas. Both involve making and constant critical evaluation, drawing on knowledge of materials.

These parallels were apparent in the *spa* session. The use of colour and materials for aesthetic reasons featured in the projects. Ritchie's picture where the 'eyes' light up (Figure 7.1), included drawing and the use of coloured markers and pens. Libby's mat (Figure 7.5) used paint and markers to add a picture and lettering. Jenny's night light, (Figure 7.3) used painting skills. Zoe's toy used paint and coloured paper for visual effect. Conrad's game (Figure 7.2) and Denny's home for a pet rock (Figure 7.6) made little use of art related skills, but as mentioned earlier, Conrad planned to develop this aspect later. Liptai (2004) comments on the National Curriculum focus on making and doing in the art curriculum. This provided knowledge, skills and understanding to support the *spa* design and technology session. Liptai (2004: 142) advocates creativity with found objects in art, where children are 'asked how they might use the objects' and encourages teachers to 'accept and celebrate both literal and fantastic solutions'. This is certainly relevant to the *spa*, where the starting points act as the found objects. This is an example of how subjects can be mutually supportive.

To summarise, the children brought some of the knowledge, skills and understanding they needed to a *spa* session from outside school. More was contributed by their experience of other areas of the curriculum such as mathematics, art and science. Their previous design and technology lessons, also played a part.

Knowledge skills and understanding from the children's school experience of design and technology.

Data about the children's previous school design and technology projects provided evidence that they brought a range of knowledge, skills and understanding to the session. Previous projects were listed in response to question 4 on the pre-*spa* questionnaire. (Appendix 11). The key stage 2 programme of study requires that pupils should be taught to: 'measure, mark out, cut and shape a range of materials, and assemble, join and combine components and materials accurately' (DfEE, QCA, 1999b:94). However, the *spa* session also very much involved the teaching and learning of design and technology knowledge, skills and understanding, as explored below.

Knowledge, skills and understanding acquired during the spa session

Teaching and learning took place in the *spa* session to support the making of the starting points. This began early in the session when the starting point was first discussed at line 4 of the transcript (Appendix 1).

4. OK so what we've got here then is a pressure pad switch, now this is very simple thing but it's very important device OK so what we've got here is three bits of card and some kitchen foil – there's nothing magic but you can do some pretty magic things with it.

Further knowledge about the construction and working of the starting point features in this example:

11. OK This bit we call the 'window' and the 'window' is just to separate the layers - the top part – mine is falling apart a bit – goes through there and when I press it what happens?

The advantages of pressure pads and their existing applications were also covered in the introduction. In the *spa*, knowledge and understanding of this kind is regarded as an important part of stimulating the children's ideas for using their pressure pad.

> 25. So these are used in things like mobile phones, microwave ovens and things like that because they are very thin and they don't take a lot of space up so that means we can make the device like the mobile smaller than if it had a great big plonky mechanical switch.
>
> 26. The other thing is they are very very tough because if I hit this really hard all I'm doing is squashing the layers together – I'm not going to damage it – not like a plastic switch which I might be able to smash.

Knowledge, skills and understanding acquired when the children were shown how to make the starting point, was further reinforced during the actual making. To use National Curriculum terminology, 'focused practical tasks' (DfEE,QCA, 1999b:95), were taught. In this example, the researcher is demonstrating a particular way of joining the circuit securely to the switch.

> 126. Put the stapler on the table – don't do it by squeezing it – put it on the table get your weight above it and put it down nice and tight OK. If you don't then the wires will keep falling out.

In the next example, ways of dealing with multi-core wire were introduced and a particular technique for twisting the wires together was explained and demonstrated.

> 110. And if you don't twiddle them together, they get all twisted up and messy. So what I do is get my fingers like that and I just twiddle it round in my fingers and what it does is twist all the little strands together into one piece and that makes it easy.
>
> 115. Now this is the cunning part OK. This is – you wouldn't think there are different ways of twisting wire together – but there are. And if you do it this way, they are likely to stay together.
>
> 116. So what I've done is I've bent them down into a sort of letter T shape.
>
> 117. Yeah so the wires there and the wires sticking out there and out there. I've done that and now I'm going to twist them together as many times as I can. Because the more twists that you put in the less likely it is to fall to bits. Yeah.

118. So you see I'm putting quite a lot of twists in there and that'll hold it fairly strongly – because it's a bit of a nuisance if it keeps falling apart.

The knowledge, skills and understanding required by the key stage 2 programme of study for design and technology, also includes pupils being taught to 'generate ideas ' and 'develop ideas' (DfEE, QCA, 2004:18). This took place during the *spa* brainstorming sessions through modelling and metacognition. See p.148 for discussion and examples. To see the complete evidence, refer to Appendix 10, Brainstorming 2 and 3 where instances are indicated by 'met' and 'mod'.

Supporting printed materials

Printed *spa* based materials further supported the acquisition of knowledge skills and understanding in the session. Relevant pages from the researcher's pupil's book on electrics (Good, 1999a) (Appendix 3) were provided for reference and to encourage independent learning. Figure 6 below, is evidence of children referring to these materials. Others were observed to use the materials before and after the picture was taken. The pages reinforced and illustrated the knowledge, skills and understanding required to make the starting point that had already been explained. There were no requests to repeat how to make the pressure pad. Ritchie (2001:61) advocates the use of texts to 'explore, introduce or reinforce knowledge and understanding'.

Figure 6

The teaching of the starting point, supported by the printed materials, provided the specific knowledge, skills and understanding needed in the *spa* session. This input was relevant to all the children's projects and freed the researcher to attend to individual needs such as supporting modifications to the starting point. This is explained further when the individual projects are considered. Pages 14-18 explain the subject knowledge, skills and understanding delivered by six exemplar starting points and the progression within and between these. Progression evident within the starting point used during the data gathering session is considered on p.192.

Designing and making in the *spa* session

During an initial consideration of the individual children's projects, their conceptual design decisions will be discussed. These data were gathered during the group session, and are indicated by indented text with line numbers. As elsewhere in this thesis, red text, indicates children's speech. This is followed by an examination of the individual designing and making that took place once the nature of the projects had been decided. These data were gathered while focus group children were working on their projects. Individual interviews with these children then precede discussion of the session.

Jones and Wyse (2004:72) caution us about concentrating solely on outcomes in design and technology.

> By purely focusing upon the outcomes (quality products), the value of designing, innovating, communicating and taking risks can be lost.

The researcher has been concerned to avoid this and the practical outcomes are not considered in isolation but as part of the evidence of the children's total reaction to the *spa*. The practical outcomes are the culmination of what Barlex (2004:115) calls the children's 'response'. The contribution of the final artefacts to the research is significant. They are evidence of the creativity, diversity and individual choice that can occur in one class when using the *spa*. Diversity of response is an important objective in the *spa*. Barlex (2004:115) highlights the significance of diverse pupil response as an indicator of creativity:

> The level of creativity achieved by the pupils can be gauged by looking at the diversity of response achieved within a class, simply by comparing the work of different pupils.

The first projects considered are those of the focus group children who were studied closely as they went through the *spa* process. However, the projects conceived by other children in the class are included later as further evidence of the diverse purposes of the outcomes in the class as a whole. The focus group work demonstrates the range of categories of project that emerged from this class. The categories were: pictures with working features, games, alarms, enhancing another project and fun projects. Any of these categories could result in a large number of different design briefs and subsequent design and technology projects. The alarms category for example, could include briefs to protect a child's bedroom, diary, bicycle, favourite chair and many other things. 'Alarms' is also a QCA unit 4D (QCA, 1998) and was used in Chapter 1 to illustrate the QCA approach. It is a significant feature of the *spa* that 'alarms' was only one of the categories of projects that emerged and the whole class did not have to make one.

The focus group children with their final artefacts

Figure 7.1 Ritchie

Figure 7.2 Conrad

Figure 7.3 Libby

Figure 7.4 Zoe

Figure 7.5 Jenny

Figure 7.6 Denny

Figure 7.1 Ritchie - a picture where the 'eyes' light up

Category: pictures with working features. The illuminated picture is at the less complicated end of the range projects devised by the focus group. Considered with the other projects, it is evidence that projects of the different degrees of sophistication can result from the common starting point. This allows for different ability levels in a class. If the teacher felt that a child's idea lacked enough challenge, they could encourage them to develop their idea further.

Figure 7.2 Conrad - a board game with pressure sensitive areas

Category: games. The idea of games of some sort (Figure 7.2) featured in the brainstorming as a provocation (De Bono, 1992) deliberately introduced by the researcher at line 324. There were also unintended provocations such as those caused by other children's ideas. In this case however, the researcher was trying to provoke ideas in a particular area. This was intended to re-start the flow of ideas when it had stopped by opening up a fresh category of projects.

> Line 324. Right right anymore? Let's have some more. Ehm What about games of some sort?

Conrad's game idea was not voiced directly after the researcher's provocation. The researcher was expecting game ideas at this point but other ideas were already 'on their way' before the provocation. The children were eager to express these ideas and fortunately, were not diverted by the attempted provocation about games.

> Line 326. Instead of speed cameras right. It might not work yeah but out in the road and if a car goes over it and the bulb come on.

> Line 327. Yeah nice idea though. Eh Yeah. Anyone got any ideas how we could make that a useful idea. Yeah go on.

Line 328. Well I got a well ehm if you like I got this idea from Legoland because right what they have. Basically they have these cars made of Lego that roll down this hill and if you at the finish line hid some pressure pads under it the first one would light up and you'd know which one won 'because it'd light up first.

The speed trap idea at provoked another car related one from a different child. Conrad finally expressed his game idea. The intervening ideas allowed time for the researcher's 'game' stimulus to gestate in Conrad's mind. Fisher (2004:15) regards gestation as one of the keys to creativity and describes it as 'allowing time for creative ideas to emerge'. Conrad had to wait to get a hearing but he neither forgot his idea nor gave up trying to share it.

Line 332. (Conrad) A game for children

Line 333. A game for children. So sometimes, when we have an idea it gives us questions. Because when he says that, I think right, what kind of games for children? There could be lots couldn't there? It could be for little children. OK so...

Line 334. Like when they touch.

Line 335. Like a play mat

The researcher used Conrad's suggestion at line 332 as an opportunity to model how an area might be explored. Modelling in this sense, emerged as one of the categories of speech when the brainstormings were analysed As games were already an interest of his, Conrad might have thought of a game without the provocation. The *spa* allows children to use their interests as stimulus and that may have happened here.

Figure 7.3 Libby - a mat which gives a warning or welcomes a guest

Category: Like the board game mentioned above, Libby's idea of a mat which a warns or welcomes (Figure 7.3) featured in the brainstorming.

Line 316. Yeah you could hide it under the mat and when they stand on it.....

Libby not only used the alarm stimulus but went beyond it. Her project also functioned as a welcome mat. Libby's somewhat breathless monologue, shows that alarms are a recurring theme with her. It also demonstrates that while most children's answers were short, this was of their own volition and the researcher was allowing longer responses.

> 375. Ehm well my cousin he is twelve and he did this at school and basically what he did was he got - because he's got a dog at home that's always escaping – and what he did was he created like loads of really big pressure pads with wires but he hid the wires he put loads of tape over them so you couldn't really see them very well and then his dog who was supposed to stay in a certain room – stay in his basket and be taken for walks so when ehm and ehm if and 'because if it was always escaping if it got off its bed then he created two lights the first light would go on at the bottom of its thing and then a light at the first door would go on.

She may be confusing fact with her own imaginings but did go on make an alarm. This is as an example of combinational creativity (Michalko, 2001) where Libby combines an alarm and a welcoming device.

Figure 7.4 Zoe - a pressure pad used to operate a light on a toy

Category: starting point used to enhance another project. The pressure pad had been presented as central to the project to be designed but Zoe chose to use it to enhance a mechanical toy that she had already made. She made a connection between two projects that had been presented completely separately. This is another example of combinational creativity (Michalko, 2001). According to Michalko (2001:114), Albert Einstein also used this approach.

> Einstein vaguely referred to the way he thought as "combinatory play". To Einstein, this combinatory play seemed to be the essential feature of his creative thought.

Michalko (2001: 140) goes on to say that 'Leonardo da Vinci wrote how he connected the unconnected' to get his creative inspiration in his notebooks'. It interesting that Zoe naturally adopted the same strategy as these two eminent creators.

Figure 7.5 Jenny - A night light where the weight of a glass of drinking water keeps the pressure pad on

Category: application in a domestic setting. Some ideas that like 'a light' at line 304 below, were open to many interpretations and the *spa* could accommodate this. The nearest equivalent QCA unit of work would be: 4C Torches (QCA, 1998). The following sample includes the researcher's comment at line 305, which may have provoked Jenny's idea.

303. (Researcher) OK We're making something here in design technology and we've got all the materials we want. What might we use it to make?

304. (Ritchie) A light.

305. Yeah yeah, we could use it to turn the light on. It could be quite handy really at ight... you know at night when you can't find the switch you could make a great big giant pressure pad and have light straight away.

306. (Jenny) I was going to say night light so that you could easily find your drink.

Jenny may have had her idea provoked by Ritchie's 'light' and the researcher's development of it at line 305 but went beyond both by making the link with finding a drink. She later developed this into a final artefact where a nightlight was kept on by putting a glass of water on it. The flipcharts of all the brainstormings were kept on display and she could in any case have remembered the suggestion 'put something on it' in Brainstorming 2 shown below.

165. (Conrad) We reckon you could put some weight on it.

The idea of putting something on the switch featured again later in Brainstorming 2. This supports the view that thoroughly exploring the starting point in the *spa* is a fruitful strategy. The nightlight mentioned above and garden light below at line 318, featured in the brainstorming of ways to make the pressure pad go on.

> 317. (Researcher) Yeah door bell or light. OK Does the way of turning it on, on the board, give us any ideas?
>
> 318. If you're working in the garden at night you could put a weight on it and it'd give you light to work in the garden.

Figure 7.6 Denny - a home for a pet rock with an interior light.

Category: fun projects. It is not surprising that no QCA unit directly corresponds with Denny's playful and somewhat quirky idea, though it could be included under Unit 1D Homes (QCA, 1998). Denny however, was highly motivated by the task he had set himself and due to the *spa*, others did not need to be. Jones and Wyse (2004:74) also recognise the importance of fostering playfulness in promoting creativity:

> A key condition of creativity is the opportunity for the incubation of new and novel ideas. This implies recognising play or playfulness as integral to developing new ideas and is consistent with the promotion of risk taking.

The fun nature of this project was appreciated by the researcher and the children in the session. Denny saw the humour in his idea, as the picture shows (7.6). How damaging it would have been if the researcher or other children had ridiculed his idea, rather than sharing in the fun. The researcher did not know what conditions pet rocks required, so Denny, like Conrad, was the 'expert' on aspects of his project. Because the purpose of *spa* projects is decided by the children, the teacher will sometimes lack knowledge and experience that the children have. Joubert (2001:22) writes that teachers need to accept this: 'Creative teachers should be prepared to learn from their pupils and not be afraid of looking foolish'. In the *spa*, the teacher needs to display a real acceptance of valid suggestions that originate from the children's experience. Boden (2001:98) cites 'an unbending insistence on the right answer', as one of the things that 'will smother creativity in the classroom'. In the *spa*, the range of valid responses from the children is wider than when products with the same purpose are being designed.

Projects designed and made by the children outside the focus group

The projects below are those of the rest of the class that were not in the focus group which was examined in greater detail. However, they are included as further evidence of the diversity of projects that resulted from the *spa*. As with the focus group projects, these reflect the children's individual needs and interests.

Birthday card

Category: pictures with working features. The child needed a birthday card for her mother, a cat lover. She exploited the fact that the pressure pad could be easily hidden, and positioned it under a 'stroke me' message. The cat's eye lit up when the pad was stroked. She had clearly generated her idea for a product after thinking about who would use it and what it would be used for (DfEE, QCA, 2004).

Tennis ball target game /baseball trainer

Category: games. This idea involved throwing a ball at a target that incorporated the pressure pad. This project was a development of a game painted on the child's playground wall. They provided instructions for use (Appendix 13), the spelling punctuation and capitalisation is their own: 'You get the Tenis ball- hang the bord on the wall then Frow the ball at the targit If you hit the Sercl it is a ballseye and to be acurt the light will light up'. This child had an interest in baseball and planned to use it to improve their pitching.

Dog wants to go out or come in warning

Category: alarms. This included a buzzer to let people know that the family dog was scratching the door to come in. It always scratched in the same place so the switch could be positioned appropriately. A second switch was planned for inside to warn that the dog needed to go out. Durable or replacement surfaces were considered to cope with damage from the dog's claws.

Notepad holder that could also be used in the dark

Category: enhancing another project. This was a green project that used paper that had already been printed on one side. The punched paper was tied to a corrugated card holder that was decorative and also held the battery and bulb. All materials were salvaged, apart from foil in the pressure pad and the circuit. The bulb went off when the pad was not being held to save energy. The publication of materials such as 'Developing Sustainability through Primary Design and Technology' (Benson and Lunt eds., 2007) indicates the interest in green issues in the subject. A teacher using *spa* could add a green requirement to the starting point if they wanted this emphasis.

Magic wand

Category: fun projects. The end of the wand lit up when the hidden pressure pad was pressed. After experimentation, the sensitive place was positioned where it would only be pressed by the initiated. The wand was then said to light up when held near people or things with various characteristics. It could also be used as a 'lie detector'.

The designing and making that took place once the focus group children had made their initial conceptual design decisions

Once the children had made their conceptual design decisions, in that they had conceived the purpose and nature of their projects, more detailed designing was required. This took place during the intermediate phase, post-brainstorms and pre-evaluation/product interviews. These data are presented under headings based on those suggested by Barlex (2004:106) for 'auditing the range of design decisions'. These are: technical detail/construction, aesthetic, and marketing. The term marketing: 'who the design is for, where it will be used, how it will be sold,' (ibid) corresponds with 'generate ideas for products after thinking about who will us them and what they will be used for' in the key stage 2 programme of study (DfEE, QCA 1999:18).

Concentrating on a focus group during this busy period, enabled the researcher to study individuals more closely than would have been possible with the whole class. The other children were not neglected by the researcher and two Student Ambassador learning assistants also helped the class. Videoing was considered to be impractical as a method of data gathering while the children were working. Movement about the room would have blocked the camera's view and capturing the audio aspect would also have been difficult due to talk away from the microphone and background noise.

The researcher observed that a considerable amount of design modelling took place during the making period. Modelling is used here to mean the manipulation of materials to temporarily represent what might be. The children were seen 'playing' with their pressure pads as they discussed ideas. They pressed them, turned them and placed them on partly made projects to see if they worked. Designing is a creative activity that has much in common with play. Jeffrey and Craft (2001:9) write that: 'Playing with information, materials and ideas is a central feature of creative practices for people of all ages'. Davies and Howe also mention starting with making as a means of stimulating ideas (2005:182). 'In order to develop their creative ideas, children may find it helpful and motivating to get their hands on materials as soon as possible'. This is a strength of the *spa*. Elmer (2002:19) writes that modelling: 'provides learners and their teachers with a 'concrete lever' that can 'expose and get a purchase on learners' thought processes'. It was however, sometimes necessary to ask children to explain the ideas they were modelling as they handled their pressure pads. This was because some of the modelling was largely cognitive; it existed largely in their minds. The intangible aspect of modelling and its ephemeral nature, might pose a problem for teachers needing evidence for assessment or Ofsted purposes. This is by no means peculiar to the *spa* and part of the solution would be to use digital photography, video clips and electronic portfolios. Benson (2004:143) recognises that ICT offers 'new opportunities to investigate, to share and record ideas, to trial and model ideas'. Mitchell, Grover and Bradley (2003:84) write that electronic portfolios could: 'document the design process leading up to the manufacture of a product'. Kimbell (2005:7) also argues that 'electronic portfolios will become really important for design and technology in the next few years' and describes how he has used digital means to capture students' modelling.

Discussion of data relating to individual children as they were designing and making

The data below were selected from the Dictaphone recording made while the children were working and field notes made shortly after. The researcher needed to move among the children to help them. Therefore it is not claimed all the 'designerly thinking' (Benson, 2003:5) was captured, but an indicative sample was recorded. Four of the six children in the focus group became involved in modifying the given starting point to suit the needs of their individual projects. This took the form of altering the size of the 'window' inside the pressure pad to make the sensitive area more or less specific. The possibility of 'customising' the original switch in this way was introduced by the researcher early in the session.

> 20. You can adjust how sensitive this switch is by the size of the 'window'. So if you make a very big 'window' it'll go on when you press it sort of anywhere OK
>
> 21. If you ehm make it a very small 'window' it'll only go on when you press it in one special place. OK So that's basically how it works.

The results of individual design decisions are also apparent in the final artefacts shown earlier (Figures 7.1-7.6). However, the data gathered while the children worked, helps to give a more complete view of their designing. This could not have been gained by considering the final artefacts alone. The levels mentioned in what follows are the National Curriculum level descriptions. A single piece of work will not meet all the expectations set out in a level description. However, the evidence that follows could contribute to deciding the children's end of key stage level. The children in the data gathering were near the end of key stage 2, when most pupils are expected to be achieving level 4 (DfEE, QCA, 2004:42).

Figure 7.1: Ritchie - a picture where the 'eyes' light up

Technical detail/construction

Ritchie was seen to experiment with the size of the 'window' or central hole in his pressure pad. He said he wanted the sensitive part 'to be in one place,' meaning a very specific area. When the existing 'window' proved larger than he wanted, he thought he had 'wrecked' (sic) his project. The researcher noticed Ritchie's frustration and suggested adding a smaller 'window' in a separate piece of card. Learning from his previous mistake, Ritchie had the idea of trying out his new smaller 'window' before fixing it. He was reflecting on his ideas as they developed and identifying what was working well and what could be improved (level 4). Ritchie had spontaneously applied the strategy of modelling a solution before committing himself to it. He evaluated two 'window' sizes and kept the one that gave the effect he wanted. Ritchie initiated the development of his project. His experience of the starting point meant that he knew how to make the changes and no demands were made on the researcher's time.

Aesthetic and marketing

Ritchie was heard to discuss individualising his project by making the picture changeable 'so that different people would like it'. In doing so, he was generating 'ideas for products after thinking about who will use them,' as is required in the key stage 2 programme of study (DfEE, QCA, 1999:18). This is evidence for level 4: taking users views into account. At first Ritchie did not indicate where the sensitive part was on his picture. After trying to find it, another child talked about making finding the sensitive place part of a game. Ritchie did not pursue this idea but it opened up new possibilities and showed the value of children sharing their work. As in the brainstorming sessions, it is noticeable that one child's idea can provoke and idea in another.

Figure 7.2: Conrad - a board game.

Technical detail /construction

Conrad wanted to 'make his game more interesting' and asked if he could 'have more than one pressure pad'. This is evidence of Conrad communicating alternative ideas (level 4). The researcher told him to make the extra pressure pads and to start thinking about how they should be connected while he was doing so. He was later observed laying out the pressure pads in different ways and modelling the possible paths of wires with his fingers. Conrad was able to make the extra pressure pads independently as this involved reproducing the starting point that he had already been taught. It was interesting to observe him devising a way to 'mass produce' his pressure pads. This included using his first switch as a template and seeing how many pieces of card he could cut at the same time. He had already written instructions such as 'move forward two squares,' on individual pieces of card. When questioned by the researcher, he said that he had not done this with any plan in mind. However, it was serendipitous, as this and the moveable pressure pads, allowed him to experiment with different layouts. Some pages (Appendix 14) of the researcher's Exciting Electrics pupil's book (Good, 1999a) were relevant, so Conrad was given access to them. These pages dealt with games and multiple, 'wandering ' pressure pads he needed. This encouraged some independent learning and showed the usefulness of support material in helping the teacher to service individual needs in the *spa*. The researcher was able to move on to attend to others, returning later to help with connecting the switches.

Aesthetic

Conrad was keen to make his game 'look good'. He planned to add materials that he had at home. These included plastic fantasy figures and stickers which he collected as a hobby. This is an example of a child adapting the starting point to fit in with their own interests. The researcher introduced Conrad to the idea of using mouldable materials. These included papier mâché and Mod-roc, a plaster impregnated cloth, to make terrain for his games board. He said he had used papier mâché in art and was interested in the possibilities that Mod-roc offered. He was given a copy of Moulding Materials (Good, 1999c) to refer to while the researcher moved to work with other children. This is an example of how this starting point could reinforce previous learning in another subject and of how new materials could be introduced as they become available.

Marketing

The researcher introduced Conrad to the possibility of developing different board games from his basic concept. This involved devising various top layers for his functional parts. He quickly realised that having different top layers meant that the games could be 'marketed' to players of different ages or with different interests. He mentioned the possibility of making another, simpler version of his game that he could play with his younger brother. He was taking prospective users' views into account (level 4). The researcher suggested adding simple knife switches so that some pressure pads could be disconnected in the simplified game. He was provided with copies of Starting CDT (Good, 1987) and Exciting Electrics (Good, 1999a) where these switches are explained (Appendix 15). This was another example of *spa* based support materials helping the researcher to cater for the diversity of projects in the class.

Figure 7.3: Libby - a mat which warns or welcomes

Technical detail /construction

Libby's first functional problem was that the original starting point pressure pad was too small to be operated by a foot. She had tried standing on it without success. The researcher explained that her shoe was bridging the 'window' or hole in the middle layer of the switch. This was preventing the top layer being bent through the 'window' to complete the circuit. She had the idea of using her shoe to find the minimum size for the 'window' in a larger version of the pressure pad. She also noticed that her pad was 'too small' and that people might ‘not step on it' and realised that a larger pad would help with that problem as well. Having made a larger pressure pad, she found that the top layer sagged through the larger 'window', causing the switch to be permanently on. This caused her some frustration, but she was encouraged to experiment with a thicker top layer and that solved the problem. Libby got other children walk on her project to test it and found that 'some still weren't making it work'. She asked them to try again while she watched closely. She was seen noticing that despite the earlier modifications, her testers were still able to miss the sensitive area on the mat. She was later seen to have changed her approach by painting on a face and the instructions: 'Don't step on my face, step on the writting' *[sic]* (Figure 7.3). The non-technical aspect of Libby's solution was designed to influence the behaviour of the users. This was a reminder to the design and technology orientated researcher that solutions to design problems do not always have to be technical ones. In this project, at this point, she arguably moved towards level 5. Libby tested and evaluated her product, showing that she understood the conditions in which her design would have to function. Although the starting point pressure pad was connected to a miniature bulb, Libby had seen buzzers on projects displayed in the room and asked for one. She realised that an audible warning would be better for her project.

Aesthetic

In this case, the appearance of the project was partly driven by functional considerations. The painted face was not merely decorative but also intended to encourage users to tread on the sensitive place. Another child later pointed out that feet would dirty the project and Libby began to talk about ways of protecting it.

Marketing

Libby's project reminded her of a dance mat, which had featured previously in the brainstorming. This provoked a discussion with other children about alternative uses for her idea. Using her understanding of the characteristics of familiar products when developing her own ideas, was a move towards level 5.

Figure 7.4: Zoe - A pressure pad used to operate a light on a toy.

Technical detail /construction

Zoe chose to enhance a mechanical toy made previously. She realised that her existing pressure pad was too large to fit easily on her toy. At first, she wanted to make another smaller switch. Then she explored the possibility of cutting her original switch down to a suitable size. The researcher showed her how to avoid cutting the functional parts of the switch. At first, she was unsure where to fix the pressure pad. The machine needed to be held while the handle was turned so Zoe decided to fix the switch where she held the toy. The possibility of using the mechanism to 'stroke' the switch on was discussed but not pursued. She said she 'liked it as it was'. Causing the mechanism to operate the switch, would have provided progression in terms of additional technical challenge.

Aesthetic

Zoe was interested in the appearance of her toy and wanted it to 'look cool'. Coloured paper was considered rather than a paint finish as she 'didn't want to wait while it dried'. However, early attempts at covering the project in paper proved difficult and paint was subsequently used. She worked with a variety of materials with some accuracy and paid attention to quality of finish and function (level 4).

Marketing

Though she had not opted for the mechanism activated switch discussed above, Zoe agreed that some users would like this and nearby children agreed that it would be 'wicked'.

Figure 7.5: Jenny - Night light

Technical detail /construction

Having previously decided on designing 'some kind of nightlight', Jenny considered different ways of using the pressure pad to turn her light on. She tried pressing the switch with her eyes shut to see how easy it would be to find in the dark. She reflected on her design as it developed, bearing in mind the way the product would be used (level 5). Then she had the idea of a switch that 'stayed on at night'. By trying things found in the room, she eventually realised that something 'heavy but not too big' was needed to keep the switch on. She was encouraged to think about things on her bedside table that could stand on the switch. She decided that her small teddy bear or watch would not be heavy enough. Jenny suddenly remembered knocking her drink over when she reached for it in the dark. Jenny borrowed a beaker to see if her nightly glass of water would make the switch go on. When it did not, she was puzzled at first but she mentioned that the plastic beaker was not as heavy as her glass, even when filled. The researcher realised that the glass or beaker would 'bridge' the 'window' in the switch, preventing the switch going on. It was suggested that to Jenny that she might try a larger 'window', which she did successfully. She said she would try her glass of water at home and 'knew how to fix the switch', if it needed further adjustment.

Aesthetic

At first, Jenny was unsure about how her project should look. The researcher suggested that it might be designed to 'fit in' with what was already in the room, or reflect an interest of hers. Jenny combined these ideas. She had a small aquarium at home and this prompted her fish design. This is an example of the researcher provoking an idea rather than providing one.

Marketing

Jenny was designing for her own use but when prompted she agreed that others might not share her interest in fish. She thought that her idea could easily be adapted for use by others. A superhero design was suggested by Conrad, who was working nearby; a West Ham version was suggested by another boy who was outside the focus group. This is an example of how the basic concept of each of the projects could be developed in different ways.

Figure 7.6 Denny - home for a pet rock

Technical detail/construction

Denny could not find anything in the room that he thought was suitable for the 'home,' so he set about making something. He clearly knew about nets or developments as he made the rectangular box without asking for help. At first, Denny said he intended to use the weight of the rock to keep his pressure pad on and 'show that it was at home'. He gathered stones during a break and found that a large one was needed to make the switch go on. This would not fit into the box that he had made. Enlarging the 'window' in the switch meant that a smaller, more easily accommodated rock would operate it. The researcher had been working with another child and missed the opportunity to suggest making the box after the size of the once the rock was known. The light stayed on while Denny worked on the 'home'. After a while, he mentioned that this was 'wasting the battery'. He was seen to take the rock off of the pad and pause for thought. After a while, he decided on a smaller, manually operated pressure pad to fit on the outside edge of the box. Having made the original starting point, Denny was able to make a smaller switch independently. The researcher did not know what conditions pet rocks required so Denny was the 'expert' on this. This teacher pupil role-reversal is features again when the final artefacts are considered.

Aesthetic

The 'home' part of the title suggested protecting the 'pets' but the bars that Denny made implied that he felt that pet rocks also need to be contained. Alert to the humorous nature of his project, he thought that this would be increased if the 'audience' could 'see the rocks inside'.

Marketing

Denny accepted in a good natured way, that not everyone would want a pet rock and need a home for one. He was able to suggest that other things could be displayed in an adapted version.

Discussion

The most striking thing about the projects designed and made successfully in this class, is how much they differ from each other in purpose. Barlex (2004:107) mentions the significance of differences and similarities when looking at children's work:

> In looking at the products designed and made by a class of pupils it will be important to look for differences and similarities in the work produced as this will give insight into the features of creative activity: levels of imagination; the extent of originality; the variety of value in the different offerings; and the different purposes pursued.

The only similarities that the projects in the *spa* class had, were the required starting point and materials used. The different purposes of the projects led to different criteria for success, for example, only Libby's project had to be capable of being operated successfully by a foot and only Jenny's by a glass. The projects are evidence of the diversity that can result from the *spa*. Within the constraints of the starting point, the children were able to set their own individual design briefs. It is possible that one of these design briefs might be set in a class following the orthodox approach without being confined using the QCA scheme. However, in contrast with the *spa*, the teacher would decide and all children would follow the single brief. There could, indeed should be considerable variation in the designs but all would be on the same theme. The *spa* session in the research resulted in successfully completed projects. These outcomes had diverse purposes that had been determined by the children themselves.

The children engaged in a considerable amount of design thinking after they had made their initial conceptual decisions. There is evidence in their interactions with the researcher and each other. Although not all the design thinking could be captured for reasons mentioned earlier, it was clear from working among the children that there was considerable 'on-task' interaction. Ritchie for example, was heard to discuss individualising his project with others and Libby got children walk on her project to test it. While the researcher was talking to Zoe, children commented on the idea for her project that was being discussed. As mentioned previously, *spa* based printed support materials proved helpful in encouraging some independent learning. They also facilitated the researcher's servicing of the diverse projects by avoiding the need to repeat how to make the pressure pad for example.

The individual interviews

As is evident above, the children engaged in a considerable amount of formative evaluation as they worked. In subsequent individual interviews, they were given the opportunity to talk about their final product.

Ritchie (Figure 7.1) was unable to identify the inspiration for his project when asked.

> OK the dollar sign right we get the idea. So how did you have the idea do you think? Do you know what gave you the idea?
>
> I just drawed the picture and then I made some dollar signs behind and it was meant to be just a picture but then I thought to make it into a pressure pad.
>
> So it started off just as a picture. Yeah OK. So what gave you the idea for the dollar signs Do you know?
>
> No, I was just like, making a picture.
>
> OK but then you thought of the idea you don't know where the idea came from.
>
> No.

Ritchie's design it seems, just came to him. Its purpose was also unclear, except that it clearly gave him pleasure. He exploited the fact that the pressure pad could be hidden and clearly enjoyed showing the 'trick' of making the bulbs light.

As it was Conrad's decision to design a board game, he arguably had greater ownership of it than if it than if the task had been imposed by an adult. He also had specialist knowledge of this kind of game that the researcher did not. During his individual interview, he showed his game off enthusiastically and said:

> I like games but this one is special because *I* thought of it for myself!

There were no other games being made that Conrad could have copied. If the class brief had been to design and make a game, different designs may have resulted but copying would have been possible.

In her individual interview, Libby commented on being given a choice about the purpose of her project.

> I like choosing my own thing to make, it made me want to try harder. This [indicating the project] works better now I've changed it. Ehm at school I had to make a little car that I didn't want.

Libby acknowledges the value of evaluating and then modifying her work. This piece of speech is evidence in microcosm of what the *spa* can provide. Libby chose the purpose of her project and her comments are evidence that she was motivated by doing so. She preferred this to the imposed project that she mentioned. Her project was completed successfully, while different projects were completed in the same class.

Zoe demonstrated her project during her individual interview.

> The light makes people notice the moving bit more. I can make it flash as fast as I want by pressing. I like being the only one to have the idea, I wanted to make the toy better.

This child had a different approach to using the starting point from any other in the class. A previous project provided her stimulus and she saw an opportunity to improve it. Zoe expressed satisfaction that her work was 'different' in this respect. The *spa* allowed this level of difference and Zoe felt able to negotiate this.

Jenny was particularly keen to demonstrate that her nightlight worked 'automatically' when the glass was put on it. She had worked out for herself how to 'make the fish stand up so that people could see it' and was pleased with overcoming this challenge and others described earlier. She said that 'she would use it every night'. Since the light would be on for long periods, a critical adult might point out the consumption of batteries, but in her terms, it was a success. This was an original project that met her particular needs.

Denny said he was 'really happy' with his project and his photograph (Figure 7.6), reflects this. However, during his individual interview, he was keen to explain an interesting idea that he did not make.

> Tell us about your design for the pressure pad then Denny.
>
> Well I was going to do an electrical stick tape ball but I didn't think the idea was suitable enough for……
>
> What do you mean by an electrical stick tape ball?
>
> OK go on then Denny, tell us about your design for the pressure pad.
>
> Well my design is an electrical stick ball tape.
>
> Right well tell us what that's like because we don't know what that means.
>
> Well you start off with the pressure pad and you put that to one side like when it's completed. Then get like anything like a ball of plasticine or something and make sure there is a hole at the top so you can put enough space to put a pressure pad inside and then after you've done that put loads and loads and loads of tape covering all of the plasticine so that you can't see it.
>
> So it's a sticky ball – it's the stickiness in the tape Ahh right. So how does it actually work?
>
> What happens when someone uses it? What they do is they kick so that it will glow.

Unfortunately, he was interrupted, so why he elected not to make the rock home in preference to the 'stick tape ball' is not known. It is interesting that neither of Denny's ideas were featured in the group brainstorming. The home for a pet rock, first appeared during individual practical work. Idea generation was clearly not confined to the time designated for it. The stick tape ball did not become known to the researcher until the individual interview after the *spa* session. It would have been missed altogether but for the data gathering. Children were observed generating and discussing ideas after the brainstorming stage. This happened particularly while children were making the starting point which provided a tangible stimulus. Idea generation is not a tidy process and ideas may come after time allocated for this has passed.

Progression within the starting point used during the spa session

The children in the study were working on entry level pressure pads (Appendix 3). Entry level meant that their designing and making was based on the simplest form of pressure pad attached to a very simple circuit. This was appropriate, as their responses to question 4 of the pre-*spa* questionnaire (Appendix 11) showed that they had not encountered pressure pads before. However, there was scope for progression within this starting point. Conrad provided an example of adding technical and conceptual complexity by using multiples of the starting point in his game (Figure 7.2). Some children progressed to modifying the starting point to meet the needs of their individual projects. The size of the sensitive area of the switch was increased by Libby and reduced by Ritchie for example. In terms of the National Curriculum level (DfEE, QCA, 2004:42) descriptions, they were seen to 'reflect on their designs as they developed' and to identify what was 'working well and what could be improved' (level 4). Arguably, they progressed to checking their work and modifying their approach in the light of progress (level 5). Evidence over a longer period would have been needed to confirm this, but they were on that 'trajectory'. Had there been subsequent sessions, the children could have built on their knowledge, skills and understanding by progressing to more complex pressure pad starting points featured in the researcher's pupil's book (Good, 1999a) (Appendix 2). These feature in the Pressure pads starting point 2 (p.15).

Knowledge, skills and understanding in the spa session

During the *spa* session, an attempt was made to enhance the children's knowledge, skills and understanding, as well as to provoke the quantity and variety of ideas discussed above. For the *spa* to be relevant to English schools, it must be compatible with the National Curriculum and this includes delivering 'Knowledge and understanding of materials and components' (DfEE, QCA, 2004:19). DATA (2005:1.1.3) endorses this:

> One of key values of design and technology to the curriculum of a school is that it provides an opportunity for children to develop an understanding of technological processes, products, their manufacture and application, and the contribution of technology to our society.

In design and technology, knowledge is not only valued for its own sake but perhaps rather more for its practical usefulness. In the *spa* session, knowledge of how the starting point worked and how it was already used, were also part of the stimulation of creative ideas. Fautley and Savage (2007:38) also make the link between knowledge and having ideas:

> Creative moments are likely to occur once pupils have assimilated enough information to allow them to think in such a way as to make new connections, or develop new insights.

Data presented in phase 1 of the research indicated that children were able to make meaningful connections between the pressure pad and existing uses of it in the made world around them. This in itself has value in terms of demystifying the technology as they made their own example. The pressure pad starting point is particularly pertinent to the National Curriculum for design and technology requirement that pupils should be taught: 'how electrical circuits, including those with simple switches, can be used to achieve results that work' (DfES, 2004:18). When they were making the pressure pads, the children acquired information and skills in basic aspects of electricity such as: open/closed circuit, conductors and insulators. This addressed aspects of the key stage 2 programme of study for National Curriculum science (DfEE, 1999: Sc41a) as well as those for design and technology (DfES, 2004:18). Crucially, the study also aimed to give children opportunities to apply their new found knowledge creatively in designing projects based on their own ideas. It was evident from the data that the children were able to apply their pressure pads in a creative and innovative manner as a response to the problems that they had identified. Here it is important to notice that it was not known beforehand what applications for pressure pads would emerge from the children. The activity focused on children's innovations. In this regard, many of the children in the data gathering session, acted in accordance with the idea put forward by Adams (1993: 87):

> Successful inventors that I know are extremely problem-sensitive. They are tuned to the little inconveniences or hardships in life that can be addressed by the technology they know.

Importantly, this is in accordance with how the made environment has developed and still develops through human activity. Ingenuity, innovation and problem solving are part of the basic essence of design and technology (Sparkes, 1993, Järvinen, 2001). This could also be crystallised in the definition: 'Technology is human innovation in action' (ITEA, 2000). Consequently, teaching design and technology must not be mere study of how technology works. This was only part of the *spa* session. Children need to be given opportunities for creative and innovative action in the subject, as they were in the data gathering. The study focused on the innovative use of pressure pads in applications arising from the pupils' own ideas. It is argued that *spa* allows and encourages creativity in technology education in a way that differs from and in terms of diversity, surpasses approaches where the purpose of the project is specified by the teacher.

'Excellence and Enjoyment- A strategy for primary schools' (DfES, 2004:5) places great importance on the child as an individual under the heading: 'Learning- focus on individual children'. The *spa* gave individual children in the data gathering session a real say in the work they would do and required them to identify problems as well as solve them. Increasing children's experience of real decision making can only benefit democracy as well as enhancing their experience of design and technology.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

The starting point approach is a pedagogical tool and process that is intended to promote creativity and choice in design and technology in a way that is manageable for the teacher. Children are encouraged to decide the purpose of their individual project as well as its design. The purpose of the research was to examine the contribution of the *spa* to primary design and technology.

Phase 1 of the research was designed to ascertain whether the children within the study could operate the *spa* demonstrating an understanding of the processes and principles involved. This was pursued through three subsidiary research questions that focused on important aspects. Question 1a, provided evidence that the children were able to identify existing uses for the exemplar starting point, a pressure pad. Question 1b, provided evidence that the children could generate a variety of ways to turn a pressure pad on; Question 1c, provided evidence that the children could find applications for their pressure pads. Findings from phase 1 indicated that the children in the study could operate the *spa*.

Findings from phase 2 suggest that the children following the *spa* were able to identify their own uses for the starting point to design and make products with different purposes within a single class. It is proposed that the use of *spa* reconciles the often conflicting demands of teaching skills and knowledge with encouraging individual creativity.

The QCA and Nuffield approaches are considered within the thesis and their major contribution to the development of creative and diverse responses and knowledge, skills and understanding in the subject is acknowledged. The prior experience of the children in the study was overwhelmingly based on the QCA scheme and it is proposed that the *spa* complements such existing approaches to design and technology.

Phase 2 investigated the *spa* process in a classroom context. It included consideration of the generation of individual conceptual ideas and the subsequent design decisions and practical outcomes made by the children. The findings indicated a number of themes that contributed to the effectiveness of the *spa* session, specifically:

- **The brainstorming sessions** emerged as significant in the *spa* and revealed the richness of the exchanges between the teacher and the children. Particular features included the children's idea generation, the teacher's provocation of ideas, modelling of idea generation and the encouragement of metacognition;

- **The promotion of psychological safety** emerged as a recurring theme. The many responses from the children together with the quantity and fluency of their ideas, supports the view that they felt 'safe' to have, and express ideas;

- **The importance of the researcher asking different types of questions to support learning.** For example to clarify the child's understanding; to request ideas; re-start the flow of ideas; encourage children to clarify or elaborate on their ideas, and importantly, to provoke ideas;

• **The coaching of idea generating skills - modelling and metacognition** by the teacher were a feature when ideas were being generated. The active coaching of thinking skills is supported in the literature. The teacher researcher's role went beyond encouragement and involved actively teaching and modelling creative techniques and strategies;

• **Ways of exploring ideas: language and manipulation of materials** were very important in the *spa* session as a means of provoking, encouraging, expressing, developing and clarifying ideas. Designing through making was also important. There was evidence that making and trying out the starting point helped to prompt the children's ideas. During the making process, children manipulated their pressure pads, discussing ideas as they did so. The final artefacts of the focus group children and those of the others in the class, are evidence of the amount and variety of designing that took place;

• **Knowledge, skills and understanding in the *spa*** were needed by the children in the research to stimulate and realise their ideas. They brought some of what they needed to the session from: outside school, other areas of the curriculum and their school experience of design and technology. It was evident that the teaching and making of the starting point provided the central knowledge, skills and understanding needed in the session. The children were observed to use supportive printed materials that reinforced knowledge and understanding. This independent learning gave the researcher more time to discuss individual projects. The children's successful completion of their projects is evidence that they had gained sufficient knowledge, skills and understanding to do so.

• **The diversity of purpose and individual choice of projects** are important and distinctive features of the *spa*. The most striking thing about the artefacts designed and made by the children in the study was how much they differed from each other in purpose as well as design. Apart from materials and finishes, the only similarity between the projects was the required starting point. The range of projects is evidence of the diversity that can result from the *spa*. Within the constraints of the starting point, the children were able to identify their own individual design briefs and decide the purpose as well as the design of their projects. The children in this research could be said to have been doubly creative. Firstly, when they devised their own individual briefs, and secondly when they designed and made solutions to their briefs.

The findings of this research supported the potential of the *spa* to impact on primary school teachers intending to promote individual work, personalisation of the curriculum, creativity, ownership and choice in primary design and technology. The research may also be of interest to teacher educators working in the primary design and technology field. They could present it to their student teachers and cpd teachers for consideration as an additional strategy for encouraging creative and diverse responses. The findings offer a new perspective on enabling primary school children to personalise their learning through identifying their own design problems. They demonstrate that projects created in the *spa* class are characterised by diversity and pupil choice. This enables teachers to work with ideas that originate from the children's own interests experience. The *spa* has the potential to encourage teachers' confidence because it gives them control of what technology will be required. For example the pressure pad used as an exemplar in this research. The necessary knowledge can be acquired through CPD and/or reference to support materials.

Contribution to knowledge

The research offers an original model of how primary school children's problem finding, choice and ownership of their work in the subject can be enhanced. It offers a way in which design and technology projects with different purposes can be made feasible in the primary school classroom. This research provides evidence of a contribution to knowledge:

- By establishing and examining a unique approach to teaching of primary design and technology;

- By providing evidence to support the effectiveness of this teaching approach;

- By demonstrating that by using this approach, design and technology projects with different purposes can be managed at the same time within one classroom. This is both a contribution to knowledge and professional practice;

- In that it supports the teaching approach as a useful contribution to existing approaches that support diversity in the classroom;

- By establishing and demonstrating a tool through which the videotaped data may be analysed. This facilitates the identification of different themes and pedagogical practices.

Future research

The research presented in this thesis was small scale and examined the work of one teacher with a single class of children from one year group. However, it demonstrates that a group of children can operate the *spa* successfully and what happens when they do. It provides a basis for a large scale follow-up study by a team of teacher researchers.

Further research questions that stem from this study

- Would the findings of this study be confirmed by research with children older and younger and than those in the data gathering? This would require a larger study involving data gathering with foundation stage and key stage 1 children and secondary school students

- What would be the long term impact on the learning of children following the *spa* over an extended period? This would involve carrying out a longitudinal study to assess the impact on children's designing and making as they become increasingly experienced operators of *spa*.

Recommendations

The findings reported in this thesis suggest that improved teaching and learning in design and technology will occur if the following recommendations are adopted:

- the *spa* should be considered as an approach to teaching primary design and technology;

- continuing professional development should be offered to enable teachers to learn about the *spa*, so that they can consider using it alongside established schemes

- teachers should be coached in the provocation of children's ideas for using the starting points. This should include leading brainstorming sessions, the role of language and questioning skills

- teachers should be encouraged to use the modelling of idea generation and the encouragement of metacognition in *spa* sessions

- support-staff who will assist in *spa* sessions, should receive training in the approach

- when using the *spa*, teachers should endeavour to create a learning climate in which children feel secure enough to risk having and expressing imaginative ideas

- teachers using the *spa* need to acknowledge the value of children's individual interests, knowledge, skills and understanding from outside school, other areas of the curriculum and that gained in previous design and technology work.

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APPENDICES

Appendix 1 Children's University Session - Transcript of speech from the video.

Appendix 2 Pressure pads starting point 2 - .Support materials from: *Exciting Electrics* (Good,1999a) and the *Design Challenge Teacher's Book* (Good, 2000).

Appendix 3 Pressure pad starting point 1 - The introductory level pressure pad used in the data gathering. Support materials from *Exciting Electrics* (Good,1999a) and the *Design Challenge Teacher's Book* (Good, 2000).

Appendix 4 Things that can collapse- starting point - Support Materials from: *Super Structures* (Good, 1999d) *Design Challenge Teacher's Book* (Good, 2000) provide support materials.

Appendix 5 Crankshaft starting point and Mechanisms starting point 2 - Support materials from: A*mazing Machines* (Good, 1999b) and the *Design Challenge Teacher's Book* (Good, 2000) provide support materials.

Appendix 6 Moulding materials starting point- Support materials from: *Moulding Materials* (Good,1999c) and the *Design Challenge Teacher's Book* (Good, 2000).

Appendix 7 Consent letter

Appendix 8a- .Flipchart from Brainstorming 1 – Uses of pressure pads in everyday life.

Appendix 8b - Flipchart from Brainstorming 2 – Ways to make the pressure pad go on

Appendix 8c- Flipchart for Brainstorming 3 – Ideas for using the pressure pads

Appendix 9- Lesson plan designed by the researcher

Appendix 10- Coding grids

Appendix 11- Pre *spa* questionnaire

Appendix 12- Post *spa* session group interview

Appendix 13- Instructions for a game designed by a child outside the focus group

Appendix 14- Wandering pressure pads - Support materials from: *Exciting Electrics* pupil's book (Good, 1999a).

Appendix 15- Knife switch - Support materials from: *Exciting Electrics* pupil's book (Good, 1999a).

Appendix 1

Children's University Session - Transcript of speech from the video.

Key

Red text = child's speech

Black text = researcher's speech

The *spa* group teaching session

1. In a bit I'm going to ask Asha to nip upstairs to the paper trimmer with some card and if you can make enough for three bits the same size for everyone and if you could take some foil and cut some foil strips about an inch wide ribbons and that will mean we can crack on that fairly quickly. You're gonna have to start on that now if you like please at the top of the stairs.

2. What Room number?

3. I've put some card there already – you'll see some coloured card if you could make those bits that would be a great help – lovely smashing.

Stage 1 - Introduction of pressure pad

4. OK So what we've got here then is a pressure pad switch, now this is very simple thing but it's very important device OK so what we've got here is three bits of card and some kitchen foil – there's nothing magic but you can do some pretty magic things with it.

5. So it's made from three layers – as you can see. Who's done switches in science? I'm sure most everybody's done switches – Good!

6. So could someone tell me what basically a switch is?

7. D- It's something what turns something on and off

8. That's it, it's a control device. Absolutely it switches something on and off.

9. Now to make a circuit, an electrical circuit work a bulb and a battery and you know bit a wire- you know that you have to have a loop Don't you?

10. Yeah so what we've got we got a switch then is where we introduce a gap but it's a gap that we can close up easily when we want to make the circuit work OK. And here you can see the gap in the circuit OK see the gap between the foil strips?

And what we'll do we'll put a loop on here which is the circuit – battery, buzzer whatever we want Yeah – that's the loop and there's the gap.

11. OK This bit we call the 'window' and the 'window' is just to separate the layers - the top part – mine's is falling apart a bit – goes through there and when I press it what happens?

12. Hands up

13. The light bulb goes on.

14. Yeah the circuit goes on absolutely yeah thanks Michael OK Zoe that's great.

15. So all it does is closes the gap so if we didn't have the middle layer what do you think would happen?

16. It would stay on

17. Yeah good hands up. Paul right at the back there

18. It'd stay on

19. Yeah you're absolutely right it would stay on so that middle layer is quite important.

20. You can adjust how sensitive this switch is by the size of the 'window'. So if you make a very big 'window' it'll go on when you press it sort of anywhere OK

21. If you ehm make it a very small 'window' it'll only go on when you press it in one special place. OK So that's basically how it works.

22. Alright now, the next thing we need to think about is why people bother with these. OK why do they have them?

23. Compared to the old mechanical switches they have a number of advantages first of all, it's very thin. Isn't it? Yeah.

24. I could make it even thinner – if I use thinner card so that means and it could be very small if you wanted it to be – Could be the size of a stamp yeah or smaller.

25. So these are used in things like mobile phones, microwave ovens and things like that because they are very thin and they don't take a lot of space up so that means we can make the device like the mobile smaller than if it had a great big plonky mechanical switch.

26. The other thing is they are very very tough because if I hit this really hard all I'm doing is squashing the layers together – I'm not going to damage it – not like a plastic switch which I might be able to smash.

27. These are pretty tough that's why they use them on things like cash point machines Yeah It just doesn't matter how hard you hit that you're not really going to break it.

28. OK so that's a number of advantages.

29. Another nice thing about it is you can put information on the switch itself. So if you want to put press here or something like that. Or press here for doctor's surgery or something you can put it on the thing and people touch the actual switch itself.

30. So that really is quite a nice thing. They're tough, they're cheap, they're easy to replace as well if something does go wrong.

31. So they are quite important little gadgets really. OK so how do we make one of these?

32. Very simple and Asha is making it even simpler by cutting up three pieces of card.

33. OK doesn't matter which, they can be different colours, doesn't matter what colour they are.
34. OK ehm that's the first job she's going to do for us. The other, the next thing you do is cut yourself a 'window' in the middle.

35. OK now we're not allowed to use craft knives. So how are we going to get that hole out of the middle?

36. Any ideas?

37. Fold the piece of paper in half and cut it.

38. Brilliant. Absolutely that's perfectly good – that's one way.

39. Could someone put the lid back on my black pen please or it's going to dry out otherwise – my black marker – whose got the lid?

40. Alright then, we've got to leave it then but eh if you do find it. Put a bit of foil over it could you? Cheers, oh you've got it - well done - that's great.

41. OK brilliant we'll need that later thanks very much.

42. Oh yeah that's the card yeah. No they only need to be about

43. A half

44. Or a quarter. I should've told you that sorry.

45. OK so we've looked at the switch we know what it is.

46. Now what's important, what's important today, is that we get as many ideas as possible.

47. OK so I want you to think of as many ideas for using this switch as you possibly can.

48. Right and we'll see how many we can get. So that's the task.

49. Now you notice you got different coloured pens in front of you OK ehm If you have any ideas - until I tell you to change pens – if you have any ideas even if I'm talking it doesn't matter I want you to do a brainstorming style.

50. You know like we did yesterday for the BAGS?

51. Have you done brainstorming where you do the loop yeah all that type of thing?

52. OK so you can put pressure pad – everyone can do that now actually – in the red pen –put a balloon in the middle.

53. If you haven't got one you can share – yeah you can share.

54. I'll get you some more paper hang on. Can you sort out some pens please?

55. We've got a couple of extra people I wasn't expecting.

56. So you need a red pen at the moment. OK. There is a tray of pens

57. Oh, here they are look. Get yourselves a red pen at the moment. Anybody else need paper?

58. Alright try and get it going see if you can get it going and eh

59. It doesn't work

60. You may have to share. It looks like we're out of red pens so you may have to share. OK use a pencil. Are you sure it won't work?

61. Mine won't work either

62. Here you go – some of these are just waking up Yeah? Alright? OK?

63. Mine won't work.

64. Yes it does. Right. Ehm.

65. I've lost all my gear now. So the idea is that at any time you have an idea. Doesn't matter what's happening you are allowed to write it down.

66. OK and I'll tell you when to change pens. So any ideas you have now, while I'm talking, you use your red pen.

67. OK So that's what's good about the thing. I've shown you how to make the thing as well haven't I. So that's that done.

68. Let's have a couple of minutes – I'll give you a couple of minutes just to bang down as many ideas you think what you could use this thing for.

69. I'll give you some more help in a minute but just put down as many things as you can as many red pen ideas as you can.

70. What you might use it for. Or what somebody could use it for. Nice and quick.

71. Try and make it so that someone else can understand it.

72. (Pause).

73. I'm about ready to start making now, we need the bits of card really, never mind .I'll tell you something else about what we do…

74. Give Tash a chance to make those for us but what we need now is the bits of card…

75. OK I'm going to show you now what I'm going to give you to fix onto the switch.

76. Right 'because it'd be pretty dull if it didn't do anything. Wouldn't it?

77. OK. What we've got here are some little things, little things called pea bulbs. OK. They are about the size of a grain of rice OK.

78. And they give you quite a bright little light. They are just clear, we could try to colour them by putting just marker pen over them or maybe by putting a piece of clear toffee wrapper, or something over it.

79. OK I'm just about in need of those. They can cut them up themselves because they'll need them in bits like that.

80. OK Anybody know what this thing is called?

81. Bet you've seen this before – go on then Ritchie – Sorry go on.

82. Wire

83. Yes, true yes but what's the whole thing called or tell me what it's for then.

84. Yeah go on then J… go on.

85. It's 'because right when you get those sort of battery holders. When you put the batteries in they have those sort of connector things and sort of long wire things and that's at the end of it.

86. Yeah that's right it's a battery connector or a battery snap and I bet most of you have used one of these. Haven't you?

87. On toys and things like that OK.

88. So what we've got here is a little pea bulb – it's just a little clear bulb and a battery snap.

89. Now you notice that the battery snap has a red and a black wire. Why is that then? Does it matter? Is it to make it look pretty?

90.Does anyone know why it's red and black?

91. Anyone... I'll tell you 'because it's quite important actually. This is, the red is the positive wire and the black is the negative wire.

92. OK now you notice that the bulb has got white wires and because they are both the same, it's telling me that it doesn't matter which way round I connect it.

93. But if I had a buzzer, you'd notice that the buzzer comes with a red and a black wire OK and if I had a buzzer, I'd have to put the black wire on the buzzer to the black wire on the battery connector and the other way round.

94. OK so sometimes it matters a lot. Some electronic things you can ruin by putting the battery in the wrong way round.

95. Yeah so it's really quite important to take care with that. Right. But when the wires are both the same colour it means it doesn't matter at all OK.

96. Now you notice the end of these wires –.and some of you are close enough to see – the end of these wires is a little bare piece of wire and it's silver coloured.

97. Right because these are designed to be soldered into electronic circuits. Yeah. Does anyone know what soldering is? What I mean when I say soldering?

98. No OK. It's you take a an electrical tool which gets hot and we use that hot tool to melt – it looks like wire – but it's actually made from tin and led and it's very soft stuff called solder. It's a kind of metal, we put that in the hole and it melts, and acts like glue. But what's special about it is unlike glue it conducts electricity. Yeah if we glued this in the glue is sort of plastic and would insulate it. You know about insulators and conductors. Don't you? Yeah. What's the difference between an insulator and a conductor? Yeah

100. A conductor let's ehm electricity through...

101.Yeah, you're absolutely right. Spot on. Well done. Yeah electricity can flow right through a conducting material like metals basically ehm it can't flow through insulating materials like plastic.

102. OK. So we need to know that. So in this case - that's why it's soldered - in this case – what's in here is copper wire and copper is a sort of ehm copper colour Isn't it?

103. It's a sort of browny colour isn't it yeah. But the reason it's silver is because these ends have been dipped in solder and solder is a mixture of tin and lead and gives it that sort of colour and that's to make it easier.

104. In the factories that solder the things in. Yeah. Now we can't do soldering here –we could – but they don't like you using them because the things are hot.

105. So what we'll have to do is twist the wires together. Alright. So there's not much bare wire there exposed at the moment, so what we'll set up later on is these gadgets.

106. Oh Ash and I'll help you with this and what we'll do is we'll strip off using these wire strippers – we'll strip off a piece of extra plastic.

107. Now the trick to do this –we'll probably do it for you – but the trick to do this is to curl it round your finger so that you can pull it. Because if you hold the bulb or battery and start to yank it you are likely to rip the wire out you see.

108. So the trick is to put it in there – these need. Setting correctly so this might not be set right but I'll try. Yeah. There you go. See.

109. Now you can see this is copper coloured. Isn't it? Yeah. Now when you get that what you want to do is twiddle the strands together because it looks like one piece from a distance but actually it's got lots of little hairy strands. Right OK.

110. And if you don't twiddle them together, they get all twisted up and messy. So what I do is get my fingers like that and I just twiddle it round in my fingers and what it does is twist all the little strands together into one piece and that makes it easy.

111. OK and then we do the same with the battery, with the battery as the bulb. This wire is a bit thinner and I have to set these specially so I'm pushing my luck a bit at the moment and see if it works.

112. Sometimes, you end up ripping the whole end off. Like that. OK There. It's really easy to rip the whole end off because the plastic is really thin and it's easy to do that. Anyway, see how they are all bushy yeah all I do then is hold it in my thumbs and twiddle it together. Right. Like that. OK.

113. What about that one?

114. Yeah that one needs doing too, but I just want to show everyone.

115. Now, this is the cunning part OK. This is – you wouldn't think there are different ways of twisting wire together – but there are. And if you do it this way, they are likely to stay together.

116. So what I've done is I've bent them down into a sort of letter T shape.

117. Yeah so the wires there and the wires sticking out there and out there. I've done that and now I'm going to twist them together as many times as I can. Because the more twists that you put in, the less likely it is to fall to bits. Yeah.

118. So you see I'm putting quite a lot of twists in there and that'll hold it fairly strongly – because it's a bit of a nuisance if it keeps falling apart.

119. We could then put a piece of tape over that if we wanted to insulate it. OK. There we have a circuit then but not a complete circuit because if I put on a battery on there now it wouldn't work would it? But if I did that would it work?

120. Yeah

121. Yeah, it would OK. Now instead of touching them together like that what we're going to do is staple them to our two strips on our pressure pad. Like that.

122. Now this is just a big one so that you can see it at a distance. We're not going to try to do this. Alright, so we got a circuit with a gap in it, and now we got somewhere to put it. OK.

123. So what Tasha'll be doing is cutting up some foil strips for you. If you use blunt scissors on foil it tends to chew it all up - you know – so it's best if we get a sharp paper trimmer and trim them all up to ribbons of foil.

124. OK and then one wire go on one strip and one wire goes on the other strip and you've got it.

125. Now there's a trick – there's an easier trick to that because we want to staple these wires on so that they stay put now - so what you do is – best to get someone to help you – one person holds the wire while the other one holds the stapler.

126. Put the stapler on the table – don't do it by squeezing it – put it on the table get your weight above it and put it down nice and tight OK. If you don't then the wires will keep falling out.

127. Now the other little trick – is this – we put two staples on each wire. It's quite a lot to remember but we will remind you if you need to be. The trick is to put one staple tight across the plastic of the wire and the other tight across the strands of the wire – the bare part yeah.

128. Because, this, the stapling it across the plastic gives it a good mechanical grip – it'll hold it yeah. But what tends to happen when you put that staple in the little bare parts tend to bend up and then they are not touching the foil – so the thing won't work. Yeah. But we know that so we are going to take care of that. So one tight across there and then one tight across there and it'll work a treat. OK.

129. So that's basically how you make the pressure pad and what we can do then is – oops mine has fallen apart because it's been all over the place and is bashed up – is ehm what we can do then is once this OK then we can staple it together so that it opens like a book.

130. It's a good idea to run the foil out to the edge of the card because that makes it easier for stapling. Yeah. You might notice I've drawn a, I've drawn a ehm square on mine.

131. and to do that all you do is you take your 'window' and if you make your 'window' 3cm square roughly yeah, try and do it tidily because it doesn't take you any longer to do it neatly does it? Yeah. About 3cm will do fine and then you stencil through that one, stencil through that one, and the stencilled squares tell you where to put the foil Yeah. Is everybody watching? NO because later on you won't know what to do.

132. I know what to do.

133. OK. But do keep watching because sometimes when I'm doing stuff like this I'll point to something and by the time you need to look –know you need to look – it's too late – it's gone. OK so we've got a stencil there, stencil there and when you look through the 'window' you need to see two bits of foil and the foil goes right to the edge and that one needs to go through the 'window' and goes on. And that's basically it. It's pretty straight forward – if you do it right. Now there are – there are other types of pressure pads we can look at but that … that'll do us for now. OK.

134 .So what we are going to do now is explore different ways of turning this thing on and everything I do now is to help you generate ideas.

135. OK a bit like we did for the bin bag. Yeah. It's that kind of thing. We want loads of ideas right. So what we are going to look at now is how can we – how can we turn this switch on? Where's me, where's me marker?

136. First of all, just before we do that, can we think of some places where these are used? I've given you some examples haven't I? I've given you some examples yeah.

137. TV remote

138. Yeah quite possibly. Yeah, yeah Ritchie

139. Sorry

140. Cash machines.

141. Yeah, cash machines yeah.

142. OK anyone got some more?

143. Light switch.

144. Yeah what kind of light switch? Have you seen these used around the place? Another others then yeah.

145. Like on the computers when you get touch screens.

146. Yeah on computers when you touch the screen it's not pressure pads actually but on computers and laptops you find that the keyboards yeah. Anymore? Yeah.

147. Mobile phone.

Stage 3 - Brainstorming 2 Ways to make the pressure pad go on

148. Yeah. OK so that's given us a few examples of where they're used ehm… now, now what we are going to do now is think about ways of turning the thing on.

149. Alright, now obviously I can press it with my thumb. How else can I turn this thing on? Let's have hands up. I can press it with my thumb.

150. What else can I do? Now as many ways as possible of turning this on yeah.

151. Step on it.

152. Yeah good. Yeah good. Ritchie

153. Sit on it.

154. Yeah good anymore?

155. Squeeze it .

156. Yeah good. Go on…

157. Pinch it.

158. Pinch it is a bit like squeezing it. Alright anymore? Sorry Sorry go on.

159. Head butt it.

160. Yeah good. Yeah head butt it. Any others? Yeah go on the

161. Use a remote control or is that the same thing as squeeze it

162. Use a remote control what would you do throw the remote control at it?

163. No, isn't it…

164. Sorry we're now thinking of ways of turning it on…yeah

165. We reckon you could put some weight on it

166. Yeah yeah good that's good

167. Belly flop it

168. Yeah yeah belly flop it well I've never had that one before

169. Good idea

170. Why not? Yeah go on

171. Elbow it

172. Yeah yeah good, we've got lots already. Doing well. Do you notice that once you get started it gets easier? Go on then

173. Punch it

174. Punch it yeah. Go on then there's still more

175. Touch it with your tongue

176. Yeah, press it with your tongue. Yeah it's possible isn't it. Now the reason we do this is any one of these might give us an idea for a project yeah. Go on then Zoe yes good – why not. Good we're doing well here. Go on then

177. Fart on it

178. I don't think we want that one. That's what we call not appropriate.

179. He said it

180. What?

181. He said it

182. You are the one that said it – you can't blame someone else.

183. He told me to say it

184. But you did it, if he said jump off a bridge would you do that? Don't answer that question.

185. Thank you, let's have appropriate answers.

186. Yeah, we could flick it like that. Anymore, yeah, we'll probably get lots more now. Once ideas start coming they tend to come easily.

187. Kneel

188. Yeah good good. I used to do karate and I was going to make a martial art training aid with it.

189. You can do all sort of things with this. Go on

190. Kick it

191. Karate chop it

192. Yeah. Go on any more? You realise you are contaminating my day by answering these questions. It's alright I'm only kidding. Anyone, go on sorry, have we got that one already somewhere. Yeah good, we've got loads though haven't we?

193. Throw the actual thing

194. Throw the pad

195…against the wall

196. Yeah yeah I've never thought of that one before. That's what makes design technology interesting you know we get new things coming up all the time. I've never thought of that one before and no one else has either. That's given me a nice little idea that has. Good.

197. Blimey just when you think we've run out someone has another idea you see. Go on then.

198. Blow on it

199. Yeah yeah if you make it sensitive enough. You're doing really well. Yeah. Good. Any more? Go on then.

200. Stamp on it

201. Yeah we haven't got that really have we. Good great stuff. Any more?

202. Drop something on it

203. Sorry?

204. Drop something on it.

205. Yeah drop something on it yeah yeah I'm running out of space here.

206. Could you shine a light on it?

207. Sorry sorry you were out of the room

208. It's a pressure pad.

209. It's a pressure pad, that's not fair. You didn't get a fair chance there. You didn't see how it works. OK but we know how it works. Right it works by bending the top layer of foil through the 'window' there so that it completes the circuit you see. So it needs some kind of pressure. That wasn't fair so you didn't get the correct answer.

210. OK any other ideas because we've got loads now? Let's see if we can see anymore.

211. Are there any ideas there that give us an idea? Well we could swing something into it couldn't we? On a rope, you know. Like that.

212. I'm running out of room. Well I think we did rather well there. But we still want some more. Go on then Alex

213. Put water on it.

214. Yeah, how do you mean like a hose a high pressure hose pipe on it that'd do it wouldn't it? I'd never have that of that one that's brilliant. Well done.

215. Like a super soaker.

216. Yeah yeah, I've got a super soaker you know. I got the biggest one in our family. With a shoulder strap and everything. It's really good. Yeah so eh yeah that's really good that one I'd never have thought of that.

217. Slap it

218. Slap it OK. This is really good I don't think we've had as many ideas as this before. Go on then.

219. Run over it

220. With what?

221. Anything.

222. Oh yeah you mean like that but that gives us another idea.

223. If it was under a doormat, you could step on it

224. Yeah but you'd step over alarms like that.

225. Yeah, pressure alarms

226. Yeah right. Yeah you put them under windows under the carpet and it sets the off. Yeah go on Ritchie

227. Tiptoe

228. Tiptoe, I think you are just trying to give me a problem of where to put this. Anymore, there can't be many left..... yeah good try.

229. OK eh I think that is quite a lot there isn't it. Yeah anymore

230. Close the window on it.

231. Yeah yeah, you could. Well that's terrific and there is still more.

232. Something about a football?

233. Yeah yeah, he saw the match last night. Footballer and that's about it. Right that is really great. There are lots there that have never come up before you know as well as all the obvious ones.

234. We could also ride a bike over it. Couldn't we? Yeah.

235. These are all your ideas we haven't got any room for mine. That's good because design technology is all about your ideas. Oh go on then let's have another one then.

236. R. Chuck it into a primary school just before the last day of term ends

237. Yeah and let them all trundle over it. Yeah. I haven't got room for that. Have I got any room for that? What about down the bottom here? Let primary school trample over it.

238. Good OK. I think we'd better move onto the next thing but one of the things you can try to do when you are trying to have ideas is look – like we did with the bin bag – you look at what you've got already and try to squeeze a little more out of it.

239. Because having ideas is really important whatever job you go into. The chances are you'll need to be creative to have ideas about how things could be done differently, how things could be done better.

240. Well, that's really good. I didn't expect to get that many ideas at all. That's tremendous. OK.

<u>Stage 4</u> - Making the pressure pads

241. The next thing we'll do then is start to make our pressure pads, so this is, is this the bits.

242. Do you need some more?

243. That's OK as long as they're the same that'll be OK. Thanks fine. What they need to do is find pieces that are the same. OK. So what you need is ehm three bits of card – we've got various sizes to choose from here. I think what we've got is two sizes mainly two sizes. If you find eh – if we could distribute these down the table, all you need to do is find yourself three bits the same OK.

244. Now what you'll need to do is cut yourself a 'window'. Which is about eh 3cm just about – you'll just about fit it on here won't you? OK you've cut the card just a little bit smaller than I'd expected. Never mind.

245. Can you use rulers?

246. Yeah you could use a ruler but that's not necessary as long as you've got scissors just fold them up, just estimate about 3cm yeah. Everyone knows what 3cm looks like yeah.

247. Yeah

248. Everybody knows what it looks like. You can have rulers if you want but we've only got these horrible metal ones though. OK. So let's grab the rulers and spread them around. They don't do estimating in law obviously. Yeah that's fine. Yeah OK.

(period of instructing Student helper)

249. So remember you only need to twist one wire to the bulb yeah. But keep it nice and here you are Paige here is your other one.

250. And if you think of anything while you're working use your black pen. Yeah. So use your black pen if you think of any ideas of what you can use this thing for. Yeah alright then.

251. Yeah but we use a different coloured pen so that we know when we had the idea. Yeah so if you have any more ideas of how you can use this then use your black pen. Yeah. That's just to help me- that's just to tell me when you had the idea – you see.

252. OK Gavin here is your bulb coming down OK. They're quite bright these bulbs because we're giving them 9 volts. A short life and a merry one. There's another one there sorry ehm

253. Near the screwdriver there, sorry I didn't aim it at anyone at all. Just there. Can you see it just inside, behind the towel. Yeah great fine.

254. What shall we do after we've done this?

255. Yeah that's fine.

256. What will we do after we've done that?

257. Put your foil on. Two strips yeah two strips on the eh… bottom yeah. And a sort of piece across the top. You can use your eh use your 'window' as a stencil. You know what you gotta see through the 'window'. Don't you? Paul here's yours coming down.

258. Too long.

259. OK ehh…. Conrad? No. What colour do you want? Sorry I can't read your badge.

260. Conrad

261 Ahh….Right. There you go Conrad there's yours. Right, how many more?

262. Right Put your hand up if you haven't got a bulb yet. One, two three, four, five right about seven, eight. Right OK I'll get you one.

263. Do you stencil that then foil it?

264. Yeah, you use the stencil just to tell you where to put the foil. Yeah?

265. I've got no foil.

266. OK there's plenty floating around – don't worry. Right before you put the foil on just to remind you OK. What do you see when you look through the 'window'? You see a piece of foil across that one. You see two strips across that one. Yeah.

(Pause)

267. OK Just give them the right amount of squeeze. So don't forget as soon as you get your bare wire – strip it, twiddle it. Alright someone else would like… you got a bulb. Who's got a bulb? That's fine. Yeah. Yeah. Just snip it down and that'll be fine. OK bulb. When I shout 'bulb' you put your hand up and I'll throw it at you.

268. Give me two seconds.

269. Two seconds.

270. One, two that's two seconds. Do you stick two like that?

271. Yeah, across the 'window'.

272. Mine are too big look.

273. You can always trim them down a bit. Right bulb – Zoe

274. It sticks up there.

275. Conrad OK. Thank you. He's always hiding his identity this bloke. Isn't he? I think that's the wrong card you need another bit of card.

<u>Stage 5</u> - Brainstorming ideas for using the pressure pad

276. OK, so what we are going to do now is brainstorm some ideas for using the ....OK. All I want you to do is put ideas for using the pressure pad yeah and you start...

277. Right let's have some hands up then. What can we use this for?

278. Remote Control.

279. Yeah what can we remote control with it?

280. Ehm a remote control car – press a button and it goes up and press the button and it goes down and another button and it goes to the side.

281. On a long bit of cable kind of thing yeah?

282. Yeah.

283. Good. OK go on then Gavin.

284. Sort of like a sort of lead

285. OK yeah so we could add to machines like a little automaton.

286. Yeah.

287. Yeah good OK. Ritchie

288. Lights.

289. Can you explain what you mean a bit more?

290. Lights on a car.

291. Yeah, if we make the toy car you mean. Is that what you mean?

292. The headlights.

293. OK good Thanks Zoe. OK Libby.

294. One of my friends said that she used it to set the tape recorder thing to scare people at her Halloween party by putting it under the door mat.

295 Scare people How do you spell Halloween?

296. H, A, L, L ,O, W, E, E, N.

297. Right OK good some more.

298. Radio alarm.

299. Yeah. Sorry.

300. Microwave oven.

301. Yeah but I'm thinking of things we could make though really. Sorry just a sec.

(Pause)

302 Hem OK OK go on then. What else could we do? What might we use it for?

303. OK We're making something here in design technology and we've got all the materials we want. What might we use it to make.

304. A light.

305. Yeah yeah, we could use it to turn the light on. It could be quite handy really at night… you know at night when you can't find the switch you could make a great big giant pressure pad and have light straight away.

306. I was going to say night light so that you could easily find your drink.

307. Yeah yeah, that's right a night light to help you find your drink easily. You could even stand the drink on it and then you it would be light all the time then. Yeah. Yeah.

308. If you're scared in the dark.

309. Yeah yeah, if you're scared in the dark. OK go on then some more. Yep?

310 You could use it as a light to help you read.

311. Yeah yeah, a reading light. Yeah. Go on then Paul.

312. You could use it for a bell.

313. Yeah yeah, it'd be an automatic door bell then no one would need to ring it and you'd know people were there.

314. Like that if it was a really bright light you could press it and it'd light in the front room and you'd know.

315. Yeah, you'd know someone was there.

316. Yeah, you could hide it under the mat and when they stand on it....

317. Yeah, door bell or light. OK Does the way of turning it on, on the board, give us any ideas?

318. If you're working in the garden at night you could put a weight on it and it'd give you light to work in the garden.

319. Yeah. It could be a garden light. Can we think about what's special about a pressure pad? One of the things that's special about a pressure pad is that you press it or put weight on it and it stays on so if it was a child's toy for example it would be quite useful. Go on then Ritchie.

320. Using the light as a signal.

321. Yeah good a signal light. Have you heard of Morse code? Yeah.

322. They used it in the war and out at sea.

323. Yeah they did. Yeah they did. A model lighthouse. Yeah yeah so we've got Morse code. You would need a Morse code key.

324. Right right anymore? Let's have some more. Ehm What about games of some sort?

325. Yeah, go on.

326. Instead of speed cameras right. It might not work yeah but out in the road and if a car goes over it and the bulb come on no no

327. Yeah nice idea though. Eh Yeah. Anyone got any ideas how we could make that a useful idea. Yeah go on.

328. Well I got a well ehm. If you like, I got this idea from Lego land because right what they have. Basically, they have these cars made of Lego that roll down this hill and if you at the finish line hid some pressure pads under it the first one would light up and you'd know which one won because it'd light up first.

329 Yeah yeah good. You could either put it so that instead of a line the cars would hit it or run over it. They both would work. Wonder which would be best? Yeah

330. You could do a buzzer.

331. Yeah yeah you could do a buzzer. Yeah OK alright that's good. Did I write that down? No no, I didn't. OK go on then. OK.

332. A game for children

333. A game for children. So sometimes, when we have an idea it gives us questions. Because when he says that I think right, what kind of games for children? There could be lots couldn't there? It could be for little children. OK so...

334. Like when they touch

335. Like a playmat

336. Yeah

337. Yeah that'd be great wouldn't it that'd be really good with lights and everything. Yeah that's good. Yeah so a number game perhaps for older children. Yeah that's great so what else have we got. It doesn't have to be a game for children it can be anything. Anything now. Go on. Right can you leave the chair alone please. Sorry carry on I couldn't hear you.

338. Right at night if you're driving in your lorry and it might be dark and when you stop they might want the light on.

339. OK So how would they turn on.

340. When the car goes quiet.

341. OK, right that'd be good. Can anyone think of any other advantage to that? The light goes on when the car goes quiet. That'd be a good idea.

342. Yeah near traffic lights or on the motorway.

343. It'd let people know that the car had stopped. Yeah yeah right yeah one idea that'd be useful for pedestrians. How else might it be used?

344. Ehm it .could be used for the car driver so that ehm say it was night time and the driver was really tired there could be a buzzer to wake him when he like ehm drops off.

345. Right eh so to keep the driver awake. Yeah. That's true.

346. For a different burglar alarm so that if he comes in the window and the window shuts the buzzer would go on.

347. Yeah if you leave your window open but if you leave the window shut you would be stuck but yeah yeah that might work.

348. Or when you see when burglars put their hand in the letter box and try and push the door then when the letter box shut the thing would go off.

349. Yeah the letter box sets it off. Go on then Ritchie. Anywhere, where there is pressure will make it work then.

350. Carry on I'm just gonna check this thing has not switched off and it's still doing its thing.

351. OK. Yeah carry on then. Let's have some more then. We're doing really well here.

352. Right it would warn the cars ahead. Yeah and it'd save energy as the lights because instead of the lights being on all the time they would only be on when someone is around.

353. Yeah you get rooms like that where it senses your movement and switches the lights come on.

354. OK. It's like when you open it go in and lock it and it turns on. Yeah quite a lot of useful automatic things. Right go on then.

355. Like if you've got a baby then a buzzer goes off when the babies crying.

356. Yeah but that wouldn't work with a pressure pad would it? Because pressure pads need something to touch them don't them? [Non verbal - D realises his mistake]

357. And babies scream loud so you could hear them.

358. Right so you do get alarms for babies but it wouldn't work with a pressure pad.

359. Anyone got any idea how you could use a pressure pad with babies?

360. It could tell you if a baby is wandering out of a room they're not supposed to.

361. Or even you could have like the pressure pad under the mat that the baby sleeps on with loads of wires to you in another room and you'd know if the baby is gone because the light would switch off.

362. Because it's in a different room it wouldn't bother the baby. But the batteries might run out. [J- realises the problem of 'normally on]

363. Yeah that would be a problem.

364. And you might think the baby is gone but it's still in the room so you might panic but it's still in the room.

365. Yeah that's true. Because one of the problems with this is that this thing only works when something is on it.

366. So the battery... so if we use it with a vase on it as a warning if someone stole the vase the battery would be on all the time. So that's a problem.

367. Yeah go on then Ritchie. Yeah his was on all the time that's because we put a staple across it. Yeah.

368. Can we think of some different situations when we could use a pressure pad? We've got alarms. Hem -What about toys. Some toys.

369. Dance mats.

370. Yeah dance mats that'd be really good.

371. If you stepped on the wrong one a buzzer or a light would come up.

372. Yeah yeah. Any ideas we can take from a dance mat… things that would be. Use a dance mat as the starter idea. Can we get any more out of that?

373. Like you could have with the light and buzzer when they do it wrong - a light comes on when they step on the right one and a buzzer goes on when they step on the wrong one.

374. OK, so let's take any dance mat type ideas but are not dance mats yeah?

375. Ehm well my cousin he is twelve and he did this at school and basically what he did was he got - because he's got a dog at home that's always escaping – and what he did was he created like loads of really big pressure pads with wires but he hid the wires he put loads of tape over them so you couldn't really see them very well and then his dog who was supposed to stay in a certain room – stay in his basket and be taken for walks so when ehm and ehm if and because if it was always escaping if it got off its bed then he created two lights the first light would go on at the bottom of its thing and then a light at the first door would go on.

376. So sort of like a dog control device.

377. But ehm he would like switch it off when he was taking it for a walk.

378. OK that's really good so a dog control device and things that tell us where things are. Any more ideas? Anything here give us any ideas?

379. That would scare people at Halloween I saw this ehm this programme and ehm there's this coffin and when they like trend on a sensor or a pressure pad a skeleton just jumps up.

380. So we could use it we could use it to operate a motor as well couldn't we? So that might give us new ideas. So we could make a figure jump up on a motor….and when you trod on it, it could rush out of a wardrobe or something.

381. Yeah. Yeah, that'd be good. So any other ideas? Yeah, go on.

382. Another one for Halloween like – a dark corridor to a Halloween party. Draw a picture of a ghost and they step inside er a light will light up with a ghost eyes and when they look back…

383. Will you sit down please, sit down. Sorry, I was interrupted.

384. So a ghost noise type thing, OK, let's move away from Halloween things now and see if we've got anything else. Anything else?

385. Have a minutes break and use you black pens to see if you can come up with any more ideas and then we'll move on and do something different.

END OF THE *SPA* TEACHING SESSION. Children then went on to make their chosen project.

Secret 'combination lock' switch

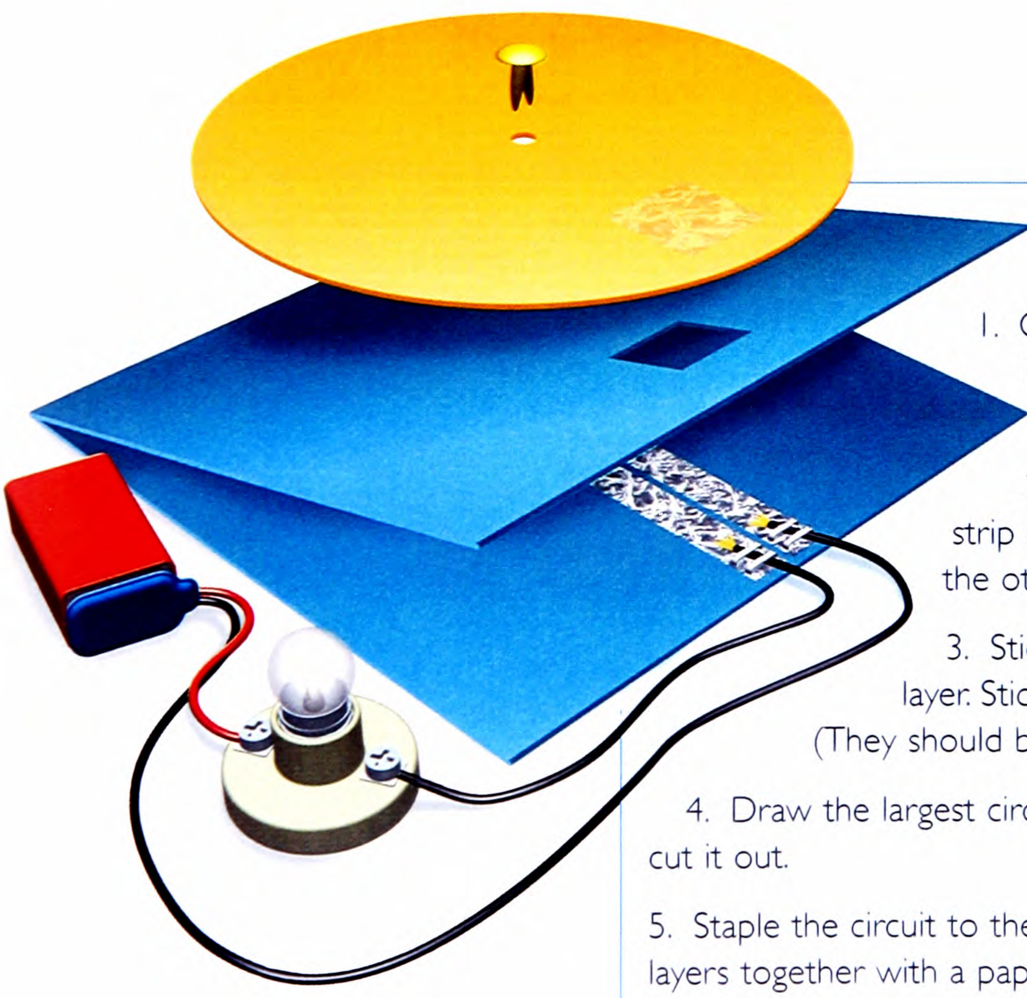
Making your own security device

To make this switch work you have to turn the top layer to the right position and know where to press. Only those who know the secret can make the circuit work. All around you can see electronic ways of letting one person make something happen while stopping others. Your library card has its own special bar code. Credit and cash point cards have their own magnetic strip and number. Special cameras can scan your eye to check that it's really you.

You can use this switch as a security device to decide who can turn on projects, or to make puzzles, games and quizzes.

You will need

- 2 pieces of A4 card
- kitchen foil
- paper fastener
- circuit



What to do

1. Cut a 15cm wide strip of card and fold it in half. Cut another piece to fit on top.

2. Cut a 2cm square 'window' in the strip and use the hole to stencil a square on the other two layers.

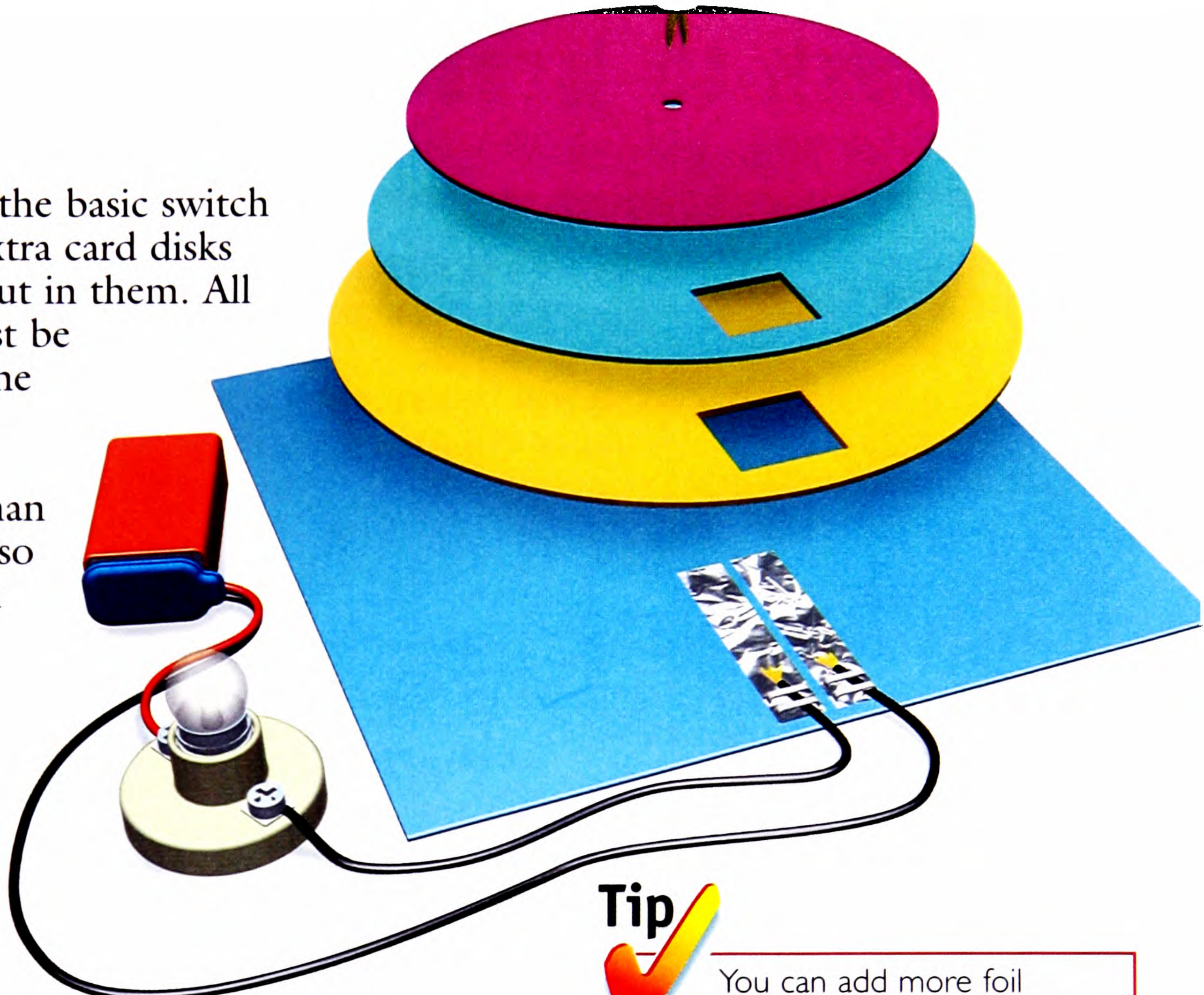
3. Stick foil over the square on the top layer. Stick two strips across the bottom square. (They should be close together but not touching.)

4. Draw the largest circle that will fit on the top layer and cut it out.

5. Staple the circuit to the foil strips. Fix the top and middle layers together with a paper fastener. Turn the circle to the right place and press!

Appendix 2:1 Pressure pads starting point 2 - .Support materials from: *Exciting Electrics* (Good, 1999a) and the *Design Challenge Teacher's Book* (Good, 2000).

You can develop the basic switch idea by adding extra card disks with 'windows' cut in them. All the windows must be lined up before the circuit will work. Make each disk slightly smaller than the one below it so that you can turn them easily.



Tip

You can add more foil squares to the top layers of these switches if you want extra 'on' positions.

Getting ideas

You could use the switch like a combination lock. Think of different things it could control. Could it control a motor that pulled back a catch? Could you make a 'doorbell' that only friends would know how to work?

Think about using the switch in puzzles, games and quizzes. You could put pictures around the disk. When the correct picture on the disk is lined up with its name, the switch would work. On the second version of the switch you could ask the player to line up all the pictures that go together before they press.

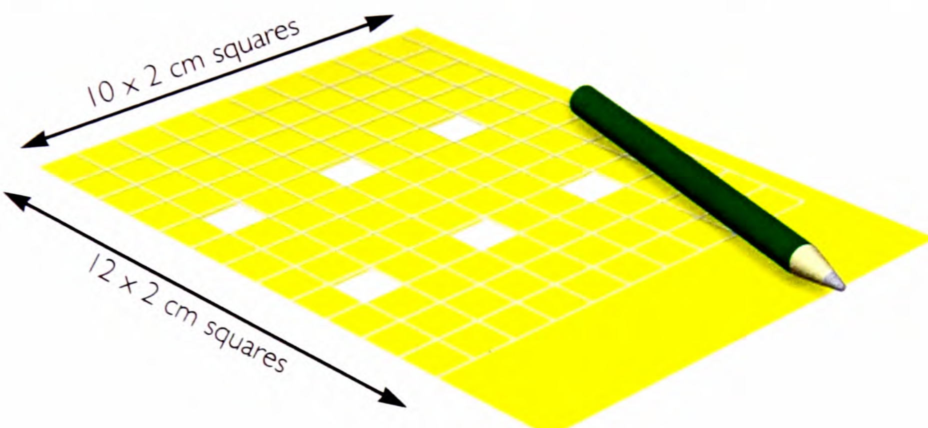
Try out your switch – it may help you have other ideas.

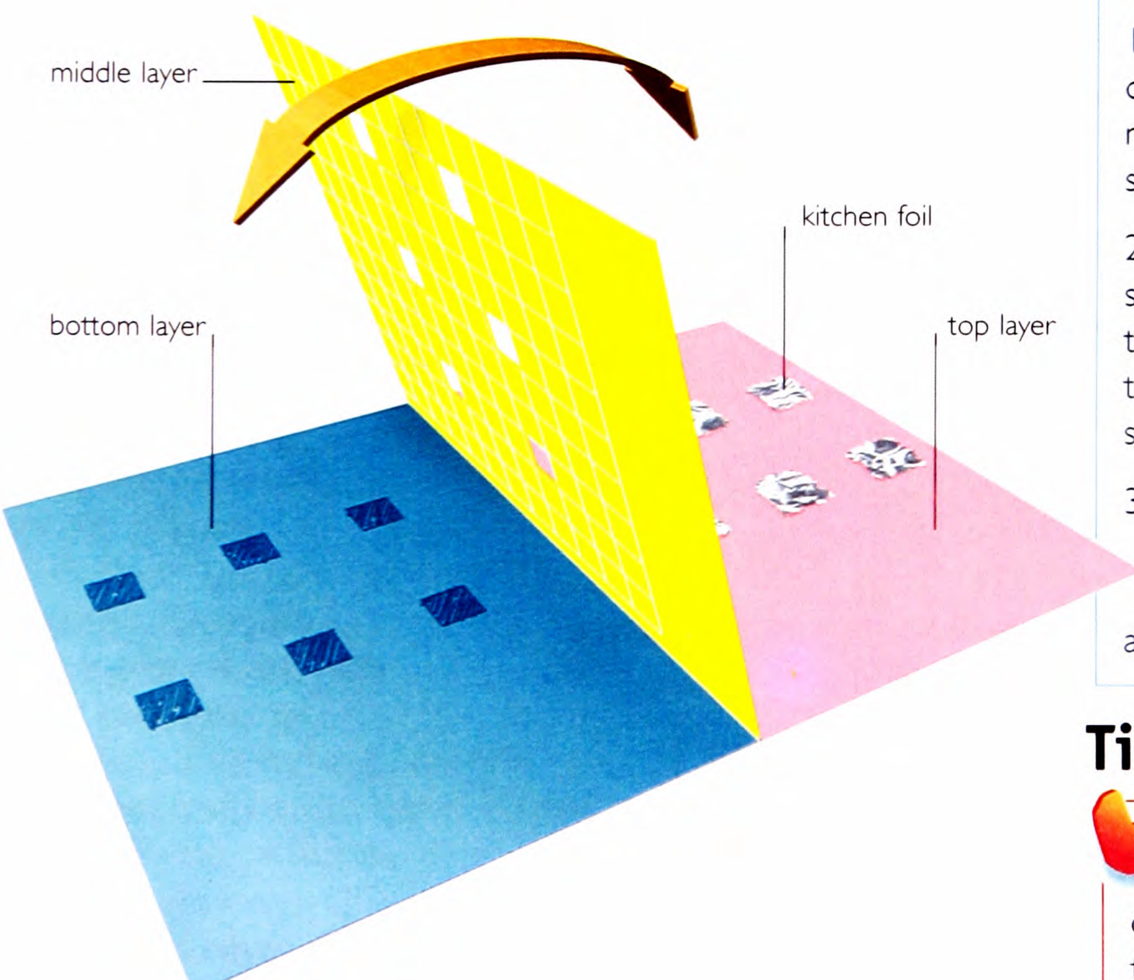
Appendix 2:2 Pressure pads starting point 2 - .Support materials from: *Exciting Electrics* (Good, 1999a) and the *Design Challenge Teacher's Book* (Good, 2000)

A secret switch

A pressure pad with pairs of switches

Key pads are often used when only certain people are allowed to open a door. These people are told which numbers to press to open the door, and they keep the numbers secret. You can make a pressure pad where the circuit will only work by pressing the right two places at the same time.





You will need

- 3 sheets of thin card, A4 size
- craft knife and cutting board

Safety note: check with an adult before using a craft knife

- kitchen foil
- glue stick
- circuit to switch on
- stapler

What to do

1. Draw a grid on one sheet of card. This will be the middle layer. Cut out the squares shown.

2. Use the holes to stencil squares on the underside of the top layer. Also stencil the squares on the top surface of the bottom layer.

3. Cover the squares underneath the top layer with foil. Fix the foil with a glue stick.

Tip

Flip the 'stencil' to make sure that the squares are one above the other when the pad is put together.

4. Use your middle layer as a stencil once more to mark the sensitive squares on the upper side of the top layer.

Important: check that the squares on the three layers are above each other when the pad is put together.

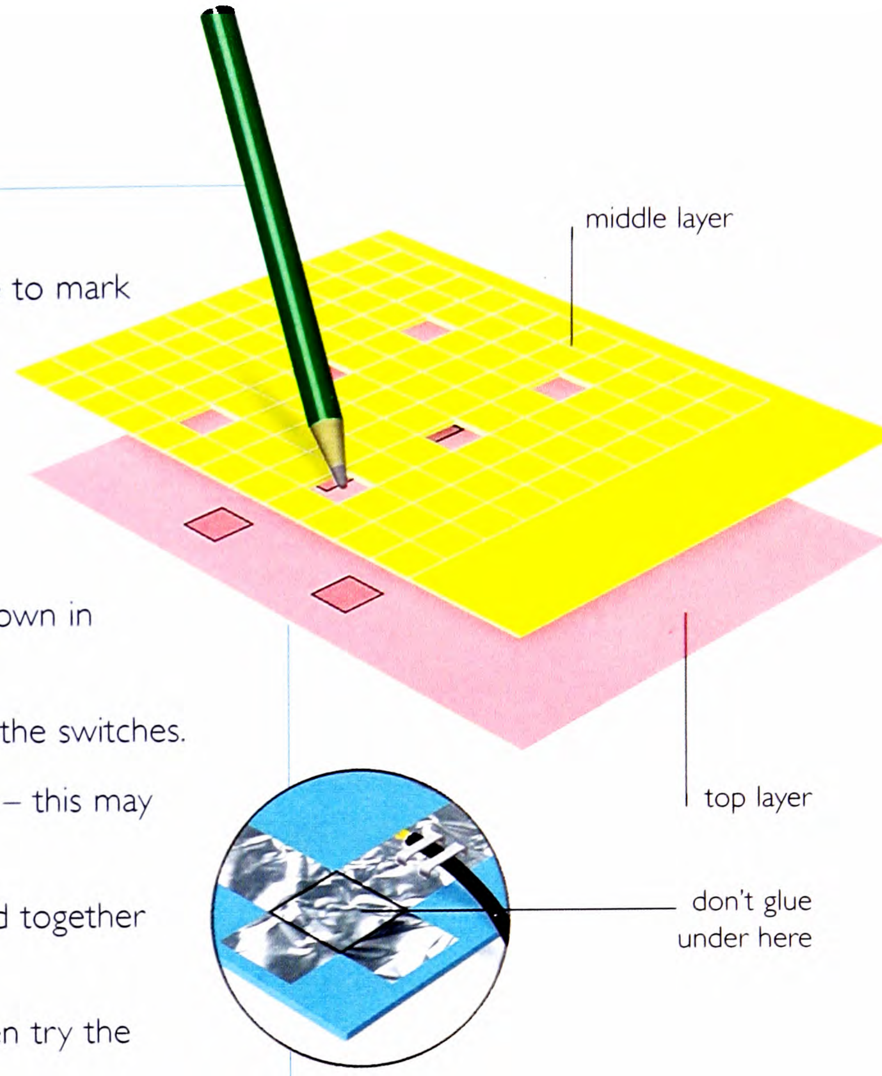
5. Add the foil tracks to the bottom layer as shown in the picture below.

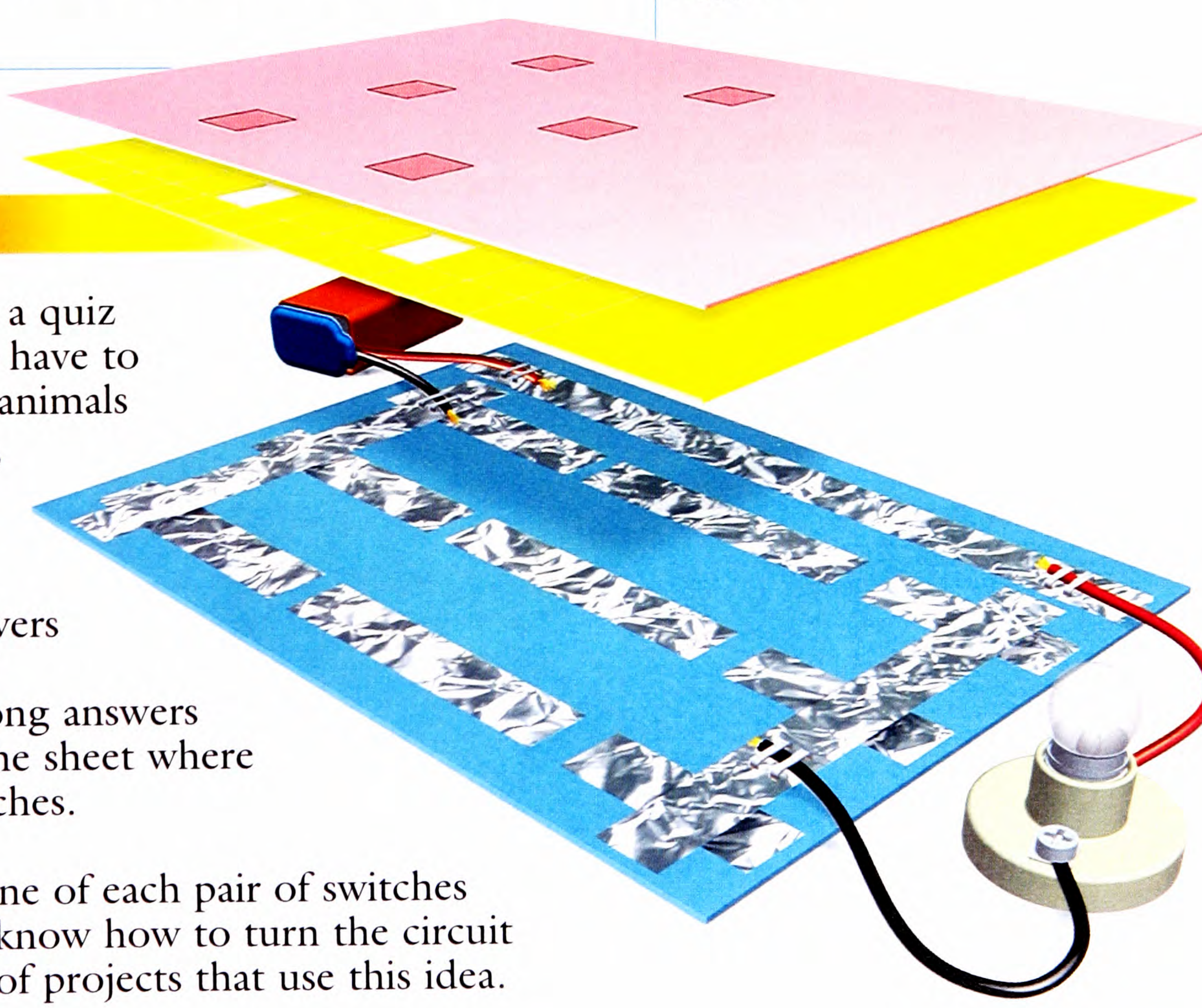
Make the six gaps about 3mm wide. These are the switches.

Important: don't glue where the tracks cross – this may act as an insulator.

6. Staple on the circuit as shown. Staple the pad together so that it opens like a book.

Press both the switches in the bottom row, then try the other pairs.





Getting ideas

You could design a quiz where two things have to be matched, e.g. animals with their homes, sports players with their country or team. Put a pair of answers over each pair of switches. Put wrong answers over the rest of the sheet where there are no switches.

You could hide one of each pair of switches so that only you know how to turn the circuit on. Try to think of projects that use this idea.

More pressure pad games

Pressure pads with several sensitive places

Pressure pad panels on cash points, microwave ovens and other products often have lots of sensitive places.

Here is how to make your own pressure pad with several sensitive places. When any of these places are pressed your circuit will be turned on. You can use your pad to make more complicated games.

You will need

- 3 sheets of thin card, A4 size
- craft knife, safety ruler and cutting board

Safety note: check with an adult before using a craft knife

- kitchen foil
- glue stick
- circuit to switch on
- stapler

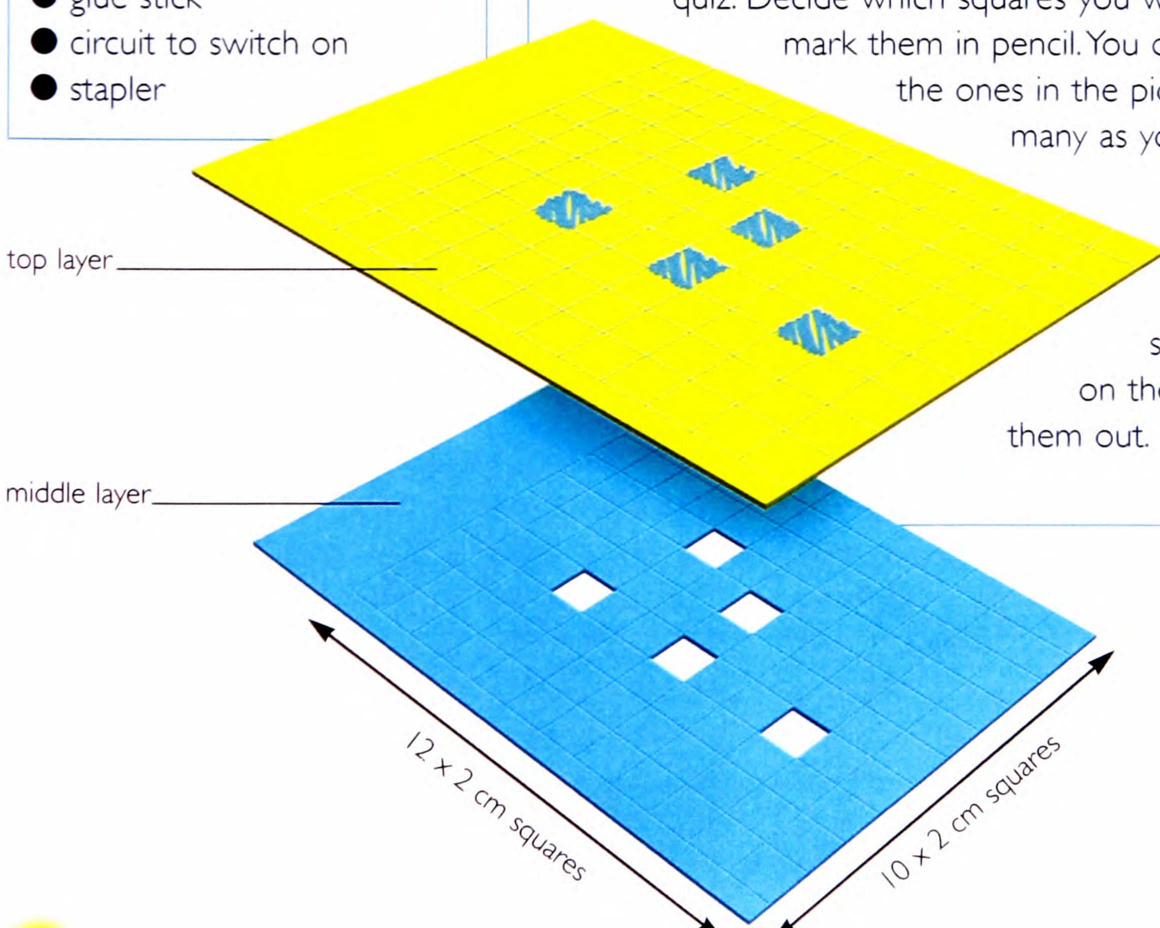
What to do

1. Draw a grid on one sheet of card (use faint pencil lines as you may not want the lines to show later). This sheet will be the top layer.

2. Cover the underside of the top layer with foil apart from a strip at one end.

3. Look at 'Getting ideas' (page 17) and design your game or quiz. Decide which squares you want to be switches and mark them in pencil. You don't have to choose the ones in the picture – choose as many as you want.

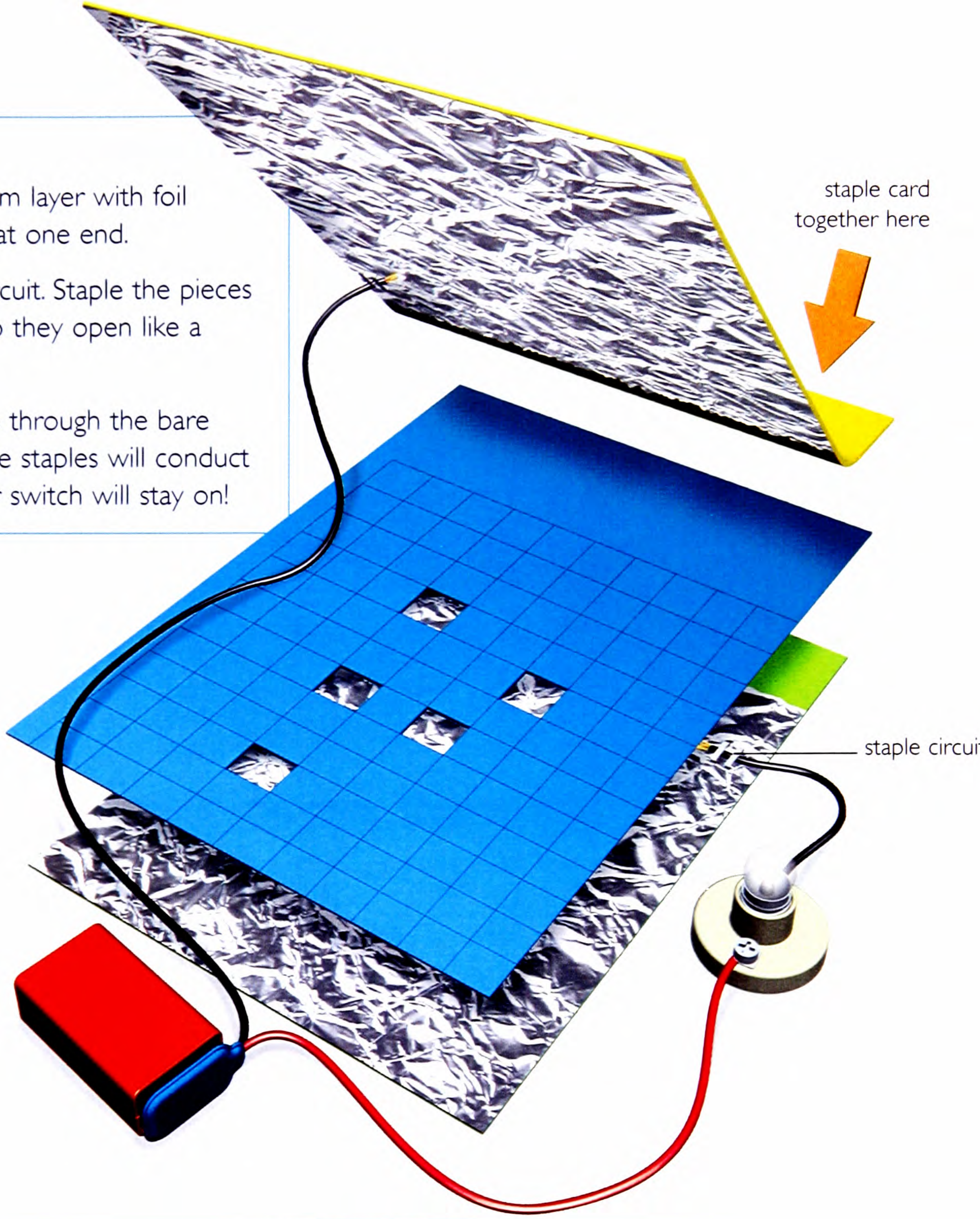
4. Draw the same grid on the middle layer. Mark the same squares as you marked on the top layer and cut them out.



5. Cover the bottom layer with foil apart from a strip at one end.

6. Staple on the circuit. Staple the pieces of card together so they open like a book.

Important: staple through the bare strips of card or the staples will conduct electricity and your switch will stay on!



Getting ideas

Design a game using the pad you have made. You could look at games like snakes and ladders and design your own version. You could draw the hazards (like monsters) on the sensitive squares or leave them unmarked to surprise the players! The switch squares could show hidden treasure instead of hazards and dangers. Use your pad to design a quiz for younger children. Write or draw pictures showing the right answers on the sensitive squares. Show wrong answers on squares where there are no switches. By covering and uncovering some holes in the middle layer you could fool people who think they know where the switches are!

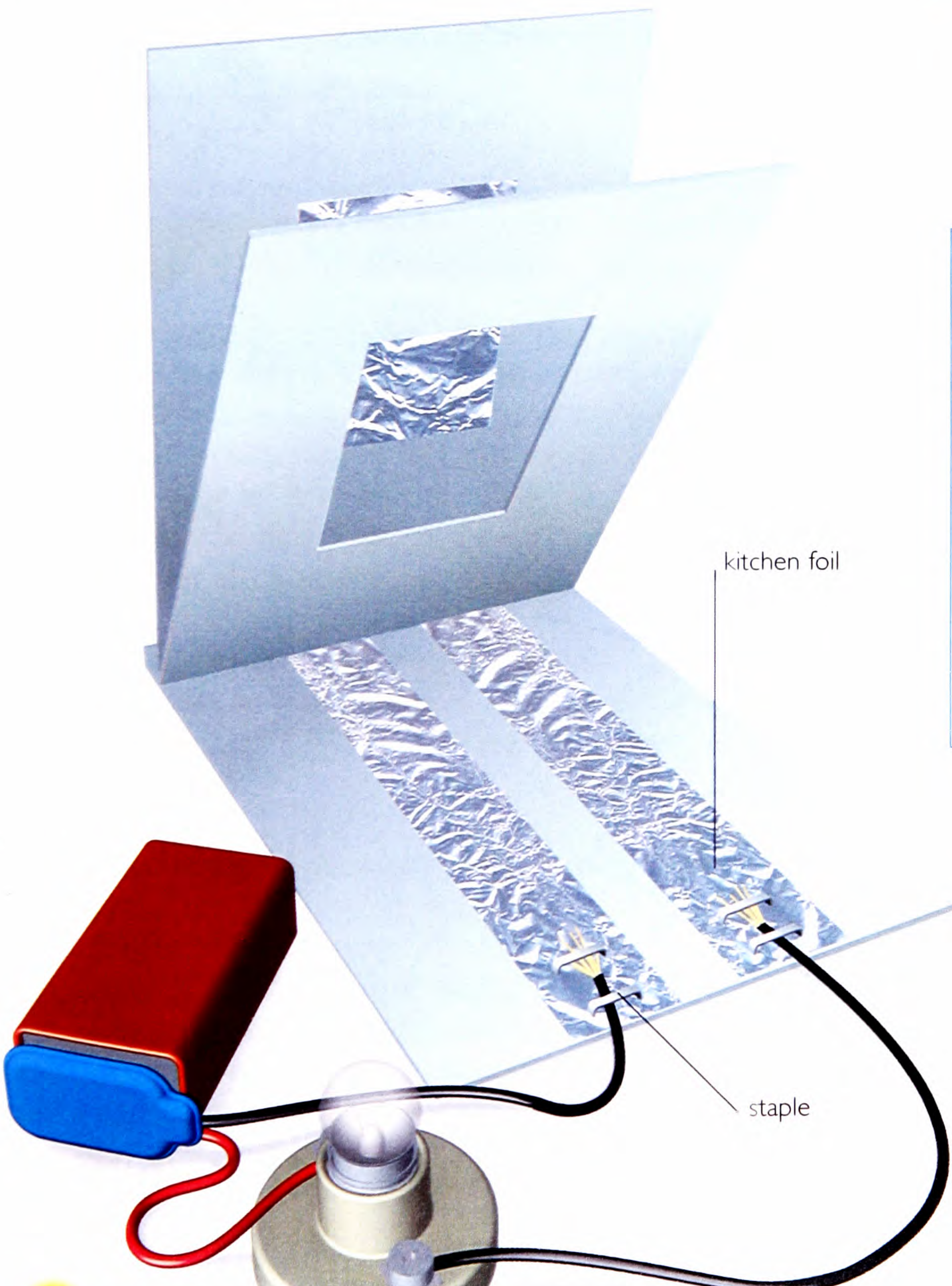
You could go on to design your own pads and think of your own uses for them.

Pressure pads

Making your own pressure pad switch

Pressure pad switches (sometimes called membrane panel switches) are made from thin layers. They are tough and don't take up much room. Look for pressure pads on cash point machines, microwave ovens and other machines that we use every day.

You can make a pressure pad switch to control anything that is battery-powered.



You will need

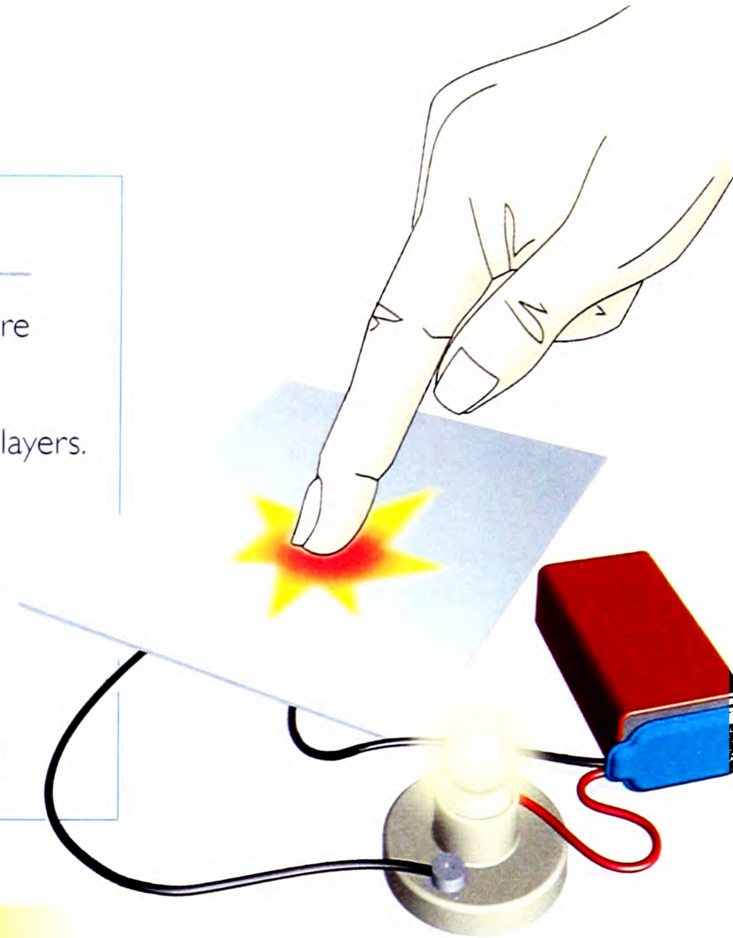
- 3 pieces of card (postcard size)
- scissors
- a glue stick
- a stapler
- kitchen foil
- something to switch on e.g. bulb, buzzer, LED (see page 9 for help)

12

Appendix 3:1 Pressure pad starting point 1

What to do

1. Cut a hole in one piece of card like the one in the picture (page 12). This will be in the middle layer.
2. Use the hole to stencil a square on the top and bottom layers.
3. Stick a square of foil over the square on the top layer.
4. Stick two strips of foil *across* the square on the bottom layer.
5. Staple your switch together at one edge like a book.
6. Staple the bare wires tightly to the foil strips - and try it!



Getting ideas

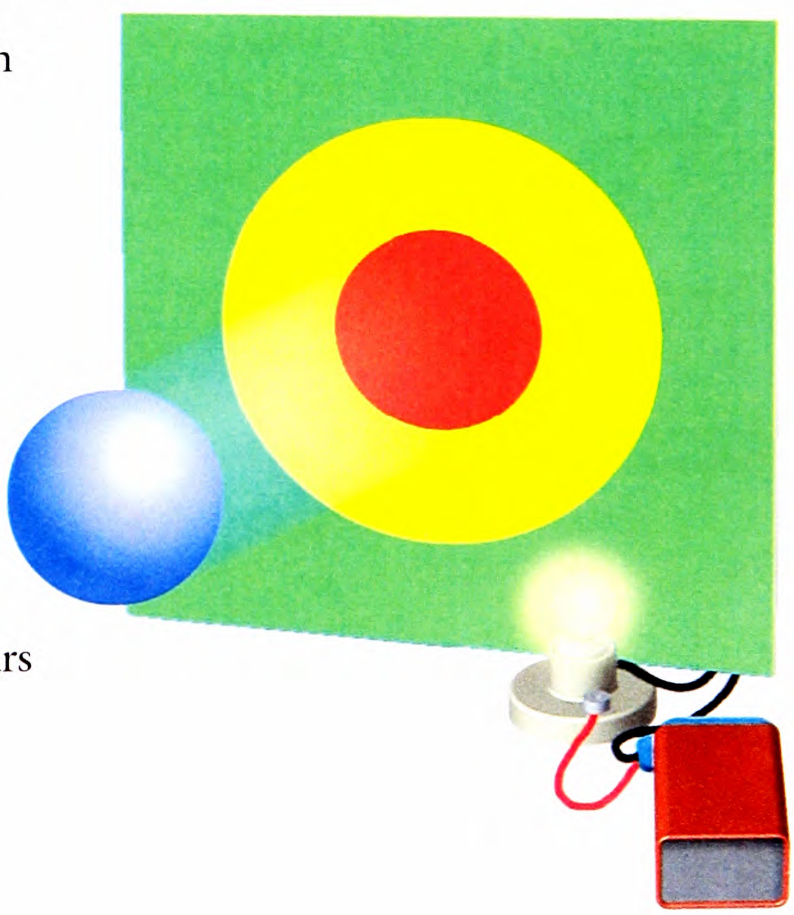
How many ways are there to turn a pressure pad on? Think about the following questions to help you get ideas. Could you swing something at it, put it where it would be turned on by accident, sit on it, or roll something over it? Could you drop something on it, stand on it, press it with your finger or do something else?

Tip

If your switch stays on, try a smaller hole.

What could you turn on with a battery-powered pressure pad – a light bulb, an electric motor, an LED, a buzzer or something else?

Could you design a creature with eyes that glow when you stroke its back? Could you make a burglar alarm? Try a bigger switch so that a foot makes it go on, and use thicker card. If you put the switch under a model road layout, toy cars could turn it on – or make up a target game like this one!

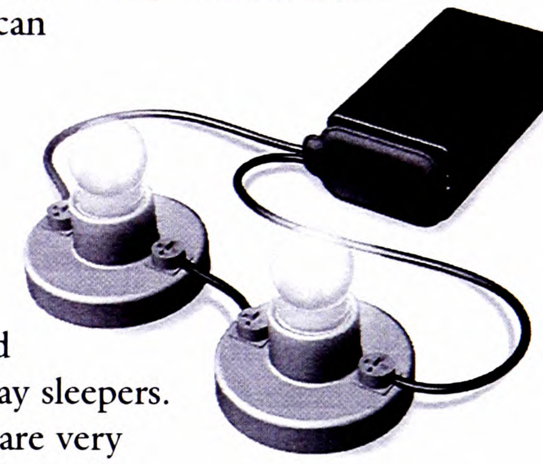


Electric circuits

Making series and parallel circuits – *pages 6 and 7*

As well as supporting the projects that follow, these two pages highlight the importance of electrical circuits and the basic requirements of successful ones. They introduce the important scientific knowledge that a complete circuit, including a battery or power supply, is needed to make any electrical device work, and show how to represent series circuits by drawings and diagrams.

- When batteries are in short supply, fix them at intervals around the room to allow pupils to test their circuits without undue movement or searching for a 'wandering' battery. When buzzers are in use, restricting access to a battery controls noise.
- Batteries are ruined very quickly by a *short circuit* i.e. if their positive (+) and negative (–) terminals are directly connected without something like a bulb or buzzer in between. While the battery is being drained in this way some heat is produced. Clipping the terminals of two 9-volt batteries together damages both of them at once! It is a good idea to warn pupils at the outset to avoid short circuits.
- To help pupils remember the layout of a *series circuit* (where one component follows another) it can be likened to a string of beads or a series of programmes. When only one component is being used, a series circuit works well enough, but as pupils will discover from the activities (page 7), adding more parts leads to disappointment. A *parallel circuit* can be likened to a railway track (with a red positive and a black negative rail) and components laid across like railway sleepers. Parallel circuits are very useful because they allow several components to work from one battery.



a series circuit

- The advantages of using symbols to draw circuits, and the uses of symbols in general for fast and accurate communication, are worth discussing.

Light, sound and movement

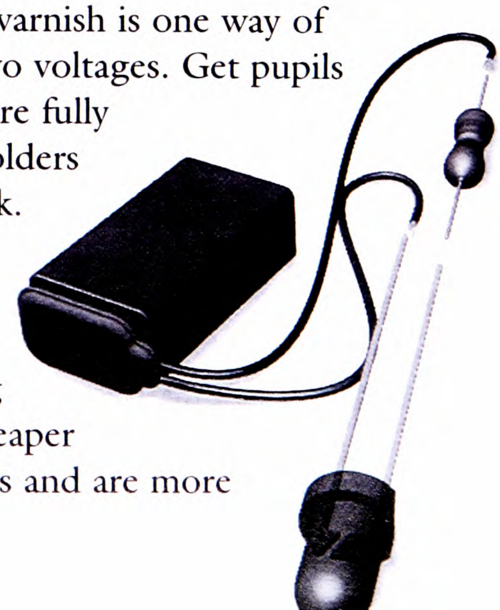
Designing circuits for your projects – *page 8*

Bulbs

Light is the cheapest output from a circuit. A 6-volt bulb will usually cope with a 9v battery – even if a fresh battery makes it rather bright! A 9-volt battery is likely to 'kill' a 3.5v bulb. Various bulb holders are available and these take either bulb. 3.5v and 6v bulbs are available and found in most schools, as they are used in science. The voltage is stamped on the bulb but it is often hard to read, so either have one kind only or keep them well apart. A dab of bright enamel paint or nail varnish is one way of distinguishing the two voltages. Get pupils to check that bulbs are fully screwed into their holders or they may not work.

LEDs

LEDs (light emitting diodes) are much cheaper and neater than bulbs and are more

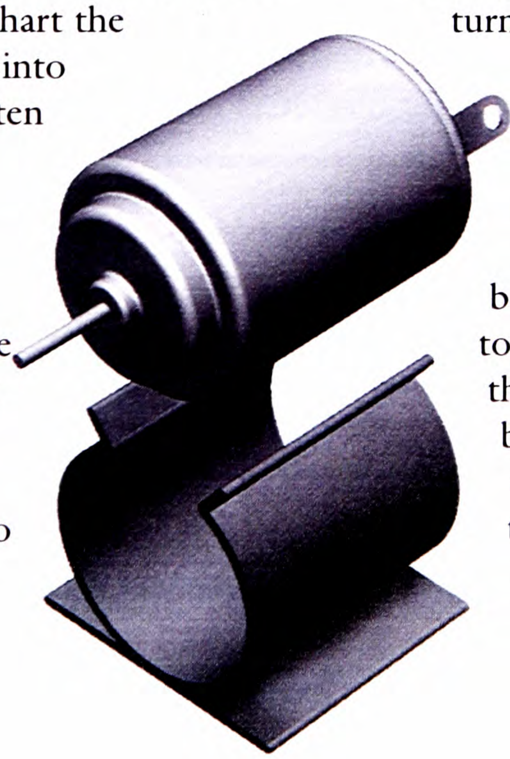


in scale with most projects. Usually red, green or yellow in colour, LEDs are widely used as indicator lights e.g. to tell you that the power is switched on to your stereo or that the caps lock on a computer is on. **Each LED used with a 9-volt battery must have a resistor or it will be ruined.**

Some interesting LEDs are available from electronics suppliers. Although more expensive than normal ones, they make impressive additions to projects. Flashing LEDs include a small microchip (visible as a black speck) and don't need an additional resistor when used with a 9-volt battery. Bi-colour (two colour) LEDs light up red or green depending on which way round the battery is connected. The lights on a motorised buggy could change colour when the buggy reverses. These LEDs are colourless/translucent when off and show that LEDs actually emit red or green light rather than just light up coloured plastic. LEDs can cope with 3 volts without a resistor.

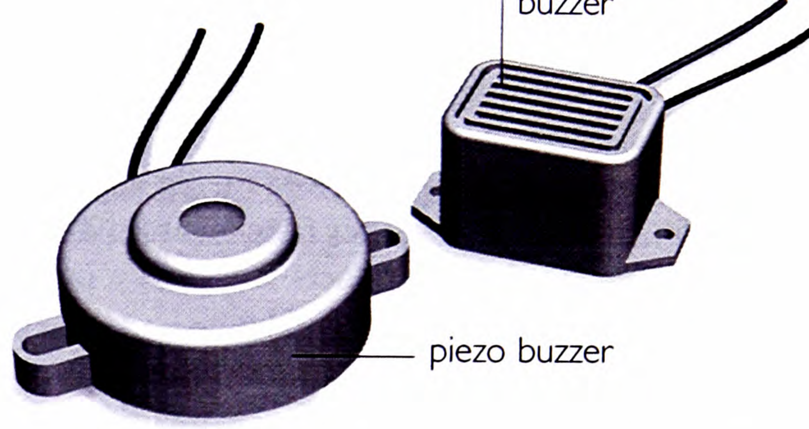
Resistors

These small striped components restrict the amount of current flowing in a circuit or part of a circuit. They feature in *Exciting Electrics* as a means to protect LEDs from too much current from the 9-volt battery. The coloured bands on a resistor indicate the amount of electrical resistance it offers, measured in units called ohms. With the aid of a chart the colours can be converted into numbers. Resistors are often supplied joined to each other by paper strips to make them easy to load into mass-production machines in factories. Like other small parts they are easily lost so it is best to give them to pupils just before they join them into a circuit.



Buzzers

Piezo electric buzzers (usually in a round case) make a 'whistling' sound. Electromagnet buzzers (usually in a rectangular case) make more of a nasal bray!



An electrolytic capacitor will cause a buzzer (or light) to stay on for some seconds then fade. A capacitor gives a longer period of sound with the piezo electric buzzer. Large capacitors will keep the circuit working longer than small ones. Two or more smaller capacitors can be joined together at both ends (i.e. in parallel) to get the same effect. Remember that capacitors must be connected the right way round (+/–). The negative side is clearly marked on the case.

Motors

Don't expect too much turning force (*torque*) from small electric motors on their own. They often go too fast and deliver too little torque or turning power for many projects. Pulleys or gears are usually needed to increase torque and reduce speed. Plastic pulleys to fit on to motors can be bought from equipment suppliers (see page 28 of this book). Small motors with gear boxes can be salvaged from broken battery-powered toys. Motors drain batteries more quickly than the other components mentioned. A big benefit of electric motors is that they allow movement to be controlled using the computer control packages mentioned earlier.

More about making circuits

Joining wires and adding switches – *page 10*

The 9-volt battery connectors (sometimes called battery snaps) shown in *Exciting Electrics* are convenient and cheap. Nine-volt batteries are compact and provide plenty of power if several components are being used in the circuit. Should you want to use 1.5-volt batteries, 35mm film containers can be used as battery holders. Make a hole in the lid and bottom and use brass paper fasteners to make the terminals. Two containers joined by a paper fastener make a 3v battery holder.

Wire with lots of copper strands inside the plastic insulation is much more flexible and easier to twist to make connections than that with a single thick strand. Multi-strand wire also makes better connections when stapled on to pressure pads. Twisting wire on to paper clips first can help pupils make connections to bulb holders.

Encourage pupils to stick to the convention red wire for positive (+) and black wire for negative (-). This is a good opportunity to discuss the use of colour as communication rather than decoration. An electric motor can be made to spin the other way if the red and black wires from the battery to the motor are swapped over.

Wire strippers are designed for removing the plastic insulation from wires. (Do *not* allow the use of craft knives.) There are many different kinds of wire stripper. Some are easier to use than others – warn about sharp parts. If possible, get pupils to try (and evaluate) a variety of borrowed ones before buying some for class use.

Once a circuit is built into a project it can be very difficult for the pupil or teacher to spot any faults and a handful of tangled wires and components is little better. To minimise problems, have pupils build and test circuits that are fixed to a board with masking tape as suggested on page 10. A corrugated card board will do. This really helps to avoid guesswork, reduces mistakes and makes it easy to see any faults that do occur. Check that circuits work while they are taped to the board i.e. before they are installed in a project. Always encourage pupils to look for faults themselves before they ask for help.

Photocopiables: SHEET 1 The fault-finding checklist can be copied so that each pupil has one for reference. Mount on card and cover with sticky-backed plastic for durability.

Pressure pads

The pressure pad or membrane switch – *pages 12 to 21*

The pressure pad or membrane panel switch is a piece of modern technology that pupils can make and use creatively in a wide range of contexts. Made from thin layers, these switches are used on many appliances such as copiers and microwave ovens where their durability and lack of bulk are an advantage. Pupils can use pads to control anything that is battery-powered. It is best to start pupils on the simplest, on page 12.

Examples of uses

- a toy car turns on lights/opens garage door when pushed over the pad.
- a large switch helps partially sighted users.
- a dragon's eyes glow when its tummy is stroked.

Structures that collapse

Designing structures that fold flat

We can design structures that are strong and rigid but collapse and fold flat when we want them to. This saves a lot of space and makes the products easier to transport. Collapsible structures are all around us; they include folding pushchairs, ironing boards, tent frames and camping or picnic furniture. Blow-up water toys, swimming armbands and even armchairs can be collapsed by letting the air out. Can you think of more things that can be collapsed? Fold-flat furniture would allow a hall or room to be cleared for games or dancing. Lots of flattened shelters could fit into one rescue aircraft. Try out some collapsible structures, think of uses for them and perhaps design your own. Read page 23 for some ideas to help you.

You will need

- corrugated cardboard to make the structures
- brown paper tape or thin card
- thin card or paper

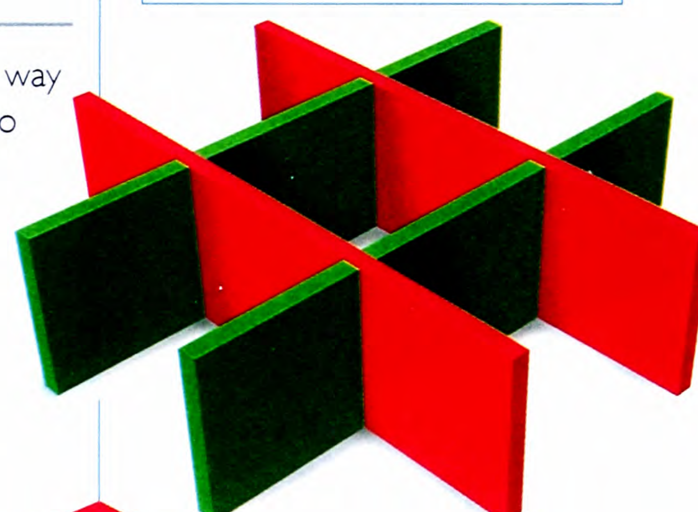
What to do

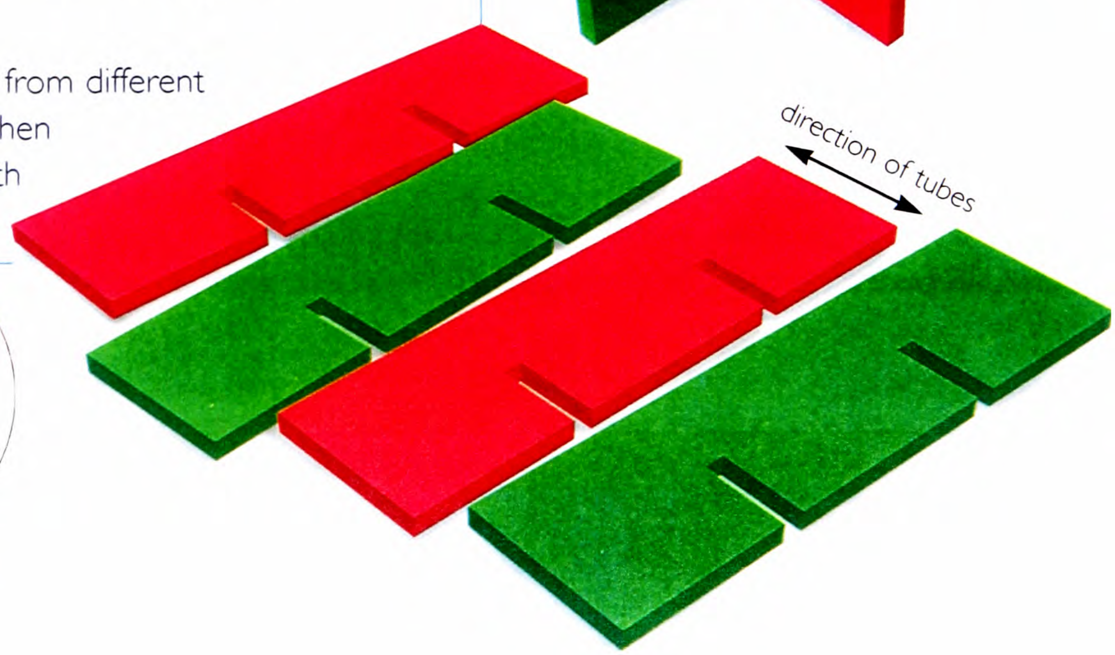
1. Look at the picture at the bottom. The arrow shows the way the tubes in the corrugated cardboard go. Mark yours out so that the tubes run the same way.

2. Cut out the pieces you need from strips that are about 8cm wide. Mark out the shapes to look like the pictures.

3. Make the creases or joins and put your structures together. To make sharp creases in the right place press down on the line with a ruler and lift the corrugated cardboard to bend it.

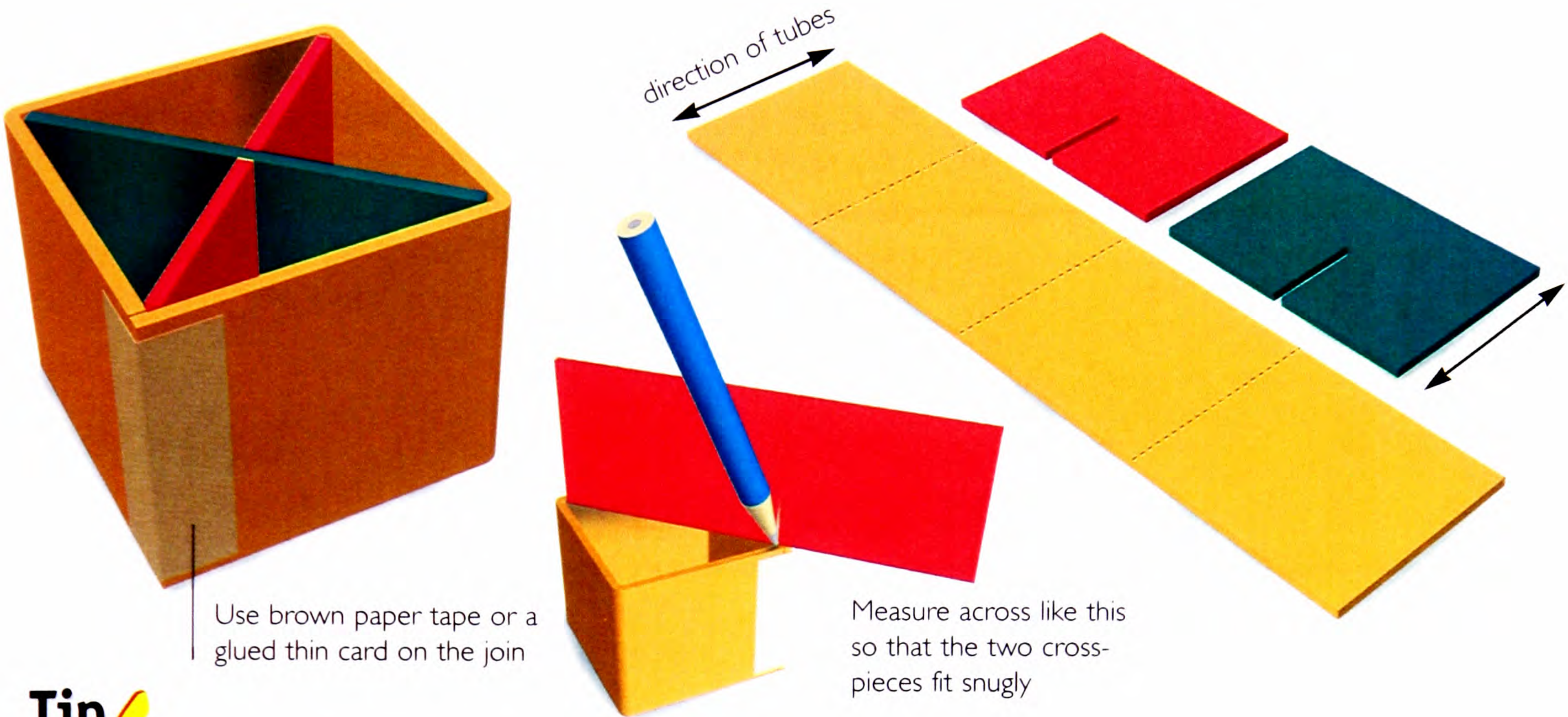
4. Press gently on your structures from different directions. Do they feel weaker when pressed some ways compared with others?





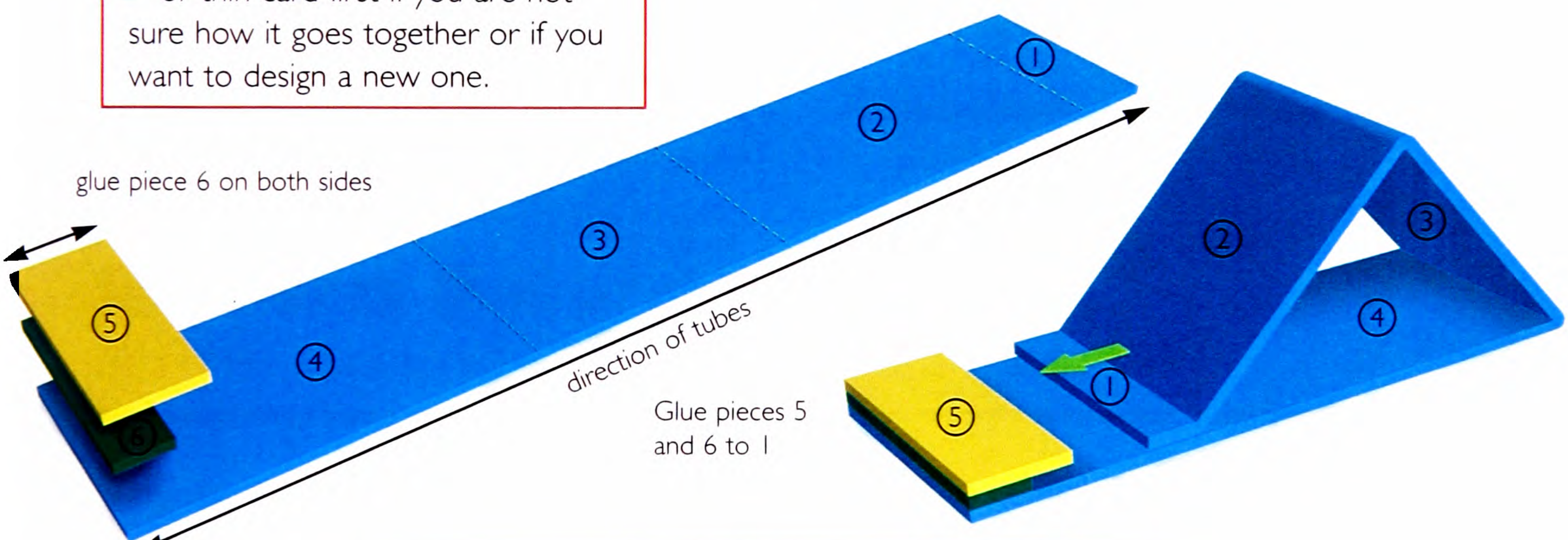
The slots lock together like this

<u>Appendix 4:2</u> Things that collapse starting point



Tip

Try out a structure in paper or thin card first if you are not sure how it goes together or if you want to design a new one.



Getting ideas

Look at the structures you have made. Turn them different ways up. What could they be used for? Could they store or hold something? Could you design a gift that would be easy to post to someone? Could you design games that use the structures? What could go in the holes: pencils, marbles or something else? You could paint or decorate your finished object. You could design a display stand for one of your favourite things. Look for fold-flat corrugated cardboard display stands in shops. Imagine that your structures were much bigger and perhaps made from something else. Draw some ideas for using bigger collapsible structures. Ideas could include furniture, survival shelters or something for the beach. Could you draw fold-flat ideas to help someone who could not find a spare seat on a train?

Structures that collapse

Designing structures that fold flat – *page 22*

This is a chance to look at everyday things such as pushchairs and ironing boards that need to be collapsible. Designing something to meet apparently conflicting needs such as rigidity and collapsibility often poses interesting design challenges. These pages encourage pupils to use the given structures creatively. Imagining the structures made on different scales opens up a much wider range of possibilities. Able pupils could try to design their own structures that can collapse.

Pop-ups

Structures that seem to vanish – *page 24*

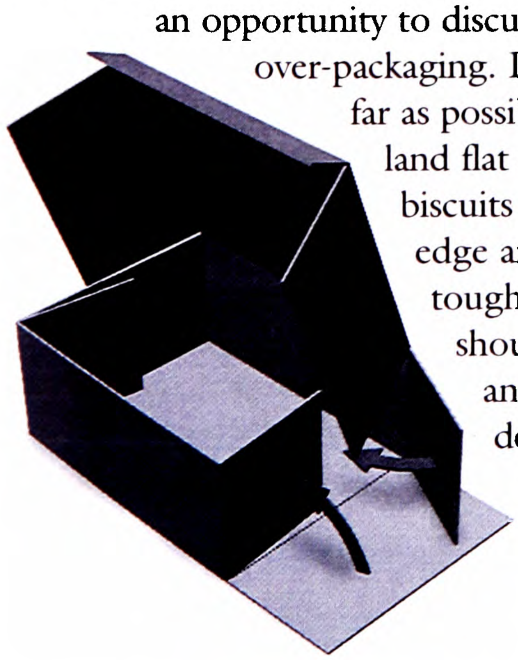
A pop-up is a self-erecting three-dimensional structure formed by opening a fold; other features like lift-up flaps are often added. Structures that appear and 'vanish' like magic have a wide appeal. Pop-up books can be shown and pupils could design their own, including word-processed text. Pop-up cards are sometimes suggested and although these can be done well, at worst the design element can be minimal e.g. sticking on a heart and writing 'Happy Mother's Day'. Games have lots of potential even for able pupils and formulating unambiguous rules presents a real challenge. Lots of other pop-up starting points can be found in the books dedicated to the subject.

Photocopiables: SHEETS 12 and 13 Copy on to coloured card.

Structures that protect

Designing packaging for fragile objects – *page 26*

Encourage pupils to make a collection of natural and manufactured protective structures. This helps establish how important they are and may stimulate their own designs. Packaging also offers an opportunity to discuss green issues and over-packaging. Packages should as far as possible be dropped to land flat on their bottom as biscuits dropped on their edge are surprisingly tough. Higher drops should be carried out by an adult. Pupils could develop the project e.g. adding a tail to the box, devising a square tube to guide it or some other way of ensuring that the package lands on its bottom. Provided they are kept clean e.g. handled with clean hands, broken biscuits can still be eaten. 'Refrigerator cake' can be made with adult help by melting chocolate in a water bath and stirring in the broken biscuits and other ingredients like raisins. The mixture is poured into moulds and set in the refrigerator. As with any food activity, there is a need to be aware of hygiene and food allergy issues and a parental consent form could be considered.

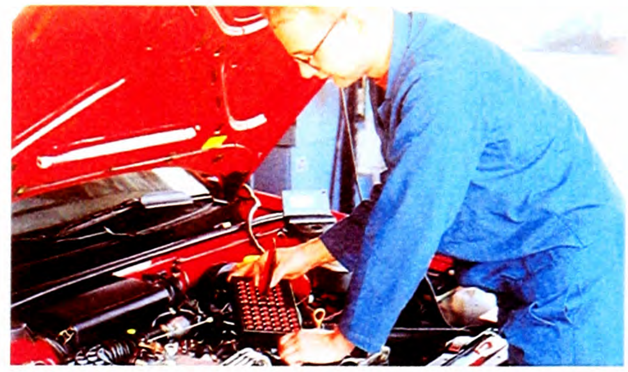


Photocopiables: SHEET 14 Copy on to coloured card.

Crankshafts

Moving parts to and fro and up and down

A crankshaft is an important part of an engine. The crankshaft changes the to and fro (*oscillating*) movement of the pistons into round and round (*rotary*) motion to turn the car's wheels. You can use a crankshaft to make mechanical toys (*automata*) that will create exciting movement when you turn the handle.



You will need

- a piece of corrugated cardboard A4 size
- 2mm thick plastic-coated garden wire
- pliers for cutting and bending the wire
- 4 paper fasteners

What to do

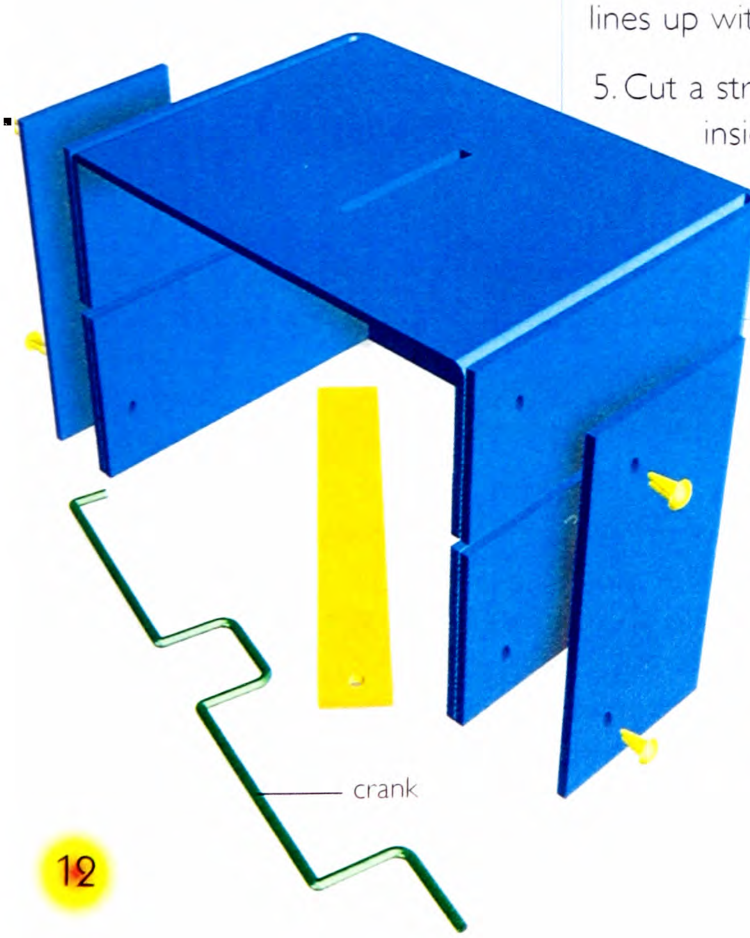
1. Look at page 6 to find out how to make the supporting structure.

2. Cut a slot half way across the end of your structure to hold the crankshaft. Make strips to keep the crankshaft in place.

3. Use pliers to bend the wire so that it looks like the picture and will fit your structure. When the handle is turned there must be a gap of at least 2cm between the crank and the structure.

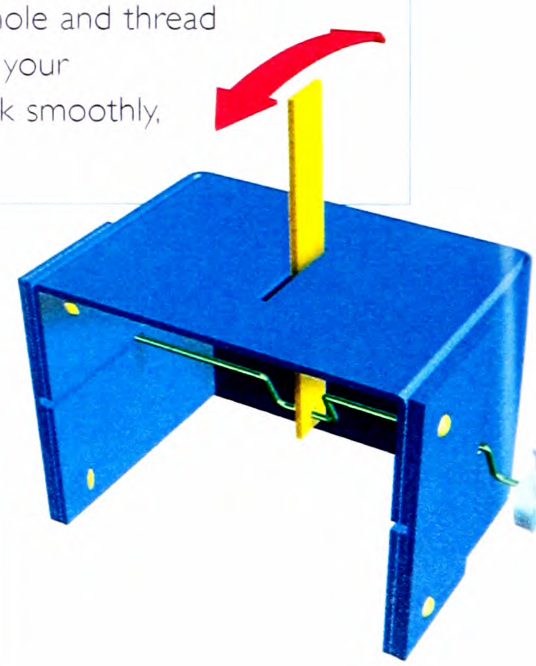
4. Cut a slot in the top of the structure, making sure that this lines up with the crank inside.

5. Cut a strip of corrugated card, making sure that the tubes inside run lengthwise. Make a hole and thread the strip onto the wire. If your mechanism does not work smoothly, try to see why.



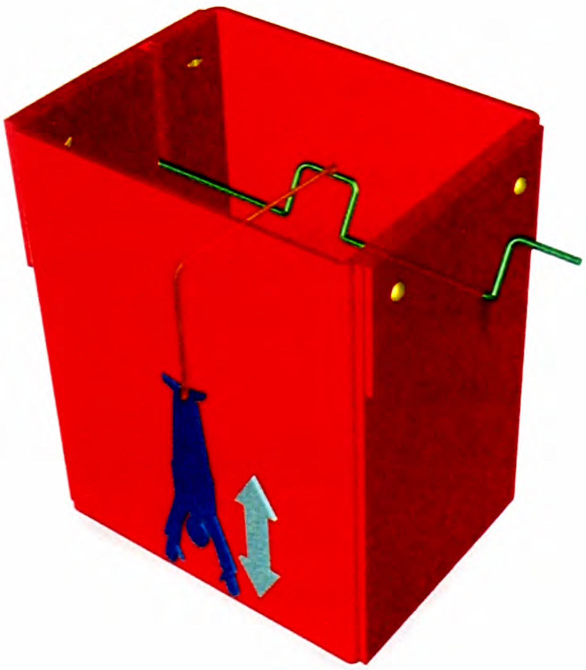
Tip

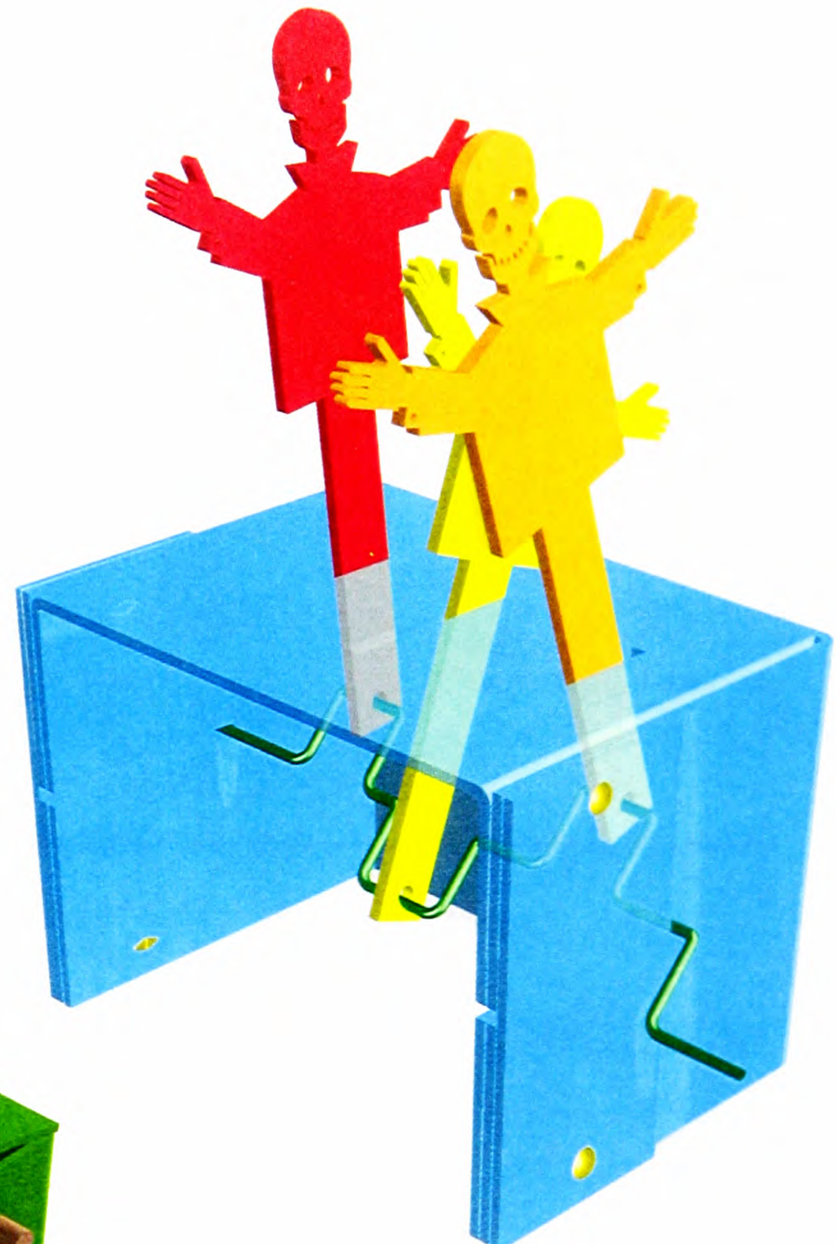
It is often easier to work on the structure when it is flattened.

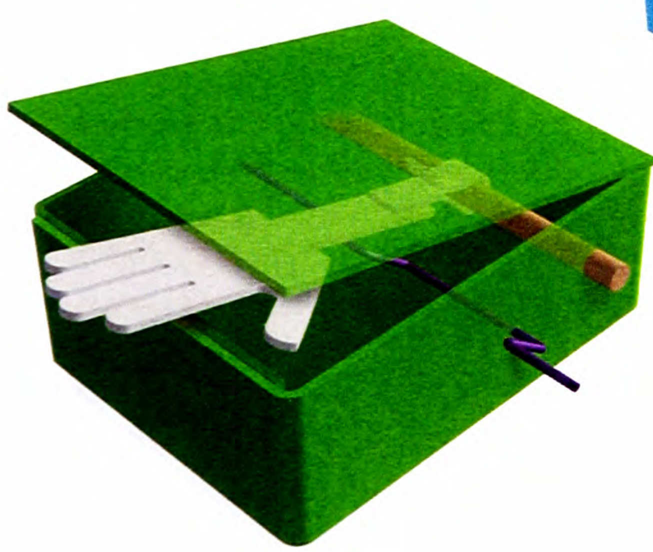


Appendix 5:1 Crankshaft starting point

Once you have made the basic mechanism successfully, you might try some of the ones shown here. What else could you use them for?







Getting ideas

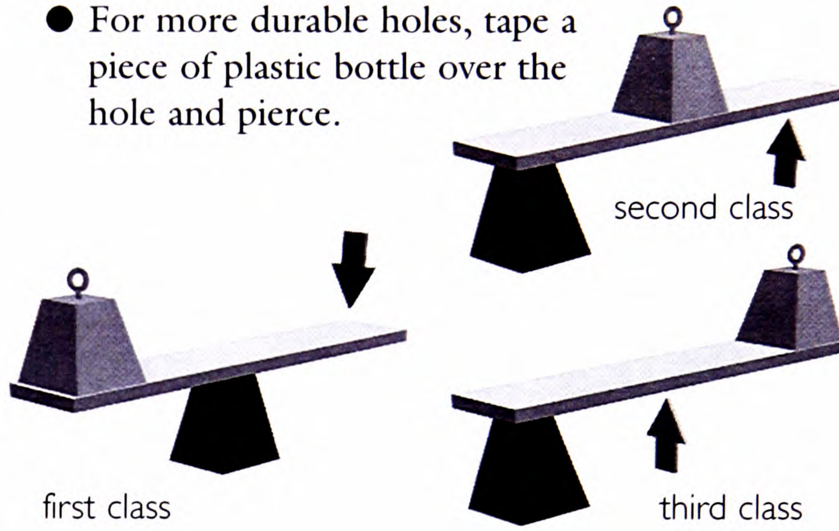
Try turning your machine different ways up and and make it work. Does the way your mechanism moves give you any ideas for a project? Could it be a chicken pecking from a crate or a baby bird in a nest? Do two moving parts look like walking legs when the machine is turned upside down? Two moving parts could be joined by flexible material like fabric or coloured paper to make a creature a bit like a snake or a dragon. Could your machine be made to advertise something? You can make moving parts that stick out from the front of the structure as well as the top.

Levers and linkages

Simple moving parts for your mechanisms – *page 10*

These pages show how to make linkages for pupils to use in design projects e.g. lunging crocodile, mechanism for tipping the back of a model lorry, shadow puppets. There are three ways of arranging the load, effort (input force) and fulcrum (pivot), giving what is known in physics as first class (EFL) levers, e.g. pliers, second class (ELF) levers, e.g. a wheelbarrow and third class levers (LEF) e.g. tweezers.

- For more durable holes, tape a piece of plastic bottle over the hole and pierce.

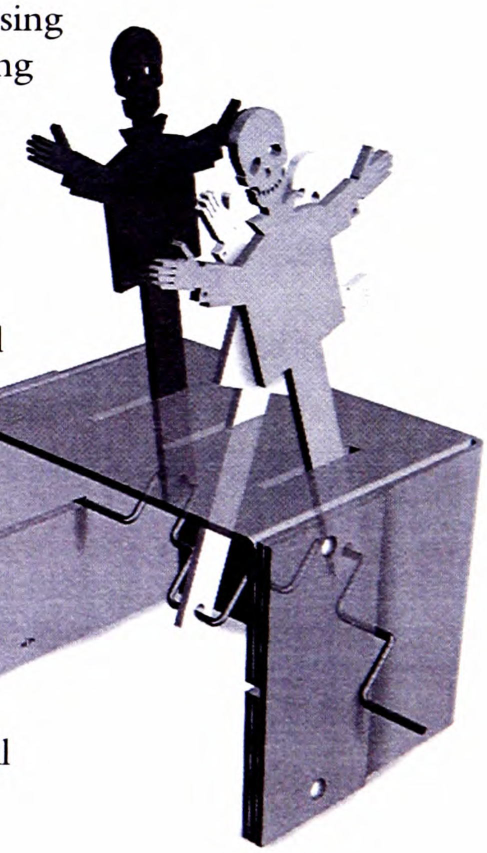


Crankshafts

Moving parts to and fro and up and down – *page 12*

Making a full-sized drawing of the crankshaft can help to make sure it is the right length and doesn't jam against the support structure. The drawing can be made on the top of the structure or on paper, having drawn round the structure. Remember to allow for the width of the corrugated card that will be threaded on to the crankshaft. The drawing can be used to work out the total length of wire needed (allow a little extra for the bends) and as a template for bending the plastic-coated wire to the right size and shape. Holding the wire with one pair of pliers and bending it with another is helpful, or the wire can be held in a small vice. Try to have an imaginary straight line (or axis of rotation) running through the crankshaft as this will help it to turn smoothly. Long lengths of wire pose more of a hazard than pieces cut to the length needed. Cut wire to length for pupils. Curling the end over makes using it safer, as does wearing goggles and working with arms straight to keep wire away from the face.

Working out the total length of wire needed is an example of how this kind of work gives pupils a chance to use and apply mathematics in practical tasks and real life problems.



Pulleys

Using wheels to make parts move – *page 14*

Pulleys are used for transferring rotary motion from one shaft to another, and increasing and decreasing speed. Pulleys have also been used for thousands of years to make it easier to lift heavy weights – physics books give more information about this.

2. Amazing Machines

This book shows how to make mechanical toys and other devices using readily available materials - corrugated cardboard, plastic-coated garden wire and so on. Each project is based on a particular mechanism which is first shown used in everyday life. The content also relates to the science curriculum, e.g. forces and motion, friction, and to the maths curriculum, e.g. making 2D and 3D shapes and applying measuring skills in a range of purposeful contexts.

If you use 4mm diameter wooden dowel rod for machine parts this will fit the holes in the stout card disks that are available from suppliers. 5mm diameter rod can be used if the holes in the disks are stretched a little with the end of a biro pen. Cut the rod with a fine-toothed junior hacksaw while holding it securely in a small vice that cramps on to a table. Depending on their age and your judgement of the child you may do this for pupils or allow them to do this under supervision. Saw close to the vice. Keeping the saw straight prevents jamming. If a child cuts the dowel, this should be under supervision and with both hands on the saw to improve control – and keep the hands away from harm!

How to support your mechanisms

Three basic structures to support moving parts – *page 6*

Whether they are made from metal or cardboard, moving parts need a firm foundation to keep them in place if they are to work properly. Corrugated cardboard is readily available at no cost and is rigid but easy to work with. Large boxes can be flattened and stored in a plan chest or behind a cupboard.

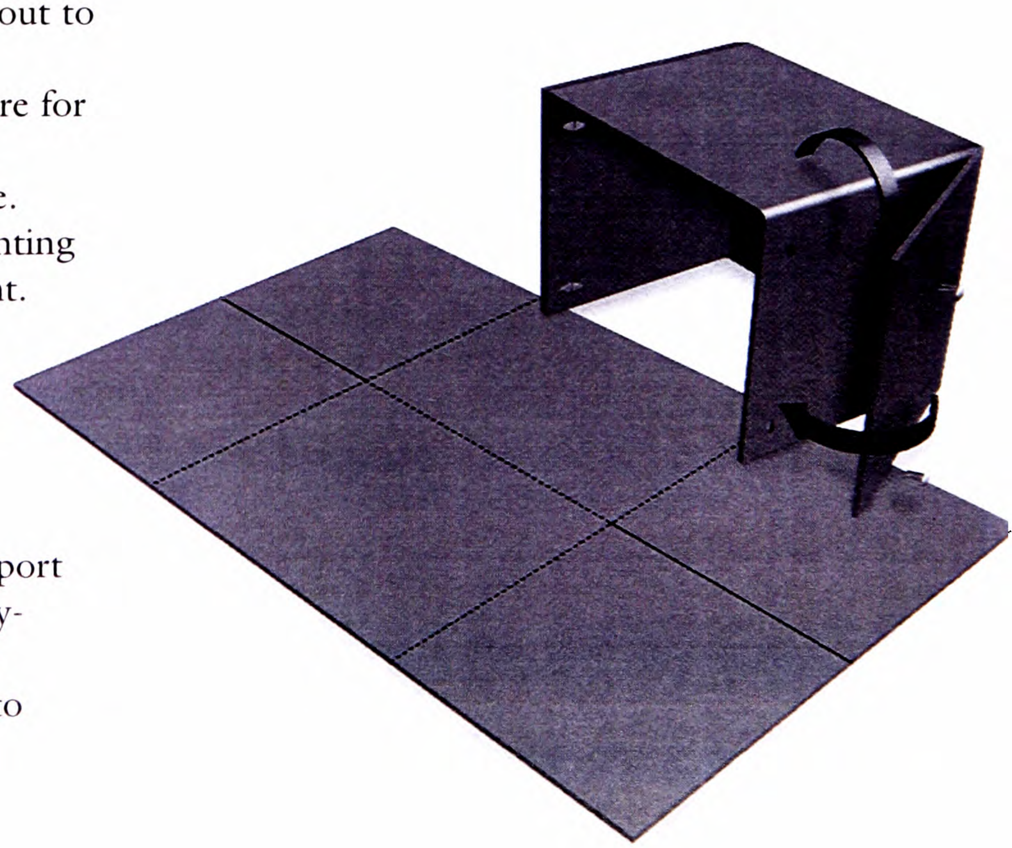
One big cardboard box can be flattened out to make lots of project-sized structures. A photocopy paper box will make a structure for several machines. Boxes (and unfinished machines) can be stored flat to save space. Turning the box inside out hides any printing that would be difficult to cover with paint.

Cutting rectangles for the pupils using a rotary trimmer or guillotine speeds up the making and improves the quality.

Photocopiables: SHEET 5 Copy this support structure on to card and cover with sticky-backed plastic for durability. Cut out the notches and mark in them with a pencil to transfer sizes to corrugated cardboard.

SHEET 6 Use as above to make support structures for conveyor belts.

NB: Longer structures can be made by sliding the template to each end of card of any desired length. Taller and wider structures can made by enlarging the template on the photocopier.



Introducing mouldable materials

Making a display

Materials that can be moulded play an important part in the world around us. They are very easy to shape into the things we need. When moulds are used, many things such as house bricks, clay pots and plastic toys can be copied quickly and cheaply. When shapes are moulded, nothing is wasted by cutting away unwanted parts. Plasticine stays soft and can be moulded over and over again. Other materials like concrete and plaster set hard when they are dry. Materials like clay are natural and very long-lasting – we can still see the footprints of dinosaurs where they moulded clay by treading in it!

You will need

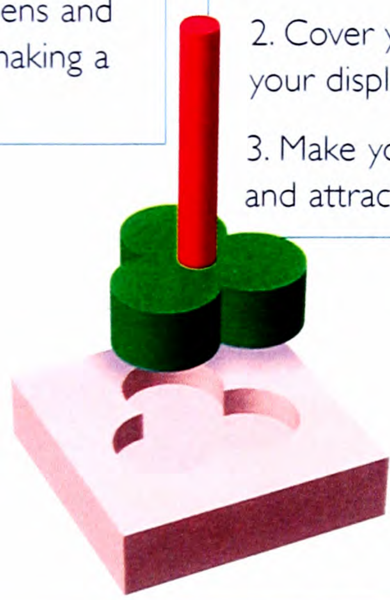
- things moulded from different materials
- pictures of moulded things
- coloured paper, pens and other things for making a display

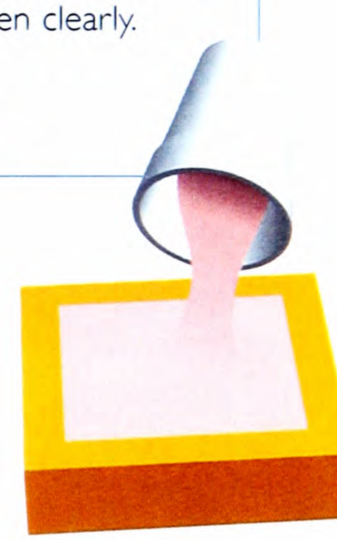
What to do

1. Set up display area for a display about mouldable materials. Use a table or other surface for standing things on and a wall or pinboard for pictures.

2. Cover your display area with cloth or coloured paper so that your display will look good and things can be seen clearly.

3. Make your display as interesting and attractive as you can.





Mouldable materials can be shaped by hand (page 12), stamped (page 14), extruded (page 16) and cast (page 18).

Getting ideas

When setting up your display, think of ways to show the different kinds of mouldable materials and what they are used for. Try to show how important they are and give samples for your audience to handle. Look at how displays are done in your school, in shops and other places. Museums are a really good place to see how things can be displayed. What makes a good display? Some displays get people to do things as well as just look. Do activities help people to understand and make a display more fun? Could you design display activities?

You could use a computer to find and print information, instructions and labels.

<u>**Appendix 6:2**</u> Moulding materials starting point

Making mouldable materials

From plaster to papier mâché

Lots of materials can be moulded but some need special equipment, others are unsafe or expensive. Here are some materials you can use. Look out for these materials in use around you. Leave projects that need to dry in a warm place so that they will be ready quicker. Always protect your working area with a plastic sheet and wear an apron to protect your clothes.

You will need

To try out some of the projects in this book you will need:

- plain flour
- salt
- water
- air-drying clay
- plaster
- sandpaper
- Mod-roc
- newspaper
- tissue paper
- foam plastic sheet (such as Plastazote or Formafoam)

Salt dough

1. Mix 2 measures of plain flour and 1 measure of salt. Gradually add 1 measure of water. Knead (squeeze, mix and squash) the dough until it moulds well.

2. When you have made your project, put it on a baking tray in an oven to harden. **Safety:** Get adult help when using the oven. Cook at a low heat (about 100° Centigrade, gas mark 1/4). A long time on a low heat is best. Big or thick pieces will take longest.

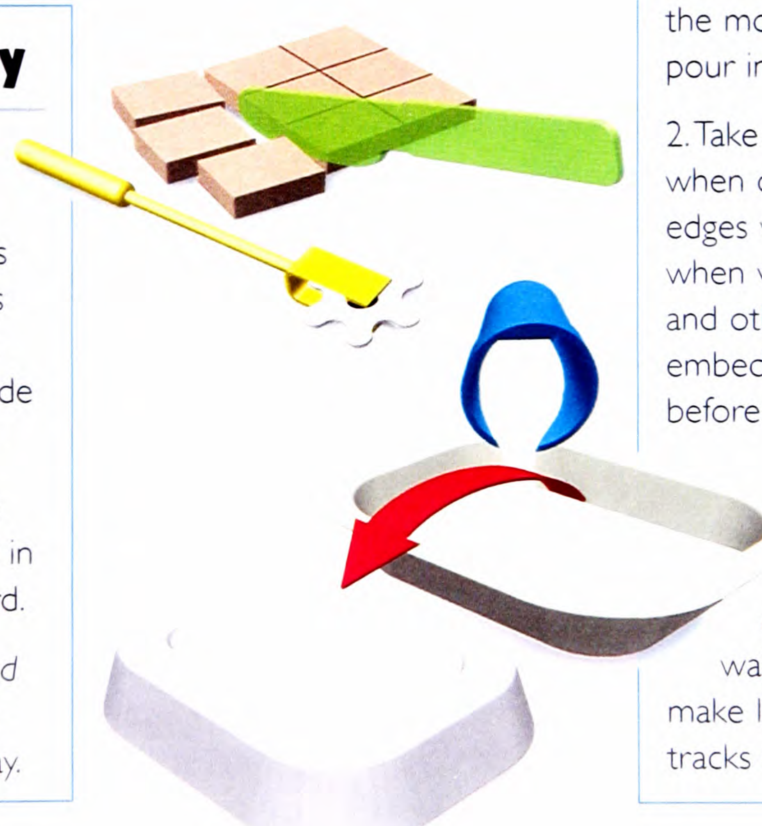
3. Wire hooks and other things can be moulded into the dough before baking. 4. Leave your project to cool before painting.

Air-drying clay

1. Mould the clay to the shape you want using fingers, plastic picnic knives and forks and other things like old pen caps that you can find. Beads can be made by moulding round a rod.

2. Leave to dry well. Keep unused clay well wrapped in plastic to stop it going hard.

Normal clay has to be *fired* (baked) in an oven. Bricks and tiles are made this way.



Plaster

1. Mix 3 measures of plaster with 1 of water. Stir well. Tap the mould gently as you pour in the liquid.

2. Take out of the mould when dry. Smooth sharp edges with sandpaper. Paint when very dry. Wire, hooks and other things can be embedded in the plaster before it sets.

This process is called *casting* (see page 18). Plaster casts are used to decorate walls and ceilings and to make lasting copies of animal tracks and footprints.

__Appendix 6:3__ Moulding materials starting point

Perishable products and materials may need to be shown as illustrations. Edible materials may need protection! Designing a mouldable materials display offers opportunities for links with *Exciting Electrics*. For example, pressure pads can be pressed to indicate the viewers' answers to questions about materials.

Making mouldable materials

From plaster to papier mâché – *page 7*

Some materials are potentially messy so cover the working area with plastic sheet and have pupils wear plastic aprons to protect their clothing.

Perhaps the least familiar material described is the foam plastic sheet. This is a polythene sheet filled with bubbles of nitrogen. It contains colouring but no other additives. Being a thermoplastic it can be repeatedly softened by gentle heat and moulded. It is much easier to cut and moulds at lower temperatures than acrylic (common brand name 'Perspex'), a plastic often used in secondary schools. The sheet can be ordered from suppliers such as those mentioned on page 27. Pupils can be encouraged to look for moulded plastic products in the world around them.

Safety

Since an oven is used to raise the plastic to moulding temperature, careful adult supervision is needed to avoid heating at too high a temperature or for too long. Use an electric oven only. Other mouldable materials (often branded products) can be found in Art and D&T suppliers, catalogues which give details about them. It is worth experimenting with small quantities.

Drawing

Modelling your ideas on paper – *page 10*

Basic drawing techniques are an important way to develop and express design ideas. Grid underlays make drawing easier. Pupils (and adults) often say that they 'can't draw' but like other skills, controlling a pencil improves with plenty of practice of the right kind. Pupils who find drawing difficult tend to concentrate on the pencil point but focusing on the 'target' and using the peripheral vision (or 'corner of the eye') to monitor the pencil is one of the 'tricks'. Most designed objects are made up of a limited number of ingredients such as cubes, cylinders and spheres and these need practice. Pupils might be reminded that other skills such as riding a bicycle that they have mastered needed practice. All the illustrations in the *Design Challenge* series were first drawn by the author using a 'pump action' pencil with B or 2B leads. Using leads softer than the usual HB gives a good dark line with little pressure that

Mouldable materials to eat

Basic recipes for biscuits and bread

Safety

Food safety and hygiene is important!

- Tie back long hair and wear a clean apron.
- Wash hands with soap, dry with a clean towel.
- All equipment must be clean and only used for food. Wash after use and dry with a clean cloth.
- Work on a clean surface.
- Don't cough or sneeze over food or equipment.
- Remember that some people must not eat certain foods.
- Get adult help with food safety and using an oven.

You will need

Basic biscuit recipe

- 125g soft margarine
- 125g brown or white sugar
- 250g plain flour
- 1 egg
- pinch of salt

Biscuit recipe

1. Beat the margarine and sugar together in a bowl.
2. Beat the egg and add it to the mixture.
3. Add the flour and salt and mix to make dough.
4. Roll out the dough and cut or stamp out the shapes you want.
5. Put the shapes on a greased baking tray and cook in a medium hot oven (about 190°C or gas mark 5) for about 15 minutes.

You will need

Basic bread recipe

- 500g of flour
- 250ml of warm water
- 1 level teaspoon of salt
- 2 tablespoons of sunflower oil
- 1 sachet of dried yeast

Bread recipe

1. Mix the ingredients in a large bowl.
2. Mix spices well in if these are wanted (divide the mix if you want to try different ones).
3. Knead the dough.
4. Leave the dough to rise for at least 20 minutes.
5. Put on a baking tray and place in an oven set to 225°C, gas mark 8, for 15-20 minutes.

Appendix 6:4 Moulding materials starting point

Moulded containers

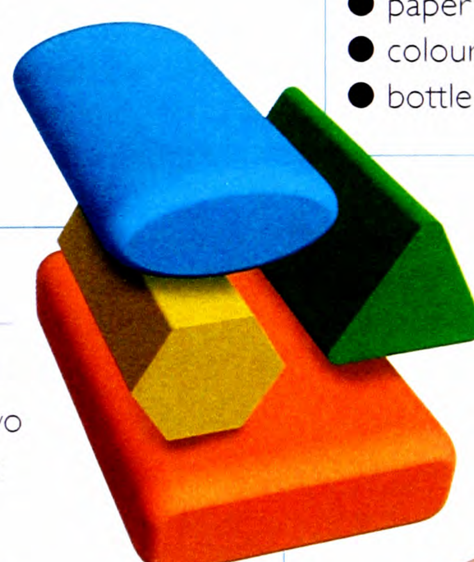
Designing practical packages

Among the moulded products you see every day are many different bottles and containers. Shower gels, shampoos, deodorants, perfumes, aftershave, make-up and toothpaste all come in moulded packages. Designers often use models to try out their ideas and to avoid expensive mistakes. Containers don't just have to hold a product. They usually have to make people want to buy it, and give information. They should also be easy to use. Designers need to think about all the energy and materials that go into containers and what should happen to them when they are empty. How many moulded glass and plastic containers are there in your home? You don't have the machines to make plastic and glass containers but you can design and model them.

You will need

- Plasticine
- air-drying clay or salt dough (page 7)
- paper
- colouring equipment
- bottle caps

Safety: some liquids used in the home can be harmful. Get adult advice and make sure that containers you look at or take parts from are washed out thoroughly first.

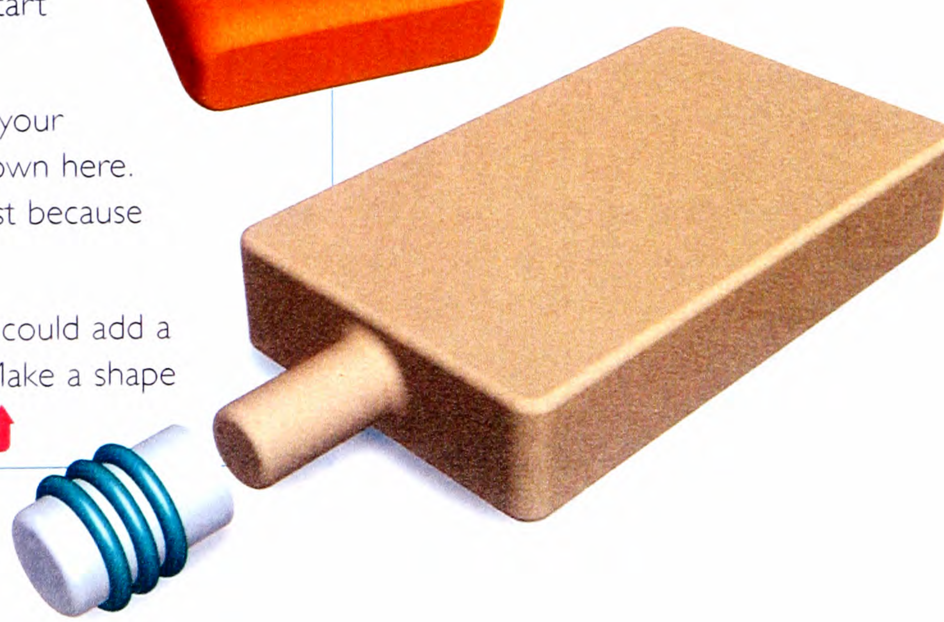


What to do

1. Think about the design of your container and what would go in it if it was real. Read these two pages and draw different ideas before you start making (see page 10).

2. Start by making a basic shape and mould your container from that. A few examples are shown here. You could try out your ideas in Plasticine first because it won't dry out while you experiment.

3. To make your project look more real you could add a lid, cap or other part that you have found. Make a shape to hold it in place when you glue it.



Appendix 7

Consent letter

(This was went to parents and carers on University of Greenwich headed paper)

1st June, 2004

Filming of Children's University Students for Research

Dear Parents and Carers,

As your child's tutor at the Children's University I am writing to say that I hope they will have a really enjoyable and educational experience with us. I am also writing to seek your co-operation.

I am planning to take video and still pictures of Children's University students as they go about their normal work and discuss ideas. This is an important part of my research into how children can be helped to have more and better ideas in design and technology.

Some still images *may* be published in *DATA*, the Design and Technology Association's journal or similar professional publications. In this case, students will *not* be identified by name. Images will *not* be published on the web. Video will be viewed by me and my co-researcher at Oulu University, Finland. Short clips may be used for teaching purposes with trainee and serving teachers.

Please send a note with your child tomorrow (Tuesday 22nd June) if you DO NOT wish your them to be filmed or photographed working.

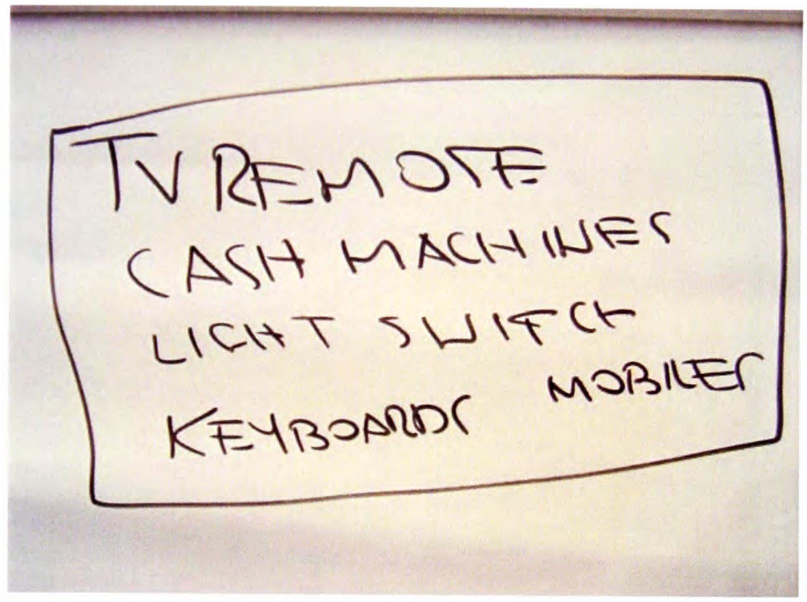
Thanks in anticipation of your co-operation.

Keith Good,

Senior Lecturer

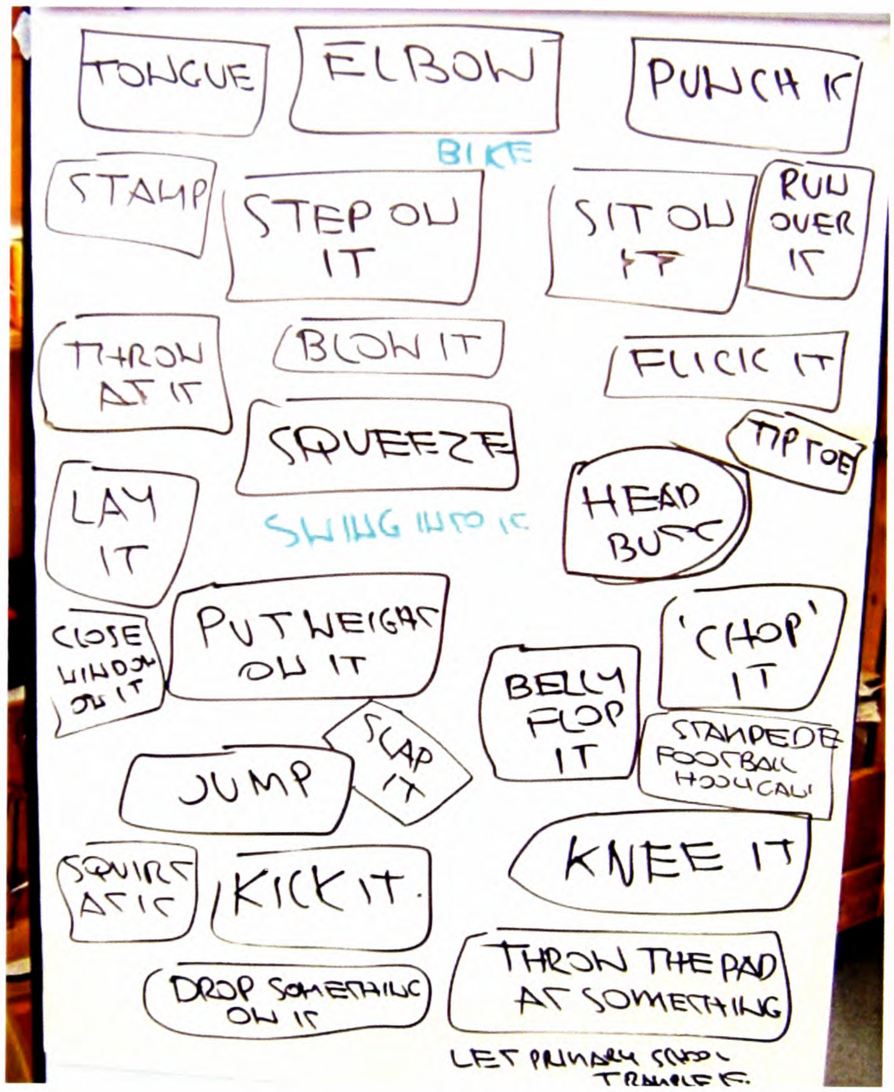
Appendix 8a

Flipchart from Brainstorming 1 – Uses of pressure pads in everyday life.



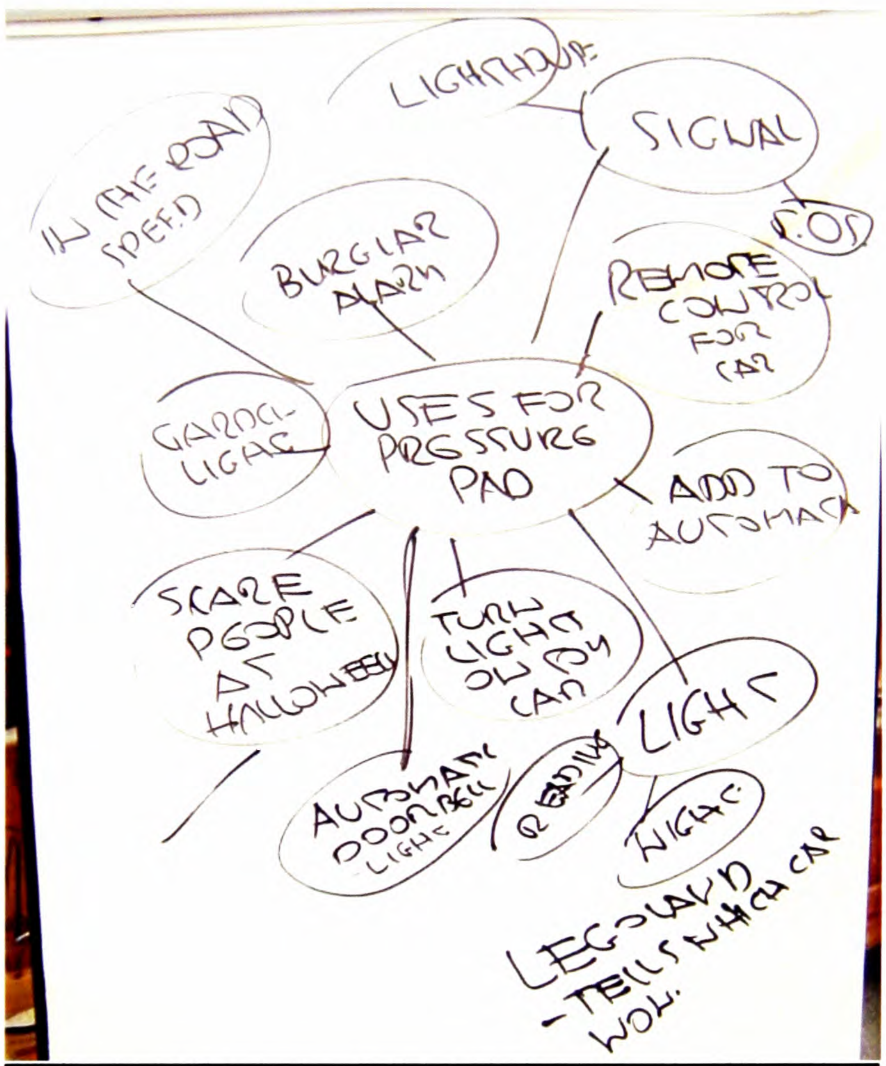
Appendix 8b

Flipchart from Brainstorming 2 – Ways to make the pressure pad go on



Appendix 8c

Flipchart for Brainstorming 3 – Ideas for using the pressure pads



Appendix 9

The shared outline 'script' from which the *spa* session was taught.

<u>Objectives</u>

To use the pressure pad (pp) switch to trial the *starting point approach* to design and technology.

- To stimulate maximum number and variety of ideas for using the pressure pad
- To gather these ideas.

<u>Stage 1</u> - Introduction of pressure pad

<u>Overview of the Session</u>

Let children know that they will be shown a kind of switch called a pressure pad and how to make their own working one.

They will then be asked to think of *as many uses as possible* for the switch.

Revise basic concept of a switch by showing the 'gap' in a circuit with a bulb, battery and wire.

<u>Introduce large scale pressure pad (pp) example.</u>

- show how it is made
- explain how it works

- advantages of pressure pads (thin, take up little room, hard wearing, tough)

<u>Show how to make the pp.</u>

Children make their pressure pad with circuit (shown 'live' and use first pp page from *Exciting Electrics.)*

Stage 2 - Brainstorming where pressure pads are already used

<u>Stimulus -Uses of Pressure Pads in society</u>

(Record on flipchart or board – *take digital picture*)

Encourage pupils to suggest examples of existing uses.

Where have they seen or used switches like this?

Tutor supplements ideas as necessary e.g. cash points, microwave ovens, photocopiers.

Stage 3 - Explore ways of turning pp on.

Children's ideas - priority

Tutor supplements if necessary

Stage 4 - Making the pressure pads

(Issue pages copied from *Exciting Electrics* by K.Good.

Stage 5 - Brainstorm ideas for using their pressure pads.

Appendix 10

Codes for interaction: Phase 2

Key

red text in dialogue box - *child's speech*

black text - *researcher's speech*

inf	information - *usually imparted by the researcher*
Qs	shooting question- (De Bono, 2004: 79) *closed question where there are a limited number or single answer- known to the questioner*
Qf	fishing question - (De Bono, 2004:78) *an open-ended question and where the questioner does not know what answer will be given*
eval	evaluation - *comment on a idea*
met	metacognition - *the coaching thinking skills by the researcher*
elab	elaboration - *asking for further information*
dir	directing- *telling the children what to do e.g. 'hands up'*
mod	modelling- *the modelling of desirable behaviour by the researcher*
rep	reply- *reply to a previous question or comment- not including an idea*
repI	reply - *a reply from a child that includes an idea*

Brainstorming 1: Introduction of pressure pad- Transcript and Analysis

Transcript from video	Cats.	Actions	Commentary
4. OK So what we've got here then is a pressure pad switch, now this is very simple thing but it's very important device OK so what we've got here is three bits of card and some kitchen foil – there's nothing magic but you can do some pretty magic things with it.	inf	Shows large switch to the group, opening it to show the construction	This first introduction is important as professional experience suggests that Ch. decide early if something is of interest or not. The stress is on simple, achievable but lots of exciting potential.
5. So it's made from three layers – as you can see. Who's done switches in science? I'm sure most, everybody's done switches – Good!	inf Qs eval	All children indicate 'yes', hands up, nods.	K moves on to how pp is constructed and tries to tap into science knowledge.
6. So could someone tell me what basically a switch is?	Qs		Getting the fundamental concept clear at the outset gives a good basis for understanding the pp. Despite indications of understanding (5) it is good practice to check.
7 .It's something what turns something on and off	rep		Understands the concept of a switch.
8. That's it, it's a control device. Absolutely, it switches something on and off.	inf eval		K encourages and elaborates (control device). Repeating the answer reinforces it and ensures all

			have heard.
9. Now to make a circuit, an electrical circuit work a bulb and a battery and you know bit a wire- you know that you have to have a loop, don't you?	inf Qs	K uses gesture to reinforce 'loop'	Gesture acts as important reinforcement. This is especially useful in design and technology where objects are often need to be visualised and discussed. Children need to be looking and this also helps control.
10. Yeah so what we've got we got a switch then is where introduce a gap but it's a gap that we can close up easily when we want to make the circuit work OK? And here you can see the gap in the circuit OK see the gap between the foil strips? And what we'll do we'll put a loop on here which is the circuit – battery, buzzer whatever we want Yeah – that's the loop and there's the gap.	inf Qs inf	K uses thumb and forefinger to reinforce 'gap'. Shows gap in the switch. Ch. nod assent.	Here the concept of a switch is emphasised and clarified. Starting the designing from fundamental concepts is an important part of the *spa*. K only met the Ch. the day prior to this session so R is getting feedback about the ch's knowledge and understanding.
11. OK This bit we call the 'window' and the 'window' is just to separate the layers - the top part – mine's is falling apart a bit – goes through there and when I press it what happens? Hands up	inf Qs dir		The question is to check engagement. Requiring 'hands up' allows the understanding of all to be assessed. Calling out would preclude this.
12. Hands up	dir	Most Ch. raise their hands.	Indicates that the majority at least, understand how the starting point (pp) works.

Transcript: Introduction of pressure pad (continued)	Cats.	Actions	Commentary
13. Zoe - The light bulb goes on .	rep		This indicates that R understands how pp works.
14. Yeah the circuit goes on absolutely yeah thanks Michael OK Zoe that's great.	inf eval		K repeats the answer to reinforce it Plenty of praise to encourage further answers and promote psychological safety.
15. So all it does is closes the gap, so if we didn't have the middle layer what do you think would happen?	inf Qf		This is to check the understanding of how the pp works.
16. D- It would stay on	rep		Shows understanding of the role of the 'window'.
18 .D- It'd stay on	rep	Ch. puts hand up	Also keen to answer, D shows understanding of the role of the 'window'.
19. Yeah you're absolutely right it would stay on so that middle layer is quite important.	eval inf	Shows middle layer	K repeats the answer to reinforce it Plenty of praise to encourage further answers and promote psychological safety.
20. You can adjust how sensitive this switch is by the size of the 'window'. So if you make a very big 'window' it'll go on when you press it sort of anywhere. OK?	inf	Shows pressing switch with palm over large area.	The basic functioning of the pp was established previously .K is now introducing refinements of the 'window' concept that might help to provoke or influence designs.

		Ch. agree.	
21. If you make it a very small 'window' it'll only go on when you press it in one special place. OK? So that's basically how it works.	inf Qs	Shows pressing the pad with finger tip. Ch. agree.	This is further refining the 'window' concept. This is further refinement that might suggest some designs where pressing in 'special place' would be a feature.
22. Alright now the next thing we need to think about is why people bother with these. OK why do they have them?	inf Qf	No response	Part of the *spa* involves identifying the particular strengths of the technology that forms the starting point. Ch. are not particularly expected to answer at this point. The question is largely rhetorical and to encourage them to think.
23. Compared to the old mechanical switches they have a number of advantages first of all it's very thin. Isn't it? Yeah.	inf Qs	Gestures using a mechanical switch.	K begins to provide the answer to the earlier question at 22.
24. I could make it even thinner – if I used thinner card so that means and it could be very small if you wanted it to be – Could be the size of a stamp yeah? Or smaller.	inf Qs	gestures 'thin'	This continues the above providing of information and eliciting feedback about their understanding. This thinness and smallness could also suggest designs where this is important.
25. So these are used in things like mobile phones,	inf		Examples of pp in use are given here to illustrate one

microwave ovens and things like that because they are very thin and they don't take a lot of space up so that means we can make the device like the mobile smaller than if it had a great big plonky mechanical switch.			of the properties of the pp i.e. its thinness. Uses mobile phone example to engage children.
26. The other thing is they are very very tough because if I hit this really hard all I'm doing is squashing the layers together – I'm not going to damage it – not like a plastic switch which I might be able to smash.	inf	hits switch repeatedly	K is using words and actions to get attention and at the same time emphasise this feature of the pp. The toughness of the pp may provoke ideas where this quality is important. The researcher had experience while teaching in the USA where a boy had the idea of 'baseball pitching target'- linking his interest with the toughness of the pp.
27. These are pretty tough that's why they use them on things like cash point machines Yeah It just doesn't matter how hard you hit that you're not really going to break it.	inf		This is more than just giving information about pps. The properties of the starting points are being highlighted so that they can be exploited when designing.
28. OK so that's a number of advantages	inf		K is verbally 'drawing a line' under this feature and moving on to another. This is part of structuring the information for the children to aid understanding.
29. Another nice thing about it is you can put information on the switch itself. So if you want to put press here or something like that. Or press here for doctor's surgery or something you can put it on the thing and people touch the actual switch itself.	inf		More information about the distinctive features of the pp starting point for designing. A specific example is given to help children understand the general idea. As at line 27, highlighting a property is intended to encourage ideas. It is not knowledge for its own sake.

31. So they are quite important little gadgets really. OK so how do we make one of these?	inf Qs		Getting ch to think about ‘how’ prior to showing them.

Brainstorming 2: Ways to make the pressure pad go on - Transcript and Analysis

Transcript from video	Cats.	Actions	Commentary
148. Yeah. OK so that's given us a few examples of where they're used ehm… now, now what we are going to do now is think about ways of turning the thing on.	inf dir		Drawing first brainstorming to a close. Experienced practitioner needs to judge this according to the reduction in the flow of ideas. Repetition of previous ideas would be another indication. Beginning the next task.
149. Alright, now obviously I can press it with my thumb. How else can I turn this thing on? Let's have hands up. I can press it with my thumb.	inf Qf inf	Pressing the pad is shown to reinforce the words.	This is to reinforce the explanation of what is required.
150. Now as many ways as possible of turning this on yeah?	Qf		Quantity of ideas is stressed at this point to overcome inhibitions and to try to start the flow if ideas. Momentum seems to help.
151. Step on it.	repl		Idea 1
152. Yeah good. Yeah good. Ritchie	eval inf		Encouraging, promoting psychological safety so that others will respond also.
153. Sit on it	repl		Idea 2

154. Yeah good anymore?	Qf		Again, encouraging responses. A sequence of ideas and encouragement follows. Important not to interrupt the momentum. Idea and encouragement sequence continues uninterrupted to 177.
155. Squeeze it.	repl		Idea 3
156. Yeah good. Go on	eval dir		
157. Pinch it.	repl		Idea 4
158. Pinch it is a bit like squeezing it. Alright anymore? Sorry Sorry, go on.	inf		It would probably have been best not to make this point in case it inhibited the flow of ideas. Filtering ideas would be better done later.
159. Head butt it.	repl		Idea 5 This is the first of several ideas on the same theme: using different body parts.
160. Yeah good. Yeah head butt it ,any others? Yeah go on the	eval Qf		

162. Use a remote control. What would you do throw the remote control at it?	elab		
164. Sorry we're now thinking of ways of turning it on…yeah?	dir Qf		K once again 'draws a line and indicates that the discussion is moving on. This need sensitivity to avoid closing a point too quickly. Momentum is important but there is a risk of missing ideas and putting children off answering.
165. We reckon you could put some weight on it	repl		Idea 7 Although the children are apparently contributing individually, the 'we' indicated some collaboration. They were also seen to confer.
167. Belly Flop it	repl		Idea 8 This is probably not provoked by the previous idea as the actions involved are very different. Independent trains of thought are sometimes going on a the same time in the group. Managing this can be difficult and there is the risk that one child may give up or forget their idea if others dominate.
168. Yeah yeah belly flop it well I've never had that one before	eval		Encouraging unusual and even outlandish ideas is important to promoting psychological safety and eliciting the more imaginative ideas. This was not the time to examine contributions too critically.
169. Good idea	eval		Child encouraging the others. This is to be encouraged.

170. Why not? Yeah go on	Qs		K adds his endorsement to reassure the group that unusual ideas that might sound like jokes,
171. Elbow it	repl		Idea 9
172. Yeah yeah good we've got lots already. Do you notice that once you get started it gets easier? Go on then	eval met dir		Encouraging but also trying to make ch. see a general point. Some' thinking about thinking' – metacognition .
173. Punch it	repl		Idea 10
174. Punch it yeah. Go on then there's still more	eval		Repeating to reinforce the answer.
175. Touch it with your tongue	repl		Idea 11
176. Yeah press it with your tongue. Yeah it's possible isn't it? Now the reason we do this is any one of these might give us an idea for a project yeah. Go on then Zoe yes good – why not. Good we're doing well here. Go on then	eval met		More encouragement and again attempting to make a general point.

177. Fart on it	repl		Idea 12
178. I don't think we want that one. That's what we call 'not appropriate'.	eval		It might have been better not to react to this idea as a distracting debate follows until 185.
184. But you did it, if he said jump off a bridge would you do that? Don't answer that question. Thank you let's have appropriate answers.	Qs dir		'Appropriateness' is a risky concept to introduce in that care is needed not to rule out or inhibit ideas. Appropriateness is however, a concept that children will be with from school. Even when brainstorming there are rules.
185. Thank you, let's have *appropriate* answers.	dir		K is in 'teacher mode' here and is bringing a halt to the unproductive exchange.
Yeah we could flick it like that. Anymore, yeah, we'll probably get lots more now. Once ideas start coming they tend to come easily. .	eval met		As at 172 and 176, a 'metacognitive' is being point made while encouraging an idea.
187. Kneel	repl		Idea 13
188. Yeah good good. I used to do karate and I was going to make a martial art training aid with it.	eval mod	shows karate hand techniques	K trying to maintain the momentum, show involvement and also 'jump starting' the Ch's ideas. Also modelling

			the strategy of relating the starting point to a personal interest
189. You can do all sort of things with this. Go on	inf dir		K emphasising that the preceding example was just an example- one of many possibilities.
190. Kick it	repl		Idea 14 This is the result of the 'jump starting' at 188.
191. Karate chop it	repl	hand chopping movements	Idea 15 A further result of the 'jump starting' at 188. and more directly from the previous idea at 190.
192. Yeah. Go on any more? (Student Ambassador helper contributes an idea) You realise you are contaminating my day by answering these questions. It's alright I'm only kidding. Anyone, go on sorry, have we got that one already somewhere. Yeah good we've got loads though haven't we?	inf eval Qf		K is making an aside here to the Student Ambassador but quickly turns to the group to avoid breaking the momentum.
193. Throw the actual thing	repl		Idea 16 This is an interesting example of what Michalko (2001: 15) calls *reversal* where a new idea is created by reversing the usual way of doing things. Hitting the pad against something rather than hitting things against the pad. There is another example of *reversal* later

194. Throw the pad?	elab		K seeks clarification and elaboration.
195…against the wall	rep		Ch. elaborates
196. Yeah yeah I've never thought of that one before. That's what makes design technology interesting you know we get new things coming up all the time. I've never thought of that one before and no one else has either. That's given me a nice little idea that has. Good.	eval met		Another example of K making a general point from the particular idea.
197. Blimey just when you think we've run out someone has another idea you see. Go on then.	met		
198. Blow on it	repl		Idea 17 This is a departure from previous ideas in that it doe not involve touching the switch.
199.Yeah yeah if you make it sensitive enough. You're doing really well. Yeah. Good. Any more? Go on then.	eval dir		K makes a suggestion that would make the idea workable. The teacher needs to take a positive view of ideas offered to encourage more.
200. Stamp on it	repl		Idea 18

201. Yeah we haven't got that really have we. Good great stuff. Any more?	Qs eval Qs		More encouragement and reinforcement of idea generating behaviour.
202. Drop something on it	repl		Idea 19
223. If it was under a doormat you could step on it	repl		Idea 24
224. Yeah but you'd step over alarms like that.	eval		
225. Yeah pressure alarms	inf		
226. Yeah right. Yeah you put them under windows under the carpet and it sets the alarm off. Yeah go on Ritchie	eval inf dir		More 'jump starting' K to provoke ideas.
227. Tiptoe	repl		Idea 25
228. Tiptoe, I think you are just trying to give me a problem of where to put this. Anymore, there can't be many left….. yeah good try.	eval	Tries to find room on flipchart for the idea.	This is said in a humorous way to emphasise how many ideas have been suggested.
229. OK eh I think that is quite a lot there isn't it? Yeah	eval		

anymore	Qf		
230. Close the window on it.	repl		Idea 26
231. Yeah yeah you could. Well that's terrific and there is still more.	eval		K is praises the Ch's idea to encourage more. Praising one child helps to encourage all.
232. Something about a football	repl		Idea 27 A partly formed idea that could be developed.
233. Yeah yeah he saw the match last night. Footballer and that's about it. Right that is really great. There are lots there that have never come up before you know as well as all the obvious ones.	eval		An 'important' football match had been televised on the evening before this session. This could be an example of how 'outside' experience can provoke ideas.
234. We could also ride a bike over it also. Couldn't we? Yeah .	mod		This appears to be K intervening too much and giving an idea that might have come from the group. However, it can also be seen as taking part, becoming one of the group.
235. These are all your ideas we haven't got any room for mine. That's good because design technology is all about your ideas. Oh go on then let's have another one then.	met		K makes a general point but this is also to promote psychological safety and encourage more ideas.

236. Chuck it into a primary school just before the last day of term ends	repl		Idea 8
237. Yeah and let them all trundle over it. Yeah. I haven't got room for that. Have I got any room for that? What about down the bottom here? Let primary school trample over it.	eval Qs Qs		
238. Good OK. I think we'd better move onto the next thing but one of the things you can try to do when you are trying to have ideas is look – like we did with the bin bag – you look at what you've got already and try to squeeze a little more out of it.	met		K has decided to bring this phase to a close. This is not to say that no more ideas would be forthcoming. The decision was based partly on the slowing in the rate of contributions. Another consideration was the time available in the session and what else remained to be done.
239. 'Because having ideas is really important whatever job you go into. The chances are you'll need to be creative to have ideas about how things could be done differently, how things could be done better.	inf met		Another example of K extrapolating a general point from the situation. K is trying to help the group see the broader picture and the 'worthwhileness' of the activity.
240. Well that's really good. I didn't expect to get that many ideas at all. That's tremendous. OK.	eval		As with any of the three brainstorming sessions. K needs to judge when the supply of ideas is exhausted. The time needed for other activities is also a factor is deciding when to stop.

Brainstorming 3: Children's ideas for using their pressure pad – Transcript and Analysis

Transcript from video	Cats.	Actions	Commentary
276. OK so what we are going to do now is brainstorm some ideas for using the ….OK. All I want you to do is put ideas for using the pressure pad yeah and you start…	inf		
277. Right let's have some hands up then. What can we use this for?	dir Qf		Although ordering the contributions (hands up) seems contrary to the spirit of brainstorming, the children would be accustomed to answering this way. It also aided the capturing of individual ideas (and their brief consideration by the group) in a way that calling out would not have.
278.Remote Control	repl		Idea 1
279. Yeah what can we remote control with it?	Qf		Asking the child to explain and elaborate.
280. Ehm a remote control car – press a button and it goes up and press the button and it goes down and another button and it goes to the side.	rep		Idea 2
281 On a long bit of cable kind of thing yeah?	Qs		Checking understanding.

282. Yeah.	rep		
283. Good. OK go on then Gavin.	eval		Approval to encourage all children, not just the speaker. A negative response from teacher at this point would almost certainly inhibit potential contributors. Ch. did not know the researcher well and would be looking for indications of how he would receive their ideas.
284. Sort of like a sort of lead	repl		D is explaining his idea. Although a good momentum seems to help the flow of ideas, there is sometimes a need to allow time for exploring or clarifying them.
285. OK yeah so we could add to machines like a little automata.	eval		
286. Yeah.	rep		
287. Yeah good OK. Ritchie.	eval		K ends the exchange on a positive note and moves on.
288. Lights .	repl		Idea 3

289. Can you explain what you mean a bit more.	elab		K is asking for elaboration
290. Lights on a car.	rep		Ch responds by elaborating.
291. Yeah, if we make the toy car you mean Is that what you mean?	elab		K is encouraging and at the same time trying to encourage him to elaborate on his idea.
292. The headlights.	rep		Further elaboration on the idea was provoked by K's question. Was Ch. explaining the idea he had in the first place, or did the questions help to develop his idea?
293. OK good Thanks Zoe. OK Libby	eval		K's 'Thanks' indicates time to move on.
294. L- One of my friends said that she used it to set the tape recorder thing to scare people at her Halloween party by putting it under the door mat.	repl		Idea 4. Differences between the children (in the way they answered) emerge. Here L makes a lengthy answer. The 'story' may be made up as the idea is very similar to one mentioned by K earlier. L makes another lengthy answer at 361.
295. Scare people. How do you spell Halloween?	Qs		

296. H A L L O W E E N.	rep		
297. Right OK good some more.	**eval** dir		Approving contributions and encouraging more.
298. Radio alarm.	**repl**		Idea 5 Here the idea seems to be 'wandering' from ideas for *their* projects.
299. Yeah. Sorry.			
300. Microwave oven.	**repl**		Idea 6. As above at Idea 5.
301. Yeah but I'm thinking of things we could make though really. Sorry just a sec.	**inf** dir		K has noticed that the ideas (298, 300) are moving away from ideas for their projects and back to existing uses for the pp. He tries to counter this.
302. Ehm OK. OK go on then. What else could we do? What might we use it for?	**Qs** **Qf**		

303. OK We're making something here in design technology and we've got all the materials we want. What might we use it to make?	**inf** **Qf**		K is emphasising the need to think of ideas for *their* projects. This is seen as a major role for the *spa*.
304. A light.	**repl**		Idea 7. This is a general idea that could be developed into a number others e.g. lights for different purposes.
305. Yeah yeah we could use it to turn the light on. It could be quite handy really at night… you know at night when you can't find the switch you could make a great big giant pressure pad and have light straight away.	**mod**		K may appear to be contributing too much here but his main purpose is to convey his enthusiasm for the ch's idea and move things along.
306. I was going to say night light so that you could easily find your drink.	**repl**		Idea 8. This is an example of a Ch's idea for a specific project being stimulated by a general one (Idea 7 at line 304).
307. Yeah yeah that's right a night light to help you find your drink easily. You could even stand the drink on it and then you it would be light all the time then. Yeah. Yeah.	**eval** **mod**		Here K is again picking up on the ch's idea, showing his enthusiasm for it- and being a *participant* for a short time to provide a model and encouragement. K is giving some practical developments of the ch's idea, taking it a little further towards a complete design idea.

308. If you're scared in the dark.	**repl**		Another example of a Ch's idea for a specific project being stimulated by a general one (Idea 7 at line 304). The ch started with a very general idea and refined it into one of many possible specific ones.
309. Yeah yeah if you're scared in the dark. OK go on then some more. Yep?	**eval**		K is encouraging but asking for the refinement to be taken further. This is not just asking for thinking that is in place to be revealed. It is likely that new thinking will be needed to answer.
310. You could use it as a light to help you read.	**repl**		With encouragement, the Ch. has moved from a problem or general idea to a specific idea. This indicates a useful strategy for the teacher.
311. Yeah yeah a reading light. Yeah. Go on then Paul.	**eval**		
312. You could use it for a bell.	**repl**		A different idea is being offered. The teacher has to balance exploring a given idea to maintaining the momentum of gathering new ones.
313. Yeah yeah it'd be an automatic door bell then no one would need to ring it and you'd know people were there.	**mod**		Questioning to the Ch. about the idea might have been better at this point. However, the teacher joining in sometimes in helps to make them part of the group. Showing enthusiasm can help to sustain it in the Ch.

314. Like that if it was a really bright light you could press it and it'd light in the front room and you'd know.	repl		Here a light *rather* than a bell is suggested.
315. Yeah you'd know someone was there.	eval		K takes care to encourage this unconventional idea for alerting the householder to visitors. Such ides can be valuable. This one could be useful for deaf people.
316. Yeah you could hide it under the mat and when they stand on it....	repl		This was suggested during the second brainstorming session. (Analysis of Transcript 2: Ways to make the pressure pad go on. Line 223).
317. Yeah door bell or light. OK Does the way of turning it on, on the board, give us any ideas?	eval met	Indicates second flipchart.	K is bringing the idea to a conclusion and trying to provoke new ones by revisiting the earlier flipchart.
318. If you're working in the garden at night you could put a weight on it and it'd give you light to work in the garden.	repl	Mimes putting a weight on the switch	The flipchart helps at this point as the idea stems from one of the ways suggested to make the switch go on.
319. Yeah It could be a garden light. Can we think about what's special about a pressure pad. One of the things that's special about a pressure pad is that you press it or put weight on it and it stays on so if it was a child's toy for example it would be quite useful. Go on then Ritchie.	eval inf mod		K is reminding the Ch. about the basic functioning of their starting point. Some more 'jump starting' follows. This concludes with suggesting and area to explore.

320. Using the light as a signal .	repl		This Ch was already thinking of his own idea while the previous stimulus was going on. This illustrates that what the teacher thinks children are doing is not always what the are. As in this case, that need not be a problem.
321 Yeah good a signal light. Have you heard of Morse code? Yeah.	eval Qs		K is again looking to make a broader point.
322. They used it in the war and out at sea.	rep		This is a link with the National Curriculum for History.
323. Yeah they did. Yeah they did. A model lighthouse. Yeah yeah so we've got Morse code. You would need a Morse code key.	eval inf		
324. Right right anymore? Let's have some more. Ehm What about games of some sort?	Qs mod		K has decided that the idea has been explored sufficiently and that it is time to move on to a new area. It is sometimes is a fine judgement to know when to do this.
325. Yeah go on.	dir		
326. Instead of speed cameras right. It might not work yeah but out in the road and if a car goes over it and the bulb come on no no	repl		This ch. is developing and evaluating his idea as he articulates it. He obviously has reservations but feels psychologically safe enough to speak anyway.

327. Yeah nice idea though. Eh Yeah. Anyone got any ideas how we could make that a useful idea. Yeah go on.	eval Qf mod		K uses the strategy of getting the group to look for the *potential* in the idea. It is wasteful to dismiss an idea without seeing if it can result in others.
328. Well I got a well ehm If you like I got this idea from Lego land because right what they have. Basically they have these cars made of Lego that roll down this hill and if you at the finish line hid some pressure pads under it the first one would light up and you'd know which one won because it'd light up first.	repl		This is an example of how a Ch. can use their personal experience outside the classroom to generate ideas. The idea is clearly well formed.
329. Yeah yeah good. You could either put it so that instead of a line the cars would hit it or run over it. They both would work. Wonder which would be best? Yeah	eval		K poses a question to provoke ideas about how the idea might be put into practice.
330. You could do a buzzer.	repl		Another Ch. contributes to the idea. This is one of the benefits of group work.
331. Yeah yeah you could do a buzzer. Yeah OK alright that's good. Did I write that down? No no I didn't. OK go on then.	eval Qs dir	Child is offering an answer (hand up)	

332. A game for children	repl		This may be completely the ch's own idea but it could also have been provoked by K's prompting much earlier at line 319. This illustrates that idea generating is not a tidy process.
333. A game for children. So sometimes when we have an idea it gives us questions. Because when he says that I think right what kind of games for children? There could be lots couldn't there? It could be for little children. OK so…	met Qf		K is modelling the strategy of analysing and idea to refine it into a finished design.
335. Like a playmat?	Qs		This is meant as working in the same way as a playmate, not the same as one.
336. Yeah	rep		
337. Yeah that'd be great wouldn't it that'd be really good with lights and everything. Yeah that's good. Yeah so a number game perhaps for older children. Yeah that's great so what else have we got? It doesn't have to be a game for children it can be anything. Anything now. Go on	eval Qf dir		More encouragement.
338. Right at night if you're driving in your lorry and it might be dark and when you stop they might want the light on.	repl		This Ch. has clearly been thinking independently during the previous exchange and introduces new idea.

339 OK So how would they turn on?	elab		
340. When the car goes quiet.	rep		
341. OK right that'd be good. Can anyone think of any other advantage to that? The light goes on when the car goes quiet. That'd be a good idea.	eval Qf		The answer is no real explanation but K wants to avoid inhibiting the flow of ideas with too much scrutiny.
342. Yeah near traffic lights or on the motorway	repl		
343. It'd let people know that the car had stopped. Yeah yeah right yeah one idea that'd be useful for pedestrians. How else might it be used?	eval Qf		Questioning here is more about getting the Ch. to develop their thoughts rather than merely getting them to express ideas they already have.
344. Ehm it .could be used for the car driver so that ehm say it was night time and the driver.was really tired there could be a buzzer to wake him when he like ehm drops off.	repl		How this might work is not explained but that could be explored later.
345. Right eh so to keep the driver awake. Yeah. That's true.	eval		Reinforcement and encouragement

346. D- For a different burglar alarm so that if he comes in the window and the window shuts the buzzer would go on.	**repl**		D is revisiting the basic idea of an alarm that emerged earlier. He is *reversing* the usual *opening* of a window to trigger an alarm. This is to accommodate the pp *Reversal* as a strategy for idea generation features p174 *Cracking Creativity*, Michalko, M.., 2001, Ten Speed Press .
347. Yeah if you leave your window open but if you leave the window shut you .would be stuck but yeah yeah that might work.	**eval**		K is pointing out a problem with the idea but gives qualified approval to encourage. In any case, there are often advantages to an idea that are not obvious at first. K wants to move on.
348. R - Or when you see when burglars .put their hand in the letter box and try and push the door then when the letter box shut the thing would go off.	**repl**		R's idea has been stimulated by D's revisiting of the 'alarm' theme. An example of one idea provoking another.
349. Yeah the letter box sets it off. Go on then Ritchie. Anywhere, where there is pressure will make it work then.	**eval** **mod**		K reinforcing how the idea works for the benefit of the group. K reiterating the main feature of the pp. Attempting to provoke further ideas.
351. OK. Yeah carry on then. Let's have some more then. We're doing really well here.	dir		More encouragement but exhortation alone is sometimes insufficient. K quickly moves to more active stimulus.

352. Right, it would warn the cars ahead. Yeah and it'd save energy as the lights because. instead of the lights being on all the time they would only be on when someone is around.	**inf**		Although apparently dealing with this idea, he is also raising the idea of pressure pad as energy saver. This might provoke further ideas.
353. Yeah, you get rooms like that where it senses your movement and switches the lights come on.	**inf**		More of the above.
354. OK. It's like when you open it go in and lock it and .it turns on. Yeah quite a lot of useful automatic things. Right go on then	dir		K refers to 'automatic things' in general in an attempt to provoke ideas where the pp is pressed 'automatically'.
. 355. Like if you've got a baby then a buzzer goes off when the baby's crying.	**repl**		D- has picked up the 'automatic' part of the provocation but forgotten the main property of the *pressure* pad. He is not relating 'problem' to the starting point
356. Yeah but that wouldn't work with a pressure pad would it. Because pressure pads need something. to touch them don't they?	**inf** **Qs**	D indicates realising his mistake	K reminds D of the need for *pressure* on the switch by getting him to think about the starting point. D immediately realises his mistake. He has simply forgotten and *not* failed to understand the pp. Slight embarrassment- need to correct gently.

357. S- And babies scream loud so you could hear them.	**repl**		S is imagining D's idea in use and suggests it would be redundant. Shows one advantage of a group approach to *spa*. – quick filtering of ideas. Need to do this in a 'safe' environment. to avoid inhibiting.
358. Right, so you do get alarms for babies but it wouldn't work with a pressure pad.	**inf**		The main property of the *pressure* pad is being reiterated for the group as well as D. D's error shows the need keep the starting point in the children's minds.
359. Anyone got any idea how you could use a pressure pad with babies?	**Qf**		K is inviting the group to start from D's idea. The tactic is to suggest a theme to provoke ideas from the group. An example of 'wasting nothing'.
360. It could tell you if a baby is wandering out of a room they're not supposed to.	**mod**		K is perhaps prompting too much here, in an effort to keep up the momentum. Skilled facilitator has to make fine judgements about when and how to intervene.
361. L- Or even you could have like the pressure pad under the mat that the baby sleeps on with loads of wires to you in another room and you'd know if the baby is gone because the light would switch off.	**repl**		L has picked up K's provocation (359) but not his specific and perhaps over-directing hint (360).

362. L. Because it's in a different room it wouldn't bother the baby. But the batteries might run out.	repl		L has thought her idea through in some detail including anticipating a problem.
363. Yeah, that would be a problem.	eval		K confirms that her thinking is correct
364. L. And you might think the baby is gone but it's still in the room so you might panic but it's still in the room.	repl		S – shows her engagement with the ideas of others. As before, she sees the problem with another child's idea.
365. Yeah, that's true. 'Because one of the problems with this is that this thing only works when something is on it.	inf		K uses this opportunity to highlight a general feature of the pp.
366. So the battery, so if we use it with a vase on it as a warning if someone stole the vase the battery would be on all the time. So that's a problem.	eval inf		K encourages S by agreeing
367. Yeah go on then Ritchie. Yeah his was on all the time that's 'because we put a staple across it. Yeah.	dir inf	R silently indicates that he relates to this.	R's pp stayed on for a different reason than that being discussed. K encourages R's non-verbal –bid as he sees a chance to warn the group of a problem to avoid. He was clearly engaged in the discussion but this was not obvious until his bid.

368. Can we think of some different situations when we could use a pressure pad. We've got alarms. Ehm What about toys. Some toys.	Qf inf		K is 'jump starting' to re-start the flow of ideas.
369. Dance mats.	repl		A link is being made with the popular computer based 'toy' and the pressure pad.
370. Yeah dance mats that'd be really good.	eval		.
371. If you stepped on the wrong one a buzzer or a light would come up.	repl		S- is encouraged and goes on to flesh out her idea and is clearly able to visualise L's idea in use.
372. Yeah yeah. Any ideas we can .take from a dance mat… things that would be. Use a dance mat as the starter idea. Can we get any more ideas out of that?	eval mod met Qf		K is using the strategy of developing something new from an idea that has already been suggested. Could be described as 'milking' an idea for others.

373. Like you could have with the light and buzzer when they do it wrong – a light comes on when they step on the right one and a buzzer goes on when they step on the wrong one.	**repl**		This child has not moved on from the dance mat idea but she has a new development of it. We can move on too quickly. Ideas need time to gestate. The flipchart may help Ch. to revisit ideas discussed earlier.
374. OK so let's take any dance mat type ideas but are not dance mats yeah?	**mod** **met**		This is the strategy of trying to develop different ideas from one already offered.
375. Ehm well my cousin he is twelve and he did this at school and basically what he did was he got - because he's got a dog at home that's always escaping – and what he did was he created like loads of really big pressure pads with wires but he hid the wires he put loads of tape over them so you couldn't really see them very well and then his dog who was supposed to stay in a certain room – stay in his basket and be taken for walks so when ehm and ehm if and 'because if it was always escaping if it got off its bed then he created two lights the first light would go on at the bottom of its thing and then a light at the first door would go on.	**repl**		This is another example of L's lengthy answers where she may be confusing truth with fiction, or her own imaginings.
376. So sort of like a dog control device?	Qs		K tries to summarise with a view to moving on to a different idea.

377. But ehm he would like switch it off when he was taking it for a walk.	inf		L is still keen to complete her explanation.
378. OK that's really good so a dog control device and things that tell us where things are. Any more ideas? Anything here give us any ideas?	eval Qf mod		K gives some credit, summarises and wants to move on. He also encourages ch. to generate different ideas from this one. K is showing an example of a useful strategy that is valuable beyond this project. as well as within it. This shows one important role for a facilitator
379. That would scare people at Halloween I saw this ehm this programme and ehm there's this coffin and when. they like tread on a sensor or a pressure pad a skeleton just jumps up.	repl		
380. So we could use it we could use it to operate a motor as well couldn't we? So that might give us new ideas. So we could make a figure jump up on a motor….and when you trod on it, it could rush out of a wardrobe or something.	Qs mod		K is again participating in the idea and trying to draw out others.
381. Yeah. Yeah, that'd be good. So any other ideas? Yeah, go on.	eval Qf dir		More encouragement and ensuring of psychological safety so crucial to a flow of idea.

382. Another one for Halloween like – a dark corridor to a Halloween party. draw a picture of a ghost and they step inside er a light will light up with a ghost eyes and when they look back.	repl		
383. Will you sit down please, sit down. Sorry, I was interrupted.	dir	L leaves her seat and is off task	This is taken as an indication that L at least has reached the end of her attention span.
384. So a ghost noise type thing OK. let's move away from Halloween things now and see if we've got anything else. Anything else? (Pause)	dir		K attempts to elicit any remaining ideas.
385. Have a minutes break and use your black pens to see if you can come up with any more ideas and then we'll move on and do something different.	dir		These are not forthcoming and K decides that the session needs bringing to a close.

Appendix 11

Children's University pre-*spa* activity questionnaire

(Dotted lines for answers not shown)

1. Are you boy or a girl?

2. The *best* thing about DT at school is...

3. Is there anything you don't like about DT at school?

4. Write a list of the things *you have made* in DT

5. Do you all have to make the same sort of thing in DT?
   (e.g. slippers, puppets)?

6. Does your teacher help you to have ideas for your project in DT?

7. If yes, say how they help you

8. Do you always have to do drawings before you start making your DT projects?

9. Would you like to start making first and design as you go along?

Thanks for your help

Appendix 12

Transcript from the video - group interview

438. Right basically, what I want to do is ask you some questions on paper –but it's difficult to write the questions on paper so that you can understand them properly….

439. Right ehm… OK so what would you say the best thing about DT at school is?

440. The designing.

441. Yeah but what I mean is that the project is... although each one is different they are all the same sort of thing.

442. Yeah sometimes she'll say here's stuff go and see what you can …

443. Right so you do get free choice. That's good. Does anyone else get that? OK

444. It's just there is a list of about twenty that a lot of schools are using – there's puppets, travelling cars.

445. Yeah we did toy cars in year two.

446. So I can guess roughly what you've probably done. OK this next question wasn't easy to put. What I'm saying is does your teacher help you to have ideas for your project in DT?

447. Yes, sometimes.

448. Yes does that mean that sometimes she doesn't?

449. No like sometimes like she helps us with ideas like when she puts up a project or a question that's really hard. Like when we were making our electric toy cars, she'll give us ideas how to make it.

450. Oh yeah so like making things. Now I'm not thinking of them helping you to make the thing, I'm wondering does she help you to get the ideas for your project? Do you know what I mean?

451. Yeah yeah.

452. So how do they do that? What do they do?

453 (Libby) Well my teacher uses mind maps.

454. OK yeah I know what they are. So lots of coloured pencils and things Yeah? Or do you do the mind maps yourself?

455. Yeah we have our mind map book in our class but whenever .... Build a balloon buggy or something or we have to build something just or we have to build something like ....what type and how to do it we mindmap all our ideas.

456. I know what a mind map is but does everyone? Can you tell the others?

457. Like when you just have to put things like when you're brainstorming and put things in circles.

458. Circles then Right then so how many peoples teachers uses this sort of brain storming sort of thing everybody.

459. It's to squeeze things out. It's to squeeze things out of your brain.

460. Yours, do they all do it then? Yea that's them trying to squeeze some ideas out. OK that's interesting isn't it? The mind map is slightly different than the ordinary brain storming isn't it? Now do you know about mind mapping as well?

461. Yeah well ehm one thing that you draw in the circle like say a wheel then you can make lots of things with a wheel.

462. Do you use coloured pencils in your mind map?

463. Yeah, no we just use pens as well...

464. Right because I think we are talking about two different things because there's brainstorming and mind mapping and there is this bloke called Tony Buzan who wrote this book... and it's got lots of branches and he used lots of coloured pencils. Did you do that with yours?

465.Yeah and another word that we use we use an inspirogram.

466. Yeah that's the same kind of thing. But in mindmapping there is a special thing called mind mapping very much coloured pencils and branches and all that – not circles.

467. Only a circle in the middle.

468. Yeah that's OK.

469. Yeah that's what we do.

470. Normally, what people have to do is not what we did here – we started making straight away then we looked at the thing and came up with some designs for it. That's the approach I'm testing out really. You don't normally do that at the start of a design and technology project do you? What do you normally do?

471. Well we would plan it (makes drawing motions) like what we think it's gonna look like at the end if and what we are starting it like. Well you go out in groups yeah and the person and the people have to go out in groups and start making and the people that are left inside the class are doing the drawings.

472. Right so how do the people inside the class know what to make though?

473. By the teacher. I think the teacher gives them. Well first of all everyone is in there [the classroom] and they've told everyone and they pick some people to go out of the room and start making and the rest (indicates drawing).

474. But don't they have to do drawings before they start making?

475. No.

476. I'm not quite sure how.... The rest of you you'll do drawings and then you make the thing.

477. I think what he's trying to say is two groups one stays in the classroom, one goes outside. The ones outside just start without your drawings

478. Ahh and then you swap over.

479 and then you start.

480. Right so you do the drawings before you finish the thing?

481. We don't do the drawings in our class.

482. What do you do?

483. We just .... And then mind map the teacher gives us the instructions how to do it and then we – you just do it. Just do it Get on with it.

484. The things aren't all the same though are they? Your projects aren't all the same so they don't tell you how to make the whole thing do they?

485. No no they do but they say like we need a certain amount of this stuff and.a certain amount of that stuff...

486. So do all the projects look the same at the end?

487. Ehh no.

488. So how do they figure out the differences? Some of them don't do it the same.

489. Well some of them and you just look and em just test them out and if you were building a dammner [dam]. A mini dammner class where if we were studying water in class and we need a dam we would test it to see test it to see because if it was supposed to be and pour water and see if it flows really fast and see if it works and the balloon buggy's case we would test it and someone's wheel came off and....

490. So did you do any drawings at all with this project?

491. No pretty much not.

492. OK that's interesting.

493. With our class what we do is she gives us one instruction say there's the to make the car cut out draw round your foot cut out get the right size and then once we've done that she'll say class go to your table gather round and tell us how to do the next bit. That's what our teacher does.

494. But basically, you do the drawings and then you do that.

495. Yeah.

496. OK that's interesting that. OK you see this way I call it the Starting point Approach OK? What I think is special about this is- if you agree- you don't have to all make the same thing so what I do is I say we are all going to make a pressure pad but then you can use the pressure pad for anything you like.

497. Yeah like what I done with mine.

498. Yeah and that's one way and we talked about all different ideas so you could get a whole class of children and you could all make a pressure pad to start with and they'd all end up with a different project at the end. Do you know what I mean? Like one chap downstairs is thinking about a ball for blind people so when you hit the pressure pad it makes a noise Yeah. So do you understand?

499. Yeah our class like sometimes we split up into three groups and like one does shelters and one does slippers and the other does puppet.

500. But the difference in this case is every child each person chooses their own project really. So you get more choice that way really.

501. Sometimes we are allowed to choose our own projects sometimes in my class but most of the time our teacher says OK class bla bla bla and now we are going to build a....and all of you got to do it. Sometimes in our three groups if one group is making a puppet the like five people in that group would all work together and make one puppet and then we'd have three big projects.

502. Sorry you're distracting people so don't do that.

503. Ehm right what I want to see if you've found the difference in the two ways of doing it. Yeah I think you did. One is where you are told in school it's going to be some kind of slipper. But if I do the pressure pad, someone could make a game and someone else could do a toy and you could do some completely different thing.

504. What do you think of the two ways of doing it? I think my way of doing it gives you more choice.

505. Yeah, Yeah this way is better because like you don't have to copy from the paper. And you don't get the teachers saying you gotta do it this way and it's all gotta be that way.

506. See but I do that, I tell you exactly what to do but then I stop telling you and then let you have a free choice.

507 Yeah because with this whenever we got no choices then sometimes we have to do what we don't want and so if we've got lots of choices if we don't like that thing we could do another thing.

508. So what I'm trying out is that I think what I want is we can give people a choice because in other words when you say to somebody go into the room and make something – you wouldn't know how to go about it particularly would you.

509. When we're making this thing right now we wouldn't know how to do it.

510. Exactly so if you were all making different things I'd be running about like a mad man because I could be showing him over here and then he needs to know over then so it can be quite impossible.

511. Stressed Out.

512. Yeah so it can be quite impossible see? So what I'm trying to think is what do you think about this starting point approach what are the good and bad things about it. You see the difference don't you? Yeah.

513. What's good about it? Do you think if anything. Well it gives you choice doesn't it. Well you can make whatever you like basically, as long as you use the starting point. Why do we give 'em a starting point? Well we've already said that. Because it means everybody knows what to do and they've got a bit of success built in. It means that everybody's got something that works but I don't show you a finished one so it's gotta look like this so normally then apart from Libby's school you normally do drawings and start making the thing

514. Yeah

515. And everybody has to make the same kind of thing like a slippers or whatever.

516. Sometimes in our school half way through we'll do a ehm drawing of what it looks like now. I wish we did more drawing in our school because the only time we gotta do it was when we independently drew cars It's because DT's fun.

517 Yeah I think it's fun too.

518. It gives you the opportunity to make things and to get better at making things.

519. Yeah having your own ideas Yeah but it's not just about making things it's about ideas. That's what I like that's the interesting part seeing what people come up with.

520. Well once I was doing DT and I was decorating so what I did I swallowed a sequin.

521. So did you notice what we did we starting making fairly straight away didn't we and then Do you think having the pressure pad actually in your hand has helped you have the ideas?

[Universal and enthusiastic assent]

522. Yeah Yeah because you get to figure out what to do with it. Like a burglar alarm. Like a piece of like what looks like a door mat.

523. Yeah so do you think it helped to have it in your hand rather than in your head?

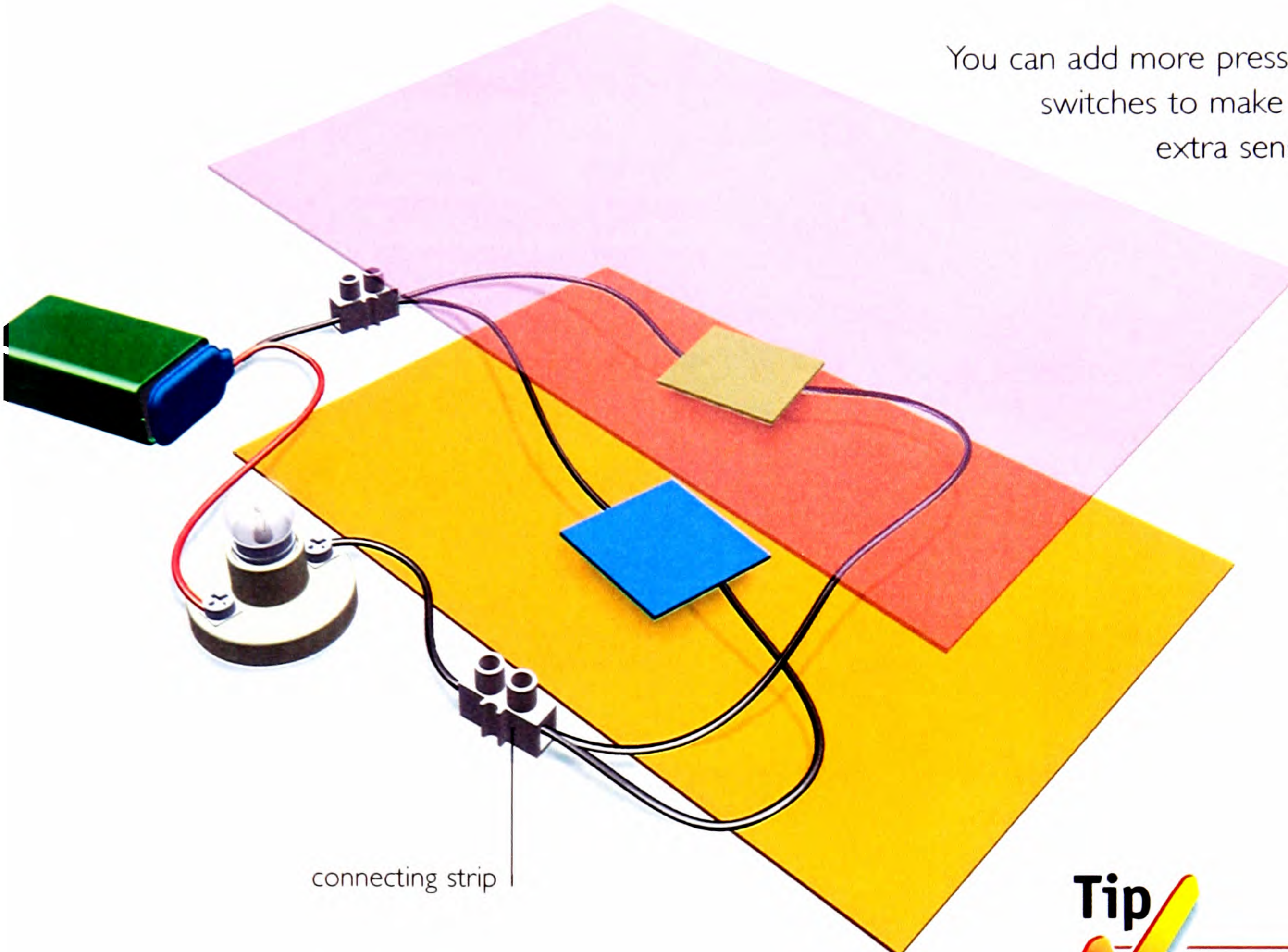
. [Universal and enthusiastic assent]

524.Yeah because if it's in your head you might not do it right.

525. Like with the mechanisms like your one Libby almost certainly came from the way it moves. Do you think that moves like a kangaroo? Do you agree with that? OK thanks very much for that it's very interesting.

Appendix 13- Instructions for a game designed by a child outside the focus group

you get the Tenis ball hang the bord
on the wall then Frow the ball at
the targ it if you hit the Sercl
it is a ballseye and to be acurt
the light will light up and enny
ofer numbers go



Tip

Hinge the two pieces of card with tape or staples so that you can reach inside.

Getting ideas

You could use a pressure pad switch in a game. Look at games that already exist. Talk to older people about games they used to play. Find out about games from different countries. All this might help you to design your own games – but don't just copy!

Think about who will play the game. How difficult should it be to play? Try to make up rules that are fair and easy to understand. If you can, use a computer to type out the rules.

Could you make counters or other extras? You might use painted pebbles, card figures or salt dough shapes. You could make packaging and advertising for your game.

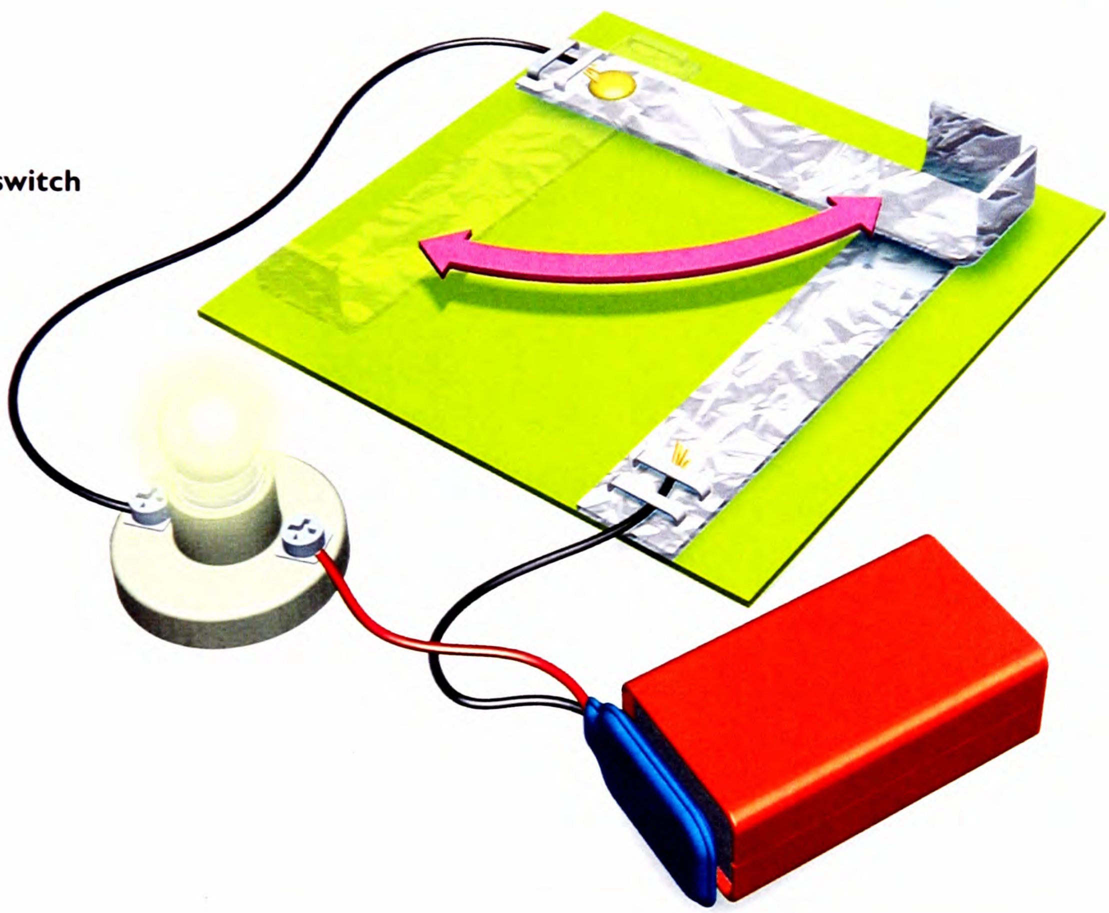
Appendix 14- Wandering pressure pads.

You can change the switch so that you have to press to turn the circuit on. Just pull one part above the other and you have a push-to-make switch. Can you see the difference between this switch and the first one?

In a knife switch, one part of the knife switch is turned to make contact with the other when you want a circuit to stay on.

A push-to-make switch
Press to switch ON.

Knife switch



Getting ideas

Think of different ways to make the switches go on or off. You could leave something resting on the push-to-break switch. If anyone moves the object the circuit could warn you. Opening a lid or door could also make a circuit work.

The push-to-make switch could be used to signal with. You could find out about Morse code. You could use this switch as part of a pinball game or whenever you want a circuit to go on. How could you keep the push-to-make switch on?

You could use the knife switch when one of your projects needs a circuit that will stay on, like the lights on a model vehicle. A cotton thread could pull the knife switch on.

Appendix 15- Knife switch