CHILDREN, TEACHERS AND LEARNING

EXPLORING PRIMARY DESIGN AND TECHNOLOGY

Rob Johnsey

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Exploring Primary Design and Technology

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Exploring Primary Design and Technology

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Dedication

To my father, who taught me much about design and technology.

Part One

Design and Technology in the Primary School

Introduction

There is no doubt that the new curriculum subject Design and Technology is a strange beast. Some will say that it has been lurking in the shadows of the primary curriculum for a long time but in a different guise and with a different name. Others will argue that it has never been seen in this form before and only now is it rearing its fascinating head. To those who have received a largely arts educational background, the subject may have an Art and Design image which in turn might be closely related to the old Art and Craft once found in the primary school. Whereas those with a scientific bias might focus on the word technology and imagine machines, electronics and practical problem solving as the essential elements of the subject.

There is little doubt that the public perception of technology is not the same as that understood by those in education. It is a small wonder, then, that teachers are still in the process of clarifying their own ideas about Design and Technology in schools. Some write of Design and Technology as being two separate subjects while others only imagine the old subject, Craft Design and Technology of the secondary school. Some imagine it to be about making products while others would want it to be about creative thinking skills only.

All the other curriculum areas outlined in the 1988 Education Act have long histories of development often backed-up by extensive research, while Design and Technology in its current form suffers from a dearth of such essential development. Almost all practising teachers as well as student teachers will have studied the other curriculum areas while they were at school and developed a feel for each sphere of study, while this will almost certainly not be so for Design and Technology as we know it today. There is no substitute for spending time in becoming familiar with the vocabulary and rationale for a subject. Some attempts have been made to provide

training in Design and Technology for practising teachers and the subject has been a statutory part of all Initial Teacher Training since 1990. These, however, have been made at a time when even the trainers have been coming to terms with an ever changing definition of the subject.

The beast, then, has risen but do we know what we have unleashed? Should the creature be nurtured or stifled, encouraged or ignored? We need to know more about it and what it can do for the education of our children. As with all beasts, Design and Technology has evolved and grown over the past few years but the development has occurred in an uncharacteristically rapid fashion. The subject has changed in nature from what we and its creators all thought it was at its birth. The evolution has been impressive and largely successful but it is still continuing apace. These are exciting times!

Defining Design and Technology for the Primary School

Let us be clear – this subject is no Jekyll and Hyde. Design and Technology is a single curriculum subject with a mind of its own. It possesses a heart and soul that is unique and a strong underlying rationale that is especially suited to the primary school. It is not like science, maths, art or information technology and yet it has strong links with these areas of study and may, indeed, enhance children's learning in all curriculum subjects. It is not solely about design nor entirely about the skills and knowledge of technology. The English language does not have a suitable word to describe the subject so we have to make do with a fudge which may compound our misunderstanding until evolution has moved us all on somewhat.

The Assessment of Performance Unit (APU) set out to explore assessment in design and technology and provides a useful definition for the subject:

> Design and technology . . . 'is an active study involving the purposeful pursuit of a task to some form of resolution that results in improvement (for someone) in the made world. It is a study that is essentially procedural and which uses knowledge and skills as a resource for action . . .'
>
> (Kimbell *et al.*, 1991)

The key ideas in this definition are that Design and Technology is about *improvement* in the made world and therefore cannot proceed without identifying the fact that something requires improvement. This would seem to be a strong justification for teaching the subject to all children, in that it might provide skills and knowledge which would be useful in the future life of the pupil. The idea of improvement, however, needs careful consideration. Different people will have different views about what constitutes

'improvement' and pupils need to be made aware of the kind of value judgements that are made when designing and making. Also the idea of using *knowledge and skills as a resource for action* points to a strong justification for the inclusion of Design and Technology in the curriculum because it can promote learning in other subjects – a theme which is developed later in this book.

Others would argue that technology should involve the use of predominantly scientific knowledge and understanding. Thus Naughton (1994, p. 8) suggests that:

> 'Technology is the application of scientific and other knowledge to practical tasks by organizations that involve people and machines.'

This connection with scientific knowledge appeared in some of the consultation documents preceding the current National Curriculum orders for design and technology:

> 'Technology is the application of scientific and related knowledge to a problem, resulting in a solution which may involve the creation of a product.'
>
> (National Curriculum Council, 1992)

Baynes (1992, pp. 11 and 19) provides a more designerly view of Design and Technology when he suggests:

> 'All design and technology is an attempt to serve human needs, wants and aspirations . . .' and 'Design and technology looks towards the future. Its job is to envisage what should be made. It attempts the difficult task of trying to "see", and then to bring into existence, places, buildings, products and images that society believes it needs.'

The guidance material for design and technology, provided as support for the National Curriculum orders, makes it clear that children with capability in design and technology should be able to 'recognize and explore people's needs and wants, develop ideas about how these might be met and develop products which meet those needs' (SCAA, 1995a, p. 4).

The key features emerging in each of these definitions are that Design and Technology is about:

(i) responding to the needs of and problems encountered by people;
(ii) developing and making products to suit these needs or solve these problems;
(iii) using designing and making skills together with knowledge and understanding from a broad range of disciplines especially science.

Design and technology can be described as an active response to the needs and problems encountered by people. The response consists of employing:

- procedures and strategies;
- knowledge and understanding;
- practical capability;

to develop and make products, which satisfy the need, or solve the problem.

Design and Technology, then, is not about making 'copy models' by following a set of instructions or a recipe. *Make a model of a Norman hill fort* (using a picture in a book for instance) is not Design and Technology but *Design and make a model of a house of the future which takes into account energy saving devices* could qualify as a suitable task if approached in the right way. A task such as *Write a story to read to a toddler* is not Design and Technology, while *Design and make an apron to protect a toddler as she paints* involves making and evaluating a product and therefore would make a successful project.

A complete design and make task should involve a made product which is produced for a clear purpose (even if the purpose is an artificial one invented by the teacher such as a hat for teddy to use on a sunny day). The skills learnt in making a model hill fort or writing a story might well contribute to those required for Design and Technology but do not provide a complete experience.

Design and Technology and the Primary School Ethos

The primary school is a special place. While each school has its own characteristics and forms of organization there are a number of common elements, some of which will contribute to the successful implementation of Design and Technology. The subject will flourish in the primary school because in most schools, conditions are favourable for its promotion. These conditions include:

A GENERALIST CLASS TEACHER HAS AN OVERVIEW OF THE WHOLE CURRICULUM FOR THE CHILD.

This enables the teacher to identify links between other curriculum areas and Design and Technology. It has already been argued that Design and Technology is about the application of knowledge from other disciplines. The primary teacher is in an ideal position to promote these links thus making Design and Technology a vehicle for learning and reinforcing ideas from other disciplines.

Case study:

A class of pupils were embarking on a cross-curricular topic entitled The Home. The teacher had planned to give them the task of designing and making a model of a folding chair suitable for their own bedroom. The chair could be folded away to provide more space when necessary. The pupils' work in maths had involved them in making measurements accurate to the nearest millimetre and in geography they had looked at the scale of various maps and plans. The teacher saw this as an opportunity to reinforce and apply this work so he asked his pupils to take measurements of the members of the class and scale these down to make a card model 'pupil'. The card model was subsequently used to help in designing the dimensions of the model chairs and in testing the final proportions.

THE CLASS TEACHER IS RESPONSIBLE FOR DELIVERING MUCH OF THE CURRICULUM TO THE SAME CLASS OF CHILDREN.

Design and Technology is often about developing open-ended tasks which give rise to sometimes unexpected links with other subjects. These reinforcing links can be exploited spontaneously by a generalist teacher as they occur in the classroom.

Case Study:

Mrs Brain wanted a group of her children to design and make simple card shadow puppets to tell the story of St George and the Dragon. The children would use the puppet play in an assembly towards the end of term. The children investigated ways of making different shadows, and how to control the movement of some of the puppets by using rods.

As the project continued and the children's interest increased Mrs Brain realized that she could exploit the situation to develop the children's language skills in speaking. She decided to use some of her language time to develop the children's ability to use their voices for special effects. At the same time she adapted what she had planned to do in her music lessons to enable the children to compose sound effects for the play.

PRIMARY SCHOOLS PROMOTE LEARNING THROUGH PRACTICAL WORK

Primary aged children need to learn much through practical experiences. This is often apparent when witnessing the pleasure children get from a practical task. Primary school teachers are already geared up for teaching through practical experiences. Design and Technology merely provides a more meaningful setting for this to happen.

MANY OF THE MATERIALS AND TOOLS REQUIRED FOR PRIMARY DESIGN AND TECHNOLOGY CAN BE MADE AVAILABLE IN THE PRIMARY SCHOOL CLASSROOM

The primary classroom is an extremely flexible workshop in which materials and tools to suit a variety of circumstances can be made readily available. This is particularly useful for a subject such as Design and Technology in which pupils' requirements cannot always be predicted. A well organized teacher will enable the children to collect materials and tools as and when they are required. If the items requested are not available then there is often a suitable alternative to hand.

Case Study:

Jill was making a model Jack-in-a-box using a card container and strips of wood. She wanted to use a flexible spring to mount Jack on so that the toy would leap out when the lid was opened. There were no suitable springs available in the classroom but the teacher was able to talk to Jill about alternatives such as elastic bands or pieces of sponge which were available in a general store. Jill knew just where to find the piece of sponge she needed and went off to search for this while her teacher made a mental note to make a collection of suitable springs for her materials store cupboard.

PRIMARY CLASSROOMS ARE SOMETIMES ARRANGED SO THAT DIFFERENT GROUPS OF CHILDREN ARE ENGAGED ON DIFFERENT TASKS AT ANY ONE TIME

If necessary the teacher is able to arrange for small groups to tackle Design and Technology tasks and to provide these with the special attention which may be required. This may be particularly beneficial when pupils are learning to use more sophisticated materials and tools for the first time.

THE PRIMARY SCHOOL TIMETABLE HAS SOME DEGREE OF FLEXIBILITY

Different curriculum subjects make different demands on school time. A school can arrange its timetable to suit these varying demands. This can be useful for a practical subject which has an open-ended and sometimes unpredictable nature.

THE CROSS-CURRICULAR APPROACH IN MANY PRIMARY SCHOOLS PERMITS REAL CONTEXTS FOR DESIGN AND TECHNOLOGY TO BE EXPLOITED

The educational benefits of cross-curricular studies which are so well championed by the primary school can just as easily be exploited when pupils carry out Design and Technology tasks. Children who do not perceive strict boundaries between subject areas can be encouraged to use knowledge and understanding from other curriculum areas in Design and Technology. Design and Technology can be seen as an umbrella subject in which knowledge and skills from elsewhere can meet and be applied in a meaningful context.

The primary school, then, is potentially an ideal place for the promotion of Design and Technology. This is a distinct advantage that the primary school possesses and should be exploited whenever possible. Parents, governors and the government should be made to appreciate that primary schools can offer experiences that are unique, extremely valuable and may often not be obtained elsewhere in the education system. The development of Design and Technology capability in children, in a supportive and creative atmosphere can be one of the jewels in the primary school crown.

The Nature of Design and Technology

Design and Technology is essentially about carrying out tasks which make improvements in the world by satisfying needs or solving problems. This will involve children in making decisions for themselves when planning and executing their own route through the task. The design and make tasks they undertake will, therefore, be of an open-ended nature and will necessarily have a degree of unpredictability about them. It would be a mistake, however, to believe that there is therefore no teaching to be done. Teachers have a responsibility to intervene appropriately in their pupils' design experiences to enable them to improve their capability, skills and knowledge and understanding in the subject.

The three aspects of Design and Technology that teachers will want to promote in their pupils are:

1 *Understanding the Procedures of Design and Technology*

This involves the identification of the skills that combine to make up how pupils and others design and make products. This understanding also involves knowing when and how to use these skills in different contexts.

2 *Knowledge and Understanding in Design and Technology*

This involves areas of knowledge which are unique to Design and Technology as well as knowledge from other subjects.

3 *Practical Capability*

This involves an understanding of how to handle materials, tools and the related processes. It also involves an ability to solve practical problems. This ability often comes with prolonged involvement with practical tasks such as those associated with many hobbies, DIY or careers involving manual dexterity.

Each of these key areas will be explored in subsequent Parts of this book. The first however, plays such a dominant part in our understanding of Design and Technology that it will be developed further here and in Part two.

Understanding the Procedures of Designing and Making

At the heart of design and technology are the procedures of designing and making. These procedures are what goes on when problems are solved or needs are met – the 'active response' in the definition on page 3. A number of publications describe the procedures as *the design process* or *the practical problem-solving process* and it is often implied that there is only one process which might cover all situations. In understanding the nature of design and technology teachers need to become aware of the things that happen when problems are solved or needs are met successfully. Once teachers have become aware of, and familiar with, these elements of Design and Technology then they can devise ways of promoting successful strategies and assessing children's ability to exercise these.

In this book the term *design process* is used to describe the complete action from when a design and make context is explored through to making and evaluating a product which satisfies an identified need. The *design process skills* describe the separate but overlapping events which, when strung together, make up a whole process. The process skills can be described in terms of the actions made by designers when designing and making. For instance, the process skills of *generating ideas* or *modelling* will be used in different ways at different times while designing and making goes on. Finally, it will often be convenient to use the word *designer* in the text to describe someone who completes the whole process of designing and making.

To begin to answer the question: *What happens when effective designing and making takes place?* we can turn to a variety of publications which purport to describe the design process or the problem solving process. These descriptions either take the form of a theoretical model, often in a flow diagram form, or they are implicit in the text of the publication.

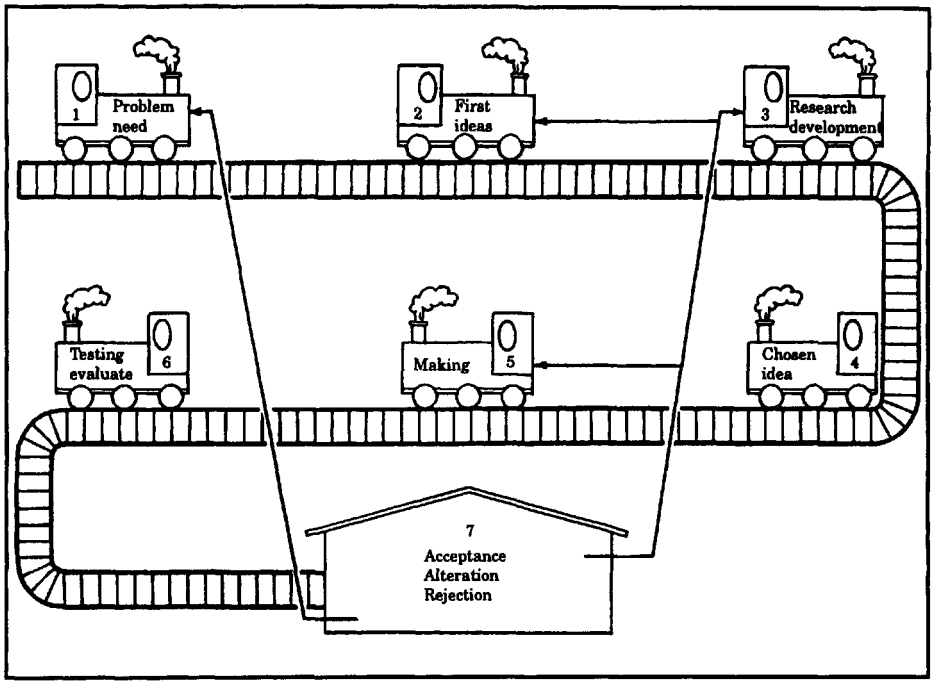
A simplistic linear model for the design and technology process is described by Williams and Jinks (Williams and Jinks, 1985), and is shown as figure 1.1 on the opposite page.

The model suggests that there is a neat set of logical steps to completing a design and technology task. It is typical of many similar examples often adopted by teachers in secondary schools in Craft Design and Technology lessons. A similar example (see figure 1.2 on page 10) was produced by the DES in their booklet Craft Design and Technology from 5–16. (DES, 1987)

This linear description of what might go on during a design and

technology task has more detail and is helpful in defining some of the design process skills which might be developed in primary schools today.

Figure 1.1 The Williams and Jinks design Line – (Adapted from Williams and Jinks 1985)



Analysis of a Range of Models for the Design Process

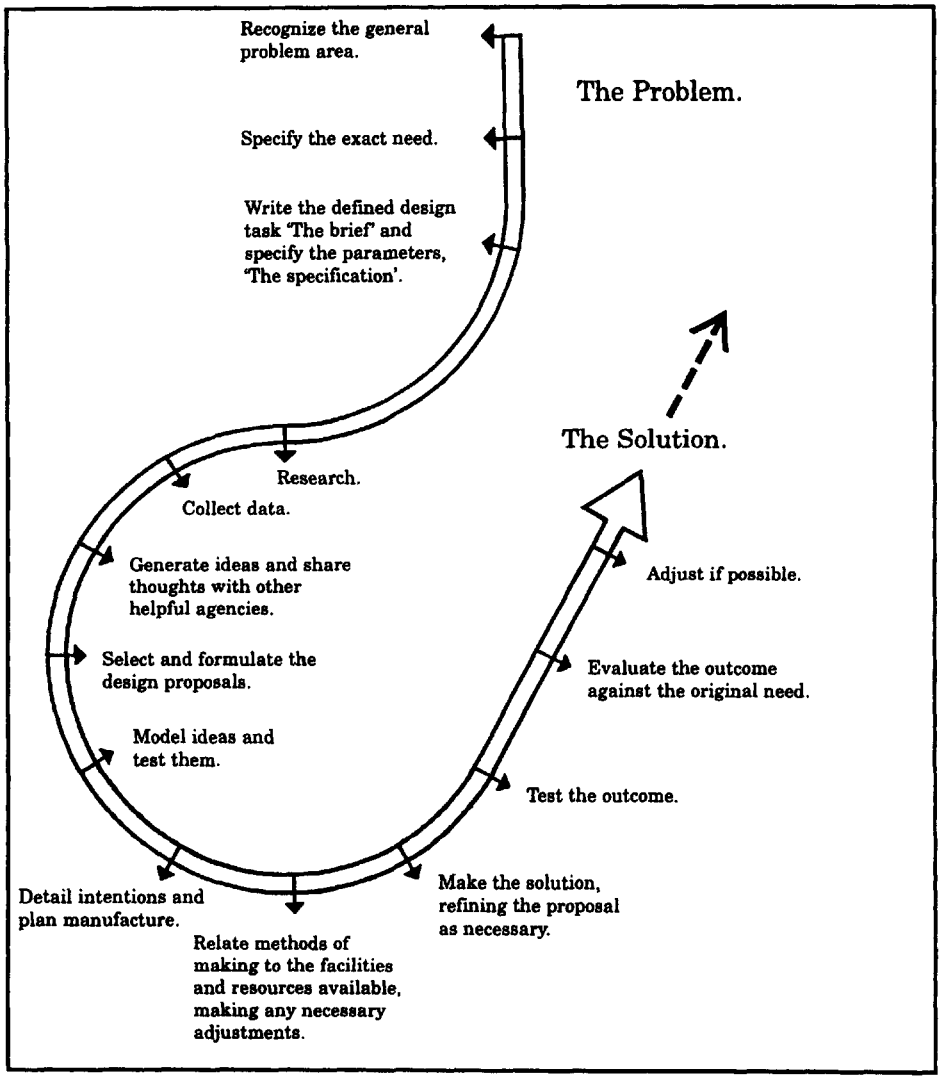
It has been shown that, historically, there has been a surprising consensus of opinion among authors as to the nature of the design process (Johnsey, 1995c). The author has shown that when a range of published models for the process of design are examined, most of them fall into a common pattern in which similar process skills can be identified. These are as follows:

DESIGN PROCESS SKILLS OBTAINED FROM A STUDY OF A WIDE VARIETY OF PUBLICATIONS

- Investigating and exploring the design context.
- Identifying needs, opportunities and potential for design related tasks.
- Clarifying the implications of the design task.
- Specifying criteria for judging the outcome of the design task.
- Carrying out research into the problem and its solution.
- Generating ideas for a product which will provide a solution.

- Modelling ideas – in discussions, as drawings, as mock-ups etc.
- Planning the making of a product.
- Organizing resources.
- Making the product.
- Testing the product.
- Improving the product.
- Evaluating various aspects of the process and the product as work proceeds.
- Evaluating the final product and processes used against original criteria.

Figure 1.2 The DES design loop – (Adapted from DES 1987)

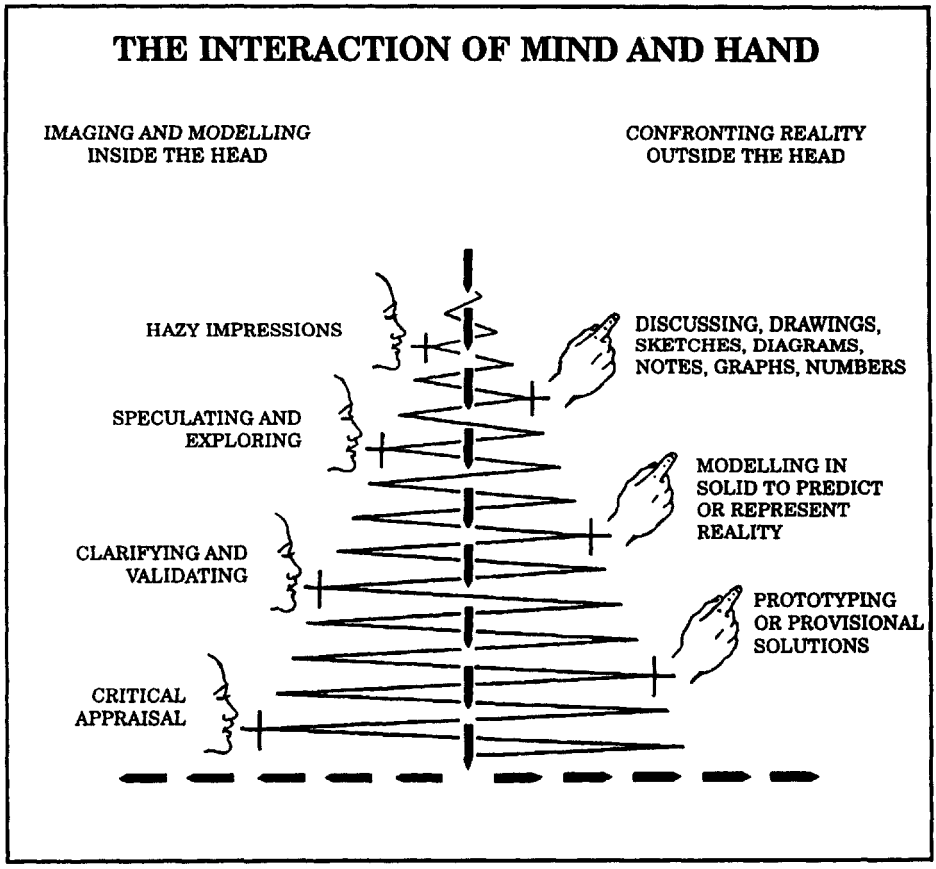


The identification, promotion and enhancement of these process skills lies at the heart of Design and Technology teaching and provides the basis for the development of the ideas in this book. Ideas concerning each of these skills are developed in depth in Part 2. At this stage, however, it is worth maintaining a broad overview of designing and making by exploring in detail some more recent models of the design process which have influenced current thinking in the subject.

The Assessment of Performance Unit (APU)

It was through the APU that a radically different view of the process of design emerged. Described as 'the interaction between thought and action' (Kelly *et al.*, 1987) and later as 'the interaction between head and hand' (Kimbell *et al.*, 1991), the model depicts a constant to-ing and fro-ing between thinking and doing.

Figure 1.3 The Assessment of Performance Unit (APU) model (Source Kimbell *et al.*, 1991)



At the beginning of the process one might imagine the introduction of a design problem which immediately leads to some hazy ideas about a solution. This is represented at the top of the model. These hazy ideas will give rise to something being done 'outside the head' such as a comment to a friend, a gesture, a sketch or a prolonged conversation. These actions outside the head will give rise to slightly more refined ideas inside the head. This process of to-ing and fro-ing from thinking to doing is described in the model. The broader base of the model represents a greater development of ideas and action towards solving the problem.

It is a theoretical model which would be almost impossible to observe in reality without knowing what the designer was thinking at all times. It does, however, provide a powerful *view* of what might happen when pupils design and make. It gives us a new image to conjure with, a new standpoint from which to take stock of the design process. It also provides a powerful argument for making assessments of the whole process of designing and making rather than just the parts of it which might be easily recorded in a written paper. This would almost certainly have been a strong motivating factor behind the creation of such a model by a body charged with developing assessment procedures in design and technology.

Observing Primary School Children as they Design and Make

One might suspect that none of the models described so far is based on the direct, systematic observation of pupils as they design and make in a wide range of situations and contexts. Some of the models will be based on previously published ones and may therefore be said to perpetuate a mythical view of what actually happens. Others will be the result of an intuitive and cumulative insight into the way pupils carry out their design and make tasks. Educators, however, are notorious for displaying a need to find tidy models for human behaviour and so it seems reasonable to display a healthy suspicion of such simplistic models.

Theoretical models are all very well but they only describe what others think ought to happen in the classroom. Some current research based on observing children in the classroom as they design and make, suggests that the published models do not necessarily describe what really happens (Johnsey, 1995a).

At this stage it is important to be clear about the type of design process being described. It is possible to identify three types of designer:

1 the professional (expert) designer;
2 the pupil designer;
3 the lay designer.

The professional designer is one who might be considered an expert in the field, having received some form of training. He or she may have specialized in just one part of the whole designing and making process. For instance, many professional designers will pass on the responsibility for manufacture of the product to someone else.

The pupil designer is one who has his or her designing and making behaviour modified by the presence of a teacher or a structured teaching programme.

The lay designer is one who is neither a professional expert nor one who is guided by a teacher or instructor. All human beings become lay designers many times throughout their lives. Pre-school children are a good example. Baynes (1992) points out that young children enter school already able to design and make through their everyday encounters with the world, and goes on to argue that teachers must learn to take this fact into account when devising learning programmes in Design and Technology.

It would seem that the models for the design process that we have explored so far, describe what is hoped will be the behaviour of the pupil designer by emulating the process we believe is used by the professional designer. We know very little, however, about the process of the lay designer when this is applied to primary school pupils. An example of a lay designer might be a primary pupil who carries out a design and make task with a relatively free hand in the classroom. We might begin our understanding of how to enhance pupils' capability in Design and Technology by observing the procedures that they currently use. The following case study is based on classroom research carried out by the author.

Case Study: Lost keys

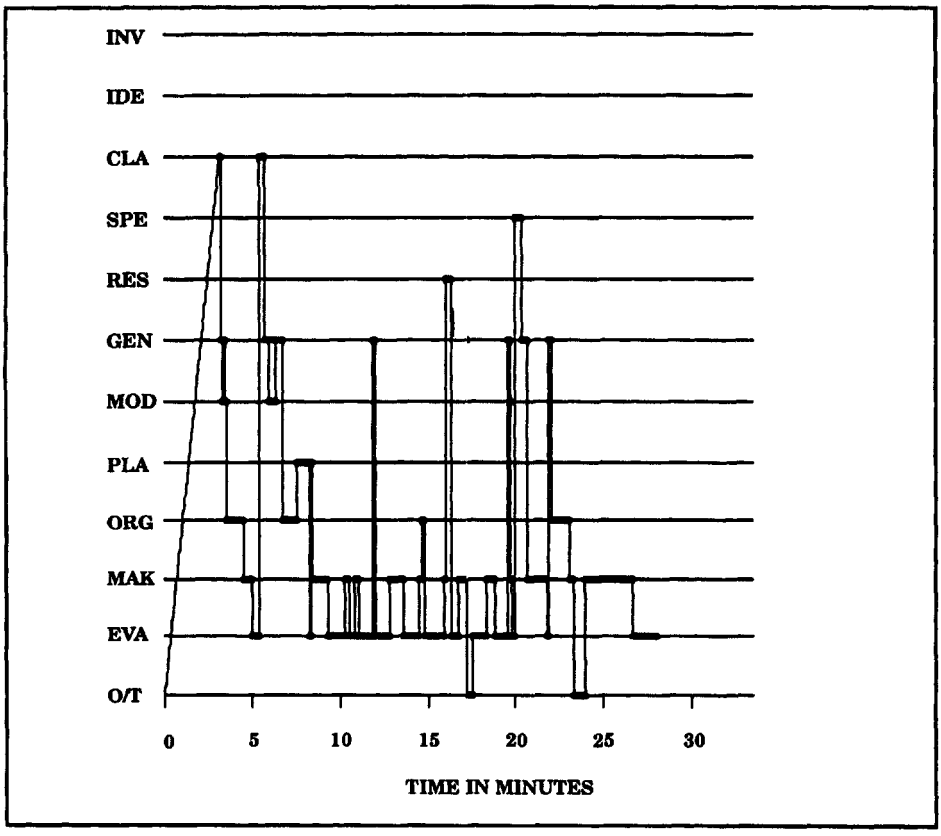
Ben, a Year 5 pupil, and his partner used a worksheet to make their own set of card keys on a wire ring. The instructions on the worksheet asked them to use any material which was available to design and make a device for recovering the keys from between a crack in two stage blocks. The pair worked well together, making two different devices in the time available. Much time was spent testing the devices and making modifications to these. The first device, a hook on a string, worked well but the second was more problematic.

The teacher's introduction lasted only three minutes. Ben and his partner discussed some ideas briefly using gestures as well as dialogue to model their ideas. The hook and line were quickly produced but more time was spent on testing it than construction. Within a few minutes Ben and his partner were working on another device involving a pair of tongs made with wire. Card 'fingers' were attached to the end of the tongs for improved grip. Some time was spent testing and improving the new device. When the tongs failed to work effectively Ben returned to the first idea and continued to test this. The manipulation of the hook and string tended to require personal

skills which needed to be learnt. Eventually Ben returned to the tongs idea and began to adapt this into a scoop. There was not enough time, however, to develop this idea.

A video recording was made of Ben as he carried out his task. This was subsequently analysed by recording the duration of each design process skill displayed by Ben. The behavioural chart for this sequence of actions is shown below.

Figure 1.4 Behavioural chart to show how Ben spent his time during the design and make task. (Source: Johnsey, 1995a)



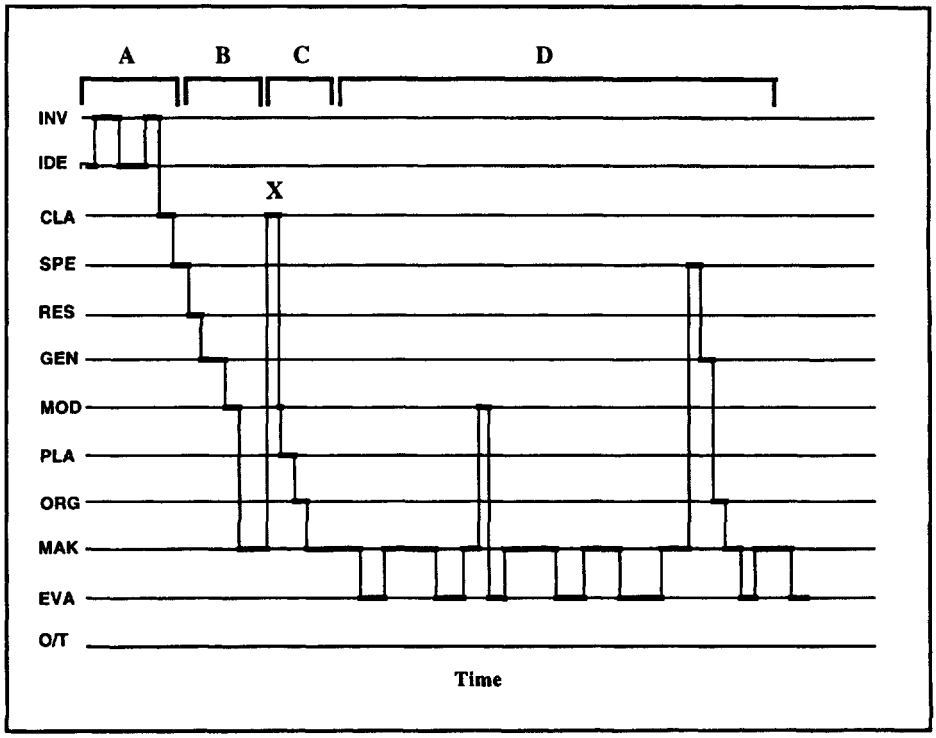
Key:

INV	Investigating	IDE	Identifying
CLA	Clarifying	SPE	Specifying
RES	Researching	GEN	Generating
MOD	Modelling	PLA	Planning
ORG	Organizing	MAK	Making
EVA	Evaluating	O/T	Off task

Each design process skill is shown on the vertical axis and is arranged in the order suggested by a wide range of published linear models for the design process. Time is represented on the horizontal axis so that the whole task can be seen at once. The length of each horizontal bar on the chart, therefore, represents the time for which the behaviour was observed and shows, at a glance, its place, duration and frequency of occurrence in the whole task. The vertical lines are only included to make the graph easier to read and simply demonstrate that one behaviour follows another. The diagonal line at the beginning of the chart represents the time when the teacher is introducing the task and the pupil is sitting listening.

This example comes from a wider study by the author, involving eight case studies of primary school children from reception to Year 5. While it would be inadvisable to generalize too far, it was found possible to construct a typical chart which could suggest how each of the pupils in the study carried out their design and make task.

Figure 1.5 A speculative model for the process of design, based on the style of a behavioural chart



For simplicity and further discussion the whole procedure has been divided into Sections A, B, C and D. In reality there will be no clear boundaries to the behaviours exhibited.

SECTION A

The model shows how the lay designer may begin by investigating a context and, within this activity, begin to identify a situation for which a design and make task is required. At the same time a clarification of what is required will be taking place. This initial part of the design procedure is often provided by the teacher in a school situation. The task setter (i.e. the teacher) will often play a large part in providing specifications for the outcome of the task, although this can be done or added to by the designer /pupil.

SECTION B

In the second stage any combination or sequence of the 'designing' skills (specifying, researching, generating, modelling) might be employed but these lead relatively rapidly to a form of making. This provides experience with the materials and tools which might be used and enables the designer to begin modelling ideas using the materials of construction. Little on-going evaluation will occur here.

SECTION C

Stimulated by the initial making and familiarization with the materials of construction, the designer is likely to return to some of the 'designing' skills as represented by the 'spike' X. This will enable the designer to consider more fully how to go about fulfilling the task by employing researching, generating and modelling skills. This stage may involve more planning and organizing than has previously occurred.

SECTION D

This is a prolonged section, taking up most of the time available and characterized by the *make – evaluate – make* sequences. The nature of the design task will dictate the relative proportions of making and evaluating that occur. There may be instances when the 'designing' skills are revisited for a short period.

General Conclusions from the Study

The generalized model for the design process shown in Figure 1.5 is not the final word on the subject. It is merely another view based on real classroom observation. Furthermore it only provides a window on to what goes on when a pupil is not influenced by the teaching process. It is a beginning, however, and one from which a number of conclusions can be drawn.

The behaviour exhibited in each of the case studies was not the same as that described in published models for the design or problem-solving process. In many instances the behaviours were considerably different, suggesting that a new model, or set of models, is required to describe these particular types of design and make activity.

The activity of making was shown to be dominant in all the case studies. It began early in the activity, before the 'designing' activities were complete, and continued with the same intensity and frequency throughout the whole activity. There is evidence to show that the making activity stimulated and supported all the other design process skills (Johnsey, 1995b).

Many of the designing skills such as specifying, researching and modelling are displayed only for limited periods (and sometimes not at all) and not solely at the beginning of a task. Published models for the design process would suggest otherwise. This may have implications for the way teachers structure design and make activities in the classroom and these are discussed later in Part 2. Children choose to move from one type of design behaviour to another fairly rapidly and there is some evidence to show that the younger they are the more rapid this movement.

The context of the design task and the way the activity is introduced will affect whether certain behaviours are exhibited by the pupil. For instance those behaviours described by many as occurring early on in the design process such as identifying will be absent if the teacher provides a design brief and allows no time for a general investigation. Pupils will often choose to go straight to the heart of a problem rather than carrying out design-related research, especially if there are no obvious resources available with which the research can be carried out.

The Development of Design and Technology Within a National Curriculum Structure

The evolution of a view of the process of design can be charted through the series of documents produced for the National Curriculum firstly in science and later in technology (Johnsey, 1995c). From the first consultative document for science which included technology (DES / WO, 1988) through to Design and Technology in the National Curriculum (SCAA, 1995a) subtle changes in the view of the design process can be charted. In each document the designing and making is not described as a singular process but rather as an implied model. This is achieved through introductory texts, the titles for Attainment Targets and the section headings for Statements of Attainment.

The National Curriculum for Design and Technology (DfE, 1995) clarifies much of this development by employing two sub-headings, Designing Skills and Making Skills where an underlying process of design can be detected which is described with subtle differences at Key Stage 1