This item was submitted to Loughborough’s Institutional Repository by the author and is made available under the following Creative Commons Licence conditions.

For the full text of this licence, please go to:
http://creativecommons.org/licenses/by-nc-nd/2.5/
DESIGN AND TECHNOLOGY: A FRAMEWORK FOR DEVELOPMENT 5-13.

PETER SELLWOOD DIRECTOR OF THE NATIONAL PROJECT:
PRACTICAL PROBLEM SOLVING 5-13

CROSS CURRICULAR PLANNING

Primary teaching functions most effectively when it works across the whole curriculum, linking broad subject areas together through a carefully constructed theme of topic. The National Curriculum Standard Assessment tasks for seven year olds are to be designed as cross curricular activities, not only allowing, but positively promoting a thematic approach to learning in early schooling.

Topics planned to bring relevance and meaning across the primary curriculum will, in light of National Curriculum requirements, need to be carefully balanced. All topics will have a bias in one direction or another and it is vital that each is planned to compliment previous work in order to meet the demands of attainment targets and levels of achievement.

Accurate recording, assessment and evaluation procedures will be essential to ensure a balanced progression, which could even out over the period of two or three topic programmes. Consideration should also be given to social and personal development, providing equal stimulus and incentive to both boys and girls from various cultures and backgrounds.

One of the criticisms of the topic approach has been that some teachers have planned work around their own special interests or teaching strengths whilst neglecting others. The balance necessary to meet National Curriculum requirements should remedy this weakness and at the same time provide a richer learning experience.

DEVELOPMENT IN DESIGN AND TECHNOLOGY

Research has shown the importance of practical activity and recognise it as a potent learning medium. This importance is reinforced in the knowledge that children more readily remember and understand what they have learned through 'doing'.

Materials, tools and equipment are central to the development of "man the maker", as it is through their use and understanding that the important skills and concepts of design and technology are developed. They must, however, be phased in gradually. Some materials and a number of tools will not be appropriate for very young children, however, in a good school, a wide range will be in use by the latter stages of primary schooling.

Children need to be guided towards an understanding of the properties of materials through exploration, building, shaping and modelling. For the very young children these materials should be easy to work and be adaptable in meeting the needs of the child's imagination. For example, cardboard tubes can be used for towers, bodies, legs, telescopes, wheels, rollers etc. Cardboard boxes can be buildings, boats or animal bodies. Ready made resources such as wheels can, at this early stage, impose ideas upon the child rather than encourage inventiveness.

'Junk' modelling plays a major role in children's practical experiences during this early stage. Some schools identify the most useful of these discarded materials and provide lists for parents in order to ensure a regular supply. A well organised storage system provides children with comparisons and choices invaluable in the development of decision making, categorising and sorting skills. A collection of discarded materials will enrich and extend stock, they should not be seen as the only materials required at the infant stage.

Educational kits play an important role in children's conceptual and learning-skill development. Ideas can be tried out without the added problems of applying difficult making skills. It is quite common practice for nursery and infant children to change the identity of
their model a number of times in a very short period of time, even older, more experienced children will frequently change the shape, size and function before arriving at a satisfactory solution. It can be incorrectly assumed that because young children quickly assemble kits into models that move or are articulated, they have formed a firm understanding of these functions. This is a dangerous misconception. Kit modelling is used best when it is an activity that is carefully balanced alongside the necessary experiences gained by using a variety of other materials.

A PROBLEM SOLVING APPROACH TO LEARNING IN PRIMARY SCHOOLS

The rapid changes in technological development have made it impossible to teach content by merely providing facts. Knowledge has doubled in the past decade - and will probably treble in the next? We are, therefore, confronted with the responsibility of developing the curriculum to meet the needs of the twenty-first century and at the same time change the way we educate in order to develop the full range of learning skills.

Problem solving has become a feature of education in recent years, however, it is important to realise that 'problem solving' is neither a separate subject within the school curriculum, nor solely part of the process of design and technology. One often hears the phrase "and in the afternoon we did some problem solving". Problem solving is not something to switch no and off, it should be a continuous process. Problem solving is the basis of all good teaching practice, there is no mystique to a genuine approach, neither should there be a binding and restrictive methodology. Problem solving places more of the responsibility for learning upon the pupil, it is an investigative approach that should have its foundations in early schooling and develop with each stage of education. It is not just the perogative of our secondary schools and colleges.

An investigative approach to learning requires the teacher to ask more questions and stimulate thinking. When properly controlled and monitored it provides pupils with the opportunity to develop the important skills of learning how to learn for themselves. While children are exploring, discovering and investigating the world around them they will inevitably be involved in problem solving of various kinds. The ability to recognise, analyse and then solve problems is a fundamental part of their intellectual development and is becoming increasingly important as a life skill.

A FRAMEWORK FOR DEVELOPMENT

The Project Team have, during the past two years, worked with teachers planning a framework for development in design and technology within a cross-curricular approach. They have matched this development to a problem solving philosophy in the following three broad stages:

Structured Play
Guided Discovery
Project Design

These stages work over a period of children's age-related development, however, they also apply at any stage when approaching something new. It is usual on receiving a packaged piece of furniture or equipment to (1) play around with the pieces, (2) be guided by the instructions and (3) when confident, complete the task unaided.

STRUCTURED PLAY

Children, on encountering something new, engage in free play that can be structured by the teacher asking challenging questions to bring familiarity and a growing confidence.

They should be provided with the opportunity of playing with a variety of materials and provided with stimulus by the teacher of achieving objectives such as "that's a good tower that you have built, can you make it higher?" or "They're nice cakes that you have made for the picnic, what else are you going to make?" Their understanding of materials properties
will be as hard, soft, bendy of floppy, they will readily build with kits and wrap, shape and join fabrics to fit their toys. They will through structure play understand that energy is needed to make things move, e.g. ourselves, toys and models. They will also develop an understanding of control by becoming capable of making things go where they want them to go by putting, pushing, pulling and guiding direction by paths, tunnels and slopes. Practical skills at this stage will involve arranging, sticking and joining things, assembling and building with cardboard boxes, soft wood and plastic containers. They should be provided with the opportunity to form, bend and mould malleable materials such as clay and plasticine, and also develop the ability to shape easily worked materials using simple tools such as scissors and junior hacksaws.

Language plays a crucial role in the development of the skills of description, and of identity by vocabulary. Technological understanding is fostered when children's language is developed alongside practical activity. Their language is extended and enriched by a creative and questioning approach and they will, when encouraged to experiment with words and descriptions, gain confidence and understanding.

The following example, a 'Teddy Bear' topic, was used by a teacher of a reception infant class. The children, who were attending school for the first time were encouraged and reassured when allowed to share this new experience with 'a friend'! They brought their favourite cuddly toy with them. Many learning experiences were related to their toys and provided stimulus to each of them. The activities recorded are a small number of examples relating to the early developments of 'Design and Technology' in relationship to the curriculum as a whole.

Language skills were developed through descriptions and ideas presented by the children about their models. They also told and wrote stories about their Teddy's adventures. Specific skills were developed through considered questions, such as, "How many Teddies do you think this box will hold?" - capacity, size of box, comparison of box to the size of Teddy. "Can you design a home for your Teddy?" - designing, and thinking about what a home looks like, and what a home needs, e.g windows. "What are windows for?" "Where do windows need to be?" "How does Teddy get in and out?" Therefore, "will it need a door?" "How do you make a door?" "Can make a door open and close?" Children were involved in making a home for Teddy using appropriate materials, learning where to bend, where to cut, estimating size, measuring Teddy against the home. "Is Teddy the right size to fit into the home?" "Can it be made bigger by adding, assembling and joining?" They were also encouraged to consider aesthetics "what colour would Teddy like?" "What would Teddy paint the door?" "What colour would Teddy paint the surround of the windows?" "Do you think Teddy would have a garden in front of the house?" "What sort of garden would Teddy have?"

The child's making, designing and technical understanding were developed through the teachers questioning approach, leading to the child reasoning through ideas and coming to decisions about their thoughts of what sort of things Teddy would like best.

'Breakfast time' provided an opportunity to cook, porridge being the obvious meal, it also presented an ideal time for role play, social interaction around a table, tasting their porridge, discussing their meal and measuring out portions to each other.

A 'picnic' presented similar opportunities but extended into decisions on where it was going to be, imagining and describing places. They prepared food, made clothes and dressed their teddies for the occasion. Other outcomes were maps, paintings, models and stories.

GUIDED DISCOVERY

The teacher can create or recognise starting points for investigation, and guide the children, again through questioning, towards a range of possible solutions. The period of Guided Discovery is most effective during the late infant and Junior phase. This is a time when children benefit most from an investigative approach to learning. They usually enjoy the responsibility of working in groups where they can plan and discuss the direction of their
investigations, outcomes and possible solutions. Problems constructed by the teacher should be of the type that guides children towards discovery through open-ended questioning. This will develop independence and lead to a more secure understanding because it has been largely self motivated learning.

Tasks are best when they broaden the concepts developed previously and extend and build on the skills acquired through STRUCTURED PLAY.

During this broad stage of development children will need to be provided with tasks that guide them into understanding that materials can be malleable, flexible and brittle, have varying degrees of hardness, be porous, non-porous, a conductor or non-conductor, and are able to utilize this knowledge to their own advantage.

They will through guided discovery, learn that energy can be stored in the form of a battery, springs and elastic. Their developing skills will include the ability to build structures that stand, support, protect and move. They will need to be competent in the safe use of a variety of tools such as: a junior hacksaw, scissors, a hand drill, mallet, hammer, pliers, sewing needles and knitting needles.

The sample used is part of a 'Learning from Industry' project supported by SATRO (Science and Technology Regional Organization). The teacher worked with the Post Office full time for one week and part time for a further period of two weeks. Curriculum materials were prepared from this experience and the Post Office supported the project in the school. Children visited the main Post Office and postal workers visited the school.

THE POST OFFICE.
PARCELS AND PACKAGING

The children chose a variety of articles to send through the post - chocolates, various toys, a pair of glasses, a plant, 'surprise parcels', so that when they were opened, something popped out etc. The children then designed parcels and packages that could be sent through the post. They tested properties of different materials for packaging - which would be the strongest, easiest to use for wrapping paper, those most suitable to use in designing decorative wrapping paper, those most suitable for protective packaging inside the parcel etc.

The children tested the properties of different shapes for strengths - which was the strongest - triangular prism - oblong box - cylinder? After making their parcels, they compared each of them for properties of strengths, attractiveness, if they were for a birthday, capacity, volume etc. The children designed a bag for a postman to use on a walking round. They tested different materials for strength, suitability for carrying and protecting the post in different weathers, ease of actually joining the material together in making the bag etc. They tested different designs of 'bag shape' for comfort, volume, capacity, strength, ease of fastening and ease of removing the post.

TRANSPORT

The children looked at the different forms of transport in the Post Office - why are there different forms of transport? Which is suitable for particular rounds, such as a rural round, a round in a small village, in a town, in a city. Is it a bicycle, a trolley on wheels, a mechanized box, a van etc. Which holds the most?

The children made small post-office vans out of different materials such as balsa wood, card, corrflute. They tested the suitability of the different materials for making the van. They experimented with different ways of joining and fixing the different materials. They experimented with the effect of using different wheels, different sized wheels, wheels made out of rubber, wood, plastic etc. The children had already discussed why bicycles had different wheels/tyres than motor bikes, why different cars had different wheels, different tyres, different treads etc. They examined the effect of different weights inside their van, on the speed and the distance that their vans would travel. They experimented with different
WAYS OF MAKING THEIR VAN MOVE - SOME USED ELECTRICITY, SOME USED STRING TO PULL THEIR VAN ALONG, SOME USED STORED ENERGY OF AN ELASTIC BAND TO MAKE IT MOVE ETC. SOME CHILDREN PUT LIGHTS ON THE FRONT OF THEIR VAN SO THAT THE POSTMAN COULD SEE IN THE DARK, SOME PUT LIGHTS INSIDE THE VAN SO THAT THE POSTMAN COULD READ THE LETTERS.

CLOTHING

CHILDREN TESTED VARIOUS FABRICS FOR THEIR DIFFERENT PROPERTIES - TO KEEP WARM, COOL, DRY ETC. THE CHILDREN THEN DESIGNED POST OFFICE OUTFITS FOR POSTMEN AND POSTWOMEN FOR DIFFERENT ROUNDS. THEY HAD TO TAKE INTO ACCOUNT NOT ONLY THE SUITABILITY OF THE FABRIC, BUT THE SUITABILITY OF THE DESIGN FOR PARTICULAR ROUNDS. FOR EXAMPLE, OUTFITS TO KEEP THE POSTMAN/WOMAN WARM AND DRY, BUT ALSO COMFORTABLE IN GETTING IN AND OUT OF A VAN. LOOKING AT CLOTHES TO KEEP THE POSTMAN/WOMAN COOL AND COMFORTABLE FOR A WALKING ROUND, OR A BICYCLE ROUND ETC. THE CHILDREN MADE PAPER PATTERNS AND THEN ACTUALLY MADE CLOTHES TO FIT THE DOLLS (MALE AND FEMALE) THAT THEY HAD BROUGHT INTO SCHOOL. THEY THEN HELD A FASHION SHOW AND MADE A CATALOGUE TO ADVERTISE THEIR VARIOUS OUTFITS. THEY DESIGNED OUTFITS TO KEEP POSTMEN/WOMEN WARM AND DRY IN A VAN ROUND, BICYCLE ROUND, WALKING ROUND.

THE RESULTS OF A WELL PLANNED AND CONSISTENT SCHOOL INVESTIGATIVE PROGRAMME OF LEARNING WILL HAVE PROGRESSED FROM 'STRUCTURED PLAY', IN EARLY INFANCY, THROUGH 'GUIDED DISCOVERY' AT JUNIOR SCHOOL THROUGH TO 'PROJECT DESIGNER' AT MIDDLE AND EARLY SECONDARY LEVEL. THIS IS WHERE THE STUDENT WILL HAVE MATURED INTO AN INDEPENDENT THINKER, HAVE THEIR OWN IDEAS AND BE CAPABLE OF FOLLOWING A PROJECT THROUGH FROM ITS INITIAL CONCEPT TO FINAL CONCLUSION.

PROJECT DESIGNER

THE PUPILS WILL HAVE THEIR OWN IDEAS AND TOGETHER WITH THE TEACHER, DISCUSS HOW TO TURN THEIR THOUGHTS INTO ACTION. A GROUNDING IN INVESTIGATIVE LEARNING WILL HAVE DEVELOPED INDEPENDENCE. IT IS A STAGE WHEN GROUP WORK WILL STILL BE SUCCESSFUL PARTICULARLY WHEN PROPERLY PLANNED. WORK SHOULD STEAM FROM OPEN ENDED DESIGN BRIEFS, NOT ONLY DRAWING ON PREVIOUS EXPERIENCE, BUT ALSO THE STRENGTHS AND INTERESTS OF THE PUPILS. PROJECTS INVOLVING A FEW SUBJECT AREAS WILL BE A MORE COMMON FEATURE OF INTEGRATED LEARNING THAN TOPICS ACROSS THE WHOLE CURRICULUM.

PUPILS WILL INVOLVE THEMSELVES IN:

- planning, designing, testing and prototyping
- choosing materials for a purpose i.e. economy, ease of manufacture and suitability for use
- working in groups
- exploring energy, mechanisms and control
- coming to understand processes of manufacture, marketing and cost

FOR EXAMPLE A GROUP OF STUDENTS IN THE THIRD YEAR AT SECONDARY SCHOOL WERE SET THE TASK TO DESIGN AND MAKE AN EDUCATIONAL PACKAGE FOR 'THIRD WORLD' CHILDREN. IT REQUIRED THE TEAM TO THINK OF THEMSELVES A REAL 'DESIGNERS' IN PROVIDING A KIT THAT WOULD ENCOURAGE AN INVESTIGATION INTO THE PRINCIPLES OF 'LIGHT'.

THE PACK HAD TO BE EASILY TRANSPORTABLE AND ITS COST KEPT TO A MINIMUM. THE PUPILS EXPERIMENTED WITH GLIDERS, POWERED MODELS, ROCKETS, PARACHUTES AND HOT AIR BALLOONS. THEY DEVELOPED THEIR IDEAS THROUGH BRAINSTORMING AND CAME TO DECISIONS THROUGH DISCUSSION AND NEGOTIATION. GRAPHIC SYMBOLS WERE INVENTED AND PRINTED ON THE PACKAGE TO EXPLAIN ASSEMBLY AND COMMUNICATION IN ITS USE TO CHILDREN THROUGHOUT THE WORLD.

THE FINAL OUTCOME WAS A MARKETABLE PACKAGE THAT CALLED UPON THEIR ACQUIRED SKILLS OF DESIGN AND TECHNOLOGY IN RELATIONSHIP TO MATERIALS, SKILLS, MANUFACTURE, PRODUCTION, PRODUCT DESIGN, AND RETAILING. A LOGICAL STEP IN THEIR PROGRESSION AS KNOWLEDGEABLE AND COMPREHENSIVELY SCOOLED YOUNG STUDENTS.