Preparing D&T for 2005 – Moving Beyond the Rhetoric
The DATA Lecture

RESEARCH

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Progress so far

Many of us here will remember the difficulties of the first five years of National Curriculum design and technology. A programme of study for each level of attainment, four attainment targets, a programme of study that seemed to match the attainment targets but not quite, an attainment target that managed to prevent teachers teaching (AT1 Identifying needs and opportunities), models of delivery that were complicated and required teachers to operate well outside their areas of expertise. The intentions were good but chaos reigned supreme. We have come a long way since then. The clarification through the revised Orders of 1995 helped considerably although some regarded these as over prescriptive. The period of relative calm between 1995 and now, (no major changes to the design and technology Orders compared with the several different versions teachers were faced with in the preceding five years) has led to a growing consensus as to the nature of design and technology and how it might be taught, although for many teachers there is still some degree of uncertainty. Ofsted inspections (1) have revealed a subject whose rate of improvement outstrips most other subjects and although there is no room for complacency, the profession can be pleased with the level of progress made so far. However this progress is only a beginning and must be extended significantly if the place of design and technology in the school curriculum is to be made secure.

The promise of design and technology

The Distinctive contribution statement (2) of the revised curriculum paints an impressive picture of the attributes developed through a good design and technology education. There are two sentences which capture the essence of capability.

> 'Pupils learn to become autonomous, creative, problem solvers both as individuals and in working with others.'

And

> 'Pupils learn to recognise needs, wants and opportunities and respond to these by producing a range of ideas and products which they can critically reflect on and evaluate from a variety of perspectives, including use, production, marketing, environmental, cultural and aesthetic.'

The key features imply:

- **autonomy** – pupils making decisions and taking action based on those decisions; the actions may require the sanction of the teacher but the aim is autonomy
- **creativity** – pupils using their imaginations to produce outcomes that are both original and of value
- **problem solving** – pupils able to find problems and work things out for themselves
- **as individuals and in working with others** – pupils able to work on their own and also co-operatively
- **recognising and responding to needs, wants and opportunities** – pupils will see the world as a place to be improved
- **producing products and ideas** – pupils able to design what they want and then make their design
- **critically reflective from a variety of perspectives** – pupils able to question their own work, and that of others, in ways which develop their appreciation of, and sensitivity to, a wide range of issues.

Young people are invited to make a difference to the world.

The sum of the above parts is impressive. The potential for learning and developing attitudes and skills for life is immense. Young people are invited to make a difference to the world. This is the promise of design and technology. My view is that it is only through empowering teachers that we can meet this promise and so secure the place of design and technology in the school curriculum. The role of teachers will be central to my lecture.

Ground rules

I believe there are four conditions that teachers must meet if their teaching of design and technology is to be successful.

Firstly the teacher should have the expectation that pupils will be capable. This means that it will be perfectly acceptable for pupils to make decisions and take actions based on those decisions. In some cases the actions will require the sanction of teacher approval but in many cases the actions will be autonomous.

Secondly the teacher will facilitate pupil capability by organising and maintaining an appropriate environment. This means that pupils will have open access to materials, components, tools and equipment. In most cases they will be able to collect what they need, as they need it, use it and return it. In some cases particularly scarce resources may need to be booked in advance. But it is essential that decisions once taken can be acted upon if pupils are not to become dispirited and de-motivated.

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Figure 1: Strongly held views that help shape the design and technology curriculum.

Thirdly the teacher must provide the resources for capability by teaching the technical knowledge and understanding, aesthetics, design strategies, making and manufacturing skill and values needed for successful designing and making.

Fourthly the teacher must maintain the motivation for capability through insight into the pupils themselves, ensuring that activities are relevant, urgent, important and attractive.

Playing as a team

It is essential that the teachers working within a design and technology department operate as a team. This is not always easy as the different members of the team are likely to have strong and differing opinions as to what is and isn't important in the teaching of design and technology. It would be odd if this were otherwise, particularly when we consider the different traditions and career paths that have contributed to the make up of the current teaching force. The teachers shown in Figure 1 are expressing their views as to the most important feature of design and technology education with special reference to designing and making. No one would argue with the significance of each of these features: aesthetics, communicating skills, design procedures, making skills, technical understanding, values. Some would argue that to consider design and technology solely in terms of pupils' designing and making is limiting. What is essential is that none of these features becomes dominant in the way a department teaches pupils through designing and making. An over emphasis or under emphasis can lead to a skewed experience resulting in a lack of breadth and balance. Clearly the head of department has a key role in enabling teachers to articulate their strongly held views in the context of a team approach so that each teacher feels valued and is able to contribute appropriately to developing a broad and balanced approach to design and technology.

Personal constructs of the subject

I have been fortunate to work with Frank Banks at the Open University in applying a model for the personal construction of your subject as a teacher to design and technology (3). This model is summarised by the diagram in Figure 2. It involves three elements – subject knowledge, pedagogic knowledge and school knowledge. So the model indicates that teachers should 'know their stuff' (subject knowledge); 'know how to teach their stuff' (pedagogic knowledge) and 'know how to teach their stuff in their school' (school

knowledge). I believe that this is a useful way of looking at your subject whatever it happens to be but particularly so for design and technology, because it is relatively new and there is still considerable uncertainty about its exact nature as far as many teachers are concerned. This is not surprising; in addition to being new, design and technology has to reflect to some extent a rapidly changing world in which technology and changes in technology are playing a major part. I believe this model gives teachers and heads of department a valuable tool for looking at their practice both as individuals and as teams. By reflecting on each of the features a team can build an effective agenda for both change and supporting in service training. In looking at school knowledge they can ask the questions 'Why do we do things this way?' and 'What about doing them that way?'

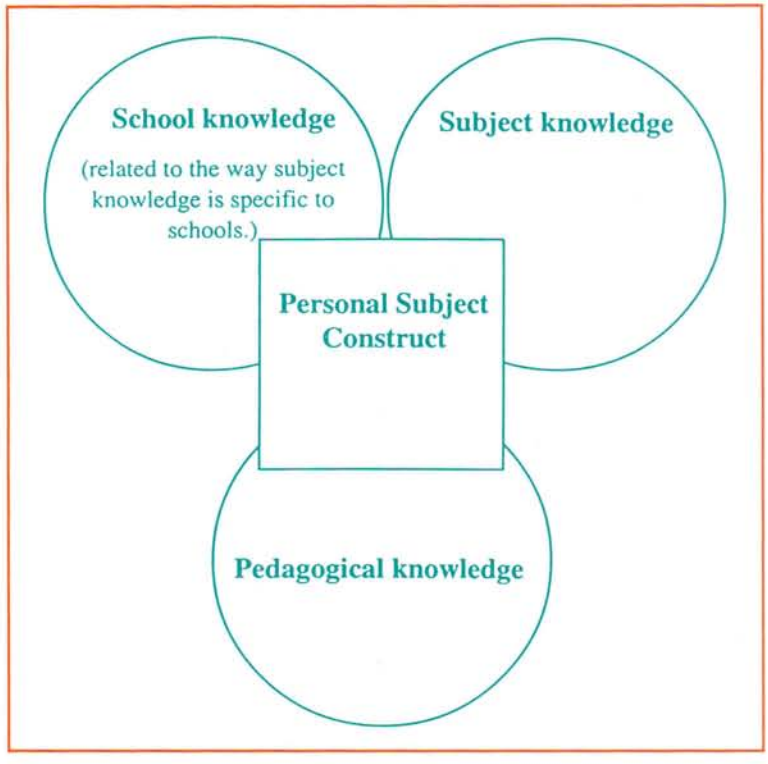

Figure 2: A simple model for the personal construction of your subject as a teacher.

Maintaining a modern design and technology curriculum through continuing professional development

Our design and technology curriculum needs to be modern. It just will not do to have lessons that are based on 'old' traditions. This does not require the values of those traditions to be lost but these values do need to be reinterpreted according to our current situation, constraints and the essentially forward-looking nature of technology. Of course pupils will need to experience handling traditional materials, using hand tools and machine tools across a wide range of media, but this should lead to experiences where they handle modern materials (and components) and use up to date making processes. This does pose large problems for continuing professional development. I want to look at three possible models.

First there is the model currently being piloted by the Association for Science Education (4) and leading to an ASE Certificate that recognises progress in continuing professional development. It is intended for teachers in the early years of their careers and uses mentors who in most cases are heads of department. The pilot is using a framework of seven areas that it sees as desirable for teachers to develop as they progress through their careers, as shown in Table 1. Each participant does a needs identification exercise on their current situation in each of the areas. They then devise a number of activities to meet some of the needs and ensure that progress in all seven areas of the framework can be made. Working with the mentor, the participants' task is to produce a portfolio of evaluative reports on

Table 1: Seven areas for professional development in the ASE certificate.

Area	Description
1 Subject knowledge	Having a sound knowledge of the subject area that you have to teach.
2 Pedagogical content knowledge (classroom science)	Translating one's own understanding of the subject into forms that will be understood by pupils of varying abilities and ages.
3 Development of teaching skills	Developing skills such as managing practical lessons, using IT in teaching science, promoting discussion techniques.
4 Theoretical understanding of teaching and learning	Being aware of the significance of the findings of recent years on the ways pupils learn best.
5 External changes affecting teaching	Being able to place one's teaching in the context of national developments.
6 Professional attitudes	Being able to manage oneself.
7 Professional skills	Being able to manage others.

the activities plus supporting evidence, that is judged against a set of assessment criteria. It is expected that this process will take two years. Assessment is carried out initially by the mentor with final judgements being made by external moderators. This is an attractive package for new science teachers and may well be applicable to design and technology.

Secondly, there are initiatives like the current DATA/DfEE CAD/CAM initiative where an area of critical curriculum development requiring both hardware and software has been identified and a limited number of schools are supplied with resources that enable them to develop a range of best practice models which will be transferable to other schools as difficulties are ironed out and costs drop. This looks to be an effective way of having significant impact albeit in a relatively small number of schools with the possibility of wider effects.

The difficulty with both these models is that they leave the bulk of teachers unaffected, so I wonder if there is another model that might be more generally applicable. Here I am indebted to colleagues at the Design Council who made this interesting connection. There are literally hundreds of NVQ courses going on at institutions of further and higher education around the country. There will be some of these that are targeted at providing up-to-date approaches for those working in either design based or particular technology specific industries. There may well be an overlap here with the professional development needs of teachers. It requires a careful investigation to find out if there is a match between these courses and the needs of design and technology teachers. Here is an example which I hope is not untypical. It is possible to learn about food photography as part of an NVQ for those working in the food industry. Many food technology teachers would find this a useful skill. The course is happening anyway so there are no special setting up costs and it is not dependent on large numbers of teachers being released for viability. There is of course the danger of teachers finding themselves on inappropriate courses but with some careful initial monitoring this could be avoided. I am happy to report that in an initial conversation with the DfEE this was seen as an idea worth pursuing.

Teaching a designing and making assignment

It is through designing and making assignments (DMAs) that design and technology comes into its own. To ensure that pupils are successful in a DMA teachers need to manage the learning effectively. I believe there are ten crucial teacher decisions for teaching a designing and making assignment. I shall discuss these in some detail (5).

Question 1: How should I introduce the task? Teachers can choose from different ways.

A talk start: Here the teacher introduces the task through description. Identify six key words related to the task. Set the scene by reading out a piece that describes the context. Ask open questions about each of the key words so that the class can discuss important issues, for example not 'Do children play with toys?' but 'What sort of toys do children play with?'

A walk start: Here the teacher takes the pupils outside the classroom environment to a location which is relevant to the DMA and where design decisions are easy to spot, e.g. a museum, a shop, a gallery. It is important to keep the pupils focused, so use no more than four questions e.g. 'Who would come here?' 'What would be popular here?' 'How much would you pay for things on sale here?' 'What is the style of this place?'

A hand start: Here the teacher uses a handling collection and focuses the pupils' attention on the objects by asking them to handle the items and writing answers to some questions. Here are some possibilities.

> 'Hold it. Does it feel heavy or light?'
> 'Touch it. Does it feel rough or smooth?'
> 'Look at it. What colours can you see? What different parts can you see?'
> 'Do any of the parts move? Try pulling, pushing, twisting. What happens?'
> 'Can you work out what the parts do?'
> 'Who do you think would use it? Why do you think that?'
> 'What would they use it for?'

At this stage ask the pupils to draw a simple sketch of the product they have investigated and use the answers to the questions as the basis for annotations.

A read start: Collect a mixture of printed resources about a theme relevant to the DMA e.g. Case Studies, newspaper articles, articles from books, magazines. Give a single resource to each pupil. Give the pupils 15 minutes silent reading time in which they have to read an article trying to identify six key points. It is important that the pupils can 'mark up' the reading matter with highlighters and fine line pens. Once the pupils have finished, their next task is to draw a map showing how the six key points relate to one another. These maps can be put on display and act as the basis for class discussion.

A computer start: Divide the class into five groups and ask each group to research an

Table 2.

Capability Task Activity	Teacher decisions
Introducing	Talk start; Walk start; Hand start; Read start; Computer start; Show start; See start; Self start
Linking	Which other area of the curriculum do you want your pupils to use in this Capability Task? Is it... maths, science, art and design, IT, one of the key skills, literacy, citizenship?
The brief	What is the scope of the brief? Just how open or closed should it be for your pupils? Closed __– – – – – – – – – – – – – – – – u – – – – – – – – – – – – – – – – __Open
Trapping ideas and first feedback	Use getting design idea strategies for pupils to produce initial design ideas. Do you want them to produce just one idea each or lots of different ideas? Display the ideas so that each pupil can get feedback from the rest of the group Just one idea __– – – – – – – – – – – – – u – – – – – – – – – – – – – – – __Lots of ideas
The specification	How complex should the task be for particular pupils? Negotiate the specification with individual pupils to achieve good differentiation Simple __– – – – – – – – – – – – – – – – u – – – – – – – – – – – – – – – – __Complex
Modelling solutions	What's the diversity of experience here? How many different sorts of modelling will be happening in your class to produce prototype products? Just one sort __– – – – – – – – – – – – – u – – – – – – – – – – – – __Several different sorts
Second feedback	Working in pairs pupils take on alternate roles of client and designer. Client has specification and designer has prototype product. Will the product meet the specification? Will it delight the client? What questions will the pupils ask? Will you give them questions or will they make them up? Given questions __– – – – – – – – – – – – u – – – – – – – – – – – – – – – – __Free questions
Teacher feedback	Use prototypes and pupil's flat work to give three point feedback to each pupil • a comment about the design either overall or a point of detail • a comment about the production • a comment to motivate (personal to the pupil)
Production	What range of tools, materials and technical components will pupils use Narrow range __– – – – – – – – – – – – – u – – – – – – – – – – – – – – – – __Wide range Will all the pupils be able to make their design? How much help will you need to give? Can they help each other? Will you need to demonstrate? Will you need to set up specialist making stations?
Final feedback	How will your pupils evaluate their products? On their own? In pairs or small groups? Through general class discussion? What criteria will they use for this evaluation?

aspect of the DMA using the world wide web or a given set of websites. The teacher can give each group help in finding the right entry into a search engine. The results of the research can be put on display and shared by all members of the class.

A look and see start: Collect images from a wide range of sources – magazines, books, postcards, catalogues, newspapers and produce a pack for each table. Give the class 15 minutes to look at the pack so that each person can identify images that…

- have a strong impact
- he/she particularly likes
- he/she particularly dislikes
- and associate words with the images.

The class can then identify a range of powerful images and associated words and this can act as a stimulus for the DMA.

A show start: Show the class a pair or small collection of products and ask them some specific questions through which they describe and compare the products. This can help the class understand ideas that will be important for the designing and making they will carry out.

A self start: Set a research task as a homework. Pupils bring the results to the next lesson to be read out to the rest of the class. Each pupil has a 30 second slot. The teacher captures key words on the board and uses these to explore the task setting.

Question 2: Do I link the task with other subjects?
The teacher can choose whether to link the task to other subjects or not. Effective links with other subjects will not happen by accident. Only a few pupils will naturally make connections with other areas of the curriculum. To ensure that the majority of pupils make good use of other subjects it is best to choose a definite subject that lends itself to links with the DMA and then to teach that task with this in mind.

Question 3: How open do I make the brief?
At Key Stage 3 the teacher is expected to provide pupils with the brief. The more open the brief, the wider the range of products that pupils in your class will want to design and make. It is important that the brief is not so open that you cannot support different pupils' attempts at designing and making. It is important that the brief is not so closed that all pupils end up designing and making very similar products. It is essential that the individual signature of the pupil can show through the work.

Question 4: How do I ensure good design ideas?
The teacher has to decide on the range of ideas that it is best to get from the class. Do you want just one from each pupil or lots? It is particularly important that each pupil gets feedback on their ideas. If the teacher limits the number of ideas they are asked to produce, this is much more manageable. If each pupil is asked to produce one idea on a large post-it note, the notes can be displayed and each pupil can get feedback from the rest of the group. In this way all pupils receive feedback and can adapt their ideas accordingly.

Question 5: How complex should the specification be?
Able pupils should be working to more ambitious specifications than less able pupils. The teacher can use the same framework for specification with all pupils in a class (what the product must do, what it should look like and other features) but the teacher can negotiate the detail with individual pupils and this is a good way to achieve differentiation.

Question 6: How will pupils model solutions?
The teacher has to decide on the diversity of experience that is appropriate and manageable. How many different sorts of modelling will be happening in your class to produce prototype products – just sketching, 3D mock ups, working models, computer images?

Question 7: How do I ensure they stay on track?
The design ideas are now more fully developed but it is still important that they are scrutinised. This process can be made more dynamic by pupils working in pairs, taking on alternate roles of client and designer. The client has the specification and the designer the prototype product in whatever form this has been developed. The client has to question the designer about the prototype. The teacher can provide questions or expect the pupils to make them up. It is important that this feedback informs the final design.

Question 8: What sort of written feedback do I give?
The teacher can give three-point feedback to each pupil based on their 'flat work' and any prototypes they have produced:

- a comment about the design, either overall or a point of detail
- a comment about the production, where particular care is necessary for example
- a comment to motivate, personal to the pupil.

Question 9: How do I ensure quality making?
It is important that pupils are able to make their designs. The teacher has to decide on the range of tools, equipment, materials and components they can use and the amount of help they can give. The teacher may need to demonstrate or set up specialist making stations. It might be important to encourage pupils to help each other.

Question 10: How will I organise final evaluation?
There are several different strategies for final evaluation:

- comparison of performance against specification
- user response
- performance in the light of wider issues (winners and losers or appropriateness).

These can be carried out by individuals, in pairs or small groups and sometimes through general class discussion.

The teachers will need to ensure that pupils are taught these methods of evaluating and given the opportunity to use them in a variety of ways.

A summary of these teacher decisions is given in Table 2.

Assessing the subject

The GCSE Examination Boards have faced a tremendous burden in the case of design and technology. Moving from a position where it was a minority, optional subject they were literally rushed into a situation where it was compulsory for all pupils aged 14–16. This, coupled with the 'newness' of the subject and an unavoidable limited experience in providing examination and assessment, has led, I believe, to a situation where the flair, innovation, creativity and modernity that are central to good design and technology are being squeezed out of GCSE course work. Richard Kimbell (6) tells us that teachers have little difficulty in putting pupils' work in order of performance. Teachers are good at making holistic judgements. The judgements are usually both reliable and valid. Reliable in that different teachers put the work in the same order. Valid in that the criteria they bring to bear are relevant to the pupil's capability.

My worry is that I see teachers being forced into an atomistic approach to assessment in order to establish the overall order in the first place. I think this is the wrong way round. Get the overall order right and then use a more detailed inspection to refine the grade boundaries. A set of questions might be useful for this inspection:

How have design strategies been used?
... intelligently? ... broadly? ... effectively?

How have communication techniques been used?
... broadly? ... appropriately? ... carefully?

How has researched information been used?
... effectively? ... efficiently?

How has technical information been used?
... appropriately? ... innovatively? ... accurately? ... elegantly?

Overall I want the pupil to tell a clear, internally consistent and coherent story about the decisions they made in designing and making the product. I want evidence of designerly behaviour. I want to see a balanced combination of:

- technical and aesthetic creativity
- sensitivity to user needs
- appreciation of market forces
- understanding of and skill in manufacturing.

I have to say that I don't see this in many GCSE project work folders.

There are moves afoot to address this situation. Ian Williams, Subject Officer for Design and Technology at QCA, set an exciting precedent when he invited Examination Boards to hear the views of successful design consultancies. These meetings produced some interesting challenges:

- creativity is essential yet the current syllabuses don't mention it let alone assess it!
- the designers nearly always work in teams yet the current syllabuses don't really encourage this or assess group work skills
- modelling design ideas using CAD/CAM is fast becoming the norm for rapid prototyping yet current GCSE syllabuses are at best not encouraging (and at worst penalising) pupils who use this modern technology.

Next year the Nuffield Foundation will hold a seminar to explore this issue as a prelude to developing an innovative GCSE design and technology syllabus; one that encourages and rewards the qualities identified in the distinctive contribution statement.

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The importance of current research

A criticism voiced at the last International Technology Education Association Conference by Karen Zuga was the lack of analytical research in our subject area. She quoted four examples of useful and appropriate work and three of them were from the UK. Richard Kimbell (6), with his work on assessment in design and technology, Bob McCormick with his work on the role of problem solving in design and technology (7) and Patricia Murphy with her work on co-operative problem solving in design and technology (8). So we have internationally acknowledged and highly relevant research activity happening in this country.

Murphy's work has particular importance because she has established the rationale for children working together not on the grounds of 'it's important that they learn to work in groups' but on the grounds that 'they learn more effectively and efficiently by working in groups'. Given the reluctance of examination boards to engage with group work this is an important finding.

Patricia Murphy has also done interesting work, as yet unpublished, within the Nuffield Primary Design and Technology Project evaluating the way teachers have used the Project's trial materials and providing evidence that the Project has been able to use to convince a commercial publisher to consider publishing primary design and technology materials at a time when all eyes (and resources) are on literacy and numeracy.

The fourth example Karen Zuga quoted was the work of Malcolm Welch from Queen's University in Ontario, Canada (9, 10). I have been fortunate enough to collaborate with Malcolm recently in work that has developed from his doctoral thesis. In broad sweep terms he has put children aged 11–12 years in pairs and asked each pair to tackle a design and make assignment. He video-recorded the results and subjected them to protocol analysis which revealed the following important points:

- pupils do not view sketching as a mediating instrument between mind and hand, between thinking and doing
- pupils move straight to three-dimensional modelling when this is possible
- pupils' ability to generate, develop and communicate design ideas is enhanced by both the dynamic relationship between pupils' talk and three-dimensional modelling and the way the task is contextualised.

His work has identified the following important issues that remain to be resolved given the centrality of modelling to the designer-maker capability required by current design and technology curricula.

- Which modelling strategies should be taught?
- What is the most appropriate sequence in which to teach modelling strategies? How does this sequence map onto the age and ability of the pupil?
- What is the most effective way to enable pupils to choose and use modelling strategies appropriately?
- What contributions does learning to model ideas make to the overall cognitive development of the pupil?

It is important that the teachers are given the opportunity to consider the implications of this research work for their classroom practice as part of their professional development. With so much home grown research talent this should not be that difficult to organise. The significance of Malcolm's research is such that he is likely to be a not infrequent visitor.

The proof of the pudding

However much we might try to resist it, it is the products that our pupils make that excite our interest, so I want to spend a short while commenting on pieces of pupils' work.

I begin with an example from one of the first activities developed for the Nuffield Primary Design and Technology Project – a Roly Poly.

This is a deceptively simple product with the potential for extremely rich learning. Through tackling this task children make technical design decisions matching the sort of movement they want to the position in which the shaft between the two wheels is fixed; aesthetic design decisions in providing decoration for the wheels and the body; making design decisions in choosing an appropriate method for attaching the wheels to the shaft and finally purpose design decisions in deciding who the toy is for and making the other decisions in the light of this. The child making all these informed decisions is likely to be six years old.

My second example is also from the Nuffield Primary Design and Technology Project – samples of bread made by Year 6 pupils. There are three things of note here. First the quality and originality of the products; several secondary school teachers have commented that they would be pleased to get work of this quality from Key Stage 4 pupils, and Key Stage 4 pupils themselves on seeing the work have commented 'Crikey and they're only 10

years old!' Second, the work was carried out by the primary pupils in the secondary school to which most of them will transfer as an exercise in primary secondary liaison. Julie Messenger of Sawtry Community College was responsible for the organisation. In addition to introducing the pupils to their new school it showed the secondary school teachers the high level of capability amongst the pupils they would be receiving a year later.

Third, the next time this liaison exercise took place the primary teacher had sufficient confidence and expertise to teach the designing and making in the specialist facilities of the secondary school with the secondary teacher acting as support and 'expert' evaluator.

The following Key Stage 3 examples are all taken from the Revised Nuffield Secondary Design and Technology Project materials (11). The first involves designing and making with food. Here the pupils have produced a range of food products in response to the theme 'The Healthy Heart' a task developed by Marion Rutland at Roehampton Institute. Having completed some focused practical tasks the pupils are given access to a range of starter recipes and told to choose one to modify so that it meets the criteria of the British Heart Foundation:

10g sugar per 100g product
20g fat per 100g product
5g saturated fat per 100g product
3g fibre per 100g product
0.5g sodium per 100g product

Here are two responses.

Asparagus and cheese quiche
The student made the following changes:

- 200g plain flour to 100g plain flour plus 100g wholemeal flour to increase fibre
- semi skimmed milk instead of plain milk to reduce fat content
- asparagus instead of bacon (as in classic quiche recipe) to reduce fat and add fibre
- low fat cheese instead of ordinary cheese to reduce fat.

Courgette and tomato soup
Starting with a cream of mushroom soup recipe the student made the following changes:

- courgettes and tomatoes instead of mushrooms to increase fibre and vitamins
- margarine instead of butter to reduce saturated fat
- water instead of milk and stock to reduce fat and sodium.

Pupils are able to use simple arithmetic to develop modifications that meet British Heart Foundation criteria. They can explore the nutritional consequences of their modifications by using simple nutritional analysis software.

Textiles are a powerful medium in which to design and make. It is important that the products pupils design are required to have technical as well as aesthetic qualities. I see little place for decorative wall hangings in design and technology and pupils will probably have had their fill of puppets by the time they reach secondary school. So the Nuffield Project has developed a suite of textiles-based DMAs (or Capability Tasks in Nuffield parlance) that require pupils to design and make textile products that have to 'work' in a variety of ways including of course looking good. Hot comfort is a task in point. The brief is as follows:

> design and make a textile product that will improve comfort by keeping somebody or something warm.

An interesting range of product results – slippers, scarves, mittens, hats, cot quilt, coffee pot cosy – all designed with thermal properties, fitting qualities and appearance in mind. The Nuffield Project sees this as a Year 8 task where the variety of possible outcomes is wide because the pupils have been taught simple pattern cutting skills by designing and making either shorts or T-shirts in Year 7.

Mechanical toys are such a favourite at Key Stage 3 that there is a danger that they become the equivalent of the tea pot stand beloved by some woodwork teachers of the past. Nick Givens (12) has noted that teachers are inclined to give very little technical autonomy to pupils – it WILL be a cam toy, and total aesthetic freedom – the cams can drive whatever you like. The result is often a tiresome array of lack lustre bobbing figures of no particular virtue. So the challenge I set Jon Parker when I asked him to write the Capability Task Petshop Parade was 'Make it different'.

Typically Jon started by providing teachers with some in-service training which they could use directly with pupils. He showed them a set of useful mechanisms made from Fischer Technic. Their task was to explore them all to find out what they do and how they work. Then they had to choose one and using MDF, dowel and appropriate mechanical components make a working copy. This teaches all sorts of 'tacit' understanding about mechanisms – alignment, tolerances, clearances.

With a little direction a class of pupils working in pairs will produce a reference set of 'made' mechanisms as opposed to 'kit' mechanisms and each pair of pupils will be the class experts on one of these mechanisms. This bridges the gap between kit work, designed to be stripped down and put back in the box, and the prototyping required to produce a finished and working mechanical product. The brief for Petshop Parade was as follows:

> design and make a mechanical toy that will provide amusement and intrigue and will be sold in a large pet shop.

Jon added two interesting constraints – the toy had to look like an animal, so the frame with moving figures on top is kicked into touch; – the toy should use just one mechanism, this prevents over complication. I think the results produced by Year 9 pupils speak for themselves. At the simplest level a dinosaur with a tongue that pokes in and out driven by a rack and pinion. Then a delightful owl constructed of discs whose head revolves through 360 o driven by a worm and wheel, lots of fast winding to produce a serene, and anatomically impossible, looking around the room with disdain. Finally a chameleon. Winding the tail slowly causes the body to revolve showing a range of different colours achieved using paint software and a colour printer through a direct drive which also causes the eyes to rotate by the use of bevel gears.

I believe it is essential that modern technologies are included at Key Stage 3 so Torben Steeg had the task of developing a Capability Task that used programmable integrated circuits. The result was Electronic Education. The task is as follows.

> Electronic Education is a company that specialises in developing fun electronic toys that meet an educational need. Its products are usually built around microcontroller integrated circuits. Your task is to identify a situation where an electronic toy could meet a learning need and then to develop a product that meets the learning needs in that situation.

The results from the trial were outstanding – a tribute to the Year 9 pupils and their teacher. Here are four examples.

'Safe Cross', a single traffic light, designed as an aid for teaching young children how to cross the road. When the button is pressed the lights go through the standard sequence and a buzzer beeps when crossing is safe.

'Blinking Bester' designed to help children co-ordinate and develop their reactions. An LED comes on for a short time; the child presses the button next that LED. If the correct button is pressed then this repeats with the time that the light is on diminishing. The game stops when the child presses the wrong button or the time delay has diminished to half a second.

'Time Bomb' designed to help children count. A buzzer beeps between one and four times. The child counts and presses the appropriate button ('1'–'4'). A green LED signals a correct answer, a red LED signals a wrong answer.

'John Says' designed to help the development of pattern recognition and counting. The LEDs blink in a particular order and the child presses the buttons next to the LEDs in the same order. If the child is correct, another sequence is presented, if wrong then the game stops.

Concluding remarks

Now I have to draw together the threads of this talk and I am conscious that there is much that I should have said that time would not allow. I make no apology for putting the future of design and technology in the hands of teachers and the decisions they make about how best to teach the subject for their pupils in their classrooms. It is only if they are successful that the subject can flourish. I have to say again that it will only be by working with colleagues, across the school at primary level, and across the design and technology department at secondary level, that the individual teacher will achieve success.

But teachers, co-ordinators and heads of department are not alone. We have an active and successful professional association in DATA ably led by Andy Breckon and Jenny Jupe. We have a tireless champion at Ofsted in Mike Ive, HMI. There is a research community finding out the sorts of things that will help teachers teach better. With the funding and training being provided for ICT it will soon be possible for teachers to lose their sense of isolation by using the resources and communication possibilities being made available through websites.

An interesting feature of the Nuffield Primary Design and Technology Project is its website designed specifically to help establish and support an on-line community of primary teachers who wish to teach design and technology really well. A Nuffield Secondary Design and Technology website is in the pipeline and will have a large section for pupils.

And of course there will be lots of other useful sites. Our subject is well supported by

curriculum development through DATA, the Technology Enhancement Programme and the RCA Project as well as the Nuffield Projects. We have active and responsive Subject Officers at QCA in Ian Williams and Louise Davies. There is considerable support for the subject within both the DfEE and the DTI. There are several national organisations interested in and committed to supporting the subject – the Design Council, The Arts Council and the Engineering Council. There is considerable support for the subject in the wider world of business and industry.

We know that there will be a National Curriculum review in 2005 if not before. I firmly believe that with the support available, teachers can, through their own efforts, respond effectively to the challenge of design and technology education and create a situation in the majority of schools such that its place in the school curriculum as an essential ingredient for all pupils throughout compulsory education is secure.

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