



## Frank Banks

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# The role of making in design & technology

Frank Banks and Gwyneth Owen-Jackson

## Introduction

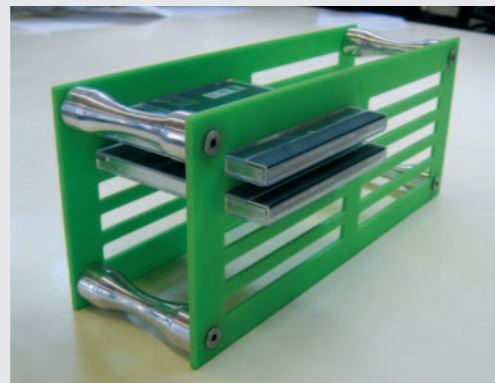
We were talking recently about why we were attracted to design & technology and we decided one of the main reasons was because we could make things. It wasn't just writing, it was doing. Of course we made things in other areas too. Art and design was good - one of us still has the pouting thin plaster head, carefully sculpted when in Year 11, that looks a bit like an emaciated Easter Island figure and the Toby jug made from papier mache by the other stood for years on the shelf in her parents' home. But the usefulness - in the broadest sense - of the artefacts made in design & technology made the subject special. The embroidered needle holder made over thirty years ago and the wooden bedside table-lamp with small bookstand base (now a bit wobbly) that seemed to take most of Year 10 to make are both still in use, although the wailing electronic musical instrument called a 'Glissandovibe' made in the design & technology club has thankfully long given up the ghost!

We don't think we are alone in our love of making things. Mark, a local builder, was chatting as he installed a new bathroom. *'I hated school'*, he said. *'Except D&T of course, I could see the point of that'*. Mark was not at all academic, but his intelligence for making, problem-solving and being creative with his hands was recognised. Learning by doing, the cornerstone of many school subjects including science and mathematics, is at its most obvious in design & technology. This is not new. Although we think that suspending the timetable to give a whole day (or even a week!) to a design & technology cross-curricular project is a recent trend, John Dewey was teaching by 'doing' at the University of Chicago Laboratory School over a hundred years ago. His idea for learning biology and chemistry through cooking breakfast in school has some very modern links to what underpins food technology lessons today (See Dewey, 1897 pp. 77-80). Indeed, learning through what we make has a long and respected pedigree.

**Q** What drew *you* to teach design & technology?  
Think of an incident that made you particularly proud of what you had done or what you had achieved in your own design & technology work. How useful was the artefact you made?  
No doubt like us, the people at home treasured your efforts - but did *you*? Did you *really* use that 'key fob'?  
Will the current Year 9 CD rack project *really* be used at home when so many thousand songs fit onto their MP3 player?

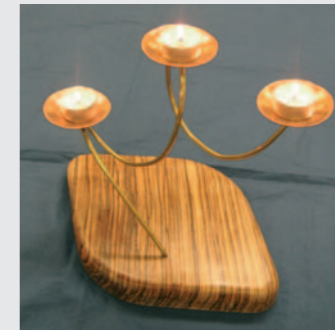
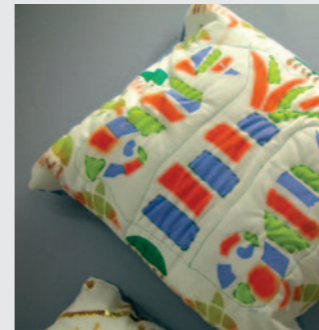
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01 What do pupils  
- learn through  
02 making simple  
products such as  
these when they  
have little control  
over the design?



03 04 05

03 What do pupils  
- learn through  
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## Do pupils always need to make what they design?

But how important is the making to pupils' learning? Have we just changed the label of the subject from woodwork and sewing to CDT and textiles and now to design & technology, or have we changed the subject as well?

The 'Glissandovibe' mentioned above was a real pain to make and was done rather half-heartedly, especially counting the four lots of 250 turns on the coil, but the teacher said that a video recorder was too hard to make. Life has moved on and domestic video recorders are in most homes - but they are often very badly designed, as are many other domestic and leisure products. Without the restriction of having to make the product, we could all suggest ways to improve badly-designed ones.

Q

On a piece of paper, brainstorm what your video recorder /DVD player can do. Circle those functions that you most use and those you *never* use. Compare your results with a friend. What does this tell you about the design of that

common artefact?

This can be done with almost any product - mobile phones, food processors, and even the local supermarket!

Surely, being creative and designing what we make is what design & technology is all about. Was the bedside lamp or needle holder creative? No, not really, we all made one and there were few design decisions to make. Does the need to make what they have designed restrict pupils' creativity? Is there a problem?

*'As creativity is now explicitly acknowledged as an essential feature of design & technology it is important to explore the reality of the subject in secondary school classrooms to find out if indeed there is a crisis in creativity'* (Barlex, 2000).

Creativity can be described in different ways, here we assume that it always involves thinking or behaving *imaginatively*. Second, overall this imaginative activity is *purposeful*: that is, it is directed to achieving an objective. Third, these processes must generate something *original*. Fourth, the outcome must be of *value* in relation to the objective (DfEE, 1999a). But how far do current teaching approaches allow pupils to achieve this kind of creativity in their work? Here are some comments about the quality of designing and creative thinking in design & technology.

*'...pupils are taught trivial aspects [of food product development/designing] such as arranging toppings decoratively on a pizza or using complex engineering CAD software to produce very simple drawings of icing on cakes...'* (Ofsted, 2006, p. 5).

*'The development of creativity in students, the opportunity for them to propose imaginative solutions, take risks, be intuitive, inventive and innovative in their work has been side-lined by an approach which has become far too mechanistic'* (Parker, 2003 p. 7).

The 'approach' that Jon Parker, former senior curriculum advisor for design & technology in Northamptonshire, refers to is the teaching and learning style where 'students are compliant rather than enthusiastic'. He is clearly critical of the narrow requirements of the examination system. Jon is supported in his views by OfSTED (2000, p. 3) who suggest that 'teachers provide coaching which allows pupils to pass through the assessment "hoops" for D&T GCSE coursework at the expense of following the rationale of wider D&T learning objectives'. Jon is also supported by research evidence:

*'...public examinations in design & technology have, on the one hand, enabled many pupils to achieve success in terms of performance, whilst on the other hand, they have wasted valuable education opportunities for the development of high order thinking skills at a crucial stage in a pupil's education'* (Atkinson, 2000, p. 277).

In food technology, creativity may also be restricted by the requirement for pupils to bring in their own food ingredients. If their choices are limited to what is available at home, or what can be afforded, this can limit their opportunities to learn. And because parents provide the ingredients they expect an edible dish to be taken home, which is the purpose of food product development but which cannot be guaranteed every time. The rationale for pupils providing ingredients is not convincing and harks back to the days of 'cooking'. Pupils don't provide learning materials in science or art, why are they required to do it in food technology?

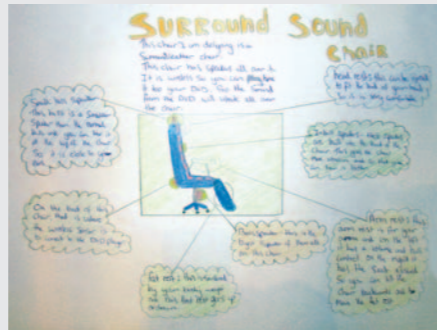
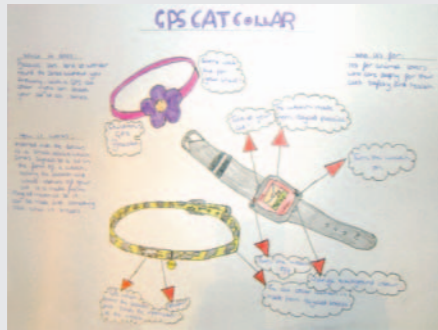
Q

Do you think that these are fair criticisms? Is it right to blame the 'hoops' of the examination system as a barrier to allowing pupils to work more widely in design & technology? If pupils do well in their design & technology exams, isn't that all that is important? And should pupils be expected to bring in food ingredients, or pay for what they use in textiles or materials technology?



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06 If pupils had  
- been required to  
07 make their  
designs would  
their ideas have  
been as creative?



08 09 10

08 Using these tools  
- well requires  
10 tuition and  
practice.



Is enabling pupils to be more creative worthwhile? This is not a trivial question; it has implications for how we treat pupils, how we value their ideas and suggestions, and how - given the reality of teaching a large group of pupils - we can really allow opportunities for them all to be creative.

We may think it is worthwhile, but what can we, as design & technology teachers, actually do to enhance pupil creativity specifically when they are designing? One programme that has tackled this head-on is "Young Foresight". "Young Foresight" is a 12-week programme for 14 year-olds that stimulates their creativity by challenging the orthodox in design & technology.

It does this in seven ways.

1. Pupils design but do NOT make.
2. Work is done in groups.
3. Designs are for products and services for the future, not for now or for an immediate market.
4. Mentors from industry work with teachers to support the pupils.
5. Design ideas are based on the use of new and emerging technologies.
6. Ideas are presented to pupils' peers, their teacher and mentor and to others.
7. Pupils develop their own design briefs for the needs and wants of people in the future and the possible new markets that might exist or could be created.

Young Foresight (Barlex, 2000) also shakes up our usual expectation of what we, as teachers,

should do to help pupils be more creative. We should ensure that the learning is:

- clarified to the pupils so they know what is expected at each session;
- active, and that all participate;
- personally relevant;
- in groups so that discussion is encouraged;
- involves problem-solving so that, in their groups, pupils can face up to conflicting demands and unanticipated difficulties;
- important and relevant to the pupils so that they engage with the problems and feel that opinions matter - they are valued.

The teaching is through:

- appropriate questioning;
- modelling ways of working;
- connecting the thinking of the pupils so that individual tasks are related to the whole design enterprise.

Q

What are your first reactions to the ideas from "Young Foresight"? Is design & technology without making, not really design & technology at all? Is this programme feasible in the schools you know about? Would you be willing to experiment with this approach?

When considering food technology, the question 'do pupils always need to make what they design?' brings a slightly different response. Although it is possible to develop ideas for new food products and model them for nutrition or cost, with food it is the look, smell and taste that determines whether a product will work or not - and this can only be done by making. However, pupils could be asked to design without making in food if the learning objectives are clearly defined. For example, the work could be planned to develop pupils' design strategies or skills, their ability to clarify and research a 'problem' or need or develop a specification, in which case designing without making would be appropriate.

Claire Catterall writes passionately about the importance of food:

*'What we eat describes who and what we are, and how we should like to be. It tells of our society, the culture and age we live in; it speaks of politics, economics and geography. It encompasses love, friendship, family; marks ritual, celebration, solace; articulates hopes, dreams and aspirations. The history of food shows us the history of mankind itself'* (Catterall, 1999, p. 23).

Although written about food, and suggesting a new way in which we might teach food technology, this statement could be applied to all areas of design & technology. Learning about and engaging in the design of products allows pupils to explore so many different aspects.

## Do pupils always need to design what they make?

Peter Williams has strong views on the place of making in design & technology. *'In the development of design & technology from the earlier subjects of manual training, handicraft and technical studies, there was a swing away from the skill-based imitative tradition towards an investigative, design-based approach. However, skill in handling tools and materials is critical if the design/make/evaluate process is to be effective'*. (Williams, 1994, p. 1).

How important are specific making skills? On early courses in control technology, pupils would often model a solution to a problem in Meccano or Lego as the final outcome of a project and never consider the aesthetics of the design or how it could ever be manufactured. Making skills were considered almost unimportant. Other courses, however, from a craft tradition continued to stress the importance of skill acquisition.

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What is your view on this - how important are 'making' skills in design & technology? Why?

In 1992, Alan Smithers, Patricia Robinson and others criticised the original national curriculum for England and Wales for not clarifying sufficiently the making skills needed

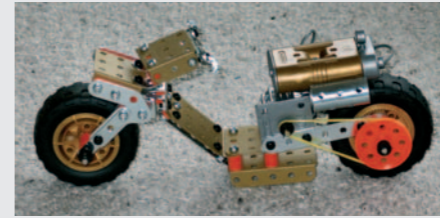
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11 Using these tools  
- well requires  
13 tuition and  
practice.



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14 Lots of  
- construction,  
15 but is it making?



for producing artefacts of quality - references to 'Blue Peter technology' were made. That such criticism could be voiced, whatever its validity, was due to a swing away from the emphasis on making skills that was typical of woodwork, metalwork, cookery and sewing courses of years ago. The argument was that such skills were irrelevant for modern production methods and that it was really only the design process, transferable to different situations, that was important.

The argument that 'making is unimportant' seriously undervalues the pride pupils have in producing a quality product. The quickly revised curriculum, in 1992 'recommend that pupils should be required to make a manageable range of good quality products' (DES/WO, 1992, para. 13), although it failed to define what it meant by 'quality', and that is the case today where the GCSE specification talks about 'quality products'. In a report on the design & technology resistant materials examination in 2002, the examiner said: 'The best work from centres was varied in its range of tasks and was of "marketable" quality. Many of these centres used the disassembly and recycling of an existing product as a starting point for, or an extension to, project work. The level of demand is still a key factor in the final grade. Some centres are continuing to use the same theme for all their candidates. Although there is no prohibition on this, it does tend to stifle individual candidates' creativity which is often the greatest spur to producing high quality work. Most projects were of wood or plastics with few "engineered" or

metal projects being seen and again a large number of "toy" or "box" type projects were in evidence. Physically smaller projects tended to have a better "surface finish" which helped their grade and allowed for rapid development. More use was seen of jigs for constructions and one or two centres are beginning to consider the commercial aspects of product design. Challenging tasks, which exhibit a variety of skills, are required for the highest grades." (AQA, 2002, p. 14)

So, making is important - but not high level craft skills? How valid is this position? And given time constraints on design & technology in school, what level of making is important - and how much attention to the use of tools and equipment should be given? Peter Williams suggests that we: 'imagine a pupil is being taught how to use a hacksaw for the first time. After the workpiece has been marked out, the pupil is helped to secure it in the vice with cut line vertical; the pupil is then shown how to hold the saw in two hands. In making the first cutting strokes, the pupil must be taught how to keep the saw cut on the "waste" side of the line, and should be encouraged to work out how the saw blade actually cuts into the material. Once this process has been assimilated and practised, the pupil could be introduced to the file as a cutting tool which is held in an identical fashion to that of the hacksaw. Because the stance and cutting actions of the two tools are almost identical, attention should be drawn to these similarities. Not only will skill in filing be acquired quickly and efficiently, but the practice in filing will actually help to consolidate skill in hacksawing.

As other tool skills are introduced, it is essential to draw attention to the similarities and differences in stance and hand positions between those tools already used and the new ones. This will continue the process of consolidation and speed up the learning process." (Williams, 1994, p. 5)

Sometimes we might ask pupils to make a product for a specific learning purpose, for example in food experimental and investigative work would require making skills. Pupils could be taught how to make a rubbed-in scone mixture then experiment with different ways of cooking it; they could be taught how to make a whisked sponge then asked to vary the sugar levels - they would be making but there would be no designing involved, does this make it less of a learning experience?



Is such instruction in the use of tools still appropriate? How much time should be spent? Do all pupils need to learn this? What making techniques that you learnt at school would you say were a waste of time?

Claire Catterall writing in 1999 has suggested that we might be 'losing sight of the traditional culture of cooking' and Ofsted (2006, p. 6)

acknowledge the tension 'between teaching about food to develop skills for living and using food as a means to teach the objectives of design & technology'. This tension could be applied to other focus areas; do pupils learn making skills in order to be able to carry out DIY at home or is there some other purpose?

### Supporting pupils in making what they design

When we, as teachers, set pupils a design and make task they may know what they want to do but not be able to realise their solution because they do not have the required knowledge or skills. Wanting to build that video recorder might have been an extreme case - the technical understanding and the skills in soldering and mechanisms were missing - but more apparently 'well matched' tasks can founder through a lack of appropriate skills. More critically, when planning their work pupils may not even consider certain approaches to a problem because they are ignorant of the existence of equipment or a technique which might help them. And here we refer not only to making skills but also to a lack of exposure to other techniques that impact on making such as sequencing tasks and fault finding.

The approach suggested by the Nuffield Design & Technology Project, and emphasised in the national curriculum, was to advocate a carefully planned selection of shorter



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16 These charts help - pupils choose 18 tools and techniques but they don't teach skills.

(With kind permission of Nuffield Design & Technology Project.)

Communication Chooser Chart	
Use the chart to decide which technique or drawing system to use.	
What you want to communicate	Technique or drawing system to use
Realistic appearance of products	rendering on perspective or isometric views
Realistic appearance of clothing	fashion drawing
Realistic appearance of food	photography
Giving impact	put drawing or photograph against a background
Putting the product in a picture	single point perspective
Plans for food	

Food Wrapping Chooser Chart			
Wrapping	Dip-coat	Wrap around	Hold
Deep-fried batter			
Shallow-fried batter (pan-fry)			
Sauces			
Shortcrust pastry			

Strategies Chooser Chart			
Strategy	Comments		
Identifying needs and likes			
Observing people			
Interviewing			
Looking in books and magazines			
PRE			
Loading of aesthetics			
Style, colour, feel, space and harmony			
Shape, form			
Using briefs and specifications			
Setting design briefs			
Setting specifications			
Generating design ideas			
Brainstorming			
Observational drawing			
Making connections			
Attribute analysis			
Modelling			

19 20 21 22 23

- 19 PC & design software communicates with CAM peripherals.
- 20 Laser cutter cuts complex shapes from flat material.
- 21 Rapid prototyper builds up 3D designs layer by layer.
- 22 Computerised sewing machine embroiders rapidly.
- 23 New generation microwave oven cooks automatically according to weight & type of food.



projects, focused or 'resource tasks' which allow pupils to learn and practice specific skills and techniques. Then when engaged in longer, more open design and make assignments or 'capability tasks' they can draw on the skills and techniques that they need. Nuffield Design & Technology has produced a series of 'chooser charts' from which pupils can select a sequence of making operations and associated tools to produce a particular outcome from a starting piece of material. For example, to decorate fabrics they could choose from tie-dying, batik, fabric marker pen, transfer printing, block printing, appliqué, embroidery, or screen printing - all with advantages and disadvantages depending on the circumstances. Similarly, if a pupil wants to cut an irregular shape in material they can choose a coping saw, tin snips or abrafile depending on the nature of the resistant material.

But does it work in practice? Research on the Nuffield Design & Technology Project suggests the answer is yes - if the teaching is right and 'capability tasks' (longer project work) are supported by pertinent 'resources tasks' that teach techniques which are likely to be useful. Chooser charts then remind the pupil about techniques they have previously been taught or suggest possible new equipment, tools or processes for them to consider. This way of teaching also fits in with the government's concern that pupils lack 'cooking skills'. The 'resource tasks' can be used to teach a range of practical skills, for example

fruit and vegetable preparation or pastry making. In a design and make activity, or 'capability task', pupils then have a range of skills on which to draw to help them in their product development. An important question to raise here, though, is what skills are important, what should we be teaching in the 'resource tasks'? With the constraints mentioned above, access to ingredients and the limited time available in practical lessons, skills are often limited to those that are 'do-able', for example biscuit-making and cake-making. Are there other skills that we should be teaching? And shouldn't we be teaching the use of modern equipment: food processors, combination ovens, temperature probes?

**GT** How widely would you define 'skills' in design & technology? What advantages and disadvantages do you see in the idea of allowing pupils to 'choose'?

### What is the place of CAD/CAM?

A question which has emerged over the last few years, as CAD/CAM programs and equipment have become more affordable for schools, is how we should balance the new skills of using computer support for design and manufacture with the development

of psychomotor skills that are promoted through basic hand and machine tools?

Steve Rutherford, a senior lecturer at Nottingham Trent University is clear about the benefits and limitations of CAD/CAM: 'CAD/CAM is just another tool. It's not a killer application that allows anybody to be a designer. It is capable of being misused as a pencil. Yet we adore it, promote it and pretend that it will save the world. [...] We need to backtrack and consider what is really important for design education in the 21st century. CAD/CAM is certainly important, but what about areas so crucial to this period in history: areas like sustainability, team working, cross-disciplinary collaboration, and risk taking?' (Rutherford, 2005, pp. 24-25).

Pupils are increasingly using CAD/CAM to design, for example with ProDesktop, Inventor, SpeedStep, SolidWorks and Techsoft, and to make, with CNC lathes, mills and routers, laser cutters and computerised sewing machines. It is now possible in almost all schools to define a design that is then produced by a computer-controlled machine, just as in industry, to an accuracy a pupil could rarely achieve. And as the software improves in its usability, the time invested in becoming competent shortens and outcomes can move from 'mass production' to one-off. For example, MIT's Fab Lab has a number of projects with community groups and developing communities that help them to participate in creating their own technological tools for finding solutions

to their own problems (MIT, 2006). Pupils can now use CAD to develop designs that they could not make using traditional 'school making skills' but which they can realise using CAM. That with CAD/CAM pupils can now design and make artefacts that would otherwise be difficult to achieve is no doubt a considerable step forward in design & technology learning.

Of course the use of ICT is not restricted to applying CAD/CAM to designing and manufacturing. The internet can be used for research and communication; drawing software can help pupils to communicate information about the final product as well as to investigate initial ideas; digital photos can be taken using cameras or mobile 'phones and audio comments can be inserted using the web, a PDA or mobile 'phone to provide a record of the development of a project. ICT, like all other teaching and learning tools, has its place in design & technology but we should always be sure about why we are using it and how it is helping pupils' learning.

However, research has identified that there still needs to be a clearer understanding of the learning experience that CAD provides (Hodgson and Fraser 2005, p. 102). The same could be said of CAM, and we would encourage you to discuss the position and purpose of CAD/CAM in design & technology and the balance between 'high tech' and 'low tech' skills, knowledge and understanding.

# Q

How would you justify teaching CAD/CAM in schools?

Is it to service the needs of industry or are there other reasons?

How much time needs to be spent on learning to use the software effectively?

What might be lost by spending this time on CAD/CAM?

Draw up a list of core basic design & technology hand skills that you think should never be replaced by CAD/CAM resources.

## Conclusion

What might pupils think about the role of making in design & technology? Might they see it as a happy release from the rigours of the more cerebral elements of the curriculum both within design & technology and other subjects? Or do they view it as an integral part of design & technology intimately bound up with the cognitively demanding activity of designing? Does developing skill in making enhance a pupil's ability to model in 3D? Does the experience of handling materials through working them with tools enhance

a pupil's appreciation of their usefulness in particular applications?

Is making through handcrafts to produce a bedside lamp, CD rack, a t-shirt or a loaf of bread a sufficient experience for pupils or should this form of making be added to or even supplanted by a hi-tech approach?

Our view is that making *is* important to design & technology, that through the making process pupils learn technical knowledge - the properties and characteristics of materials and ingredients - and develop other skills - planning, independent learning, problem-solving. Making can also contribute to pupils' emotional development by fostering decision-making, motivation and self-esteem.

Your view of the role of making in design & technology will influence profoundly your view of the role of design & technology in the curriculum. If making is there to provide dexterity in manual skills for those who will need this in future employment this moves design & technology into a vocational position within the curriculum and one not inclusive of all pupils. If however making is seen as an integral part of design & technology contributing to both practical and intellectual development then design & technology moves into a position justified by its appropriateness for all pupils whatever career path they choose.

What do *you* think?

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