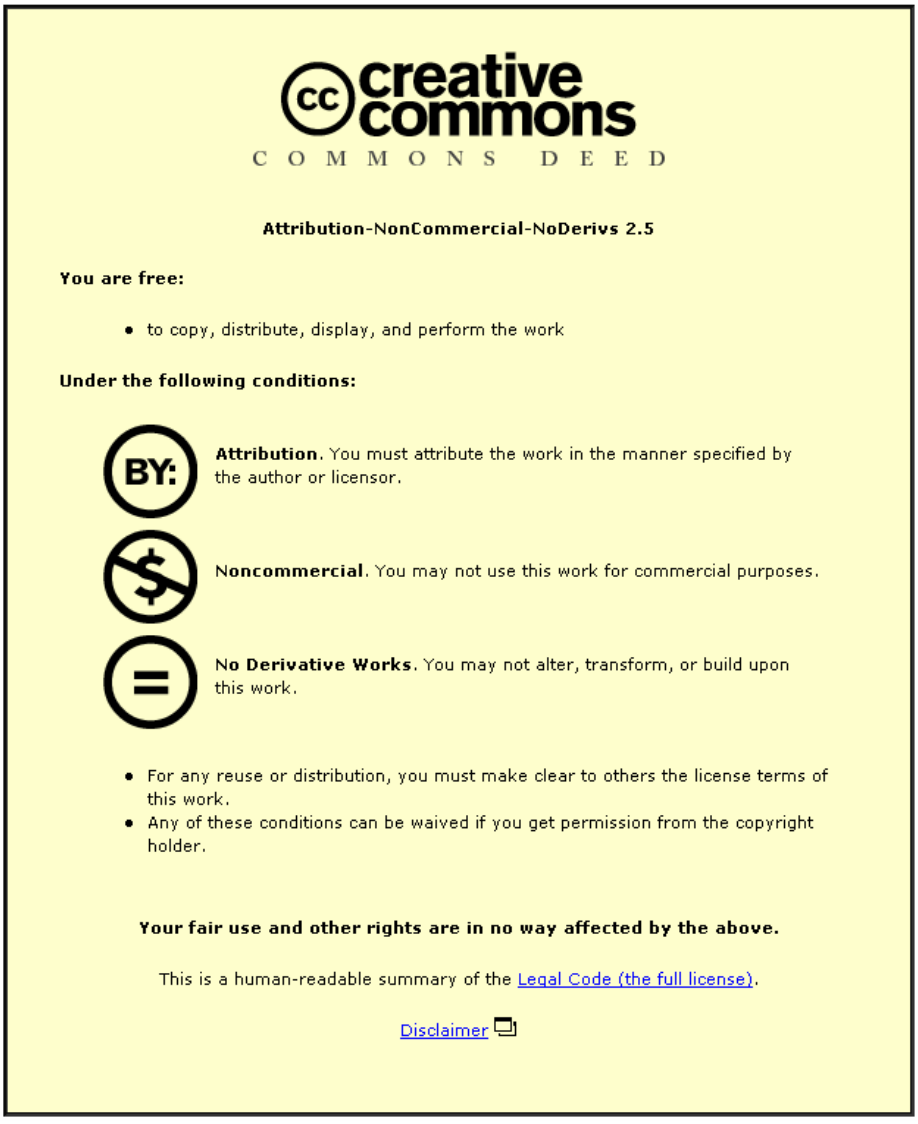

creative commons

COMMONS DEED

Attribution-NonCommercial-NoDerivs 2.5

You are free:

- to copy, distribute, display, and perform the work

Under the following conditions:

BY: **Attribution**. You must attribute the work in the manner specified by the author or licensor.

Noncommercial. You may not use this work for commercial purposes.

No Derivative Works. You may not alter, transform, or build upon this work.

- For any reuse or distribution, you must make clear to others the license terms of this work.
- Any of these conditions can be waived if you get permission from the copyright holder.

Your fair use and other rights are in no way affected by the above.

This is a human-readable summary of the Legal Code (the full license).

Disclaimer

D&T Subject Knowledge and its Relationship with Designing and Making

Tim Lewis, Principal Lecturer, Sheffield Hallam University, UK

Abstract

The new paradigm for design and technology introduced by Breckon in 2001 re-opened the debate about the nature and assessment of design and technology (D&T) in schools. He proposed a model with four elements each independently assessed. Design and technology subject knowledge was one of these elements. This re-opened the debate about the relationship between designing and subject knowledge.

This paper charts a brief history of the change in thinking about this relationship, particularly design process models. Research with focus groups of students in higher education, all with experience of doing D&T at GCSE level, throws further light on what is currently happening in schools and particularly the GCSE examination system. Comparisons are made with how subject knowledge is used to support designing within degree level product design courses. The paper concludes with a call for a re-think of how subject knowledge and designing can be taught in a more integrated way in schools, possibly using the product design model as a starting point.

Keywords

designing, design and technology, D&T, design process models, subject knowledge, new paradigm, design degree courses

Introduction

The nature and purpose of design and technology (D&T) subject knowledge and particularly its relationship with designing activity has been an on-going debate within the D&T profession and seems to be un-resolved. There appears to be two schools of thought:

- D&T subject knowledge needs to be taught to facilitate designing activity
- D&T subject knowledge can be acquired during designing activities.

Breckon (2001) listed 'design and technological knowledge' as one of the components of D&T which should be assessed independently. He argued that the 'knowledge and skills acquired on a need to know basis' (2001: 15) did not provide a 'sufficiently rich basis for designing activities' (2001: 15). Barlex (2002) skilfully used seven 'expert witnesses' (2002: 2) to challenge Breckon's new paradigm for design and technology which included the above comments about the relationship between subject knowledge and designing.

This paper sets out to establish if present D&T activities in schools support the notion that knowledge and understanding can be acquired or that it needs to be taught. The research draws on commentators who have contributed significant documents to the debate, which have contributed to shaping the subject and the examination system that, throughout the development of D&T, has provided the mechanism by which pupils have been assessed. Additionally, important evidence from students who have recently 'been through' the present D&T system is used to obtain the perspective of some 'consumers' in this on-going debate.

Historical perspective

During the 1960s, change from craft-based work in schools to design and technology gained momentum. Dodd (1978) used time lines of technological knowledge and freedom of expression within the curriculum to illustrate change. The 1960s was a time of divergence of these time lines, the result being change in the subjects previously known as handicraft. During this period, designing became an increasingly important element of the subject. This change spanned two decades. Prior to this, and during the period of change, material-based examinations

dominated usually with a practical test and written examination testing craft knowledge. The type and nature of examination questions used provides a good indication of how the subject was developing. The following examination question is from the 1968 Oxford Local Examination metalwork paper:

> 'A potato masher consists basically of a hard aluminium disc with holes in it, an aluminium stirrup and, at the centre of the loop of the stirrup, some form of handle. Design this potato masher, giving detailed sketches of each part and showing how the parts are joined together to make the whole. State the kind of finish, if any, which you propose for each part.'
>
> (1968: 5)

There is very little opportunity for original design work as virtually all the components of the solution are dictated. However, there is ample opportunity for candidates to describe manufacturing processes and knowledge of materials. This is an early example of integrating the application of subject knowledge and designing and highlights the dilemma of implementing designing within a craft subject.

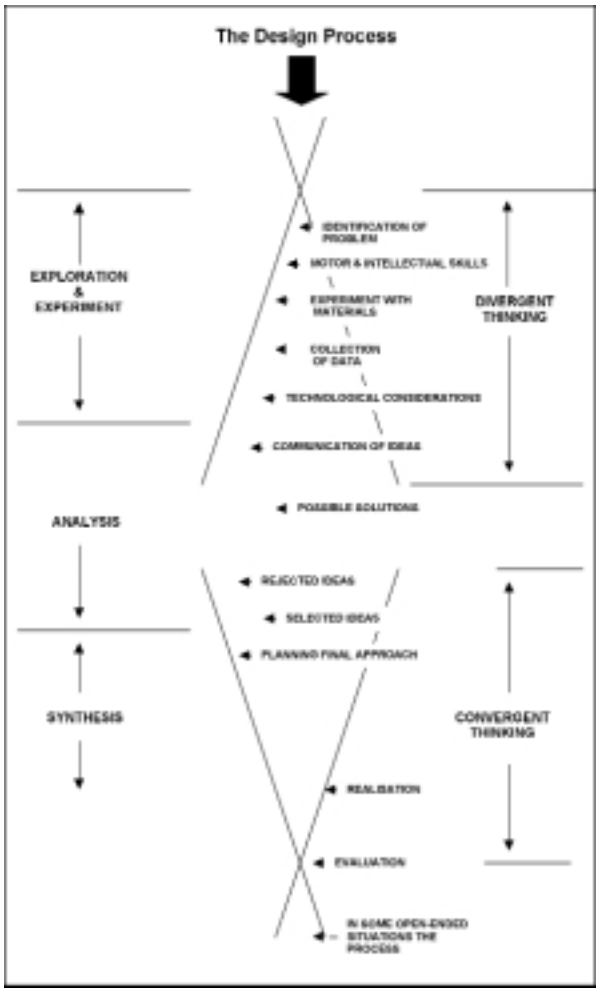

Figure 1: The Design and Craft Project 'design process' model. Dodd (1978) Design and Technology in the School Curriculum.

In order to develop a new integrated subject which focused on design and technology two major projects were established in the late 1960s. The Design and Craft project, based at Keele University, and Project Technology, initially at Loughborough College of Education and then Trent Polytechnic. Both established models of design processes. Figure 1 shows the example produced by the Design and Craft Project and Figure 2 that produced by Project Technology. The Design and Craft project model is entirely process-based and can be described as a 'thinking process' model. The more complex Project Technology's model included references to materials, concepts and methods of technology and laws of science feeding into 'the Process of Technology', which is effectively a design process model. There is a reasonably close relationship between this model and Breckon's thinking expressed three decades later.

Both these models had their supporters and critics. Dodd (1978) when commenting on these projects said that:

> 'Project Technology interpreted the fusion of technology and education into what its team members termed 'the process of technology'. This was essentially based on the problem solving activity, based on the industrial design line, a disciplined activity, with facilities for a real creative response.'
>
> (1978: 30)

He was less enthusiastic when commenting about the implementation of the Design and Craft Projects model:

> '…particularly in the area of 'Design and Make', early attempts to introduce basic design courses were often misguided. Craft teachers modelled them on foundation courses common in Colleges of Art, and in copying the style placed undue emphasis on the product.'
>
> (1978: 58)

The Project Technology model implies that knowledge is important to the success of designing activity. Whether this is the case or not, the fact that these models existed provided the subject with a legacy of design process models which have dominated the development of the subject.

20 years later this view is confirmed by Roberts and Norman (1999) when they made the following comments about these projects. They concluded that:

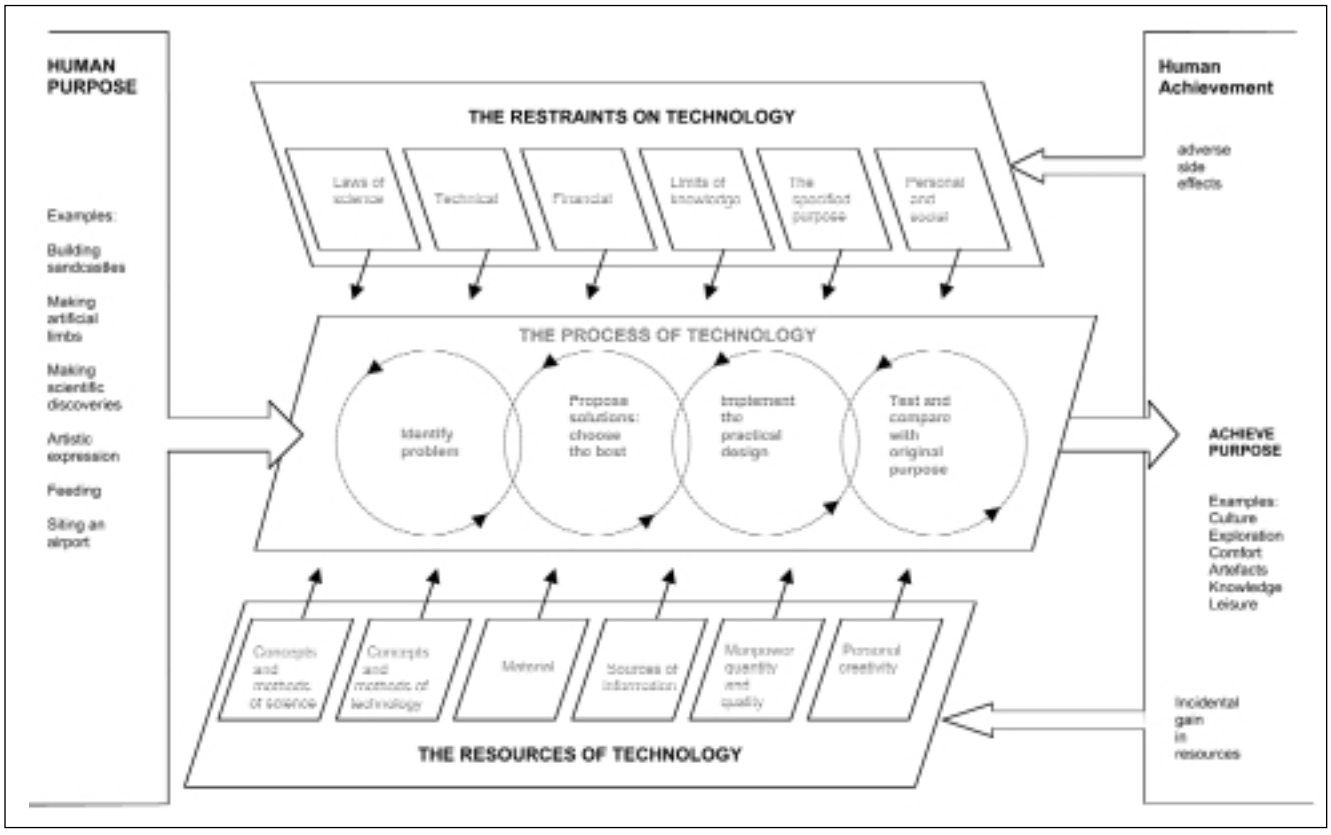

Figure 2: Project Technology's 'design process' model.
Project Technology: The Next Two Years. Schools Council, 1970.

'The end result was a somewhat uneasy co-existence between these movements and the establishment of Craft, Design and Technology (CDT), as well as the potential for much confusion. The models employed to introduce the meaning of 'designing' and 'technology' to schools had superficial similarities and with enough simplification became the 'design process', to which reference is now commonly made.'

(1999: 124)

The folios should be set out in the following sequence. Marks allocated to each section are shown in brackets.

1. Analysis of the problem and research	(20)
2. Preliminary ideas for solving the design problem	(15)
3. The development of the most suitable idea with methods of construction, comments on materials, cost and feasibility	(40)
4. The dimensioned sketch or working drawing of the final solution, in sufficient detail to enable someone else to make it up	(20)
5. Materials list	(5)

Figure 3: Rubric from a 1980 AEB Design and Craft examination.

Regardless of unease about these 'design process models', it became fashionable for examination boards to develop their own models and use them as the basis for the assessment of project work. Boards provided guidance to teachers about how to use the model as a form of assessment tool. Figure 3 is an example from the rubric of 1980 Associated Examining Board's (AEB) Design and Craft examinations.

A common feature of these design process models is the lack of any reference to subject knowledge and how it can either be applied or at least inform the designing activity. Analysis of the examination board syllabuses and papers of the 1970s confirms that in examinations designing and making skills were assessed separately to subject knowledge. During this period material-focused craft examinations (woodwork and metalwork) included design elements. However, new design-based examinations were emerging. Designers put forward a view that the subject required a different approach. Carter (1983) when discussing the then title of the subject, Craft, Design and Technology (CDT), emphasised a more holistic approach to the model being used in schools. He said:

'As a point of procedure, I shall tend to use the

> term 'design' generally – rather than 'craft', 'design' and 'technology' separately – when I talk of the activities with which I am most familiar in this context. This does not imply I have less sympathy with, or enthusiasm for, craft and technology. It suggests, rather to me they are indissolubly mixed into a single process of understanding, ordering, creating and manipulating – with skill and sensitivity and a lot of common sense.'
>
> (1983: 2)

Regardless of calls for a more holistic approach models for designing dominated at the time of establishing the first General Certificate of Secondary Education (GCSE) examination syllabuses during the mid 1980s. The Secondary Examinations Council GCSE Guide for Teachers of CDT produced the model shown in Figure 4. It is a development of previous models.

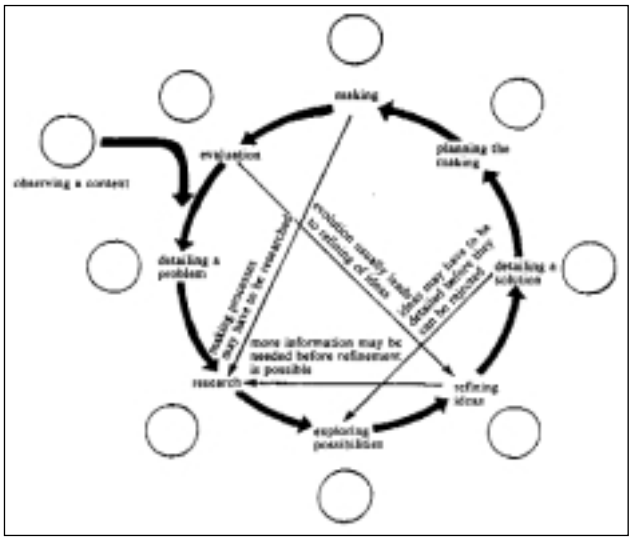

Figure 4: The Design Loop model from the Secondary Examinations Council GCSE Guide for teachers of CDT.

The following advice was given to teachers:

> 'This design loop as with other diagrammatic representations of design activities can be utilised to good effect as a central linking system for all design and communication activities. In its totality it represents your students' route through the Design-Make-Evaluate process.'
>
> (1987: 10)

Models of design processes are a legacy D&T is still working with. Current D&T examination specifications have this, or a similar statement, as an aim:

> '…demonstrate fully their design and technology capability, which requires them to combine skills and knowledge and understanding in order to design and make quality products.'
>
> (AQA, 2003)

The statement, from a D&T specification provided by the Assessment and Qualifications Alliance (AQA, 2003), recognises that subject knowledge and designing go together. However, the specification then includes details of designing skills, with helpful guidance in the form of what 'candidates should be taught', followed by a section on making skills and concluding with a wide range of knowledge-based material with detailed information which includes 'possible learning experiences'. The scheme of assessment includes a written paper and a coursework project. The written paper is described as:

> 'Questions to test the application of knowledge and understanding of three materials (metal, plastic and wood), components, processes, techniques, technologies and the evaluation of commercial practices and products.'
>
> (AQA, 2003)

For the teacher, 'assessed project criteria' are provided. These are essentially a design process model which has been broken down into grades with clearly defined descriptors. More sophisticated but definitely related to those early models.

There is no doubt that knowledge and understanding are being tested in the written examination, including a considerable breadth of knowledge. Realistic contexts are used which extend well beyond making practice in schools, taking D&T into aspects such as industrial production. Although examination techniques have improved considerably, the present system perpetuates the practice of separating 'designing and making' from 'knowledge and understanding'. It is understandable, therefore, that the majority of D&T teachers in schools follow this model as it provides a pathway to success for their pupils.

It seems that regardless of considerable development opportunities in D&T we are still working to process-based design models and knowledge-based written examinations. McCormick (1999) summed this up as:

> 'I have tried to illustrate that the early models of capability were based on process. This focus put knowledge to one side, and I argue, also characterised the process (design or problem solving) in ways that did not do justice to its use in practice.'
>
> (1999: 12)

He did attempt to point a way forward indicating that problem solving is an amalgam of procedure and knowledge:

> 'Expert problem solving, for example, is based on rich knowledge of the context and substance of the problem and its solution. Although it has a strong procedural element, it is not simply procedural.' (1999: 12)

It seems reasonable to conclude that the D&T may well have restricted its own development by adopting the models of designing developed in the 1970s.

To gain further insight into the relationship between subject knowledge and designing, students pursuing design courses in higher education were consulted and the results analysed.

Throwing further light on the issue.
The research method adopted to obtain a clearer picture of the relationship between D&T subject knowledge and designing activity was to explore the experiences of people who had recently studied D&T in schools. Students following product design courses in higher education provided an ideal group. Two focus groups were formed, each of five students (three male and two female in each group). Selection was by reference to the students' Universities and Colleges Admissions Service (UCAS) application forms. These provided information about GCSE and General Certificate of Education (GCE) Advanced Level (A' Level) qualifications. All 10 students had pursued D&T to GCSE level with the majority having a GCSE in resistant materials, two in graphic products and one in systems and control. Five of the students had gained a qualification in D&T at A' Level (grade C or above); these students became group A. The remaining five had qualifications which included art and design at A' Level (grade C or above) and/or foundation courses in art and design at Further Education (FE) colleges; these became group B.

The interview schedule prepared included three distinct groups of questions:

1. Teaching and learning experiences within D&T at school.
Questions were in the following areas:

- What were their experiences of D&T projects at Key Stage 3 (11 to 14 age phase)?
- How were they taught to design at Key Stage 3?
- What other aspects of D&T were taught at Key Stage 3?
- What were their experiences of project work in preparation for their D&T GCSE examination?
- What kind of preparation did they have for the written D&T GCSE examination?

2. Teaching and learning experiences within their degree course.
Questions were in the following areas:

- How is designing taught within their degree course?
- How is knowledge and understanding acquired and applied during their degree course?
- How do previous designing and making experiences help them with their work at undergraduate level?
- How do the assessment methods used to assess degree level work provide a mechanism for assessing designing capability?

3. The relationship between subject knowledge and designing

- One question to establish students' views about whether processes and technology should be taught separately and then applied in project work or if knowledge and understanding can be acquired through design project work.

The schedule was designed on the basis that the degree level work was common to all the students. The work in school had a fairly good degree of commonality as they all had done a GCSE D&T course. However, the 16 to 19 phase of the students' education were distinctly different. Questions about this phase of their education were not included as it was anticipated that students would draw on these experiences when answering the questions about their degree course. Groups A and B were interviewed separately.

Discussion of results

Groups A and B

Teaching and learning experiences within D&T at school
Students were asked to describe a project they had completed at Key Stage 3, emphasising what they had learned. Responses indicated that they had done a wide range of projects, some of which they did not see as being particularly relevant. There was a consensus of opinion that making was important to them at that stage and they enjoyed being taught how to use tools and equipment. More than half the group thought that too much time was given to drawing when they wanted to get on with practical work. All but two students said that at Key Stage 3 they had not been taught how to design, rather they had been given instructions to do certain tasks such as research from

books and sketching ideas. The majority of these students considered that most of the research was irrelevant. The two students who had received design teaching reported that their experiences included teaching about analysing products and developing ideas from that point. Automata and shaky hand game projects were the most common within the group, both of which were popular, however students did not see that designing had played an important part in the development of these projects. One student commented that 'the design work for the shaky hand game was designing a background and deciding what colour to paint it.' Six students reported that they had done design work in textile technology when they had been given the opportunity to design an item of clothing for themselves. However, the view of these students was that the designing was very limited as it was confined to choosing patterns, material and making modifications. All students agreed that learning making skills at that stage was important and this was one aspect of D&T which had made them enthusiastic about the subject.

The students' experiences of doing GCSE project work were consistent in that they had all worked in a very structured way, particularly on producing the design portfolio. All had been given information from the examination specification and followed it carefully. More than half the students liked working in this way as they enjoyed producing good quality work which they knew would achieve good marks in the examination. Other students considered they spent too much time doing their design portfolio and not enough time making their project. All agreed that they had learned a lot of new practical skills when making their project and this had contributed to their understanding of working with materials. Four students commented they did not like the project they had been set and this had demotivated them.

Students experienced considerable variation in preparation for the written examination. The practice seems to fall into three categories:

1. 'We were given a couple of old exam papers to do for homework.'
2. 'In the last term we did one lesson a week on exam questions.'
3. 'We had one lesson a week doing design and theory work right through Year 10 and Year 11.'

When asked about how this related to their project work, the consensus was that most of the work was about making or drawing processes. The drawing processes helped with producing their portfolio and some of the information about making had helped getting the making part of their project right. Four of the students had done work related to industry during this time, which they found interesting.

The overall view of each group was that they had followed a design process which had helped them pass their examination, but they now have a different view about how to tackle designing. The majority considered that they had learned valuable skills such as making and drawing processes, which they felt were essential to pass their GCSE examination.

Teaching and learning experiences within design degree courses

Students were asked about how they developed their designing skills within their degree course. As they were all working with a common experience the majority considered that the taught modules which are part of the course had enabled them to develop their designing expertise. However, group A students commented that some of the work they had done in semester one was a repeat of the work they had done at A' Level. Exploring this further revealed that at A' Level topics, such as ergonomics, computer aided design (CAD), generating ideas and experimenting with materials, had been covered. However, they did like to explore the topics further. Those in group B had found the same modules valuable as they did not have this knowledge when they started the course. A particularly popular module for group B was 'Manufacturing, Mechanisms and Machines' which has a strong technological focus. Students had explored a range of technologies and liked designing and making things which worked. Most students agreed that the design project work they had done during their first year had been well supported by the taught modules. The consensus view of both groups was that modules, such as Product Interaction and Meaning, Design in Context, and Consumer-Centred Design and Design Futures, had helped them understand how to design. However, the emphasis of the course was on developing their own designing method and style.

There was considerable variation in answers to the question about 'how previous designing and making experiences helped them with their work at undergraduate level' . Group A students repeatedly referred to how experiences during their A' Level course had helped them with project work at university, particularly confidence with making skills. Group B however, seemed to be more theoretical designers concerned with design issues making less reference to their experiences in the 16 to 19 age phase of their education. Regarding assessment, all students found that the variety of assessment tools used in their degree course helped them produce good work. For example, presentations to peers, critiques

and presenting ideas using electronic media seemed to be popular. The view of group A was that the assessment was more individual and not as constrained by a set of rules they had to follow previously. Group B considered that the form of assessment was similar to that used by courses they had completed in their post-16 education.

The question about the importance of subject knowledge when designing produced a mixed response. Group A students considered this was important and their A' Level courses had prepared them well for the making aspect of their degree course and some aspects of designing. They liked the knowledge part of their degree course as it helped them 'keep up-to-date with new materials and technology'. Group B also considered that subject knowledge was important with four out of the five students considering that their foundation course had given them a breadth of understanding about design but left them short of some technological knowledge and making skills. They were pleased that the course they were now doing provided opportunity to develop these.

The final question produced similar answers from both groups. All students considered that some knowledge and understanding was important before starting design projects. If a particular topic was interesting then they would gain greater understanding of it during their project. There was agreement that at school they had to learn skills or knowledge regardless of the need to use them.

Lessons from the focus group research

Regardless of our greater understanding of designing and the calls for developing the different ways of approaching D&T activities, design models still predominate. These are supported by the GCSE examination system. Student experiences indicate that initially their D&T was constrained with little designing but they enjoyed the making aspect of the subject. They are not over-critical of their experiences at GCSE level, recognising that the system adopted helped them get a good examination grade. They do recognise that they were not taught to design at this level. It seems that at GCSE level the strict adherence to a system which separates designing and making and knowledge and understanding for examination purposes does not enable pupils to demonstrate their D&T capabilities fully.

Developments at post-16 have resulted in more realistic approaches to developing designing and making capability. Students who had done A' Level were generally positive about their experiences and found their studies had been a good preparation for their present undergraduate course. Students with post-16 art and design foundation course backgrounds felt they lacked some of the practical skills but they liked the way their undergraduate modules supported their design work.

The views of these students seems to support the model of teaching 'concepts, knowledge and skills' to a point where they can be applied during the initial stages of project work. As the project progresses the learner acquires a more in-depth understanding of particular topics they wish to pursue. Students did not support the model of acquiring knowledge on a need to know basis unless they had done some preliminary work. Perhaps the Breckon model needs minor modification to one which teaches some knowledge and understanding and then phases this into project work where a greater depth of knowledge and understanding can be acquired.

Modules pursued by undergraduate students to support their design work are designed to broaden their experience and enhance designing activity rather than dictate the nature of how to go about a particular design task. The more technological modules tend to be exploring technology, although this is done in a structured way as described in this module description from the Sheffield Hallam University Design Programme Handbook:

> 'This module provides essential knowledge about mechanisms and structures, and about materials and manufacturing processes that will underpin future design project work.'
>
> (2002/3: 6)

The intention is therefore, to introduce knowledge with the view to using it in project work. The project module has the following description:

'Introduction to design

> Projects and assignments will be set so that students can develop their drawing skills, explore the use and application of material, learn and develop computer skills and demonstrate their creative and inventive skills.'
>
> (2002/3: 6)

These descriptions demonstrate that modules are integrated and students seem to like this approach. D&T in school could adopt this way of working.

Conclusion

D&T teaching in schools relies on design models which emanate from the models developed in the 1960s regardless of a greater understanding of design and calls by prominent educationalists for change.

Examination boards have developed these models to become assessment tools. In schools, subject knowledge is mainly taught as a separate and distinct element of D&T. The focus seems to be preparing for the written examination rather than supporting designing and making.

Design students in higher education who have recently experienced D&T in schools, including the examination system, are critical about their Key Stage 3 experiences. However, those who did A' Level considered the experience worthwhile and a good introduction to their undergraduate work. Students who did not study A' Level D&T considered the broad experience provided by other post-16 courses had served them well for entry to undergraduate work, but they did need to catch up with making and technological skills. They considered themselves to be more theoretical designers.

Undergraduate design courses include knowledge and understanding as taught modules which are designed to:

- support designing and making activity
- motivate students into further subject knowledge study thus enabling them to develop aspects of the subject which are relevant to their project work and personal interests.

It can be argued therefore that the way forward for D&T lies somewhere between 'knowledge being acquired on a need to know basis' and the present 'taught for examination model', which exists in many schools. It seems reasonable, therefore, that as the examination system dominates curriculum development the lead should come from the examination providers. We need to re-think the model and move towards taught subject knowledge, which leads towards project briefs. The designing models should be different depending on the project and could be decided by the pupil.

Breckon (2001) followed his initial comments about acquiring design and technological knowledge on a 'need to know basis' (2001: 15) with:

> 'This, in my view, will not provide a sufficiently rich basis for designing activities, where pupils are intelligently taught the key knowledge and skills that will better prepare them for the design and make activity.'
>
> (2001: 15)

Key words in this statement are 'intelligently taught'. Teachers are basing D&T on a model provided by examination boards which is not surprising. This is outdated. We need an intelligent re-think about how to integrate subject knowledge and designing more closely.

References

AQA Design and Technology (Resistant Materials Technology), 2003

BA (Hons) Design Programme: First year Course Guide and Handbook:
2002/03, Sheffield Hallam University

Barlex, D. (2002) 'Questioning the design and technology paradigm', in E. Norman (Ed), *DATA International Research Conference 2002*, The Design and Technology Association, Wellesbourne: 1-9

Breckon, A. (2002) 'DATA Chief Executive Challenges Design and Technology', in Issue 18, *DATANEWS*, The Design and Technology Association, Wellesbourne: 14-15

Carter, D. (1983) 'Design in Education versus Design in Industry – are the objectives totally incompatible?', *The Stanley Lecture, Royal Society of Arts*, London: Stanley Tools

Dodd, T. (1978) *Design and Technology in the School Curriculum*, Hodder and Stoughton

McCormick, R. (1999) 'Capability Lost and Found? The Maurice Brown Memorial Lecture', in R. Kimbell (Ed), *The Journal of Design and Technology Education*, 4(1), The Design and Technology Association, Wellesbourne: 5-13

Oxford Local Examinations Metalwork, *Paper 1 Drawing and Theory*, June 1968

Roberts, P. and Norman, E. (1999) 'Models of Design and Technology and their Significance for Research and Curriculum Development', in R. Kimbell (Ed), *The Journal of Design and Technology Education*, 4 (2), The Design and Technology Association, Wellesbourne: 124-129

Secondary Examinations Council GCSE Guide for teachers of CDT (1987) reproduced in the *Southern Examining Group GCSE Teachers' Guide*