

Paradigm? What paradigm?

Abstract

At the DATA International Research Conference in July 2002, proposals for keynote presentations were invited on the theme of 'challenging the design and technology paradigm'. This article explores the question of whether current primary design and technology practice can be said to constitute a 'paradigm' and, if so, to what extent it needs to be challenged. At a time when design and technology is 'under pressure' in primary schools, this article argues that we need to give it a new lease of life as a cross-curricular vehicle for children's creativity and citizenship, making closer links with art and providing rich, meaningful contexts for scientific learning.

Introduction

We are all familiar with the phrase 'paradigm shift' – a sudden and fundamental change in the way we look at or think about something. The phrase was first coined by the philosopher of science, Thomas Kuhn (1970); indeed Chambers Concise Dictionary defines a 'paradigm' as '... a conceptual framework within which scientific theories are constructed'. Kuhn's thesis is that many aspects of science have undergone a series of revolutions over the last 300 years as one paradigm, or dominant idea, has given way to another which appears to fit observations more closely and gains comparatively rapid acceptance by scientists working in the field. Between these revolutions are periods of 'normal science' during which work continues within the existing paradigm. But what has all this to do with design and technology education? How could design and technology be said to be a paradigm and in what ways might it be shifted?

In some ways, the establishment of National Curriculum design and technology in England and Wales, itself represents a paradigm shift from what went before. It is worth reminding ourselves that out of previous primary practice, including junk modelling, cookery and needlework, arose an entirely new curriculum subject during the late 1980s. Despite all the arguments, redrafting and blind alleys of the 1990s, design and technology in primary schools is now an established, if rather minor, part of the curriculum. Its three types of activities – IEAs, FPTs and DMAs – have crystallised into stages within the medium term units of a national Scheme of Work (QCA/DfEE 1998). Recently a number of new resources to support teachers, such as *Primary Solutions* (Nuffield Foundation 2001), the *DATA Helpsheets* (1999) and even complete *Lesson Plans* (QCA/DATA 2002) are

leading towards increasing uniformity in practice. It would appear that there is now widespread consensus as to how design and technology should be taught (Barlex 2000) and is becoming increasingly difficult for publishers to market anything that deviates from the 'standard' model. A paradigm indeed!

Features of the paradigm

A 'unitary concept'

In one sense, the introduction of design and technology to the school curriculum was an attempt to reconcile the perspectives bound up with the 'Arts' versus 'Sciences' divide in education and society as a whole (Snow 1959). The Design and Technology Working Group, in their visionary Interim Report (1988), stressed the essentially educational rationale for their decision to adopt 'design and technology' as the subject title:

'Our use of design and technology as a unitary concept, to be spoken in one breath as it were, does not therefore embody redundancy. It is intended to emphasise the intimate connection between the two activities as well as to imply a concept which is broader than either design or technology individually and the whole of which we believe is educationally important.' (National Curriculum Design and Technology Working Group 1988: 2)

Thus the authors of the first statutory technology curriculum in the world were making a bid for the new subject to be seen as an educational 'third way', embracing the best of designers' 'artistic' concerns about form, function and aesthetics, with the technologist's 'scientific' preoccupations with structure, force, mechanisms and control systems. The 'holistic' development of design and technological capability by pupils was to enable them to bridge the divide between the two cultures. They were to be both 'creators' and 'makers', active and reflective, so that the composite activity of 'design and technology' was indeed to be greater than the sum of its parts.

England and Wales are practically unique in adopting the dual title 'design and technology' for the subject. It is almost universally referred to in the singular – 'design and technology is' rather than 'design and technology are' (Ritchie 1995). Eggleston (1994) links this choice to an attempt to break out of the low status of technical education, increasing its perceived cognitive content for all. It can perhaps also be linked to the presence of a strong design education lobby, reinforced at a crucial stage by the powerful Engineering Council. Many other countries

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have been influenced by the design and technology model over the past decade, though very few have bought into our 'unitary concept', since technology education tends to be heavily influenced by national culture. (Kimbell 1997)

However, it is worth noting that this 'unitary concept' was nearly strangled at birth. At an early stage in the establishment of the National Curriculum Council, it was not thought necessary to have a separate Design and Technology Working Group, but to include it instead as an overarching cross-curricular theme:

'The original pure and simple concept was that technology should and could permeate all subjects and that it may not have needed any of its own space in the timetable.' (Graham 1993: 56)

It was soon decided, however, that this would risk marginalising one of the government's central tools for industrial renewal. With such an overcrowded curriculum, overarching themes can get easily lost. Design and technology has maintained its identity as a subject with many potential links into art, history and geography, whilst providing meaningful contexts for the development of mathematical and scientific understanding. OFSTED noted in 1999 that 'pupils make more use of what they have learned in other subjects and make better progress as a result'. A unitary concept yes, but one with many ideas and skills borrowed from, and contributing to, other areas.

A Process Model

Looking back at the original four Attainment Target (AT) model of the 1990 Order, it is easy to forget how radical an approach this was to assessment within the emerging National Curriculum. Every other subject to date had defined its assessment structure within traditional domains of knowledge; design and technology had at its heart a *process*. All elements of this process would be undertaken – and potentially assessed – every time children undertook a design and technology project, whereas in science and mathematics only small parts of the assessment framework would be covered at once. Whilst most subjects in the National Curriculum had some element of process built into them, it tended to take second place behind the acquisition of knowledge. Design and technology was, and remains the reverse, – process first, knowledge second.

The nature of this process is not, of course, unproblematic. One of the initial problems with the four AT model, particularly in primary schools, was that many teachers

interpreted it as a set of instructions or prescriptive sequence for project work in design and technology, rather than, as they were intended, 'a series of windows into the interactive processes of design and technology through which information useful to teachers about the performance of their pupils can be obtained' (Layton 1991: 5). This situation, in which teachers were teaching to the assessment framework rather than the Programmes of Study, led to a linear, mechanistic sequence of events which came under criticism as unrepresentative of what designers and technologists actually do (Kimbell *et al* 1991). Criticisms from powerful groups from 1992 led to a simplification of the AT structure into a simple two-stage process – designing and making – in the 1995 Order, with greater weighting given to the making component (60%).

Further simplification of this process model were proposed for Curriculum 2000:

'The two attainment targets have been combined into a single attainment target to reflect the changes in the programmes of study, to simplify assessment and to emphasise the interdependence of designing and making.' (QCA/DfEE 1999: 7).

Ironically, the original Design and Technology Working Group had considered adopting a single Attainment Target back in 1988 to emphasise the holistic nature of the process, but decided against it, partly because they wanted to provide more guidance to primary teachers unfamiliar with this model of design and technology activity. The parallels with earlier thinking in Curriculum 2000 do not end here however; witness the section dealing with Programmes of Study:

'The requirements about designing and making skills and applying knowledge and understanding have been clarified by conflation into four strands – developing, planning and communicating ideas; working with tools, equipment, materials and components; evaluating processes and products; and applying knowledge and understanding – to reflect the designing and making process.' (QCA/DfEE 1999: 7)

These four strands bear more than passing resemblance to the original four attainment target model in the 1990 Order, suggesting that at least in some ways we have come full circle in our attempts to define the slippery nature of design and technology process and its associated concept of 'design and technology capability'.

Capability

Capability was another of the Design and Technology Working Group's key concepts, less talked about nowadays but still at the heart of the paradigm:

'The special characteristic of design and technology is that pupils learn the *capability* to operate effectively and creatively in the made world.' (Design and Technology Working Group: 74)

Capability can be distinguished from ability in that it is revealed through action. It is a multi-faceted quality, embracing technological 'know-how', creativity and fine manipulative skills. 'Holistic' capability is said to be displayed by pupils who are able to undertake the whole design and technology process successfully, integrating the active and reflective components in a seamless whole. It was quickly realised that this was a) possessed by very few gifted individuals and b) very difficult to teach without breaking it down into its constituent parts. The emphasis upon holistic capability in the early 1990s arguably led to some of the criticisms levelled at 'Mickey Mouse' or 'Blue Peter' outcomes by the Engineering Council and media in 1992. Since that time, we have established support mechanisms within the 'big task' of a design and make assignment (DMA). Investigation and evaluation activities (IEAs, formerly IDEAs when we were allowed to take things to bits) support some of the reflective and creative elements of capability, whilst focused practical tasks (FPTs) supposedly teach the understanding of materials and technological concepts, together with manual skills. As suggested above, this 'holy trinity' of activity types – overlapping as they may be in actual practice – are central pillars of the paradigm.

Questioning the paradigm

Is the paradigm already under threat through the possible extinction of design and technology in the primary curriculum? In 1999, Maggie Rogers and I conducted a small-scale, questionnaire-based survey of primary teachers to gain some insight into the situation for design and technology in schools during the introduction of the National Literacy Strategy. Since the suspension of statutory Orders for Foundation Subjects (QCA 1998) and the introduction of the National Literacy Strategy (DfEE 1998) a majority (64%) of our sample of 31 primary teachers reported that design and technology had received less time in the primary timetable, whilst none reported an increase. The majority (58%) reported a lack of flexibility to accommodate the blocks of time occasionally required for designing and making activities. In a later study with 110 primary student teachers from four institutions

(Davies *et al* 2000), we identified a number of creative teaching solutions developed by students to overcome these constraints, including:

- **creative use of time**
 - a group working on design and technology during other lessons
 - using lunch-times, break-times for finishing off
 - maximising whole-class hands-on
- **creative use of curricular relationships**
 - using timetable slots allocated to other subjects
 - using links between units in QCA schemes (e.g. science)
 - 'double counting' cross-curricular work
- **creative use of literacy hour**
 - reading design and technology related non-fiction texts in literacy hour
 - writing evaluations and instructions as 'different genres'
 - using stories as starting contexts for design and technology
- **creative use of children's prior experience**
 - peer teaching from children with more experience
 - drawing upon any design and technology already going on in class
 - skipping elements (e.g. FPTs which children had already experienced)
- **creative use of resources**
 - children bringing in resources from home
 - using construction kits to reduce making time
 - setting design and technology tasks for children to complete at home.

Through its re-establishment in Curriculum 2000, design and technology, along with other foundation subjects, appeared to have received a stay of execution. The jury is still out as to whether it will maintain its position, or whether there will be a paradigm left to challenge within the next five years. In the meantime, questions can be asked of the three features of the paradigm identified above.

Unitary concept?

My work with John Williams at Edith Cowan University in Perth, Western Australia (Davies and Williams 2001), has made me question the industrial authenticity of our curriculum model. John has argued that, far from design and technology being a 'third way', it is deeply polarised in professional practice since designers belong to the 'Arts' culture (since they tend to be trained at art colleges) whereas technologists belong to the 'Sciences' having received, in many cases, engineering or physics degrees.

In the case studies we collected of product design consultancies, designers subcontract prototyping to specialist companies and leave the physical manufacture of designed objects to those with expertise in the 'technology' elements – production engineers. Is it realistic in a classroom context to expect pupils to become 'experts' in both fields? Does a 'design and technology' curriculum place expectations upon them which even professionals would not be expected to fulfil? The Western Australia curriculum model of 'technology and enterprise', in placing the emphasis on the development of innovation, manufacturing and marketing skills, arguably avoids this difficulty.

In another of our case studies (locomotive design), the move to have participants from the full continuum of the design development and manufacturing process, did result in issues arising which could be interpreted as complicating the whole process, evidenced in the change of communication strategies used. However, the industry has identified that the longer-term effectiveness of the design development process is enhanced by representation and participation from the traditionally disparate groups of design and production practitioners in the total process. Similarly, in the field of food technology, there are references in the professional literature to technologists involved in the process of 'designing':

'Food technologists in the new product development team created, sampled and tested suitable breads in the test bakery over a period of two months until the loaves were ready to be taken into full production.' (Power, 1999: 7)

The processes described above are recognisably 'designerly' in content, and a similar argument may be applied to the work of engineers. Few would argue that primary-aged children should not have first hand experience of manipulating, exploring, shaping and assembling materials. Such experience is at the heart of effective learning for this age group. So long as we appreciate that the unity of design and technology is an educational construct rather than a model of industrial practice, the paradigm is under little threat from this direction.

The identity and integrity of design and technology as a discrete subject in the primary curriculum has, however, been brought into question for me by my PhD research undertaken with first year primary student teachers at Goldsmiths College (Davies and Rogers 2000). The purpose of the project was to study the influence of student teachers' prior educational experience and beliefs about

the nature of – and relationship between – science and design and technology upon their planning for classroom activities incorporating both areas of the curriculum.

The findings concerning beliefs about science and design and technology supported those from previous studies (Aikenhead and Ryan 1992, Johnston and Hayed 1995, Jarvis and Rennie 1996), indicating widespread confusion concerning the nature of and relationship between science and design and technology in society and in the primary curriculum. From analysis of students' school-based assignment, it became apparent that approximately two thirds of the sample had planned a sequence of activities using a scientific starting point whilst almost a half maintained a science focus throughout the unit of work.

Of course, science is not the only subject threatening design and technology's hard-won 'curriculum space'. Somewhat confusingly, there are now two subjects in the curriculum which include the word 'design' in the title, and at primary level considerable overlaps are evident in the National Schemes of Work for design and technology (QCA/DfEE 1998) and art and design (QCA/DfEE 2000).

For example, one project cited in Howe *et al* (2001) started from a copy of Hogarth's, 'The Graham Children', loaned by the National Gallery. As the design and technology activity, pupils designed and made model rooms for the children pictured, based on the period in which the painting was done. This required them to focus on the details and clues they could see in the picture and use other sources to research the period. To bring the work into the modern era and link with the children's understanding of popular culture, the teachers then asked the groups to think about what a contemporary setting for such a picture might involve. The original is very formally posed – their ideas for new compositions included, in several cases, technological props such as a portable CD player and games consoles. One group decided to set their picture on the beach with appropriate dress and props. Each group set up their scenes using real or modeled artifacts and themselves in appropriate clothes, which were photographed by another child using the school's digital camera – the present day equivalent of the painted portrait perhaps? The children modified and printed the portraits for display, then produced their own works of art using the photographs as the stimulus, which involved designing and making frames. In such cross-curricular cases, the teacher's clear understanding of the distinctive nature of design and technology is of vital importance in maintaining our unitary

concept, lest it become submerged in the kind of undifferentiated 'topic work' so criticised in the early 1990s.

Process?

My second challenge to the paradigm concerns the process model we have invented and refined for design and technology. Questions in my mind about the authenticity of this model in describing children's approaches have arisen largely from observational studies of professional designers working with primary pupils:

- classroom furniture designers working with children in Key Stage 1 (Davies 1992)
- a stage designer working with children in my own Year 5 class (Davies 1996)
- graphics, textiles, food and ceramic designers working with Year 6 children as part of the Young Designers on Location project in Bath and Ironbridge (Davies and Howe 2001).

I have begun to tease out specific aspects of designing behaviour in which children seemed to have more in common with professionals than with curriculum models of the design and technology process. The first of these is the role that play performs in children's development of creativity and inventiveness. Since play is such a natural activity, it is easy to overlook the foundations of designerly, highly abstract thought being laid down as children manipulate and rearrange objects in space. Professional designers too talk about 'playing' in the sense of trying out propositions, an essential stage of their progress towards a solution:

'I often say to directors: 'let's have a play in the model box'. I'm trying to discover how it will work in three dimensions and different combinations.' (Francis O'Connor, stage designer)

The second under-emphasised aspect of design and technology process I have observed, is the use of mental imaging. Kosslyn (1978) suggests that this is a faculty which children may be able to exercise with a greater degree of clarity than adults, yet it has featured little in curriculum documentation for design and technology. The imaging that results from children's concrete manipulation of objects and materials appears central to finding a 'big idea' [or 'primary generator' (Darke 1979)] to drive their designs forward.

The final neglected feature of process is the role that narrative language can play. Both children and designers tell stories about the people for whom they are designing, to help them gain a deeper insight into what will be

required. They also use narrative language in discussing their mental images of possible solutions, in order to bring these ideas into the public domain for analysis and refinement. My experience of working with children and designers together is that they are able to talk the same language and build on the approaches they hold in common. Children respond instinctively to the apprenticeship model of design and technology education offered by the designer in the classroom, rather than to more rigid, curriculum-led attempts to 'teach children how to design'.

Alternative process models emerge from the literature on developing children's creativity. As part of our research for *Primary Design and Technology for the Future* (Howe, Davies and Ritchie 2001) we isolated some of the features and preconditions for creativity in classroom case studies. We were able to investigate these further in our 'Young Designers on Location' (YDoL) project in Bath and Ironbridge (Davies and Howe 2001). The YDoL project, funded by the National Endowment for Science, Technology and the Arts (NESTA) brought groups of Year 6 children – identified by their teachers as having 'creative potential' – together for a week over half-term holiday to develop this potential with different 'design-related professionals' (see above). We wanted to explore the criteria by which teachers had identified them, together with their own self-perceptions as 'creative people' and the influences on their creative development over this intensive period.

Dust (1999) summarises a body of literature that has broken down the 'creative process' into stages or phases. She suggests that four such phases are commonly identified:

- **Preparation** – investigating the problem and gathering of data
- **Incubation** – usually an unconscious/subconscious phase during which we mentally sift through information and 'turn' the problem over
- **Illumination/revelation** – the insight, the moment of creation (e.g. Mendeleyev's insights in the periodic table of elements)
- **Verification/re-framing** – the 'testing', usually through communicating the outcome to peers or 'gatekeepers' (e.g. critics).

Harrington (1990) brings the factors of process, people and physical environment together within a theoretical framework of the 'Creative Ecosystem'. He uses the biological ecosystem as an analogy. Just as a balanced ecosystem can sustain life, so a creative ecosystem could be said to sustain creative output. The attributes of the individual, the

relationship between the individual and members of the system (peers/mentors) and the physical factors (resources and facilities, even comfortable circumstances) will all contribute to the likelihood of creativity flourishing. The ideal conditions for such an 'ecosystem' he summarises as:

- an atmosphere or 'ambience' of creativity
- stimulation
- opportunities for 'play'
- easy access to resources
- mentors and role models
- permission/support
- motivation/encouragement
- information
- open-ended assignments (Harrington 1990).

We sought to structure the YDoL project around Dust's creative process model, and to explore some of Harrington's conditions through the careful selection of environment, personnel and resources for the project. Findings from this research are still at an early stage, but some interesting features of teachers' selection processes soon became apparent. It would appear that, in some teachers' eyes, a 'creative' child was one who was perhaps a 'bit of a loner', or slightly eccentric:

'He comes up with some interesting ways to get to an answer. Perfectly accurate and gets you there but is in a very different way from perhaps what 75% of the class will have done ... even if other children are disagreeing with him he'll carry on explaining it until, you know, he's got his point across.' (nominating teacher)

Such children, whilst pursuing their own creative agendas enthusiastically, found working collaboratively difficult. However, from our observations we identified another type – the 'creative collaborator' whose creativity was released through interactions with peers. Other insights that emerged during the project included the significant role that design-related professionals played as 'permission-givers' in letting children get messy and follow an idea through to its conclusion. However, if given too much choice, the children tended to revert to activities or processes with which they felt safe. This may have been because of the limited areas in which there was specific skills-teaching. We are hoping to replicate the projects in other locations to explore some features of the creative ecosystem in more depth, but early indications are that Dust's creative process model described the stages children went through with a better fit than the 'evaluate-propose-make-evaluate' cycle

characteristic of current design and technology practice.

Capability?

We are so familiar with the emphasis upon practical process skills in our notion of design and technology capability, that there is a danger of *conceptual* aspects (such as the understanding of mechanisms and control systems) remaining under-developed (OFSTED 1999). This concern is not new nor necessarily restricted to the engineering-type knowledge above; in 1987 the Design Council's primary report emphasised children's need for *design awareness*, and there have been calls for greater *visual literacy* (e.g. Howe 1999) and *technological literacy* (e.g. Siraj-Blatchford 1996). The latter in particular relates directly to children's understanding of the design and technological issues which affect their lives:

'Technological literacy will only be achieved when children are able to apply the principles they have established through critically considering the technological developments of previous times, and those of today.' (Siraj-Blatchford, 1996: 9)

Technological literacy can be developed through work based on the National Scheme of Work. For example, I observed a design and technology co-ordinator in South Gloucestershire adapting unit 4e *Lighting it up*, so that children should appreciate some of the social impact of technology – particularly the widespread use of security lights, cameras and alarms. Children learned how a switch could be used to activate a security light (for example attached to a garden gate), going on to design and make prototype control circuits for Lego model houses, incorporating different switch mechanisms. They were asked to consider the effects of their designs upon those living in and visiting the houses, bringing a critical dimension to their work. Such approaches are echoed in work going on elsewhere; for example in the United States Bill Duggan has recently published a set of *Standards for Technological Literacy* (ITEA 2000) reflecting a curriculum based on awareness and understanding rather than capability.

Technological literacy approaches to the design and technology curriculum, whilst challenging the nature of design and technology capability, also re-assert the place of values in design and technology. Of course, values have long been emphasised in our subject; the work of David Layton and the Intermediate Technology group (Budgett-Meakin 1992) amongst others laid the foundations for the current renaissance under

the broader umbrella of Curriculum 2000. Mike Martin, Ruth Conway and others are currently developing the values section of the DATA web site.

The 'slimming down' that resulted from numerous curriculum changes in the early 1990s and national literacy and numeracy initiatives in the late 1990s, removed any consideration of how design and technology would contribute to the education of our young people in a wider sense. Curriculum 2000, with its acknowledgement of the importance of broader themes in education, offers design and technology educators the opportunity to restate the opportunities our subject offers teachers and children to access these themes. For example, citizenship education is, like design and technology, deeply value-laden, but the links go deeper than this. Technological literacy is an essential pre-requisite for informed citizenship in the 21st century and, conversely, engaging in design and technology necessarily involves participation in communities and responsible action at different levels.

The most obvious context in which children can exercise their citizenship is the school, a formal institution with at least some notional democratic structure. Davies (1999) suggests several ways in which children's perceptions of being school citizens might be explored, including *power maps*: 'asking the children to draw a rough map of the school, using coloured stickers to show the places where important decisions were made or where the powerful people were'. Another approach involves asking the question 'What if you want to change something?' inviting children's suggestions for how it might be done. This approach is reflected in the draft QCA Scheme of Work for Citizenship (QCA 2001). Both of these activities could become a design and technology project, since the power map could involve elements of planning and graphic presentation, whilst changing an aspect of the school environment (such as the playground) is an often-used design brief to contextualise Design and Make Assignments (DMAs, e.g. QCA unit 1B). Howe *et al* (2001) contains other examples of design and technology activities embodying different approaches to citizenship education.

Conclusion

For all the questions and the perceived threats I have outlined in this article, I believe the current 'paradigm' is serving us well in primary design and technology and see few indications of a dramatic paradigm shift on the near horizon. Yet, as Kuhn reminds us, revolutions in thinking are actually comparatively rare, and are usually preceded

by long periods in which small pieces of evidence 'chip away' at established theory. I have tried to identify some of these 'erosion points' above: the incursions of other subject areas to undermine design and technology's unitary concept; the challenge to process models from observational studies of children working with designers; and the potential re-definition of capability to include greater conceptual and values components. Yet none of these at present threatens to undermine the whole edifice. David Blunket came closest to that in 1998 by making the subject temporarily non-statutory, and there are further signs of design and technology's marginalisation in primary initial teacher training through its designation as an alternative to art and design in the new standards (DfES 2002). We must try to ensure that in future years there is a design and technology paradigm left to shift! One way of doing this is to convince those in power that ours is a curriculum area under constant review, with new research-based ideas influencing the direction of practice and important contributions to make to a broader educational vision.

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