Reflections on the DATA Conference 'Paradigm' Debate

RESEARCH

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Introduction

An emergency eye operation (for a torn and detached retina) forced my absence from the DATA research conference, so it was really interesting to receive all the papers in the conference book, which has been admirably edited by Eddie Norman. There is an abundance of riches here. The Editorial Board of the Journal has debated how the Journal should best respond to all these papers, and, specifically, how the Journal should seek to bring to a wider audience the excellence of those papers. This piece is an attempt at that process, and I propose to take a single theme and explore how a number of the papers tackled it. In the following text, I have quoted liberally from the presenters' texts, and the reader needs to understand my system for doing that for there are often three voices at work simultaneously throughout the piece with much potential for confusion. My voice is written in plain text. The presenters' voices are indented in italics and quoted directly from their various papers and, where the presenter is quoting a separate source, this is further indented and condensed. I hope, in this way, to give the reader a direct source back to the original paper, to which reference should be made in the event of confusion.

In the process of writing this I have condensed many papers into a single short one and, quite possibly (though unwittingly), distorted the original flavour and intent of the authors. This is all the more likely since I wasn't there myself and could only glean material from the published conference report. For any such distortion, I apologise in advance and make an offer. If you were there or if you feel that there are better themes that can be drawn together from the separate papers, then write it and send it to us. We would be delighted to promote a critical debate based on the conference and the published papers.

It was not difficult for me to decide what the central theme should be for this piece. Because of the explicit challenge that Andy Breckon laid down earlier in the year, many of the papers addressed the question of the paradigm for design and technology. Are we teaching the right things? Are we striving after the right goals? Is it time to reconfigure design and technology, or should we leave it well alone? Several of the papers tackled this matter, but from very different perspectives, and I hope here to bring at least some of their arguments together.

Initially, **Gill Hope** helped us out with a useful definition of what a paradigm is:

> *The use of the term 'paradigm' to refer to major shifts in concepts and practice is usually associated with the insights of Thomas Kuhn (1962), who used the term to refer to achievements which are 'sufficiently unprecedented to attract an enduring group of adherents away from competing modes of scientific activity' and yet 'sufficiently open-ended to leave all sorts of problems for the redefined group of practitioners to resolve.'*
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> *Kuhn defines a paradigm as a theory that seems better than its competitors at solving 'a few acute problems, but it never solves everything, thus always leaving open the possibility of the emergence of a new paradigm.'*

We might say that the current paradigm for design and technology sees the process of design and development as central, with the groupings of knowledge and skill seen as resources for action in design and organised into programmes of study that lead to the focus areas with which we are familiar. Overlaying all this is the concept of capability (expressed in a single attainment target), informing approaches to assessment, specifically, performance assessment on design and make projects rather than isolated tests of knowledge and skill. So this is the paradigm under challenge. Is it right? Is it the best we can do?

In his keynote lecture, **David Barlex** uses interviews with seven experts to establish his debate about the paradigm:

> *My first expert witness is David Layton and his evidence is contained in the National Curriculum Design and Technology Working Group Interim Report (DES and Welsh Office, 1988), usually referred to as the Parkes Report. There is no doubt that David was the intellectual architect of design and technology as conceived for educational purposes within the National Curriculum. In the report he asks the question:*
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> > *'What is it that pupils learn from design and technological activities which can be learnt in no other way?' He provides the answer: 'In its most general form, the answer to this question is in terms of capability to operate effectively and creatively in the made world. The goal is increased competence in the indeterminate zones of practice.'*
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> *I can still remember both the excitement and puzzlement this answer provoked. Yes, that is what it's all about, but how on earth do you teach 'competence in the indeterminate zones of practice'? Design and technology is a construct designed specifically to meet the educational goal of teaching 'capability to operate effectively and creatively in the made world'. This is its greatest strength and also a weakness in that it ensures that it is not a subject with venerable roots in the academic*

tradition, which values particularly the acquisition of knowledge for its own sake. Here again, the report was clear in its thinking about the place of knowledge in design and technological activities:

> *'We have argued above that, because knowledge is a resource to be used as a means to an end, it should not be the prime characteristic of attainment targets for design and technology. This is not to devalue knowledge, but rather to locate it in our scheme according to its function. What is crucial here is that knowledge is not possessed only in propositional form ('knowing that'), but that it becomes active by being integrated into the imagining, decision-making, modelling, making, evaluating, and other processes which constitute design and technological activity.'*

Here then is a 'straight from the horse's mouth' argument for capability as both the core of design and technology and the focus for assessment. David then cites some of my work, illustrating my alignment of design and technology with a particular pedagogy.

He identifies strongly with David Layton's 'ability to intervene effectively and creatively in the made world' as a main aim for design and technology education. He explains clearly why tackling designing and making assignments is an essential pedagogy to achieve this aim:

> *'At the heart of the development lies a fundamental shift of emphasis from the study of technological outcomes (making them and understanding their social impact) to the exercise of a technological process (of design, development, manufacture, and testing) that generates the outcomes. We should not underestimate the massive significance of this move, particularly in the context of pupils' learning in schools. It is a move from receiving 'hand-me-down' outcomes and truths to a situation in which we generate our own truths. The pupil is transformed from being a passive recipient into active participant. Not so much studying technology as being a technologist.'*

This stance leads him inexorably to the position where the assessment of pupils' procedural competence should take precedence over other forms of assessment.

All this raises a bit of a challenge to Barlex's third expert, **Bob McCormick**, who is concerned to re-examine, and perhaps even rehabilitate, the role of knowledge in design and technology:

> *'The role of using knowledge has always been present in ideas of capability, but its relationship to the process is ill-defined, as is how knowledge is used in action. Although we started with a clear focus on both action and the combination of knowledge and process, we have moved the focus to process alone, leaving the role of knowledge unclear.'*

...the way experts use device knowledge is qualitative. This is a key feature of technological thinking, and one which those teaching design and technology should take seriously. He concludes as follows:

> *'The way those involved in design and technology have refined their views on processes, albeit slowly, now needs to be developed to incorporate those of knowledge. My exploration of this kind of knowledge has sought to suggest that we should not look, in the first instance, to the abstraction of science and mathematics, but to the practical knowledge used by technologists. This search does not imply a swing from process to knowledge, but the search for the relationship of the two. Nor does this imply that science and mathematics are to be ignored, but that their role in the design and technology lesson may be more complex than assumed.'*

This clearly indicates that design and technology knowledge is very complicated territory. As knowledge in action, it is context-dependent and not abstracted in terms of concepts that can only exist in an idealised world.

By the time we get to David's fourth expert, **Patricia Murphy**, we might be forgiven for thinking that the scientists have a bit of a stranglehold on the evidence, but, in the event, Murphy's priority is with the social significance of learning:

> *'Collaboration is an important aspect of problem solving, which enhances learning (including planning) by making thinking more explicit and accessible and enabling pupils to construct joint understanding of tasks and solutions. In the case of design and technology, we would expect procedural knowledge to become more explicit.'*

Patricia believes passionately in the benefits of collaborative learning, but is well aware that the gatekeeper to these benefits is the teacher.

Barlex is clear that Murphy's real concern is about the ways that good learning in design and technology can be enhanced by innovative classroom practice. Good pedagogy, she argues, lies at the heart of things.

The fifth and sixth experts - **Mike Ive** and **Malcolm Welch** – focus on the act of designing. Ive draws his concerns from OFSTED reports, through which he has been a tireless advocate for new and better ways of teaching designing. Barlex presents the evidence thus:

'Pupils' designing ability (Ive argues) still lags behind their ability to make. This is a cause for concern because it is design ability that many see as the indispensable element in pupils' procedural competence that lies at the heart of the educational rationale for design and technology.

> *In many schools, however, attainment is limited because pupils spend too much time on superficial work associated with the presentation of their design portfolios at the expense of the main core of designing and making activities.'*

Nick Givens of Exeter University writes passionately about this:

> *'Our problem always has been, and remains, that of finding efficient, painless ways of generating evidence that don't stifle the creativity. So the ritualisation of designing, the conversion of the design folio into a product, and the inflexible narrow interpretation of what constitutes design represent a major problem. There needs to be scope for pupils to model and record their thinking in a variety of ways and orders. We can't carry on letting a narrow view of what constitutes evidence of design dictate the nature of design.'*

My sixth expert witness is Malcolm Welch, and his evidence stems from his work on the way children actually generate and develop design ideas. Malcolm has analysed video tape recordings of pupil pairs tackling various design tasks and then subjected everything the pupils say and do to rigorous protocol analysis. He concludes from these observations that an insistence on sketching as the predominant mode of generating and developing design ideas may be very limiting for many pupils. For naïve designers, whose sketching skills are of necessity limited, discussion combined with 3D modelling offer opportunities not afforded by sketching alone. He also noted that situating the tasks in an appropriate context enhances pupils' abilities to generate and develop design ideas. This work challenges conventional practice, where an insistence on sketching as the majority means of generating and developing design ideas is seen almost as de rigeur.

Barlex's seventh expert witness is **Stephen Petrina** (like Malcolm Welch, he is from Canada), and his concern is that technology education, at least as enacted in North America and Canada by most teachers in most classrooms, is orchestrated by the interests of business and industry. He sees this as a weakness.

> *He provides an alternative model for technological literacy, one that embraces criticism from perspectives that are overtly political and challenge the assumptions hidden within conventional technology literacy rationales. He articulates the advantages of 'Crit Tech' (critical technological literacy) over 'Tech Ed' (conventional technological literacy):*
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> *'Without the strings attached to business and industry, which control the movement and rhetoric of 'Tech Ed', 'Crit Tech' is free to collectively organise and agitate to say no to competitive supremacy, ecological destruction, exploitative practices of globalisation, homophobic aggression, racist structures, and sexist displays of masculinity.'*

Steve Petrina's paradigm has a clear values base, prioritising the importance of the critical and reflective consumer. I suspect that he would be happier with our original (1990) National Curriculum order, which was largely Layton's handiwork and was rich in statements about the importance of such values. In our current order much of that has been expunged.

Barlex sums up his own position as follows:

> *The profession should operate within the current statutory arrangement, or minor modifications thereof, and focus on the following to enable the subject to develop:*
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> - *engage with curriculum development initiatives that target areas of known difficulty*
> - *concentrate on identifying, developing, and promoting better pedagogy, particularly those that capitalise on collaborative learning*
> - *develop assessment regimes that are sensitive to preferred learning styles and allow the individual signature of the candidate to be revealed by they way they are encouraged to make and record design decisions.*

Interestingly, the values debate raised above by Petrina is also reflected very explicitly in a paper by **Steve Keirl** from Australia. It is ostensibly a piece about new technologies, but the essence of Keirl's argument is (I think) that, since it is very hard for schools to keep pace with buying and installing all the new technologies into our curricula, schools have to develop a more thoughtful response to coping with them.

> *At this point, we can imagine a range of simplistic possibilities so far as the design and technology curriculum is concerned. We can argue that these technological futures are beyond our remit. Either they're not hands-on (so not our bag) or they must remain theoretical and the business of social studies. We can go to the other extreme by virtually abandoning workshops, studios, and the world of the human hand. Perhaps we can strike a middle path of considered change and allowing these (some already with us) futures into our brief. If we choose this path, what ought we to consider? Until*

now, we have had to play a constant game of curriculum catch-up with industrial and professional practices. It is very easy for design and technology to model itself on such practices and to forget its own very special educational integrity. With growing discourse on futures, identity, thinking, and ethics as core curricular interests, it would seem that the integrated and holistic educational path is the way forward.

Clearly, aspects of these emergent technologies can hardly be practised in schools, but the design process can be legitimately explored and simulations undertaken. Of particular merit is an expanded role for criticism and critical thinking through design and technology. Design as mental modelling and critiquing, as a dimension of technological practice, will never be more important. There will remain the powerful lesson that design and technology teaches, namely, that designing and creating technologies are human acts that change, in large and small ways, the world we live in.

The problem of teaching designing was raised in Barlex's keynote, where he drew on evidence from Mike Ive, and this matter is taken up wholeheartedly by **Osnat Dagan** and **David (Dov) Mioduser** from Israel. If process is at the heart of design and technology, and if designing is the process we are concerned with, then should we not know a great deal more about different ways of teaching designing if we are to develop an appropriate pedagogy? I have been fortunate to see some of Osnat and Dov's work in schools, and have been deeply impressed by the very clear research discipline they bring to this difficult task. I outline below the very bare bones of their paper.

One of the major goals of technological literacy is to provide students with tools for solving technological problems. The main methodological resource for this purpose is the design process, as used by technologists to create solutions in response to human needs and enhance the quality of life. There is a conflict regarding the nature and qualities of the design process. On one hand, it is conceived as a creative, branching, and cyclical process based on multi-disciplinary knowledge, while, on the other hand, it has to meet the requirements of products-production processes, e.g. to be structured, to proceed in stages, to meet schedules, to be clearly product-oriented. Signs of this conflict can be found amongst researchers and educators dealing with technology literacy. There are two methodological approaches for teaching the problem solving process:

a) *the structural (stage-by-stage) approach*
b) *the functional approach.*

The structural approach emphasises the need for an ordered learning of the stages of the design process. Different models (differing from each other mainly by the number of stages into which the process is divided) were developed all over the world for teaching design as an organised and methodical tool (e.g. DES in UK 1989, in the US, Australia, Argentina, the Netherlands). The learning process proceeds as the gradual implementation of the different stages.

The functional approach emphasises the teaching and study of design functions (rather than stages) - problem identification and definition, investigation, decision making, planning, making, evaluation. At every stage of the process the problem solver may use more than one of the design functions (e.g. investigation and evaluation). According to this approach, the process of problem solving is expected to be more flexible and cyclical. The instructional plan is based on the teaching of the different design functions, so that the students will use them in the way that best matches the problem, the situation, and their own personal style.

The structural approach is more commonly implemented in curricular materials, and many studies have focused on it. The studies' results raised doubts about the capability of the students to achieve a holistic view of the process by this instructional approach. In contrast, for the functional approach, very few attempts for the orderly development of instructional materials have been made, and only a few studies have been conducted.

A central goal of design process instruction is to allow the construction of appropriate mental models of the technological problem solving process, in the form of internal representations of the real world situation and its solution. By mental design models we refer to systematic structural/functional/causal internal models of the design process. We still lack appropriate research knowledge of mental models construction by students while learning design in both of the above approaches to design instruction. The study reported in this paper is part of a larger research aiming to identify the

relationship between the instructional approaches, the mental models constructed by the students, and the problem solving processes actually taking place. Our overall question focused on the examination of the connection between learning design in either of the two instructional approaches (structural and functional) and:

1. *the students' mental models of the technological problem solving process*
2. *the scope and quality of use of the various design functions by the students while designing a solution*
3. *the components and quality of solutions for different problems as generated by the students.*

The study reported here is part of a larger research project aimed to examine the relationship between alternative approaches towards design teaching (structural or functional), and the students' mental modelling of the design process and the quality of their solutions to design tasks. In this report we present preliminary results focusing on the students' representations of the design process along several points in time prior, during, and after the learning process. Based on this preliminary analysis of the results, we can identify the following trends:

- *We can see that the instructional process itself (regardless of the approach) influences the mental modelling of the problem solving process. In both groups we found an increase in the internal logic and coherence of the generated models over time.*
- *The stages group learns the design process in a very orderly manner. Consequently, immediately after the second lesson it is possible to see an increase in the number of internally logical models up to the end of the process. In contrast, in the functional group the students construct by themselves the most suitable method for solving the problem. In other words, they learn while trying out different options, and thus only from the fourth model on could we see an increase in the number of internally logical models (according to our defined criteria).*
- *In the functional group most of the students use a finite linear model, although they learned in a way that permits greater flexibility. In contrast, the stages group uses both the finite linear model and the cyclic linear model to an equal extent.*
- *We expected that in the functional group there would be more recurrent use of the different design functions at different stages of the solution generation process and, in fact, this was the case.*
- *The results of the whole study are currently being analysed. At its end, we expect to unveil the underlying cognitive processes characterising the generation of design solutions in both groups, as well as the way these solutions were affected by the alternative approaches towards design instruction.*

If Osnat and Dov allowed us to get to grips with different approaches to teaching designing, Gill Hope takes us down a quite different pathway, inviting us to see the heart of design and technology (and hence the paradigm of design and technology) as concerned with change and the uncertainty of the future.

Although mindful of Keirl's warning, 'Change should not be so radical as to burden and stress the profession.' (p. 114), design and technology, which by the nature of its subject matter is a continually fast-changing field, requires a paradigm of teaching and learning which fits its recipients for a future of rapid and possibly radical change. The sweeping changes wrought by the microchip revolution are just a foretaste of the depth and breadth of the technological and societal changes which the children in our schools today will experience in their lifetime. Whatever paradigm we accept and promote, change needs to be part of it. It needs to be celebrated, created, relished, and sustained, not merely coped with. It is surely a contradiction to hold a backward-looking conventional view of a subject whose lesson content involves children planning for their own future actions. Inherent in any new paradigm for design and technology, therefore, must be an awareness of current future-orientated issues.

> *'Most adults, teachers, and parents will not have experiences on which they can draw to prepare youngsters for a world in which they can expect to change their jobs regularly.'*

Should we, therefore, aim to equip children for such a rapidly changing job market by introducing them to the new technologies? This is expressed, for example, by Kalkanis (2000), who proposes:

> *'A reform of the content of technology education, enhancing it with nowadays state of the art technological tools and processes, which are used in all aspects of everyday human activity and need (scientific, economic,*

> *medical...), whilst presenting them as the direct application of the contemporary scientific models.'*

Or was Toffler (1970) right, over 30 years ago, to suggest that the rate of change is too fast to build a curriculum on any specific technology? He claimed that, despite the rhetoric about people's futures as never before depending on their education, education itself is backward-looking, bent on

> *'cranking out Industrial Man - people tooled for survival in a system that will be dead before they are'.*

My favourite piece of terminology in relation to creativity in design and technology is Anna Craft's 'possibility thinking'. She speaks of this being 'as if ' thinking. A related term, one I came across recently during a college workshop, is 'dream room thinking'. In rethinking the paradigm of design and technology, this has a double application. Not only am I indulging in 'dream room thinking', creating a personal wish list for an educative experience in a subject area about which I care passionately, but I perceive the subject itself as essentially to do with encouraging 'dream room thinking' in others.

But Hope concludes with a cautionary note, insisting that her paradigm must measure up to a number of critical qualities. First, it must be based in a clear philosophy, second, it must allow for diversity of opinion, third, it needs to be socially responsible, and, finally, a new paradigm must not be prescriptive but must recognise the creativity and dynamism of designing. Here, right at the end of the piece, we can see Hope's real agenda for the paradigm. It is about changing the role of the teacher (or liberating the role of the teacher) from the constraints of having an unbending paradigm. In a lovely twist of the argument, she concludes that her preconditions for a paradigm could only be met in classrooms where the teacher is not constrained,

> *otherwise we shall continue to lose our most reflective, creative, and innovative practitioners to careers in which their most precious talents are encouraged rather than ignored.*
>
> *It would be an interesting quirk of fate if the subject most lauded by politicians for its instrumentalism, vocationalism, and contribution to the country's GNP were to be seen as leading the way forward on the education of the spiritual, moral, and social dimensions of what it is to be human.*

The critical and reflective tone of Hope's paper puts a different spin on Pertina's and Keirl's arguments (earlier) for a value-rich paradigm enabling youngsters to develop thoughtful critiques of the made world. Petrina's case seemed to me to be that the paradigm should have values as its content, but Hope's point, in my opinion, is that the paradigm (whatever it contains) must be seen to operate within a curricular and classroom framework that is itself subject to a set of values, specifically, values that ensure diversity, openness, and a tolerance of difference.

So, where does this all leave us? After Barlex's seven experts (Layton, Kimbell, McCormick, Murphy, Ive, Welch, Petrina, and himself of course), and after Steve Keirl, Osnat Dagan, David (Dov) Mioduser, and Gill Hope, what now might we say about the design and technology paradigm debate at the DATA research conference?

None of them appears to want a fundamental change of direction for design and technology that might burden and stress the profession, though each accentuates different parts of the whole. Taking huge liberties with the evidence, I think that four features emerge from the arguments presented:

- the centrality of capability at the core of design and technology - that design and technology prioritises active, task-based learning; developing and exploiting task-related knowledge, and performance assessment on design tasks
- the importance of appropriate design pedagogy - utilising social (collaborative) learning, not least as a liberating tool for youngsters' imaginations and creativity
- the importance of critical reflexivity - developing it as a designer of new products and helping youngsters (and ourselves) to live through design and technology as critical consumers, applying such criticality to the construction of curriculum.

But then there is the final twist in the tail of the paradigm debate. For I interpret the fourth issue to emerge as a question:

- Do we need a nationalised (NC) paradigm to fashion our behaviour and expectations? Does an established paradigm demand orthodoxy? Is an established paradigm (orthodoxy) antipathetic to innovation (and hence to design and technology)? Can a paradigm be presented so as to allow and encourage critical thought beyond it?