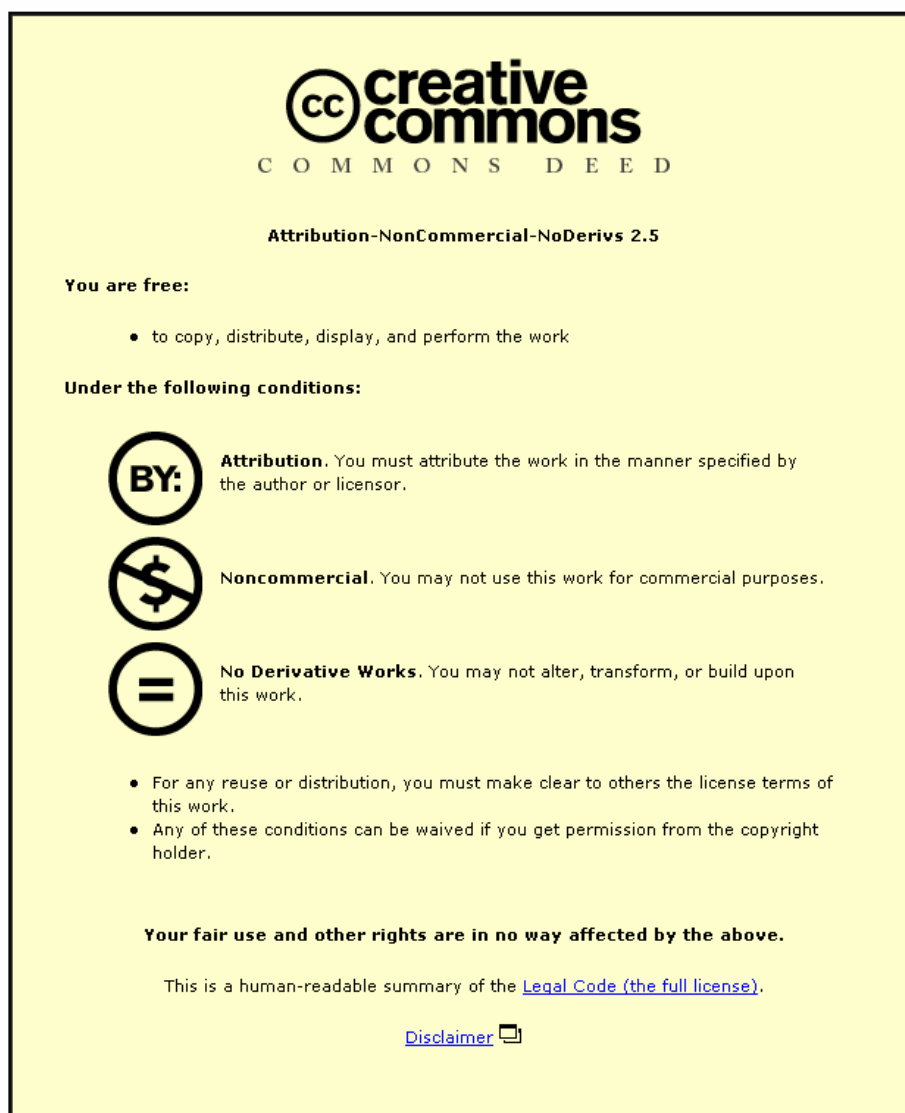Loughborough University

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Questioning the design and technology paradigm

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Abstract
My initial reaction to 'Questioning the design and technology paradigm' was a list of questions about the question:

1. *Define paradigm*
2. *Whose paradigm? (question the and paradigm singular) What is the design and technology paradigm? Does a consensual view exist, in the UK? worldwide? Do teachers know what the present paradigm is meant to be? How close is this to political doctrine – the rightness of what we believe?*
3. *Who is doing the questioning – teachers/implementers or the politically ambitious?*
4. *Why and in what way is it being questioned?*
5. *Does it need to be questioned, if it exists?*
6. *What changes will this lead to? (change overload?)*

Then the questions I would like to ask:
- *do we need a consensus view?*
- *is there not strength in diversity?*
- *are there not dangers in an agreed ontology?*

I definitely want to challenge the one right answer paradigm. I think that what is needed is a clearer idea of what design and technology is, or could become. And this, finally, became the question which I found myself addressing.

Keywords
paradigm, epistemology, change, creativity, reflection

On the origin of paradigms

The use of the term of the '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.'

and be engaged in 'mopping up operations'. (p. 10)

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.

A paradigm gives its community a criterion for problem solving, a puzzle-form, through a 'new and more rigid definition of the field.' (*ibid*: 19). Anything that does not fit the form is considered outside the discipline, which then marginalises those who do not accept the paradigm, since puzzle-forms imply rules i.e. established viewpoints or preconceptions. Working within a paradigm means that practitioners no longer need to justify their stance or define their terms of reference.

Paradigms can exist without a full interpretation or rationalisation and scholarship can proceed without articulating its paradigm as long as the problem solutions already achieved are accepted without question by the community. Paradigms provide the framework for what Kuhn terms 'normal science' and the identification of anomalies which triggers 'revolutionary science' appears only against the background provided by the paradigm.

Polanyi (1958), who does not use the term 'paradigm' but describes the same phenomenon at a personal level, links this firmly to having solved a puzzle or made a discovery after which the change is irrevocable and forever changes our interpretive framework:

> 'I shall never see the world again as before. My eyes have become different; I have made myself

into a person seeing and thinking differently. I have crossed a gap, the heuristic gap which lies between problem and discovery.' (p. 143)

Is this the position in which we find ourselves with regard to design and technology? Did the defining of the field in the 1980s constitute the emergence of a paradigm? The National Curriculum certainly provided a rigid definition and marginalised any other research. Have sufficient anomalies emerged in the paradigm to warrant a revolution or are we still just 'mopping up'? Are we on the brink of 'seeing and thinking differently'?

From within the design and technology community there has recently been an intuitive feel of conceptual changes afoot, which might fit Kuhn's characterisation of a paradigm shift. For example, Roberts (2000) describes the tensions between differing theoretical positions and differing existential persuasions (and hence curriculum practices) which derive from groups of practitioners who think their version is rationally or self-evidently well-founded, in other words, form part of a paradigm community. He comments that:

'Paradigmatic change inevitably brings disturbance in the taken-for-granted perspectives and rationales of normal practices.' (p. 13)

A new and larger paradigm of practice would be signalled by the general acceptance and usage of new categories. Such a new paradigm would offer the possibility of models which enable construction of personal models which in turn lead to a better understanding of change and, therefore, towards a sense of being in control.

This is consistent with Kuhn's view of how paradigms emerge, develop and change. In relation to the pedagogical issues, it is vital that future curriculum change be one which makes practitioners feel in control of their own practice and restores their position as professional educators and not just deliverers of a curriculum.

Roberts stresses the *socially constructed* nature of paradigms, ideologies and, hence, curricula. design and technology is a social construct, with a historical past, date of origin and record of achievement, as is the whole of the National Curriculum and the view of teachers as deliverers of it. I baffled a group of ITT students recently by asking 'What did teachers do before they delivered the National Curriculum?' For most of my generation of teachers, the gut reaction to this question would simply be: *teach*.

Whether in reality it was better before or since, or only different, is not the issue. The issue is in teachers' perception of the nature and value (personal as well as societal) placed on their role in the job they do, which has a knock-on effect in terms of whether they want to continue to do the job or find something else to do in which they feel their level of education and expertise is more valued and better rewarded. Any new paradigm in the world of education must address this as a major cause for concern.

Lockhead and Yager (1996) compare the shift in understanding of the construction of knowledge ('what it is, how it is formed, and how it changes.') (p. 25) to the discovery of plate tectonics. They call this the 'Theory of Conceptual Drift.'

The headings within their paper reflect their exploitation of the juxtaposition of paradigm shift and continental drift and I have adapted and conflated these to create the following key points of my argument in the present paper:

- from first rumblings to aftershocks
- the epicentre: the core of cognitive theory and the origins of conceptual drift
- conception currents and attempts to rejoin divided concepts
- can we harness the energy of concept construction?
- the social implications of concept construction
- the wave of the future.

Lockhead and Yager also have a heading 'Analysing Sedimentary Textbooks'. This would, perhaps, be the next phase?

With 'Measurement and Prediction of Conceptual Tremors' contracted out to Ofsted or QCA?

From first rumblings to aftershocks: The chalkface paradigm
Design and technology (as every child's entitlement) was launched on the unsuspecting British educational public without a clear definition of what the subject was. Essential underlying questions had not been addressed: What was its rationale, its knowledge base, its underlying philosophy? What were its meta-skills to be? What were their contributory skills and knowledge? How do the cognitive and haptic build together into the education of the skilled design-and-technologist? What is design capability?

The only part of the document which seemed applicable to lessons across all the disparate subject areas that huddled under the design and technology umbrella was *The Design Process* (identify needs – generate solutions – evaluate results). For many teachers this is still what design and technology is

about, despite the passage of time and changes in the wording of the National Curriculum documents.

It became obvious to me, reading journals and conference proceedings after the introduction of the National Curriculum, that research into how children learn had transformed itself into how children could best be taught the National Curriculum. I remember walking down the path to my classroom thinking to myself, 'Research is dead then.' This seemed especially true in design and technology. Prior to the National Curriculum there was little research into how small children designed things that they made. After its introduction, books and articles appeared to instruct teachers how to teach them to do so. The National Curriculum became the benchmark against which to measure capability and progress towards being good at design and technology.

Yet our subject was an artificially created marriage of convenience of the strands of craftwork (wood and metal), domestic studies (cookery and needlework) and business studies in the secondary phase and a recasting of the craft side of art and craft at primary level. The enforced coming together of disparate subject areas each with their own understandings and ways of knowing did not contribute towards a smooth transition in many secondary schools. The lack of clarity about what this new subject actually entailed, especially since it was couched in unfamiliar jargon (artifacts, systems and environments), led to confusion and distrust of the subject among primary practitioners, which has in turn led to design and technology being squeezed out the back door as soon as greater emphasis on literacy, numeracy and ICT were heralded in through the front door of most schools. Lack of understanding of the nature and value of the subject has led directly to its devaluing in the minds of many teachers. If we are going to create a new paradigm, it needs to be one that teachers can understand as relating directly to the needs of children, rather than to an external political agenda.

Teachers will always view the children as their primary clientele, with a sense of responsibility to their parents coming a close second and other stakeholders a lot further down the line. Teachers, especially those of young children, are concerned with how any curriculum area benefits the learning of their children. They will not readily be drawn into delivering something for which they feel little commitment. A new paradigm for design and technology needs to be firmly rooted in its benefit for the cognitive development and manipulative skills of the children.

Our choice of a new educational paradigm is closely linked to how we answer the questions about the

purpose of schooling, what it mean to be an educated person and the part that tuition will play in the development of such a person. So, if we are going on a search for a new paradigm for design and technology, we need to be sure that all our stakeholders, if not coming with us, are at least happy for us to take the journey. For our new paradigm, should we locate it, will affect epistemology and pedagogy at the most fundamental level: what counts as knowledge and how it is transmitted and acquired, as well as the way we organise resources, timetables, assessment; in short, our aims, objectives, success criteria, experiences of pupils and evaluation of the results.

At IDATER99, Phil Roberts laid out his agenda for future research into design and technology. He commented that:

> 'It is the implementation requirement that has perhaps the greatest potential for hindering progress in fundamental and scholarly research (as well as operational research and development activity).'
>
> (Roberts, 2001: 7)

This is because implementation is not based on inquiry and analysis. Practitioners 'merely' implement policy and 'policies are predicated on ideology'. He typified the contrast between research agenda and public policy agendas as:

> 'Research agendas and research enquiries are based on the absence of certainty and, typically, begin from an inadequate knowledge base. Much public policy displays, in contrast, an absence of doubt.'
>
> (*ibid*)

Regarding implementation, he asks: Whose developmental stages, needs, attributes, aspirations, hopes and values are to be attended to?

For despite part of the subject content of design and technology being the study of structures, its own underpinning has been at fault from the start. The forays into the world of small children were few and at best cursory before the introduction of a document carrying the force of Parliamentary Law made it illegal for teachers not to teach five-year-olds artifacts, systems and environments. For those of us who lived and taught through it, the lack of enquiry into child development and the needs of small children made the first step of the process to be taught in this new subject, 'identifying client needs', farcical (and still barely forgiven). The cry of 'Has no one heard of Piaget?' rang through the ranks.

Applying to ourselves the framework of design and technology pedagogy as currently perceived, we need to

identify our clients and their needs, and then look for a creative design solution, fit for the purpose, good on form and function, crafted to meet the needs of the users/clients (which includes some very small children as well as those about to enter the adult world of work), which can be evaluated by those involved in the process as well as those who look at the finished product.

Whatever our future paradigm, it must address the needs of children to be children. Education may be teleological but children are here and now creatures. We cannot teach them on an 'eat up your greens, they will make you grow strong' basis. Children still prefer the taste of chocolate. Fortunately, most children when questioned say they enjoy design and technology lessons. They enjoy hands-on problem solving, the freedom to discuss, try out, make things which they have imagined and invented. This we have as the great strength of our subject. It has been revised and changed in response to chalk-face criticism and is now more fitted to the needs of children but we need to actively celebrate and publicise the way that it does.

We do not yet have (and need) a firm theoretical foundation rooted into the developmental needs of those to whom we deliver our offerings. We need a clear statement of how design and technology contributes to children's learning and development, a seminal work which summarises our understanding of children and their needs. Geoffrey Harrison's (2001) The Continuum of Design Education for Engineering is an excellent start but this needs to be built on and developed, perhaps with experts in each of his life-stages contributing to a series of books which become the definitive works on their subject.

The epicentre: The core of cognitive theory and the origins of conceptual drift

The epistemology of designing for technology

As Taba (1962) observed, confusion surrounding curriculum development often stems from insufficient analysis of what constitutes knowledge in any subject or discipline, which leads to misunderstandings about the role of knowledge both in learning and in the curriculum.

Finding the place for design and technology knowledge within the traditional structuring of knowledge has proved difficult. As Kimbell and Perry (2001) comment:

> 'The design sub-label leans towards the arts, and the technology towards the sciences. But neither will do as a natural home. It is a restive, itinerant, non-discipline.' (p. 19)

A rationalistic view of science, coupled with the valuing of science above other ways of truth-knowing, and the economic need for more engineers, led to the concept of technology being firmly coupled to the empirical model of knowledge (the advertising industry contributed the catchphrase 'the appliance of science'). However, appliance of science is not the same as the creation of science, and is certainly only a small part of design, which is concerned, not with the search for defining generalizations, but with the ill-defined, the indeterminate and the particular (Buchanan, 1996).

Before Kant, although philosophers disagreed about what really exists, their conception of truth was always tied to the notion of objective reality. However, in spite of Kant's thesis (our mind does not derive laws from nature, but imposes them on it), most today still consider scientists as discoverers of an empirical reality, which continues to distinguish the claims of science from the claims of other ways of knowing.

The over-valuing of science as a way of knowing led to the casting of the analysis of design methodology as 'Design Science'. But design is not rationalistic – even in science. Although accounts of scientific results are written according to the rules of the rationalistic model, research is not done that way.

Many major breakthroughs in science and technology are created by heuristic knowledge, analogy or even by occasional flights of fancy. Much of quantum physics was discovered as thought experiments which relied heavily on metaphysics and the playing of logic games (for example, Einstein and Bohr's photon in a box or Schrodinger's cat). The dependence on analogy shows in many of the words used for scientific phenomena (e.g. electrical current and flow, blackholes and wormholes in space), analogies which come, not from observation, but from metaphors in the researcher's head.

Science itself, therefore, is not created according to the rules of rationalism. Science is much more messy, indeterminant and creative than its credo suggests, as indeed Popper (1959: 246–250) asserted.

Von Glasenfeld (1987) invoked a useful analogy:

> 'Knowledge can never be interpreted as a picture or representation of [the] real world, but only as a key that unlocks possible pathways for us.' (p. 194)

Metaphysical realists look for knowledge that matches reality (like paint matching some already on the wall). But if we say it *fits* in the sense of a key fits a lock then we have a totally different relation. *The fit describes the key, not the lock*. Many keys fit the same

lock (knowledge exploited by burglars! says Von Glasenfeld). Although Von Glaserfeld is discussing science, it is close to the notion of design implicit in Buchanan (1995): indeterminate, in which no solutions are true/false only good/bad, every problem is unique and in which designers are required constantly to flip between the general and the particular.

Despite such attempts to redress the balance between knowledge paths, defining and placing design and technology in the established framework of knowledge has inherent problems. Smithers and Robinson (1994) consider that technology is different from other areas of the curriculum, most of which conform to Hirst's (1974) 'forms of knowledge', in that it is a 'practical organisation of knowledge'. The 'centre of gravity' (what is/are at the heart of technology and what is/are more peripheral?) needs to be decided, leading to a statement of technology's domain. Smithers and Robinson make a useful analogy with English with its dual components, 'language' (knowledge and skills) and 'literature' (the art of creating).

In describing the development of the South Australian design and technology curriculum, Keirl (2000: 115) observes that 'this is essentially a doing field' But what kind of '*doing*' and, is this 'doing' a form of knowledge?

Herschbach (1995) typifies technological knowledge as being defined and established through activity, which:

> 'orders the framework within which technological knowledge is generated and used… Technology best finds expression through the specific application of knowledge and technique to particular technological activities.'

If technology is to do with the instrumentation and application of knowledge, is it knowledge or applied knowledge, or is it knowing how to apply knowledge? What is it, therefore, that we are aiming to teach children and how will we judge its value, let alone its success?

I have used Ryle's (1949) division of knowledge into *knowing how* and *knowing that* to create my own epistemology, which, I believe, expresses an answer to these questions:
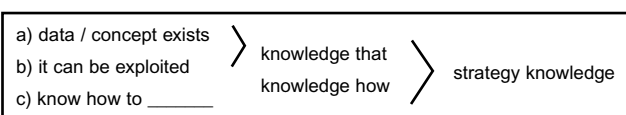

Figure 1: (Hope, 2002).

In this model, Ryle's *knowing that* is extended to cover, not just factual information, but also concepts and understanding, including perception of similarities to previously experienced problems, as well as analogical insight. But the problem-solver also needs to know that this knowledge can be harnessed to the solving of the current problem, i.e. *knowledge that o*nly has power if linked to *knowledge of relevance* to the problem. Then *knowledge how* is needed. This may be a physical skill, a mental strategy, or previous experience of solving like problems.

This combination of *know that*, *know relevance* and *know how* form the basis of the strategy to be employed to solve the problem. The choice of appropriate strategy in any problem situation depends on the depth and salience of the *know that* and *know how* which support it. This problem-solving methodology is at the heart of design and technology and can be taught to children.

Polanyi (1958) coined the phrase tacit knowledge, which is pre-articulate and therefore covers all those forms of knowledge which do not depend on words and constructs of language. It includes hand-skills, hunches, creativity and inner feelings of rightness, which many would see as foundational to the acts of designing and making. We do not have a monopoly on this form of knowledge, however; art, music, religious experience share it too and so too, claims Polanyi, at their heart, do science and mathematics. The problem is that education has traditionally devalued this means of knowing.

So part of a new paradigm must be the re-assertion of the importance of the heuristic, coupled with social responsibility, to which Polanyi devotes a whole chapter ('Conviviality'). These themes can be seen in recent statements of technological literacy. For example, Kierl (2000) lists the operational (skills and competences at technical level), the cultural (contextualised learning) and the critical (citizenship, learning about, and to be with, technology).

Conception currents and attempts to rejoin divided concepts: A paradigm for a changing world
Although mindful of Keirl's (2000) 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, as a continually and 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. 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.'
>
> (Gardner, 1999: 45)

Should we, therefore, aim to equip children for a such a rapidly changing job-market by introducing them to the new technologies, as 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.' (p. 199)

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 future 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.' (p. 361)

The curriculum, he claimed,

> 'is not based on any well thought out conception of contemporary human needs. Still less is it based on any grasp of the `future, any understanding of what skills Johnny will require to live in the hurricane's eye of change.' (p. 371)

Reading past future prediction can be salutary. The consultative document *Education 2000* (1983) makes interesting reading in this light. Unaware of the massive and rapid changes about to commence in the very field on which they were speculating, the consultative committee comment to the effect that although society and technology were changing rapidly,

> 'the typical lead-time for the implementation of major educational reform is at present of the order of twenty years.' (p. vii)

Throughout the document, the group reiterate their view that the most certain thing about the future is *change*, rapid and continuous. In discussing technology's impact, they warn against schools as places of vocational training:

> 'the attempt to match individuals to a variegated, volatile job-market proves hopelessly speculative. Vocationalism as an incentive requires even now a high degree of make-believe among teachers and taught.' (p. 59)

Yet our subject was ushered in under a largely instrumentalist and vocationalist banner. Only after its introduction did apologists voice the view that design and technology was intrinsically 'good' for children to learn. That primary teachers were barely convinced that the subject added anything significant is revealed by reports that, currently, with the emphasis on literacy, mathematics and ICT, science is being sidelined and design and technology squeezed into a Friday afternoon if the teacher has enough energy left at the end of a long and taxing week, especially in the SATs years.

Robinson (2001) sees the most important resource in the face of rapid technological and economic change as the capacity of both companies and individuals for creativity, innovation, flexibility and adaptability. These are generic capabilities which design and technology education should be able to foster and develop in our pupils.

Can we harness the energy of concept construction? Creative designing
Inventors and designers are highly creative individuals and creativity seems to be one of the most elusive of human qualities. Where does it come from? How do we recognise it in small children? How can we foster it in the general school population?

Lockhead and Yager (1996) comment:

> 'We cannot stop the continents drifting and we cannot stop students from constructing their own knowledge. It may not be convenient, but we must adapt to a world in which students have minds of their own.' (p. 28)

There have been manifold attempts to define this elusive quality of human cognitive functioning. For creativity in design and technology, that proffered by Mednick (1962) has stood the test of time:

'The forming of associative elements into new combinations which either meet requirements or are in some way useful.' (p. 220)

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. Craft's 'possibility thinking' ties the fantasy securely to reality and to dream realisation.

Perkins (Boden, 1994) asserts that:

> 'Inventors are metacognitively aware of their own process. Inventors move back and forth between real inventions and prototypes and the virtual space of ideas' (p. 140).

> 'The part of an inventor's possibility space concerned with general forms is, of course, much smaller than the part concerned with particular forms. By moving back and forth between the general and particular conceptions, inventors can avoid the worst effects of a combinatorial explosion of possibilities.'
> (Perkins, 1994: 120)

Perkins used the term '*creative systems*', citing nature, the mind of the inventor and social processes as examples. Education, especially design and technology education, should surely be a 'creative system'.

Harrington (1990) uses almost identical terminology, bringing together the factors of process, people and physical environment within the theoretical framework of the 'Creative Ecosystem', using biological ecosystems as an analogy, reminiscent of the metaphors of progressivism: children flowering, blossoming, etc. An important aspect of Harrington's model is the *people environment* – and this is not just true of children.

It has so frequently been stated that adults hold key roles in developing children's creativity as supporter, permission-giver, mentor, role-model. Yet these are no less important factors for adults as teachers, curriculum-writers, inspectors and ministers of education. In order to foster creativity in children, it

needs to be encouraged amongst their teachers, as Richard Kimbell so eloquently and pointedly demonstrated at DATA's Millennium Conference (2000). I doubt if I was the only member of the audience feeling emotional over old wounds. Education, not just creativity, is in crisis in this country because its practitioners lack support, permission, mentors and role-models in creative problem identification and generation of solutions.

There is no one-right-answer. If design and technology as a mode of knowing can teach anything to other areas of expertise and knowledge, it is in the acceptance that the 'science of the particular' (changing the use of Buchannan's (1996) phrase here) allows for multiple solutions. The obsession with the search for *the theory of everything* has led science to a *theory of multiple universes*. The reaction against the *theory of intelligence* has led to a *theory of multiple intelligences*:

> 'Educators need to take into account the differences among minds and, as far as possible, fashion an education that can reach the infinite variety of students.' (Gardner, 1999: 187)

In a world of increasingly complex and difficult socio-technological problems, we need not just the recognition of the possibility of multiple solutions, but celebration of diversity and complexity, a strength rather than yet another problem to be solved. Design and technology is not just 'good' for children because it will enable them to become creative at some future time and in some unknown workplace but because it fosters their creativity and playfulness *where they are now*.

This raises the issues of inclusion. An instrumental view of pedagogy (education as preparation for adult working life) excludes those who have no such future. Designing as creative experience, making as empowerment, personal fulfilment, adding to the joy of life, are essential for those whose participation in society is limited by other difficulties. I treasure the memory and the small gifts created by two of my pupils who, through illness, never lived beyond their childhood years. Children in wheelchairs, who have to depend on the help of others to do things the rest of us take for granted, need to design and create, not just to feel in control, but to feel able to contribute. It has long been recognised that creative activity plays a role in healing emotional scars and dissipating energies which might otherwise become destructive. If design and technology is about creating the future, then children damaged by their past need design and technology. As always, what is true for children with special needs, is frequently also true for the majority.

We can no longer countenance a one-right-answer or one-size-fits-all education. Children are not entitled to identical education regardless of fit. They are entitled to an education which, in the words of the 1944 Education Act, fits their 'age, aptitude and attainment'. Interestingly, the advent of broadband multi-media technology may enable the progressivists' child-centred dream come true. Pearsons, for example, produce a 'Knowledge Box' that enables a multi-user interactive learning environment in which individuals and groups are able to follow their own interests and pathways through a subject via on-screen hotspots which link to intranet and Internet resources. Linked to CAD/CAM software, this would enable children to research and play with design ideas without the constraints of the demands of making a product. This would not only open up the field of design briefs which children could develop to include architecture, landscape design and re-modeling of urban environments, but it would also enable children with physical handicaps to express their design capability and creativity.

There are management issues here, of course. How does a National Curriculum manage creativity and diversity? Is creativity really untamable and is it diametrically opposed to management? If we manage design will it cease to be creative?

Creativity certainly does not thrive in tightly constrained methodologies. It is aware of too many other things. It can balance conflict on its nose and juggle with confusion at the same time. It can see structure in chaos storms and view rainbows in a grain of sand. Consistent with Heisenberg's uncertainty principle, stardust disappears under inspection.

If we are designing a curriculum for designers and inventors, do we catch this will o' the wisp and put it in a document labeled 'moonshine' and wait for it to fade or do we give freedom to our educators to foster the latent talents of our young people and trust them to find their own truth-way?

Papanek's (1995) opening statement 'All design is goal directed play,' seems to give us a way into combining the teleological with the spontaneous, which might give us a basis for including creativity into our paradigm for design and technology. Play and creativity are fused in the fun and joy of young children and yet our adult-led model of pedagogy barely taps into the natural learning styles of the very young, denigrating instead of celebrating children's play-learning and building on its strengths: its natural slipping and sliding of concepts into one another, fusing reality and fantasy, adapting found objects for another purpose, constructing paracosms

from a single creative spark of an idea, maintaining narrative in fantasy space across hours and days, and taking other participants along for the ride, team-building, disseminating ideas and accepting the ideas and enthusiasms of others, negotiating, accommodating and having a natural intuition for the rightness of fit in the context of the jointly created fantasy world.

But how can you base a curriculum on such intangibles, or build for a creative future, when no one knows or can predict what the future might hold?

Toffler's (1970) way of resolving the conflict is to distinguish between 'data' and 'skills' (cf Ryle's know that: know how). Skills, Toffler identifies as learning, relating and choosing. Gardner (1999) opts for a curriculum not based on information at all but on truth, beauty and goodness:

> 'There is the realm of truth … and its underside, what is false or indeterminable. There is the realm of beauty … and its absence in experiences or objects that are ugly or kitschy. And there is the realm of morality … what we consider to be good, and what we consider to be evil.'

These qualities are not incompatible with a new paradigm for design and technology.

The social implications of concept construction: Reflective design
The term 'reflective practitioner' is frequently applied to the good teacher, especially if involved in action research: reflection on 'praxis'. I think it could equally well be applied to the child involved in design and technology. As we encourage pupils to evaluate their work, we are essentially asking them to reflect on praxis, yet this needs to be a small part of a bigger picture.

There are, as I see it, two sides to this, ethical and spiritual and both are issues which cannot be ignored by design and technology as an educational enterprise.

Human life is inherently value-laden and every corner of it, the intellectual equally with the affective, is permeated with our values. Even the choice to work as if ethics did not apply is itself a conscious ethical position. If design is in response to human need then it cannot duck the moral issue. Design education must embrace the difficult and frequently contradictory mess of ethics and responsibility. Citizenship education needs to be incorporated into design and technology education, not just added as yet another curriculum strand.

Reflection and evaluation has always had a role in models of design but Rogers and Clare (1994) place it centrally.
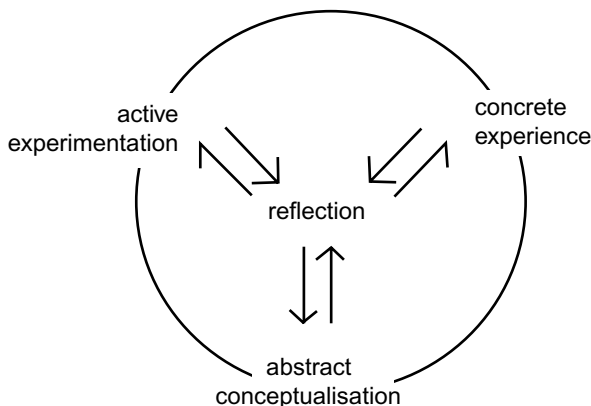

Figure 2.

It needs, I feel, to be central in the big picture, the pedagogy, the rationale of what our subject is about, not just something to which we give nodding assent in passing.

Howe, Davies and Ritchie (2001) see reflection as not accepting what already exists but being future-oriented and learning from past products and systems, yet breaking with conventional solutions rather than replicating them. They make a strong claim for the contribution of design and technology both to citizenship education and in educating the spiritual dimension of personal development. They see this as founded on the notion of the self and the child's development of self-awareness through interaction with others. The dual aspect of a sense of wonder at well made designed objects is linked to a sense of achievement of producing something aesthetically pleasing oneself. This sense of wonder incorporates the sense of awe on entering, say, a special man-made place, such as a temple or cathedral, and also the sense of respect for a well-crafted product, be it as humble as a chair or a cup.

This respecting awareness of the process of creation which others have experienced (as well as admiration for the product itself) should become a central part of viewing and handling existing products as a stimulus for children's own work. This is a far more positive and enhancing response than 'dis-assembly', which haunted the backwoods of design and technology for a while.

Howe, Davies and Ritchie's insight into the contribution of design and technology to the spiritual well-being of young citizens is important, not just because it proposes a much more central position for design and technology in what might be termed the 'subject hierarchy', but because it is a view founded

on the needs of children, regardless of their future contribution to the economic state of the nation.

By juxtaposing the development of self-esteem and pride in creation with reflection on the made world and the relationship between it and the natural resources of the planet, the issues which design and technology address become big and bold and central to the education of all. This to me is one of the most powerful insights into where education for creativity should go. It takes hold of the spiritual dimension of creativity in one hand and the social responsibility embedded in citizenship education in the other. Rationalism does not allow for close inspection of underlying values or moralities. What *could* be done is not the same as what *should* be done, as Wittgenstein reasoned and his generation discovered.

In a world of increasing globalisation, we need to succour the traditions of the marginalised. Western technology has proved itself short of answers on many issues. This needs airing in our technology curriculum, not leave it to P.S.H.E. and R.E. to provide the alternative (and possibly critical) voice in the wilderness. I would, therefore, like to take two steps further than Howe, Davies and Ritchie to include the insights inherent in non-Western technological traditions and to embrace the issues of responsibility towards both our pupils' immediate, local environment and towards the global, planetary and beyond.

Kimbell and Perry (2001) claim that:

'design and technology empowers us to change the made world … design is not just about change, it is about improvement … Any designed object is the manifestation of a set of values. And the concept of improvement is essentially value-laden.' (p. 3).

They espouse a project-based pedagogy involving:
• unpacking the wickedness of tasks
• identifying values
• creative exploration
• modelling futures
• managing complexity and uncertainty.

In such a pedagogy:

'The pupil is transformed from passive recipient into active participant.' (p. 7)

This is important because it grants to the pupil a sense of personal empowerment. In a culture which increasingly dictates the choices to be made through advertising media, design and technology can attempt to redress the balance, by encouraging pupils to

critically examine products for fitness for purpose, to endorse the personal creativity of each individual and to raise issues of responsibility to society, to the environment, to the safety of the planet.

The wave of the future: Towards a new paradigm
Firstly, we need to clarify our philosophy and be upfront about the difficulty of such a task, accepting help from a wide forum, especially including practitioners. Kuhn stresses that in the pre-paradigmatic phase, many practitioners are frequently working on the same thing from different perspectives. If we are planning a paradigm shift or looking for one that is emerging naturally, then we need to look for the areas of growth. The issues of inclusion and citizenship are currently occupying much print space. Kuhn (1962) claimed that the pre-paradigmatic phase is typified by book-writing, aimed at large and diverse audiences. Once the paradigm is established, practitioners write esoteric papers for each other, in which terms of reference need no longer to be defined.

This leads into the second point. We need to recognise the diversity of opinion and not try to produce a simplistic definition, regarding at least part of our task as fostering creative, divergent thinking. There are currently many teachers both engaged and wishing to become engaged in Masters level, small-scale research. From informal encounters with a local action research group, I have observed that although many of them appear to be researching school management issues, a significant proportion are researching ways of applying multiple intelligence pedagogy, especially at secondary school level. It would not be wise to ignore their findings or their insights – and funding must not just go to those who are researching how to deliver the National Curriculum and the National Strategies better or this will severely hamper pedagogical debate. We need desperately to know *what else works* and to hear from the experts *in* the field, not just those *on* the field.

The now-discarded model of the Kent Agreed Syllabus for Religious Education (Core Units, County Units and School Units) might be a practical way forward in organising the design and technology curriculum, so that all children experience a nationally agreed common core, geographical areas reflect local traditions and industrial needs, whilst also allowing schools to choose areas of study for themselves, thereby utilising expertise of individual teachers.

Thirdly, our new paradigm needs to be socially responsive and educate for reflective consumerism, in the global and environmental, not just the narrow, market-place sense of the term. It needs to meet the present needs of *all* children, not just prepare those who will contribute most positively to the economic status of the nation. It is important recognise the importance of encouraging children's self-esteem through creating pleasing solutions to a specific problem, which will enable them to appreciate the solutions of others, both the creations of their peers and in the made environment at large. It must teach them to discuss the morality of technology, the concept of 'progress', and learn to address more than just the client's needs. By aiming to address the big issues, ethical, social and environmental, whilst trying to solve the specific and particular, design and technology can provide a forum for discussion and reflection which contributes towards education for responsible citizenry.

Finally, a new paradigm must not be prescriptive. It must recognise the creativity and dynamism of designing. In teaching children the rules of the game, it must also give them the freedom to explore bending and breaking the mould. This will only occur 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 and 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. But then technology has always been a leader, a creative force in human development. If the distinction between humanity and our closest primate relatives is in our ability to reflect and make choices, then to educate those in whose hands we are entrusting our future to do so with regard to the technology which they have inherited and by which they are surrounded, will be our greatest contribution to the technological possibilities of the future.

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