THE NATURE OF RESEARCH INTO DESIGN AND TECHNOLOGY EDUCATION

Design Curriculum Matters

Department of Design and Technology
Loughborough University of Technology

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Department of Design and Technology

Design Curriculum Matters Series

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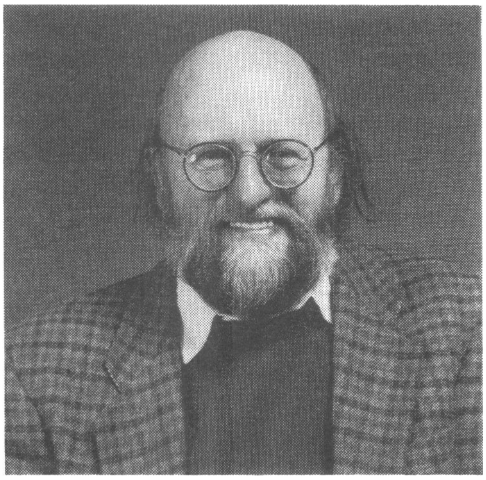

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Principal areas of research interest are: the design of research into design; the design curriculum; design pedagogy, design philosophy (especially epistemology and semantics), design cognition, design educational policy. Published in areas of design education, curriculum, philosophy, and pedagogy.

This is the first of a number of publications to be brought out by the Department of Design and Technology at Loughborough University. The aim of the DESIGN CURRICULUM MATTERS series is to create more helpful links between theory and practice in the field of Design and Technology education.

We have decided to begin with a discussion of the nature of research in the area. There seems to be agreement between practitioners and academics that research is needed. However, it is not always so clear WHAT needs to be investigated, HOW to investigate it or WHO should do the work. Those are the issues we set out to explore in this publication.

We tackle it in three ways. First Bruce Archer addresses the broadest issues of research, making the links between design, design education and the role of teachers in any research programme. Next Ken Baynes looks more closely at the Primary field, reviewing existing theory and attempting to identify the right focus for future work. Finally, Phil Roberts presents an annotated Bibliography covering some of the essential reading that gives access to the 'ideas culture' of design and technology as an aspect of education in the widest sense of that word.

Research is not neutral. It implies a particular attitude to what is being researched. However objective the methods used in an investigation, the values of the researcher are important even if only because they shape decisions about what it is worthwhile to research. Two 'big ideas' certainly inform our own approach.

The first is that Design capability is a universal attribute of human beings and not simply a specialist skill developed by professionals such as architects, engineers, graphic or fashion designers. On the contrary: shaping the environment is an activity in which everyone shares from the moment they are born. The second is that there needs to be a strong link between theory and practice in the field of design and technology education.

There exists a very unhelpful tradition in academic circles that would relegate practice to a secondary status and this is matched by a closely matched tradition amongst practitioners that would characterise theory as irrelevant.

In this publication we take the view that theory needs to develop from practice but that equally practice needs the support of useful and well substantiated theory. One way of achieving this is to encourage practitioners to engage in research and so develop what we might call a 'practitioners theory'. This is a way of working that we have adopted at Loughborough. We are now in the process of establishing a number of research seminar groups where academics and practitioners will work together. Our first group is looking at Primary Design and Technology. Material produced by these groups will be appearing in future DESIGN CURRICULUM MATTERS publications.

THE NATURE OF RESEARCH INTO DESIGN AND DESIGN EDUCATION

by BRUCE ARCHER

Based on the Keynote Address given to DATER 91, the 4th National Conference on Design and Technology Educational Research and Curriculum Development held at Loughborough University of Technology 5-7 September 1991.

This Keynote Address could perhaps have been titled:

'What kind of research is appropriate to the study of education through Design and Technology?'

or even:

'What should be the priorities of an (Inter)national Design and Technology Educational Research and Curriculum Development Conference?'

Strictly speaking, I should be better able to answer such questions at the end of this Conference rather than at the beginning. Nevertheless, there is value in setting out principles in advance of the event. Over the next two and a half days, I am hoping that we will all hear answers, or tentative answers, to questions about Education and Design and Technology posed at all levels of generality and particularity. In order for each of us to put such contributions into context, it may be useful to remind ourselves where we have got, so far, in our understanding of the four key ideas in the title of the conference, that is: Design, Technology, Educational Research and Curriculum Development. In particular, we need to remember how the meanings of these terms are qualified when they are used in combination. This will help us to appreciate the continuing development of Design and Technology, not only as a curriculum subject, with an extensive body of practical knowledge to be taught and examined within specific timetable slots, but also as an educational discipline with theoretical underpinnings having implications for the whole curriculum.

Technology

Let me begin with the idea 'Technology'. And let me get down to absolute basics. One fundamental attribute of human beings - that is, one of the attributes that define creatures as being human - is that they devise and make tools, and use these tools to adapt their environments. Another definitive attribute of human beings is, of course, their ability to invent and use language, but we will return to that later. It is essentially through their ability to make and use tools that men and women have been able to explore their environments; to discover and employ the resources of the natural world; and to create the conditions under which there is time and resource to form, cultivate and express personal, social, cultural and aesthetic values. The activity of toolmaking and toolusing has made possible, and continues to make possible, sculpture, architecture, agriculture, industry, music, writing, printing, computing, scientific experimentation, surgery, communication at a distance, and the recording, for later use, of knowledge, experience and expression. Humankind's collected knowledge about tools of every sort; about the way they work; and about where and how to use them, is what we call Technology. Technology, or knowing-how, in this very general sense, is related to, but different from, Science. Science is knowing what is the case, making informed judgements as to why things are the way they are, and predicting what is most likely to happen in given circumstances. Technology draws on this knowledge and on its own experience in order to make things happen in a desired way. If Science is a *sine qua non* of Technology, Technology is a *sine qua non* of the progress of a civilisation.

It is a pity that, for historical reasons that I do not have time to go into today, our social system, for more than two centuries, has undervalued Technology as a subject of study and banished it to the margins of education. There it remained until the 1970s, by which time the products of technology, and especially the products of Information Technology, had intruded so ubiquitously and dominantly in society that such marginalisation had become untenable. Most me and women in the modern world exercise at least some degree of skill in the use of technology in their everyday life, and many attain an advanced level of performance and understanding. Nonetheless, most schools and universities remained unexcited by the proposition that the acquisition of technological capability should be seen as a central objective of general education. Even in the 1970s, when the Big Bangs of the Information Technology revolution in business were headline news, and the retraining of workers in new technology was a national priority, it took a prodigious effort on the part of many doughty fighters to bring Design and Technology at least into the mainstream of the school curriculum.

Design

If Technology is 'knowing-how', then Design is 'envisaging-what'. The capacity for envisaging a non-present reality, analysing it and modelling it externally, is the third great defining characteristic of humankind, along with toolmaking and language use. The ability of the human being to picture things in the mind's eye; the ability to comprehend the three dimensional configuration of something, even when it is seen from only one viewpoint; the ability to perceive order, pattern, connectivity and causation in complex things or systems; the ability to conceive of a construction or arrangement that will meet a need; the ability to invent, and to image in the mind's eye, something which does not yet exist; the ability to capture such a cognitive model, analyse it, and externalise it through drawings, models, notation or language so as to bring it to realisation or test: such abilities are common to all human beings, in at least some measure. We have seen that Technology rests heavily on Science, from which much of its operational data is drawn, and upon which are modelled many of the intellectual disciplines whereby Technology codifies and applies its experience. Design embodies an entirely different mental discipline. The distinctions are worth noting.

Science is a process. The science process seeks to isolate a phenomenon from the complexities of the situation in which it is embedded, and to abstract generalisable principles from observation and experiment. Much scientific activity is devoted to testing in new ways generalisations that have been made previously. The scientific process itself is subject to strict disciplines calculated to minimise the probability of error in both observations and in findings. On the other hand, there is no insistent demand that subjects for scientific enquiry should be confined to particular categories or that findings should be useful. Scientists are entitled to turn their minds to anything so long as they do it scientifically.

Design, also, is a process. However, Design is directed towards meeting a particular need, producing a practicable result and embodying a set of technological, economic, marketing, aesthetic, ecological, cultural and ethical values determined by its functional, commercial and social context. If we are to sustain a claim that Design and Technology is a distinctive discipline, we must identify the descriptors that set it apart from other disciplines. We can say that Design is:

Useful
Productive
Intentional
Integrative
Inventive
Expedient

The distinguishing characteristics of the Design discipline

Figure 1

Design is described as **useful** to distinguish it from the expressive arts, many of which explicitly deny there is operational value to their expressions.

Design is described as **productive** to distinguish it both from Science, which, as we have seen, is explanatory, and from Humanities, which are reflective, and to place Design in the world of action. Design is always seen as setting in train the production, and the introduction into the world, of some real thing or system.

Design is described as **intentional** to distinguish it from serendipity, or discovery by chance, and to place it in the social and commercial world, where practitioners are obliged to make judgements on difficult and complex issues, and to take decisions in the face of imperfect information and the capricious turns of event that confront everyone in the practical world.

Design is described as **integrative** to reflect the fact that a design has both to be complete and coherent internally, and to be well adapted to the environment in which it will be sold and used. A designer has the right and the duty to employ information drawn from any and every field of knowledge that happens to be relevant to the case in hand. In this sense, the body of knowledge in support of Design has to be regarded formally as unbounded.

Design is described as **inventive** because it necessarily demands the introduction of something new. Whilst it is not completely unknown for a designer to be asked to produce a specification, drawings or data for an absolutely standard, unoriginal product, such a task would not normally merit the description 'design'. The inventiveness of Design is in many ways its most distinctive feature. The word "creativity" is often used in this context. The term 'creativity', however, more properly describes a combination of inventiveness with productivity. Inventiveness itself has many facets. A design may be inventive in a functional sense, that is, it may perform an operation or supply a service that has not been offered before. It may be inventive in the operational sense, that is, it may perform its function in a new and more efficient or more convenient way. It may be inventive in the technical sense, that is, it may embody a mechanism or a construction that has not been proposed before. It may be inventive in the sense of offering aesthetic, stylish or marketing configurations that have not been seen before.

Design is described as **expedient** because design activities are justified by their results, rather than their reasons. In contrast to the overriding importance of orthodox methodology in the conduct of Science, the conduct of Design is validated by its efficacy rather than the rigour of its methods. designers can, and do, on occasion, seize upon chance information, adopt capricious ideas and exercise untidy methods in the course of a project. None of this matters if it delivers a satisfactory result. The two procedures in design methodology that really do need to be conducted rigorously are the procedures for determining the precise design requirements and the procedures for determining the validity of the design result.

Almost the same descriptors can be applied to Technology. The only significant differences between Design and Technology are the relative weights to be attached to the various descriptors, and the range of the fields of knowledge that would be regarded as within their respective purviews. Technologists tend to set less store by inventiveness than do designers, and technologists may well look askance at the idea of expediency. In practice, however, technological activity exhibits both these qualities in various measures from time to time. In respect of fields of knowledge embraced, technologists tend to regard subjective areas of human concerns, such as aesthetics and marketing values, as being outside their areas of direct responsibility, whilst designers are obliged to take these into account.

Design and Technology in the Curriculum

For the purposes of general education, the National Curriculum Council has quite rightly linked the two ideas, Design and Technology, and has defined their combination as a single curriculum area. Rather ambiguously, the authors of the Non-Statutory Guidance notes published in March 1990 describe Design and Technology as 'likely to be taught as a separately timetabled subject in secondary schools', whilst in the same text they define it as 'an activity which spans the curriculum, drawing on and linking a range of subjects', naming Art and Design, Business Education, CDT and Home Economics as subjects drawn upon. Information Technology is dealt with separately, and is seen largely as an instrumental contribution to learning skills and communication skills generally. Design and technological capability, as defined by the National Curriculum Council, is widely seen elsewhere as being analogous with literacy and numeracy. Crosscurricular educational objectives such as literacy, numeracy and technological capability may be just as achievable - perhaps more readily achievable - through the pursuit of common attainment targets in parallel or alternative subjects as through a single subject that attempts to distil, as the Non-Statutory Guidance notes suggest, a variety of ideas and values extracted from a variety of subjects and delivered separately from them.

The parallel with literacy and numeracy is clear from the descriptions given in the Notes of technological capability. Give this parallel, one can note that it is seldom argued anywhere that literacy or numeracy are deliverable through single subjects. The alternative course is the setting of appropriate common attainment targets in parallel or alternative subjects, so that each pupil may develop the essential crosscurricular capabilities through the learning media that best capture his or her interests and that best exploit the school's resources and the teachers' talents. Indeed, as I see it, logistically speaking, there is no way, other than by common attainment targets in parallel and alternative subjects, that education for design and technological capability can be delivered to the majority of the children in the majority of schools. Few, if any, schools can provide enough timetable slots in enough technology classrooms to accommodate the majority of the children on roll. Last summer's GCSE and A-level results in the subjects listed by the Non-Statutory Guidance notes give some idea of the relative sizes of the subject learning resources available today.

		GCSE		A-Level			Total
	Technology:	161,513	+	8,274	=		169,787
cf.	(Art and Design:	209,469	+	31,161	=	240,630)	
	(Business Studies:	82,918	+	15,082	=	98,000)	
	(Home Economics:	129,067	+	3,660	=	132,737)	471,367
							641,154
cf.	English Language:	642,911	+	79,137	=		722,048
	Mathematics:	570,818	+	75,006	=		645,824
	Science:	633,762	+	93,206	=		726,968

Numbers of pupils sitting GCSE and A-level examinations in 1991

Figure 2

Only by harnessing to common attainment targets the resources of all the subjects in the broad curriculum area, numbering last year's 641,154 places altogether, can design and technological capability be delivered to sufficient numbers of pupils to compare with the other key National Curriculum areas.

Curriculum Development

We thus confront one of the most critical issues affecting the future of Design and Technology: Intersubject collaboration in curriculum development. Several educational research reports published in the 1970's argued that major curriculum change can only be brought about by research and curriculum development carried out by teachers in schools. Change agents brought in from outside seldom had lasting influence. However, A V Kelly, writing in the 1980's, noted that trying to encourage teachers to act as in-school change agents, and helping them to make curriculum changes stick, was much easier said than done. If and when an instance of curriculum change entails, as the National Curriculum Council's notes can be interpreted as entailing, the annexation by one subject of ideas and values cherished by others and/or the superimposition of common attainment targets on hitherto autonomous subject specialisms, then change agency is even more of an uphill task. Being an agent for change demands skill in three separate arts: educational research, curriculum development and advocacy. Intending change agents needed training in these arts. Moreover, getting the other teachers in the school to appreciate new ideas, assimilate new information and acquire new skills is, in fact, teacher development. Teacher development demands time, resources and commitment. The advancement of Design and Technology demands such resources more, perhaps, than any other.

Educational Research

One of the factors identified by Kelly as inhibiting school based educational research and curriculum change was the difficulties he had others had encountered in converting good teachers into good researchers. In fact, this is not a characteristic observable only in teachers. Most practitioners find it hard to set aside their practitioner values and skills in favour of researcher values and skills. Managers generally make poor researchers. So do airline pilots. So do film directors. Even doctors, despite their close reliance on the output of medical science, are not usually very good at research. It is not surprising that the same has to be said of teachers. There are absolutely fundamental differences in priorities and attitudes of mind between practitioners, who are obliged to take decisive and early action, whether they are in possession of perfect information or not, and researchers, who are obliged to remain sceptical indefinitely, even when the information before them appears to be unequivocal. Many practitioners are unaware of these differences, or are unwilling to acknowledge them, and blunder into research without the necessary mental set. Even where they recognise the need to acquire the necessary skills, teachers may be ill served by having the wrong model of research exposed to them. Much of the training offered in post experience courses in education is dominated by training in the methods of historical enquiry. For teachers of subjects in the Design and Technology area of the curriculum, such a model is even further removed from the mental set they have properly acquired in the practice of teaching than is the more familiar science model.

The designerly approach

Fortunately, an alternative model is to hand. A designerly approach, rather than a scholarly or a scientific approach, can with advantage be made towards educational research and curriculum development. Design, in a certain sense, is research done backwards. Research starts with the particular, and moves towards the general. Design starts with the general and works towards the particular. Designers are told, or decide, at the outset, what their end product must be and do. They begin by conceiving of one or more broad configurations that seem likely to be, and to do, what is required. They then elaborate the structure of these configurations and develop the subsystems of one or more of the most promising proposals. They then detail the construction, working backwards to the particular, the bits and pieces, upon whose correct construction depends the efficacy of the whole. At various stages, the validity of assumptions is checked and performances are measured. The same basic design process can be, and is being, applied to the development of all sorts of artefacts and systems that have not hitherto been thought of as subjects for design. For example, providers of banking and other financial services now speak of their products (that is, charge cards, insurance policies, etc) as having been designed to meet the needs of given classes of the user. Curricula, courses, lessons and examinations are thus proper subjects for design. Happily, the National Curriculum Council's attainment targets provide ready-made design requirement specifications. A designerly approach to curriculum or course design might be to ask:

'What sort of capability profile would a pupil need to exhibit in order to be seen to have attained the target in question?"

and then:

'What are the categories of knowledge, skill and values that contribute to such a profile?'

'What are the components of each category?'

'What kinds of learning experience are likely to imprint each of these components of knowledge, skill and value?'

'How can such learning experiences be provided?'

and so on, from the general to the particular, down to exercise design, performance assessment design and resource allocation. There is every reason for teachers of design and technology to use the techniques with which they are familiar to attain the objectives to which they are committed.

I opened this address with the question:
'What kind of research is appropriate to the study of education through Design and Technology?'

My answer has been:
'The designerly mode of enquiry is entirely appropriate to the study of education through Design and Technology. It is also less prone than are scholarly or scientific modes of enquiry to distortions arising from conflicts between the mental set of the practitioner and the mental set required of the researcher'.

That is not to say that scholarly and scientific research methods do not have their proper place in educational research. I do say that scholarly and scientific methods need to be executed by people properly trained in their employment.

Design as learning

There is one important issue that I have not touched upon so far. In the 1970s and 1980s, cognitive psychologists working at the Department of Design Research, Royal College of Art, in collaboration with mid-career teachers studying in the Design Education Unit at the College, identified a close relationship between the mental activity of designing and the mental activity of learning. The design process is a special application of the learning process. This led the mid-career teachers in the Design Education Unit to explore two possibilities: that design activity might provide a suitable vehicle for learning in selected subjects in the curriculum, or that the enhanced learning capability apparently engendered by experience in the design subjects might facilitate learning in other subjects. Some evidence was produced in support of both propositions, but this research ceased when both departments were closed under the Royal College of Art's reorganisation programme in 1985. Both Professor Ken Baynes and Professor Phil Roberts were in turn Head of the Design Education Unit at the College before it closed, and have carried on the work elsewhere since then. The implications of the findings of these studies are important. First, this evidence supports the proposition that imaging capability is, indeed, a fundamental human characteristic, ranking with language use and toolmaking in defining the human being. Second, it supports the proposition that design and technological capability ranks properly with literacy, numeracy and science awareness as the key crosscurricular areas in the National Curriculum. Third, it gives weight to the argument that education in design and technological capability can and should be delivered by the setting of Attainment Targets that are common to a range of contributory curriculum subjects.

This really gives my answer to the second question with which I opened this address: 'What should be the priorities of an International design and Technology Educational Research and Curriculum development Conference?' In my view, such a Conference must have high on its agenda:

1 Contributions to the development of theoretical underpinnings for Design and Technology identifying it as a distinctive and fundamental discipline having implications for the whole curriculum.

2 Studies of the nature of design activity and the nature of technological activity, at professional and at school levels, respectively; and arising therefrom, the identification of the attainment targets for design and technological capability in schools, appropriate to pupils' various age and ability levels.

3 Studies in the logistics of engendering design and technological capability to the majority of the pupils in the majority of schools.

4 Contributions to the study of the implications of setting up common Attainment Targets for design and technological capability in parallel or alternative subjects across the curriculum, calculated to make it possible for each pupil to acquire design and technological capability

through subject specialisms that best capture his or her interests and that best exploit the school's resources and the teachers' talents.

5 Studies in the types of learning experience that contribute most effectively to the development of various aspects of design and technological capability.

We all have a lot to learn together.

RESEARCH INTO PRIMARY DESIGN AND TECHNOLOGY

by KEN BAYNES

At the outset it is important to distinguish between two diametrically opposed views of design and designing. These are:

1 That designing and understanding design is a highly specialist, complex and esoteric thing which people can only do after a long apprenticeship and

2 That design ability - the ability <u>to</u> design and to <u>understand</u> design - is, like language ability, something that everyone possesses at least to some degree.

The common sense view is the second one. It is borne out by ordinary experience quite as much as by a growing weight of evidence now coming from psychology.

All small children display a high degree of design and technology ability and use it in their play even when it is neglected in formal education. This is hardly surprising because some knowledge of design and technology, however acquired, is needed for survival and a rich experience of life.

We all, for example:

1 Try to create a home environment which reflects our aspirations;

2 Use tools and materials purposefully in cooking, gardening, do-it-yourself, dressmaking and hobbies;

3 Make judgements about the places and things we like or dislike attempting to say why;

4 Find ourselves moved and excited by fine things that other people have made;

5 Choose to wear clothes which make us feel at ease, which we believe are 'like ourselves';

6 Respond to the visual messages of places, things and messages.

From the moment they are born children are curious about their surroundings and very soon begin to influence them. Babies use their sense of sight intelligently but they also rely on sucking and holding as important ways of learning about their surroundings. At first, they focus very largely on people. Gradually, however, they begin to be curious about and take pleasure in the world of things. They enjoy the fact that different materials provide different sensations and that handling toys can be surprising and entertaining. From this pattern of early activities, the human mind is structured so that people quickly develop the desire not only to understand their physical surroundings but to modify, organise and control them.

Children learn a great deal about design and technology before they go to school Growing up in surroundings that are natural or designed, leads to a basic awareness of space, shape, colour, texture and taste. At a very early stage, the human kind has learnt how to interpret the mass of information that bombards our senses. By the time children are crawling and walking they have a new freedom to explore the world independently and a new appreciation of the qualities of space. From the start, children are active agents of their own learning.

The development of personality is, of course, most deeply embedded in relationships with people but it is also expressed in personal likes and dislikes. It is not long before children want to find ways of expressing their own preferences. They may take a liking to a particular pair of shoes, a certain food, even a special place in which to play. They begin to exercise control over the material world that surrounds them.

Children learn about design and technology by exercising their own ability to choose. They also learn from watching other people choose and imitating them. They grow up in surroundings where design decisions are being made as a part of everyday life. Parents are planning changes to their house, deciding how to improve the garden, discussing what clothes to wear for an outing to the seaside. Children see and understand that in order to make something - let's say a cake - you need the right materials, tools and equipment. They experience the drama of the oven which uses heat to transform the materials from one state into another. Children come to the Infant classroom with a wealth of experience in design and technology and a strong desire to engage in it.

Children quickly learn that there is an important relationship between what people do, the places where they work the clothes they wear and the equipment they use. Their experience is lived out in play. The child can become a bus driver, using a toy steering wheel to get along safely and issuing the tickets from an old biscuit tin. Or there is a model bus and this is pushed with grr-ing noises along the carpet road. Play takes a great variety of forms, many of which are directly relevant to design and technology. It can be about understanding the purposeful relationship that exists between people, places, objects and the work we need to do in order to live our lives. It often involves using tools and materials, making models, rearranging equipment, creating environments and pretending to be someone else.

The significance of these pointers to the capability of children as designers are summarised in the diagram opposite. This view of children is widely accepted by Primary teachers. It conforms to their own observations of what children can actually do and say. However, it is useful to supplement this direct experience with a theoretical perspective. What research evidence exists for the proposition that young children have such a high level of design capacity?

Children as Designers

* Children have in-born ability in design and technology.

* They are curious about their environment and at a very early stage want to influence and change it.

* At a very early stage, children begin to exercise choice about made things, choosing food, clothes, toys and things for their own bedroom.

* Children can imagine themselves into strange places and 'be' in other people's shoes. Often they can do this more readily than adults.

* Children have a direct, concrete relationship with their surroundings and for them this is a major way of learning about design and technology.

* Children use role-play, games and toys to 'enact' and so learn about the made world and its relationship with people.

* Children want to know how things work and want to make things that do work.

these physical or 'design' phenomena into a meaningful pattern is active a long time before the ability to name them.

Further evidence for the validity or the Gestalt view can be found in what people have actually made. There is a clear and direct link between the perceptual predisposition and the design output of human societies. Here again proximity, sameness, closure, symmetry and contrast (amongst others) are qualities that can be seen in buildings and products from all cultures. Rather as with the world's languages which are hugely varied but which all display the underlying logic and form of language, so too with designs. Designed things exist in extraordinary variety but all exhibit the underlying logic and form of the made. We would never, for example, mistake a made object for a natural structure. So finely tuned is our design intelligence that it could never make such a mistake, any more than our linguistic intelligence could mistake birdsong for a poem even though exactly the same senses are involved.

Multiple Intelligence

In his book Frames of Mind, Howard Gardner (1984) discusses the idea of 'multiple intelligence'. He describes the growing biological evidence for locating certain kinds of thinking and feeling in particular parts of the brain. Although it is clear that the brain has extraordinary recuperative powers and that it can shift functions around to circumvent damage, it is also clear that this work of substitution has rather strict limits. There is a physical developmental process called 'canalisation' which has the effect of confirming and crystallising paths of use and custom in and between the different areas of the brain. It is rather as if a highway were to be made wider and its route more fixed directly by the passage and amount of the traffic using it. After a certain point, different for different functions, the route becomes permanent and cannot be changed or replaced.

Gardner argues that with this new biological understanding goes a change of philosophical approach. In the immediate past, the common view has been that all 'intelligence' is really the same thing - a particular style of thinking and reasoning which we apply to widely differing activities. We can see that this idea has had a powerful influence in education where, for example, problem-solving has been identified as a fundamental human strategy discoverable in every school subject. But with the strong physical location of different functions there has developed the concept that different kinds of intelligence actually depend on the existence of distinctive kinds of mental processes. Howard Gardner is quite clear, for example, that spatial intelligence involves its own perceptions, depends on its own 'language' and is expressed in very particular behaviour. It also relates to a particular side of the brain.

If we were to attempt to characterise 'design intelligence' in this way, we might argue that:

1. it is speculative, directed towards imagining changes in the human environment or places, things and messages;

2. it exists because imaging makes it possible to form an internal 'representation' of imagined changes;

3. it exists socially because physical models can be used to form an external 'representation' of imagined changes - these are its language, the medium through which it finds shared expression that leads to social action; and

4. its content is determined by the 'rules' of human perception and these perceptual boundaries are vividly re-expressed, perhaps reinforced, in the environmental change that people imagine and in the places, products and messages they create.

Chomsky

When dealing with any aspect of human intelligence it is useful for teachers to be able to distinguish between the inevitable development of an ability and what can be done deliberately and consciously to aid its growth. An analogy between language and design is useful here. Any baby growing up in an environment where people are talking will learn the use of language. As Noam Chomsky (1968) puts it, humans have a 'language acquisition device'. Language is 'wired in' to the human mind; people are predisposed to learn to speak. Recent work on perception and child behaviour shows that babies learn to react intelligently to the world of objects and space even before they can speak. What is more, they very soon take pleasure in making the environment react to their wishes. They do this not only for survival but also in a spirit of playfulness, by themselves and with other people. Humans have a 'wired-in' predisposition to explore and change their environment. They have, if you like a DAD of 'design acquisition device'. In the case of language, however, it is well understood that this development process will fall far short of human potential if this is not deliberately fostered by education and supported by play activities that make sense to the child. For the rudimentary language acquisition device to grow into an effective and consciously available tool for thought and social discourse it requires the mutual exchange of learning, teaching and taking action.

Exactly the same is true of the wired-in predisposition to interpret and shape the environment. Unless it is deliberately fostered through teaching, learning and action, access to it will be lost by those who once possessed it. They will grow up dumb in this respect, unable to communicate effectively with themselves or other people about this aspect of life. To some degree this has been well understood by parents and teachers. The almost universal existence of toys demonstrates one of the ways in which different cultures have encouraged small children to engage with objects. In the home, mothers seem always to have invited children to join in domestic, environmental work and have done this not only as a necessity but as a vivid kind of informal education.

Psychoanalysis

Psychoanalysts have provided a broad interpretation of nurturing that identifies the mother as the child's first environment. A purposeful awareness of her geography - and by analogy other geographies - comes from this first interactive relationship with a world separate from the self. The elements of time, space and physical form (fundamental to all design awareness) are, in the mother's body, brought vividly alive in the cycle of hunger and its satisfaction.

It seems very likely that these deep emotional roots in aesthetic experience are absolutely fundamental to all adult perceptions of form, space, colour and texture. They link again with the world of Gestalt.

Vera Coghill (1987), a nursery school teacher and designer who has studied the design ability of very young children, has seized on the significance of Winnicott's work on the 'transitional object'. She recognises, in his analysis of the particular attachment of a child to a beloved thing, the emergence of that special sensibility towards the environment that enables people to create places and products that combine symbolic meaning and practical utility in a single entity. From a modest beginning in a magical shawl or teddy, it expands into the extraordinary ability of human beings to attribute emotional and spiritual meaning to architecture, works of art and products of every kind.

Educational Pioneers

In this context of nurturing, it is significant that both Pestalozzi and Froebel saw in 'caring mothers' the best model for the primary school teachers of the future. Froebel's 'mothering made conscious' was partly based on his observations of the way in which peasant mothers drew children into the world of their work and encouraged them to learn through this experience. The provision of a rich learning environment at school was emphasised by Froebel who also called for 'light, airy, classrooms'. This pioneer thinking gradually became accepted so that a early as the 1870s there were kindergartens inspired by these ideas established in working-class districts. By the 1890s the approach was adopted as official policy by the Board of Education. Before the First World War, Rachel and Margaret McMillan set up garden and camp schools in south-east London where the child's curiosity about the physical world was given a central place in the pedagogical strategy. Between the wars ordinary practice absorbed more and more of the 'modern' ethos. And after the Second World War, primary schools were deliberately designed with windows on the outside world and made full of learning materials to do with 'proximity, sameness, closure, symmetry and contrast'.

When he fled Nazi Germany and designed Impington Village College in Cambridgeshire, Walter Gropius provided Britain with an architectural model for the future learning environment. They represented the fruits of a hundred years of educational thinking.

Jean Piaget and Margaret Donaldson

The early pioneers emphasised playing with the environment for its own sake. But in accepting the importance of physical, tactile, sensual development they seem to have forgotten a further step: that shaping the environment is an active cognitive process in which reason and speculation are also involved. It is as though these pioneers were teaching half of an experience, encouraging children to listen to sounds and to make sounds, but not to turn the sounds into words to create stories, poems or songs. The children encountered the world of objects, they played with and drew and modelled natural things, they handled clay, sand and water (and sometimes even fire), but they were not asked to use their experience to make a world of their own. They were not shown that people everywhere had used exactly these resources to bring about changes in places, products and communications, and that they could do the same.

Educationalists have not been good at recognising the cognitive aspect of design. They tend to see cognition as the preserve of science. Since design links the qualitative and the quantitative, it has tended to be neglected in schools. Design questions cross the boundaries between the arts and sciences and therefore pose problems for curriculum planners.

It may be that Piaget's influence has helped to keep these designerly questions out of primary classrooms. In Piaget's studies we are confronted by work that seems to demonstrate the essential self-centredness of young children's perceptual experience. Piaget himself suggested that pre-school children are incapable of imagining viewpoints other than their own. He tried to show that they have an understanding of time that is like a relatively unconnected series of film stills. However, Margaret Donaldson (1978) has challenged Piaget very directly in her book Children's Minds. She says that provided the social setting makes sense to them, children of this age can in fact 'de-centre' effectively and so can imagine the situations and experience of other people. For the idea of design this is a crucial issue because to have design experience it is essential to imagine alternative worlds and to foresee the possibility of change taking place through time.

Piaget placed such importance on the scientific, rational mode of thought that he put it at the pinnacle of his model of the child's development. His books are really a study of the way in which this particular 'frame of mind' emerges and becomes available to the child. Inevitably, other frames of mind appear in a rather distorted form when viewed through this teleological telescope. In his fascinating discussion of the child's developing understanding of the environment, Piaget concentrates on the growth of scientific analysis and not on the ability to shape the environment or imagine the existence of alternative environments. It will be important to re-work Piaget's environmental observations to give proper weight to this 'shaping' aspect of the child's intelligence.

In my own work on the Schools Council Art and the Built Environment project, I became convinced that even six and seven-year olds can make realistic and enlightening critical judgements about towns and buildings and that they can de-centre sufficiently to engage in design activity.

This brief summary of the evidence about the design and technology capacity of Primary children might seem to suggest that it has been well studied and understood, but one truth is otherwise. Although there seems to be general agreement that the capacity does exist, we do not have in the field anything comparable to Piaget's work on scientific understanding. Neither is there anything like the detailed analysis of the development of children's drawing which traces the emergence of scheme from purposeful 'scribbles' and the refinement of these into a versatile means of communication. We know little about young children's understanding of buildings, products and machines or where they get their ideas about such things. What do small children know or feel about tools and how do they use them? The answers are not readily available.

It seems to me that educationalists have recognised that children learn a great deal through the medium of an active engagement with tools, materials and the environment but not how they learn about the very tools, materials and environments which are the raw material for their learning. Seeing the situation in this light, perhaps demonstrates why further research is so important. Not only will it throw light on design and technology but also on the whole learning experience of young children.

Where should we begin? The first essential must be to engage in a great deal more close observation of children. This should include what they do at home and in play away from the influence of adults as well as what happens in the classroom. It seems that children have always engaged in what I like to call 'designerly play' and I believe we will gain a lot from trying to understand it better.

But what are we looking for? Here it is useful to refer back to Bruce Archer's characterisation of design as being:

USEFUL
PRODUCTIVE
INTENTIONAL
INTEGRATIVE
INVENTIVE
EXPEDIENT

These relate well to my own attempt to describe the nature of 'design intelligence'. Relating it more closely to the experience of children, we can say that it:

<u>Is Speculative</u>, to do with shaping the future of places, things and messages (children do this in their own worlds of play, home and school).

Uses Imaging and Modelling, to generate and communicate ideas and proposals about the future of places, things and messages (children use imaging and modelling in their play and with their parents and teachers).

Gives rise to social action to bring ideas to reality, often using tools and materials to shape new places, things and messages (children organise their own social world in play and relate to the adults world of social actions at home and school).

Is constrained both by the way the human mind perceives and imagines and by the practical limitations of resources, technological know-how and the laws of nature. (We all, children and adults, share the existential frustration of being limited by mind, body and environment.)

To grasp this vivid nexus and its reality in the experience of children we will need to study it as an active and changing phenomenon in which children are disposed to be the agents of their own learning.

DESIGN IN EDUCATION:
A SELECT BIBLIOGRAPHY

by PHIL ROBERTS

(Prepared for a first seminar meeting of mid-career research students)

The object behind this list of readings is to introduce students who are beginning research studies to something of the stream of ideas relating to the deliberate rethinking in recent years of design in education.

I am not identifying 'design' with any single school subject, nor with any well-established subject writ large. Indeed, there is no necessary connection between design and the school curriculum.

It is prudent similarly not to identify design with the depiction of the activity - whether that depiction is to be understood as designerly activity or as technological activity - that is at the heart of National Curriculum Technology. There is a reason for this caution in the face of such a potential red herring: an unexamined acceptance of National Curriculum Technology may lead to a failure to distinguish between the nature and status of, on the one hand, research enquiry into the fundamental bases of the phenomena of design and, on the other, the implementation of policy.

Let me elaborate briefly. The essential design research agenda - and, by extension, the design educational research agenda - is the perennial research agenda. It is to do with the nature of the design capacity; with the development of design ability; with the phenomena with which we treat when we are 'designing'; and with the relations between these and, further, teaching and learning. The introduction of National Curriculum Technology does not necessarily introduce any substantive change into that. What the introduction of National Curriculum Technology may introduce, however, are problems deriving from the requirement of implementation. That is, problems may arise precisely from the demands to achieve specified end-states of policy. The imperatives of the implementation of policy do not necessarily coincide with the imperatives of fundamental, nor even of applied operational research and development, research. But further: the National Curriculum version of Technology introduces, first, a view of the design field, of designing, and of technology which, whatever its possible merits, is philosophically and therefore operationally partial; and second, displays a view which is ideologically based and thereby philosophically problematic. Third, National Curriculum Technology brings into being a range of issues which arise directly from the requirement of implementation.

It is this third point which is perhaps the one with the greatest potential for hindering progress in fundamental and scholarly research (as well as operational research and development activity). It is easy to accept that the process of working towards policy objectives may throw light on fundamental issues. But the essential focus of implementation is not on enquiry into and the analysis of fundamentally problematic phenomena: it is on implementation; and implementation is a condition in which the perennial research agenda may remain untouched. This is not surprising: the receivers of policy - the practitioners in the field - are required to implement policy objectives. Never mind that the policy may beg the philosophical and operational questions: the object of implementation is a match with specified objectives, not questioning of the well-foundedness of policy. Moreover, even were the distinctions between problems located in a fundamental research agenda and those which arise from the required implementation of policy more frequently distinguished and less rarely conflated, it is not as simple even as that: policies are predicated on ideology.

Public policy and ideology may have an obvious connection but are rarely explicitly distinguished. Even more rarely is the ideological basis of much public policy made clear. Research projects which may be established to support the implementation of policy are also obliged (if they wish to continue) to work within the ideological framework.
On this view, the introduction of National Curriculum Technology can perhaps most usefully be understood as an episode in the continuing cultural evolution of design in education and society. *The implementation of an ideologically-loaded policy does not necessarily diminish, or remove, or resolve any of the perennial and fundamental design research agenda.*

Indeed, there is always the possibility that the introduction of any putative 'reform' may burden further that research agenda. That some development work may intersect with research, both in its process and its subject matter, serves to illustrate this proposition rather than to alter it. The nature and logics of research activity and the nature and logics of the implementing of public policy are different. Research agenda 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.

This digression arising from the introduction of National Curriculum Technology is longer than I intended. I merely wanted to indicate the existence of a well-filled trap which waits for the unwary: of failing to recognise that the ideological dimension of policy is itself part of any research agenda.

To return, then, to the stream of ideas of the opening paragraph. It may also be that not only are some <u>ideas</u> influential, but also <u>attitudes</u>. For instance, creative discontent suggests an attitude rather than an idea, and such an attitude may be influential as a stimulus to rethinking and developing taken-for-granted practice and theory. Attitudes are also evident in the missionary zeal of those who wish to promote some ideology. Our stance should be, rather, both committed and disinterested: the object, as researcher, is to know and understand better, rather than persuade.

You may think this a long list of readings. My response to that is to say that it could be, properly and more adequately, much longer. Do not, however, panic or despair; no need, either, to run to the library. You are not expected or required to read all of them, nor even all of any one. There is some repetition: that is deliberate; and many can be scanned quickly. More perhaps to the point is the fact that some of the papers are not readily available in libraries: I have copies of all the papers - and more - when you want them. But remember: the object of your reading is simply to become more familiar with the stream of ideas, that is all. In any case, you will have your own suggestions of readings - those which have been significant for you - and you may wish to offer these to others. Such additions, incidentally, will illustrate the diversity and the extent of possible reading. They would show, too, that this list is, after all, very select.

1 'Design education' entered the educational vocabulary some 20-25 years ago. This is not of course to say that no designerly activity had occurred in schools and colleges before then. The use of the term referred, for what was the small minority of innovators, to a belief that conventional practice was in need of some major review and development. Essentially, what was beginning to emerge was a conceptual re-tooling which would accompany developments in curricula, courses and pedagogy. 'Design education' was not to be simply an addition to conventional subject-based conceptions and practices; and it was certainly not to be subject-bound. There was no suggestion, either, that any single specialist school subject represented the exemplar of design in education. Central to the ideas culture was, I believe, a conviction that the curriculum in general education should be encountered by pupils (and their teachers) as possibility. And central to that conviction were, and are, the propositions that learning entails the

making of meaning; that this process is in an active relation to worthwhile questions that arise out of the experience of lived situations; and that, on this view, 'the curriculum' ought to enable the emergence of, or provide, occasions for individuals to act, and to reflect on their acting, in and on the world. Implicit, of course, must be the notion that conventional curricula and pedagogy were inadequate, but susceptible to development.

2 The Royal College of Art was commissioned in the early 1970s by the then Secretary of State for Education and Science to undertake a survey and enquiry into the phenomena of 'design education'. Its Report must be essential reading. The research team reported in 1976; some definitions were offered. 'Design' (it said) could 'be used to categorise a range of activities and disciplines within the educational spectrum, to distinguish them from other ranges such as those of 'Science' and 'Humanities', thus:

> The Design area of education embraces all those activities and disciplines which are characterised by being anthropocentric, aspirational and operational; that is, that are man-related, that have a value-seeking, feeling or judging aspect, and that have a planning, making or doing aspect.

Disciplines such as art, handicraft, home economics and technical studies tend to form the broad middle ground of the Design area in schools.' (Part One, p 44)

It went on,

'The term 'design', in the educational context, can also be qualified to define it as an area of man's concern, thus:

> Design awareness is the consciousness of the issues of the material culture and of the products and the values of making and doing, together with the ability to understand and handle ideas related with them,'

And, 'It can also be qualified to define it as an area of man['s competence, thus:

> Design activity is the exercise of the set of skills useful in planning, doing and making.

The whole field of design in education can therefore be defined at any of these levels of generality, thus:

> Design education is the set of formal and informal experiences effecting the transmission of the body of ideas, information and technique which constitutes the received state of knowledge of the material culture, and of the arts of doing and making at a given level of generality, and within a given field of relevance.'
> (ibid, pp 44-45)

These are useful starting points (and it is important to accept that they were definitions offered when they were [the mid-1970s]).
They were helpful definitions but they did not dissolve some of the most challenging conceptual disagreements. (Again, it's worth noting that this is an historical process; it is not legitimate to fault them by using later understandings.) My own view at the time was that they were too narrowly operational ('planning, doing and making'), so that the

interpretation might well be along the lines of, 'Provided the pupils are making things they must be - clearly - engaging in design activity and, presumably, design education activity'. This seemed to me to beg precisely the questions that should be being addressed: whether, for instance, to be making things was necessarily to be engaged in an educational activity. 'Aspirational and operational' seemed appropriate characterisations, but 'anthropocentric' not. Even in the early 1970s - indeed especially in the ecologically aware 70s - this seemed unwarranted arrogance in its apparent placing of man at the centre: anthropological (and anthropocentric in a sense yet to be determined), aspirational and operational seemed more educationally appropriate. Following that, the shorthand of 'planning, doing, and making' appeared in need of extension: to 'planning, doing, producing, and being', thus locating designerly activity in the larger, existential and value-laden context of human action and the human condition. Apart from these reservations, it was impossible to accept that a model of would-be educative activity based, apparently, on the making of things was self-evidently the most appropriate model for educational practice: it seemed to be a particular low-level model which was being offered as though it were a model at a high level of generality. A model at a higher level of generality would be able to subsume artefact production, and especially if it were based on the notion of designing-as-changing - that is, changing states of affairs 'out there', and changing some aspect of 'the designer's' capability and sensibility via the agency of the designerly activity. Such a model would also point up the crucial and valuable distinction, when thinking of 'outcomes' of the activity, between means and ends. There is, after all, a profound difference between seeing the intended outcome in terms of artefacts or some change in the student's competence or understanding.

3 These readings are among those that may be found to have something helpful to say towards making sense of the complexity of relating design phenomena and design in education. They may appear a pretty eclectic collection; they are certainly not an exhaustive collection; and they do not provide a sufficient specialist introduction to any particular area (eg, design methods, design epistemology, child development, cognitive modelling). That kind of specificity would, I think, come later and arise from individual research programmes. There is one general point that might be helpful: provided you have some kind of guiding focus for your reading (as offered by, say, a set of key questions), reading across a wide range of specialist fields can be related and kept under control. In other words, these readings offer the possibility of a number of perspectives and insights across a range of fields to me because my set of key concerns provides an underlying and unifying framework. But in any event, it is not realistic to confine reading to one area, nor to a low level; it is necessary, as well as more enjoyable and refreshing, to shift between levels and across fields.

Some of the key notions are therefore pursued and, to an extent that is variable in quality, something of their enactment or influence is illustrated in some of the case account material.

Among the omissions are some that are intended: cases of special pleading (they are always partial, and often innocently ideologically loaded); arguments by assertion; official publications: such publications may be necessary reading, but may be shaky from an academic point of view; subject-bound articles; subject associations' journals. There remain, of course, differing conceptions and emphases: that is fair enough. We can talk about specialist and professional associations' journals when we meet. We can also talk in due time about the kind of research approaches that may be most appropriate to the phenomena of design and to the subject matter and emphases of individual enquiries.

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[This GCE A level course is the successor to the innovative 9883 Design syllabus which was pioneered in the 1970s. There are other A level syllabuses and examinations but this one reflects particularly closely the thinking of those curriculum innovators who wished to develop a design-based course.]

Arnold Pacey, The Culture of Technology, Oxford: Blackwell 1983
[A brilliant but largely unknown book: much of it applies to Design (the terms Design and Technology could often be used interchangeably in it); and there are excellent chapters which, pursued, could lead to some radical transformation in mainstream conceptualisations of design and designing.]

Victor Papanek, Design for the Real World, London: Paladin 1974
[First published in 1971; later editions available; irritated considerably many of the design establishment; radical, slightly tiresome in its polemic here and there, but its ideas were never more topical than now.]

Michael Polanyi, Personal Knowledge, London: R & K Paul 1972
[Do not attempt to read it all: read chapter 4, which is an excellent discussion of the nature of skills, or degrees of skilfulness.]

Karl R Popper, Conjectures and Refutations, London: R & K Paul 1972
[Justly famous, and widely influential; another 'good read'.]

Neil Postman and Charles Weingartner, Teaching as a Subversive Activity, Harmondsworth: Penguin
[Radical polemic, balanced by Postman's later Teaching as a Conserving Activity; both still worth scanning.]

Norman Potter, What is a designer: things, places, messages, London: Hyphen (3rd edn) 1989
[Brilliantly fresh; wonderfully allusive style.]

David Pye, The Nature of Design, London: Studio Vista 1964 (but see the later version which combines this with The Nature of Art of Workmanship) [Worth sticking with: excellent, for instance, on the nature of function and on such easy slogans as 'form follows function'.]

William A Reid, Thinking about the curriculum: the nature and treatment of curriculum problems, London: R & K Paul 1978

Horst W J Rittel and Melvin M Webber, 'Wicket Problems'. in Cross et al
[A much-published article, worth reading.]

Carl R Rogers, On Becoming a Person, London: Constable 1967

Phil Roberts, Design Examinations at 16+: Discussion and Proposals, London: RCA DEU 1982

Phil Roberts, 'Design is for Everyone', Studies in Design Education Craft & Technology, Volume 11 Number 2 Spring 1979, pp 73-75

Phil Roberts, 'Beyond Ideology: Retrospect and Prospect', Studies in Design Education Craft & Technology, Volume 14 Number 2 Spring 1982, pp 84-89

Phil Roberts, 'Learning to Mean', Design Studies, Volume 3 No 4 October 1982, pp 205-211

Phil Roberts and Bruce Archer, 'Design and Technological Awareness in Education', Studies in Design Education Craft & Technology, Volume 12 Number 1 Winter 1979, pp 55-56

Gilbert Ryle, The Concept of Mind, Harmondsworth: Penguin 1963
[This reading, like so many others that become necessary, takes you into another specialist field - in this case, philosophy and, more particularly, the theory of knowledge and a theory of the mind. Chapter I and II however, are important: I deals with the myth of Descartes' doctrine of the separateness of mental and physical existences; II is a most useful discussion and clarification of the distinctions between 'knowing how and knowing that'. Essential reading. All you may need to remind yourself of is that you

are not required to become an academic philosopher; but that does not and should not stop you reading the work of such specialists.]
Donald Schön, The Design Studio, London: RIBA 1985
John R Searle, Speech Acts: An Essay in the Philosophy of Language, London: Cambridge University Press 1969
Howard Sharron, Changing Children's Minds, London: Souvenir Press 1987
Lawrence Stenhouse, An Introduction to Curriculum Research and Development, London: Heinemann 1975
David Thistlewood (ed), Issues in Design Education, London: Longman 1990
[A collection of essays which balances those in Eggleston (1988), and more toughly refereed.]