A framework for Design and Design Education

A reader containing papers from the 1970s and 80s

Professor L Bruce Archer
Ken Baynes
Phil Roberts

DATA
THE DESIGN AND TECHNOLOGY ASSOCIATION

Loughborough University

A Framework for Design and Design Education

Bruce Archer
Ken Baynes
Phil Roberts

A reader containing key papers from the 1970s and 80s

Design Education Research Group,
Department of Design and Technology

Loughborough University

DATA
THE DESIGN AND TECHNOLOGY ASSOCIATION

First published 2005 by DATA

The Design and Technology Association
16 Wellesbourne House
Walton Road
Wellesbourne
Warwickshire
CV35 9JB

ISBN 1 898788 78 2

Contents

The Authors

Bruce Archer CBE, Dr RCA, Hon DSc, CEng, MIMechE

[1922 – 2005]

Served Scots Guards, 1941-44; City University, 1964-50. Various posts in manufacturing industry, 1950-57. Lecturer, Central School of Art and Design, London 1957-60. Guest Professor, Hochschule Für Gestaltung, Ulm 1960-61; Research Fellow, later Professor, Royal College of Art 1961-88, Head of Department of Design Research RCA 1968-86; and of Design Education Unit. Director of RCA Research 1985-88. Member: Design Council, 1972-80; International Science Policy Foundation from 1979; Council, Association of Art Institutions. Chairman, Confederation of Art and Design Associations 1981-88; Director, Gore Projects Limited 1982-90; Design Research Innovation Centre Limited, 1982-86; Honorary DSc City University 1986; Varied publications on theory and practice of Design Research, Design Development and Education.

Ken Baynes ARCA

Ken Baynes is editor of *Cook School* magazine and until recently was visiting Professor at the Design and Technology Department, Loughborough University. He is a partner in the Brochocka Baynes educational design partnership.

He was trained as a painter and craftsman in stained glass but has spent the whole of his professional life working as a designer, educator and writer. Head of the Design Education Unit at the Royal College of Art. Responsible for a ground breaking series of exhibitions created in partnership with the Welsh Arts Council. Many toured in England and Scotland after opening in Wales. They included *Snap!* (with the National Portrait Gallery), the *Art and Society* series, *Scoop and Scandal and Strife* (toured in the Netherlands), and *The Art of the Engineer* (with the Science Museum). His most recent exhibitions include the *ART of LEGO*, *The Art Machine*, *Design Works*, *Animal Magic* and *Artworks*. He was the scriptwriter and presenter for the *Design Matters* television series on Channel 4 dealing with every aspect of design.

Phil Roberts MA(Ed) PhD

Deputy Vice-Chancellor, Loughborough University.

Professional experience includes appointments as Head of Design Faculty; Deputy Headteacher; Tutor and Research Supervisor, Department of Design Research and Design Education Unit, Royal College of Art; Research Fellow, Curtin University, Perth, Western Australia; LEA Inspector (Art and Design); HM Inspectorate (Art and Design); sometime General Secretary, and Chair, National Association for Design Education (NADE); sometime Hon Secretary, Confederation of Art and Design Associations (CADA). Formerly Head of Department of Design & Technology, Dean of Faculty of Social Sciences & Humanities, Loughborough University.

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.

Introduction

The aim of this publication is to make more readily available ideas and approaches toward theory about design and design education that came together at London's Royal College of Art during the late 1970s and early 1980s. This is worth doing because the relevant texts are now difficult to find. Many were originally contained in Conference proceedings or journals. It is certainly not possible now to find them brought together in one place.

The work at the College took place under the leadership of Bruce Archer. He put forward a number of radical propositions that shaped the 'design education movement' and which provided – and continue to provide – an extraordinarily useful framework for research and teaching. The essence of the argument is contained in 'The Three Rs' (see page 8), a paper which Archer presented on a number of occasions in slightly different versions.

In 'The Three Rs', 'Design' is identified for the first time as a missing sector in general education, balancing and complementing the Humanities and Science. The claim remains controversial but it contains a brilliant new insight that goes beyond C P Snow's idea of the 'Two Cultures'. The field of 'Design' emerges as something more than a rag bag of things that are 'other than Science' or 'other than Humanities'. It is seen as an operational area of doing, making and human being that includes shaping the world of material culture and many aspects of the arts.

From this, two other essential insights follow. The paper identifies 'language' (or natural language) as the essential medium of the Humanities and 'notation' (and especially mathematical notation) as the essential medium of Science. What then is the essential medium of Design? The answer given is: modelling. This is a daring leap towards new areas of meaning and analysis. It has the potential to re-define, re-locate and re-interpret both design activity and design educational activity. Its full significance is still being worked through and discovered.

The second insight is that all human beings share the capacity to make models in the mind and to use these models to shape their own and the world's future. In short, that all human beings are able to design and to understand design phenomena, and that the ability to design is an essential and universal aspect of human culture.

This also distinguishes the *field* of Design and the *activity* of *designing*. This conceptual and terminological classification offered scope for the clearer discussion of designing.

'The Three Rs' goes on to attempt the difficult task of identifying the knowledge base for Design. It does this in a series of very brief definitions but Archer's taxonomy for the field has not been bettered or superseded. Again, its significance is still being worked through but it appears to provide a conceptual key that can unlock many intellectual dilemmas that continue to plague design educators and researchers.

Archer continued to refine and develop his ideas and he was joined in this task by Phil Roberts and Ken Baynes. Together they worked towards a series of propositions about design and design education which, they argued, should form the basis of future national policy on design education:

- all human beings are born with at least a degree of design capability and design awareness: that is, humans have an innate capacity to design;
- material culture – the world of 'things' and 'places' created by human beings – is the direct result and repository of design capability and design awareness working within societies;
- design capability, in its functioning, depends on a number of characteristic cognitive processes found in human intelligence – particularly 'cognitive modelling' or 'seeing in the mind's eye';

- it is on the ability to model future possibilities in the mind that all other aspects of design and technological activity depend including ways of externalising and sharing design proposals and bringing them to fruition by the use of management skill, economics, tools, technology and scientific knowledge;

- specific design capabilities latent in all young children can be identified and systematically extended and developed by teaching and learning;

- the crucial strategy for developing design capability and awareness is to enable and encourage children and young people to experience and reflect on design activity for themselves in contexts relevant to their age and stage of cognitive/emotional development;

- because many of the key issues facing the world are related to material culture and the wise use of technology, it is important for the cultural, economic and environmental future of the world to provide the human and physical resources necessary for effective design education. It is an investment in the future.

Thinking on design education in the 1970s and 80s was inevitably influenced by the intellectual currents of the period. This was a time of intense speculation about the nature of human creativity and the factors that had allowed humans to spread their material culture throughout the globe. Flexibility was seen as a unique element, marking humans off from other species. When faced with new situations, humans were able to use a kind of 'general purpose' intelligence that enabled them to respond in novel and effective ways. This ability – seen as the key aspect of human intelligence – was commonly, but nevertheless somewhat naively, referred to as 'problem solving'. Not surprisingly, design activity was, at a high level of generality, quickly identified as a type of problem solving.

However, the idea demanded further refinement before it began to have explanatory or illuminative power. The main puzzle was that although design activity certainly seemed to address and even solve some economic, social and manufacturing problems, it did not come up with a single unique or 'best' solution. For example, attempts to solve the problem 'a space for family living' result not in a single 'perfect' house design but in a multitude of responses representing, in fact, different balances of the priorities inherent in the requirement: 'a space for family living'. Moreover, the design solutions proposed and built in different cultures and in response to different economic and technological resources differed dramatically. The same could be said for everything designed and made by human beings.

These 'problems' - better understood as 'ill-defined states of affairs' – are ones, which have a range of viable solutions rather than a single perfect outcome. They have usefully been tagged 'wicked problems'. Characteristically in the case of wicked problems, the problem definition is incomplete and the problem definition may have to change as work proceeds. Design activity includes not only solving the problem but also re-defining the problem in the light of emerging solutions. In short, creative thought is applied to re-working the problem as well as solving it. *Resolving* it would be a better word to use.

It is doubtful if the full and radical significance of this has even now been digested by the design education community. Certainly it is not reflected in the linear model of design activity that appears to be enshrined in the English National Curriculum for Design and Technology.

A more radical step would have been to recognise that design activity in fact encompasses a number of very different mental and physical processes including the solution of conventional problems, resolving 'wicked problems', visualisation and modelling, handling tools and materials, studying 'prior art', management and persuasion – and a host more should they prove to be relevant to the particular project in hand. At the highest philosophical

level it became clear that design activity was as much about opening up new possibilities and creating new 'meanings' in the human environment as it was about solving problems defined in advance.

Even with modelling (in the broadest sense of the word) established as the key cognitive element in design activity, the nature of 'design intelligence' and 'designerly thinking' remained hazy. Attempts were made to look at design and designing through various lenses to see what insights other disciplines could offer. History, aesthetic theory, epistemology, sociology, psychology and cultural history all had something to offer but to this day it remains the case that the phenomena of design, the phenomena of designing and their impact on our lives call out for further study and explanation.

Linked to the attempt to characterise design activity and 'designerly thinking' was the beginnings of an attempt to find out what children thought about design and what they were capable of designing. Two strands influenced this area of enquiry. First, the revolution in art education which, during the course of the Twentieth Century, recognised the value of children's drawings and paintings for their own sake and not simply as inferior 'apprentice' works leading onto the proper adult performance. Second, such educational pioneers as Froebel, Montessori and Piaget, whose work formed the often unacknowledged basis for the reform of primary education after 1945. They agreed that all children passed through a series of developmental and intellectual stages and that teaching and learning should be planned to work with and capitalise on these stages. Design educators found that they had the task of achieving similar insights for design activity and design awareness. Without such knowledge, curriculum planning and teaching and learning strategies could not be constructed on a firm foundation. This remains a hot topic for research because it seems that policy makers have often been content to say what children *should* be able to know and do without any real understanding of what they are actually *capable* of knowing and doing. Put more strongly, this is to say that educational policy has been largely ill-founded – based on the educational mythology of 'what we all know'.

The 1970s and 80s were particularly difficult times in Britain. Design and design education developed against a background of relative economic and industrial decline. Old industries were closing with a catastrophic loss of jobs. It was far from clear what would replace them. Some of the protagonists of design argued that it could perform a key role in the nation's economic survival and renewal. A number of politicians, notably Margaret Thatcher, were also persuaded. They argued that in essence what industry needed to do was to make and market products that people wanted to buy: only more attention to design could enable that to happen. The argument for design education in schools became entangled in arguments about British economic success. Britain needed young people capable of forming a cadre of designers, design managers, manufacturers and retailers who, supported by a design-aware public, would put Britain back on the world's manufacturing map.

Interestingly, few people at that juncture foresaw a further area where design would prove essential to economic and social renewal. It was far from clear in the 80s that tourism, service industries and mass media would later become so important or that there would need to be environmental renewal on a grand scale replacing old industry with new international venues and houses for an expanding middle class.

There also developed a very different – perhaps complementary or contradictory position and interpretation. Many teachers of Craft, Design and Technology, Art and Design, and Home Economics were becoming aware of the need to reform and reinvigorate their subject areas to meet the challenges posed by a world of consumerism, mass media, mass marketing and emerging environmental and social problems.

What they sought was an educational approach that would enable their pupils to

take part in this new world without being overwhelmed by it. Future citizens needed to be able to take control of their own lives without simply succumbing to the pressures of consumerism. In design education they saw a strategy for teaching and learning that was relevant to the task of providing young people with intellectual and practical tools useful for their future in an industrialised world.

The design education movement was caught between these two impulses and never succeeded in resolving them. The pressure continues unabated today.

Have these ideas, developed in the 1980s, stood the test of time? In many ways they seem to have gained in explanatory power. Referring to them can throw light on many of the questions that still bedevil academic and theoretical writing about design and design education. For example, Bruce Archer's propositions about the possible scope of the 'design discipline' still provide the most useful definition of the boundaries to and topics for design research. As already suggested, his radical re-definition of the field, his identification of modelling as the essential medium for designing and his brilliant taxonomy, all provide a framework or map which researchers and teachers in the Twenty-first century will find enormously useful. Phil Roberts' penetrating analysis of the relationship between cognitive modelling, problem solving and design action continues to go to the heart of the situation in design teaching and learning. Ken Baynes' work on the design ability of young children has led to a wider appreciation of the explanatory potential of neuroscience and the beginnings of an attempt to understand better the links between design activity and the workings of the human mind. The fact that many are unaware of this body of work continues to lead to much unnecessary and fruitless research and speculation.

Phil Roberts and Ken Baynes have added a brief Chapter which indicates the links between the work of the 1970s and 80s and current agenda for debate. The hope is that this publication will have the effect of stimulating both teachers and researchers to make their own contributions to the theory and practice of design and design education.

It is important to note that the ideas in this book were not the sole property of the Royal College of Art. They were widely debated at the time and were influential in shaping the future of design education. In addition, they had identifiable historical roots in the Arts and Crafts Movement, the Bauhaus and the European 'child art' movement. In the immediate post-war years, Herbert Read's and Tom Hudson's revolutionary approach to art and design education helped to change what happened first in art schools and then in school art departments. A more official dimension came from the Engineering Council, The Design Council and the Royal Society of Arts. The Open University played a very active role in the development of design theory. Influential voices at that time included Nigel and Anita Cross, Norman Potter, Christopher Jones, Peter Green, Colin Ward and Patrick Nuttgens. Design magazine, edited by John Blake, provided an excellent forum for news and discussion. It became common ground that general education should pay more attention to practical skills and knowledge, particularly in the fields of design, environment and technology.

However, these 'top down' influences were probably less important than the grass roots efforts of specialist subject teachers and advisers. State schools in the Midlands, particularly Leicestershire (where Bernard Aylward provided visionary inspiration), took the lead in creating 'design departments'. They were supported by particular individuals in teacher training, notably at Hornsey College of Art. Later other institutions joined in, particularly Loughborough College of Education, Goldsmiths' College and Roehampton Institute.

During the course of events the Royal College of Art created a Design Education Unit intended to work with practising teachers, college lecturers and local education authority advisers, offering them the opportunity to study for Higher Degrees. The Unit was short-lived, killed by

other priorities during Jocelyn Stevens' time as Rector. In its brief period of activity, however, it helped to develop a cadre of experienced design teachers and advisers, was instrumental in launching the Art and the Build Environment project and helped to set up the Design Dimension Educational Trust which today continues to promote design education, most recently through the Focus on Food project.

It would be easy to believe that the status of design is now secure. There is more popular interest in design than ever before. Manufacturers and retailers recognise not only that design is 'important' to their business: they know that successful design innovation is now a matter of commercial life or death. Yet, on a global scale, key problems in the world of material culture remain unsolved. Current levels of production – supported by design innovation – are clearly impossible to sustain. In school, design education may be on the curriculum but it is doubtful that the teaching and learning on offer really reflects the radical nature of design and design education and, therefore, its potential power. The core problem remains. Design is recognised as important but its nature as a creative activity, cultural as well as technological, is poorly understood. It is precisely in this area that these texts should prove useful.

The Three Rs

Bruce Archer

This paper can be regarded as the foundation document for the work which took place at the Royal College of Art during the 1970s and 80s. It was presented in a number of different forms at conferences and seminars and formed the Preface to the Design in General Education report that the RCA delivered to the then Department of Education and Science in 1976.

In it Archer proposed 'Design' as the missing segment of education to be placed alongside Science and the Humanities. 'Modelling' is identified as the medium for designing and a comprehensive taxonomy is set out for the design field. To this radical and fundamental material we have added a set of closely related definitions of design and designing which also underpinned the RCA approach.

The world of education is full of anomalies. No definition or categorisation or form or organisation devised for one purpose seems to remain valid when applied to another purpose. Few educational definitions are watertight even when examined in their own terms. Take that extraordinarily durable expression, 'the three Rs', for example. It is very widely held that when all the layers of refinement and complexity are stripped away, the heart of education is the transmission of the essential skills of reading, writing and arithmetic. This expression is internally inconsistent, to begin with. Reading and writing are the passive and active sides, respectively, of the language skill, whilst arithmetic is the subject matter of that other skill which, at the lower end of school, we tend to call 'number'. So the expression 'the three Rs' only refers to two ideas: language and number. The first idea, language is referred to twice and the second idea, number, is referred to once. Moreover, the word 'arithmetic' is mispronounced as well as mis-spelled, giving the impression that the speaker takes the view that the ability and the necessity to do sums is somehow culturally inferior. If challenged, most who use the expression would deny they intended any such bias, but aphorisms often betray a cultural set. Explicit or implied denigration of Science and numeracy in favour of the Humanities and literacy was certainly widespread in English education up to and beyond the period of the Second World War, and was the subject of C P Snow's famous campaign against the separation of 'the two cultures' in 1959. The two cultures may be less isolated from one another these days, and may speak less slightingly of one another, but the idea that education is divided into two parts, Science and the Humanities, prevails. There are many people, however, who have always felt that this division leaves out too much. Art and craft, dance and drama, music, physical education and sport are all valid school activities but belong to neither camp. There is a substantial body of opinion, not only amongst teachers but also amongst groups outside that profession, which holds that modern society is faced with problems such as the material culture problem, the ecological problem, the environmental problem, the quality-of-urban-life problem and so on, all of which demand of the population of an affluent industrial democracy competence in something else besides literacy and numeracy. Let us call this competence 'a level of awareness of the issues in the material culture', for the time being. Under present circumstances, it is rather rare for a child who is academically bright to take art or craft or home economics or any of the other so-called 'practical' subjects having a bearing on the material culture to a high level in the fourth or sixth forms. Universities and professional bodies do not usually accept advanced level qualifications in these subjects as admission qualifications for their courses, even where the course, such as architecture, engineering or even, in some cases, art and design, is itself concerned with the material culture. It is really rather an alarming thought that most of those who make the most far-reaching decisions on matters affecting the material culture, such as businessmen, senior civil

servants, local government officers, members of councils and public committees, not to mention members of parliament, had an education in which contact with the most relevant disciplines ceased at the age of thirteen.

A third area in education

The idea that there is a third area in education concerned with the making and doing aspects of human activity, is not new, of course. It has a distinguished tradition going back through William Morris all the way to Plato. When Saint Thomas Aquinas defined the objects of education in the Thirteenth century he adopted the four Cardinal Virtues of Plato (Prudence, Justice, Fortitude and Temperance) and added the three Christian Virtues (Faith, Hope and Charity). These have a quaint ring in modern English, but Plato's virtues, rendered into Latin by Saint Thomas Aquinas, were taken to mean something quite specific and rather different from their modern English interpretations. To Saint Thomas Aquinas PRUDENTIA meant 'being realistic, knowing what is practicable'. JUSTITIA meant 'being ethical, knowing what is good'. FORTITUDO means 'being thorough, knowing what is comprehensive'. TEMPERENTIA meant 'being economic, knowing when to leave well enough alone'. It is no co-incidence that in our own day Dr E F Schumacher, in the epilogue to his book *Small is Beautiful* quotes the four cardinal virtues of Plato as the basis for the socially and culturally responsible use of technology in the modern world. Certainly the craft guilds, who bore a major responsibility for the general education of the populace following the Renaissance, took the view that a virtuous education meant learning to know what is practicable, what is good, what is comprehensive and what is enough in a very broad sense. It is a curious twist in fortunes that when the craft guilds lost their general educational role somewhere between the Fourteenth and Eighteenth centuries, it was the rather narrow, specialist, bookish universities, academies and schools which had been set up to train priests to read and translate the scriptures which became the guardians of what we now call general education. No wonder our education system came to be dominated by the Humanities. When Sir William Curtis, MP, coined the phrase 'the three Rs' in or about 1807, he placed an emphasis on literacy which reflected the virtual monopoly which the church then had in the running of schools. I had an old great-aunt who protested fiercely whenever the phrase 'the three Rs' was mentioned. She swore that Sir William had got it all wrong. The three Rs were:

1. Reading and writing
2. Reckoning and figuring
3. Wroughting and wrighting

By wroughting she meant knowing how things are brought about, which we might now call technology. By wrighting she meant knowing how to do it, which we would now call craftsmanship. From reading and writing comes the idea of literacy, by which we generally mean more than just the ability to read and write. Being literate means having the ability to understand, appreciate and value those ideas, which are expressed through the medium of words. From reckoning and figuring comes the idea of numeracy. Being numerate means being able to understand, appreciate and value those ideas that are expressed in the language of mathematics. It was from literacy that the rich fabric of the Humanities was woven. It was from numeracy that the immense structure of Science was built. But what of wroughting and writing? It is significant that modern English has no word, equivalent to literacy and numeracy, meaning the ability to understand and appreciate and value those ideas which are expressed through the medium of making and doing. We have no word, equivalent to Science and the Humanities, meaning the collected experience of the material culture. Yet the output of the practical arts fills our museums and galleries, equips out homes, constructs our cities, constitutes our habitat. Anthropology and archaeology, in seeking to know and understand other cultures, set at least as much store by the art, buildings and artefacts of those cultures as they do by their literature. If the medium of doing and making represents a distinctive facet of a

culture, then the transmission of the collected experience of the doing and making facet should represent a distinctive area in education.

The vacant plot

If there *is* a third area in education, what distinguishes it from Science and the Humanities? What do Science and the Humanities leave out? It now seems generally agreed amongst philosophers of science, that the distinctive feature of science is not the subject matter to which the scientist turns his attention, but the kind of intellectual procedure that he brings to bear upon it. Science is concerned with the attainment of understanding based upon observation, measurement, the formulation of theory and the testing of theory by further observation or experiment. A scientist may study any phenomenon he chooses, but the kind of understanding he may achieve will be limited by the observations he can make, the measures he can apply, the theory available to him and the testability of his findings. Some sorts of phenomenon may therefore be inappropriate for scientific study, for the time being or for ever. Some sorts of knowledge will be inaccessible to science, for the time being or for ever. Moreover, the scientist is concerned with theory, that is, with generalisable knowledge. He is not necessarily competent or interested in the practical application of that knowledge, where social, economic, aesthetic and other considerations for which he does not possess any theory may need to be taken into account. He would regard most of the making and doing activities of the material as being culture outside his scope, although he would be prepared to bring a scientific philosophy to bear upon the study of the making and doing activities of other people.

Amongst scholars in the Humanities there seems to be less agreement about the nature of their discipline, apart from unanimity in the view that it is quite distinct from Science. There is a fair consensus that the humanities are especially concerned with human values and the expression of the spirit of man. This justifies scholars in the humanities in studying the history and philosophy of science, but not in contributing to its content. There also seems to be a measure of agreement, by no means universal, that the humanities exclude the making and doing aspects of the fine, performing and useful arts, although their historical, critical and philosophical aspects would still be fair game for the humanities scholar. It is interesting to note that writers on the science side frequently mention technology and the useful arts as being excluded from their purview, presumably because they are only just outside the boundary. Writers on the humanities side frequently mention the fine and performing arts as being excluded presumably because they, too, are only just outside. A third area in education could therefore legitimately claim technology and the fine performing and useful arts, although not their scientific knowledge base (if any) or their history, philosophy and criticism (if any), without treading on anyone else's grass.

The naming of the parts

Clearly, the ground thus left vacant by the specific claims of Science and the Humanities extends beyond the bounds of the 'material culture' with whose pressing problems we began. The performing arts are a case in point. There are other areas, such as physical education, which have not been mentioned at all. It would be tempting to claim for the third area in education everything that the other two have left out. However, we should stick to our last, if I may take my metaphor from the doing and making area, and clarify the question of education in the issues of the material culture. Any subject that relates with man's material culture must necessarily be anthropocentric. A discipline which claims, as some kinds of science do, to deal with matters that would remain true whether man existed or not, would be ruled out from our third area. Material culture comprises the ideas that govern the nature of every sort of artefact produced, used and valued by man. Those ideas which take the form of scientific knowledge would belong to Science. The historical, philosophical and critical ideas would belong the Humanities. What is left is the artefacts themselves and the experience, sensibility and skill that goes into their

production and use. If the human values, hopes and fears on which the expression of the spirit of man are based are shared with the Humanities, the striving towards them, and the inventiveness that goes into the production and use of artefacts, is a necessary characteristic of our third area. Any discipline falling into this area must therefore be aspirational in character, and, to take them clearly out of both the Science and the Humanities fields, it must be operational, that is to say, concerned with doing or making. Under these tests, how do the subjects ordinarily left out by the traditional Science/Humanities division fare? The fine arts, which in schools can be executed in a variety of materials such as ceramics and textiles as well as through the medium of painting and sculpture, clearly fall into the third area. In the useful arts, woodwork and metalwork would usually qualify. Technical studies are sometimes conducted in such a way that they are not actually concerned with doing and making, and therefore may or may not rank as Science, instead. Similarly environmental studies might or might not fall into the third area, according to their manner of treatment. Home economics presents a problem. Taken as a whole, home economics is clearly anthropocentric, aspirational and operational, and therefore falls centrally into the third area. In practice, however, home economics may be taught in schools through the medium of individual subjects ranging from needlecraft taken as fine art through home-making taken as useful arts to nutrition taken as science. So home economics, too, may fall into Science, the Humanities or the third area, according to the manner of treatment adopted. Outside the bounds of the material culture altogether are the other subjects explicitly left out by the first and second areas. Amongst the performing arts, music might qualify as anthropocentric, aspirational and operational. So might drama and perhaps dance. So might gymnastics, the way it is pursued these days, but probably not the other areas of physical education. But this is going too fast. Any number of objections can be raised and counter-arguments offered in respect of many, but perhaps not all, the subjects I have mentioned as belonging or possibly belonging to an alleged third area in education. The point I wanted to make is simply this. The justification for the nomination of a third area in education lies not in the existence of subjects which do not fit readily into the definitions of Science and the Humanities, but by the existence of an approach to knowledge, and of a manner of knowing, which is distinct from those of Science and the Humanities. Where Science is the collected body of theoretical knowledge based upon observation, measurement, hypothesis and test, and the Humanities is the collected body of interpretive knowledge based upon contemplation, criticism, evaluation and discourse, the third area is the collected body of practical knowledge based upon sensibility, invention, validation and implementation.

The naming of the whole

This leaves us with the problem of finding the correct title for the third area. The term ‘the Arts’ would be ideal, if the expression had not been appropriated by, and used more of less as a synonym for the Humanities. Plato would not have objected to ‘Aesthetics’, but that has taken on a special and distracting meaning in modern English. ‘Technics’ has been used, and is in the dictionary, but has not proved very popular in educational or common use. A term which has gained a good deal of currency especially in secondary schools in England and Wales, is ‘Design’, spelt with a big D and used in a sense which goes far beyond the day-to-day meaning which architects, engineers and other professional designers would assign to it. Thus Design in its most general educational sense, where it is equated with Science and the Humanities, is defined as the area of human experience, skill and understanding that reflects man’s concern with the appreciation and adaption of his surroundings in the light of his material and spiritual needs. In particular, though not exclusively, it relates with configuration, composition, meaning, value and purpose in man-made phenomena. We can then go on to adopt, as an equivalent to literacy and numeracy, the term ‘design awareness’, which thus means ‘the ability to understand and handle those ideas which are expressed through the medium

of doing and making'. The question of the language in which such ideas may be expressed is an interesting one. The essential language of Science is notation, especially mathematical notation. The essential language of the Humanities is natural language, especially written language. The essential language of Design is modelling. A model is a representation of something. An artist's painting is a representation of an idea he is trying to explore. A gesture in mime is a representation of some idea. Everyone engaged in the handling of ideas in the fine arts, performing arts, useful arts or technology employs models or representations to capture, analyse, explore and transmit those ideas. Just as the vocabulary and syntax of natural language or of scientific notation can be conveyed through spoken sounds, words on paper, semaphore signals, Morse code or electronic digits, to suit convenience, so the vocabulary and syntax of the modelling of ideas in the Design area can be conveyed through a variety of media such as drawings, diagrams, physical representations, gestures, algorithms – not to mention natural language and scientific notation. With all these definitions in mind it is now possible to show the relationships between the three areas of human knowledge according to the diagram in Figure 1.

The repository of knowledge in Science is not only the literature of science but also the analytical skills and the intellectual integrity of which the scientist is the guardian. The repository of knowledge in the Humanities is not simply the literature of the humanities but also the discursive skills and the spiritual values of which the scholar is the guardian. In Design, the

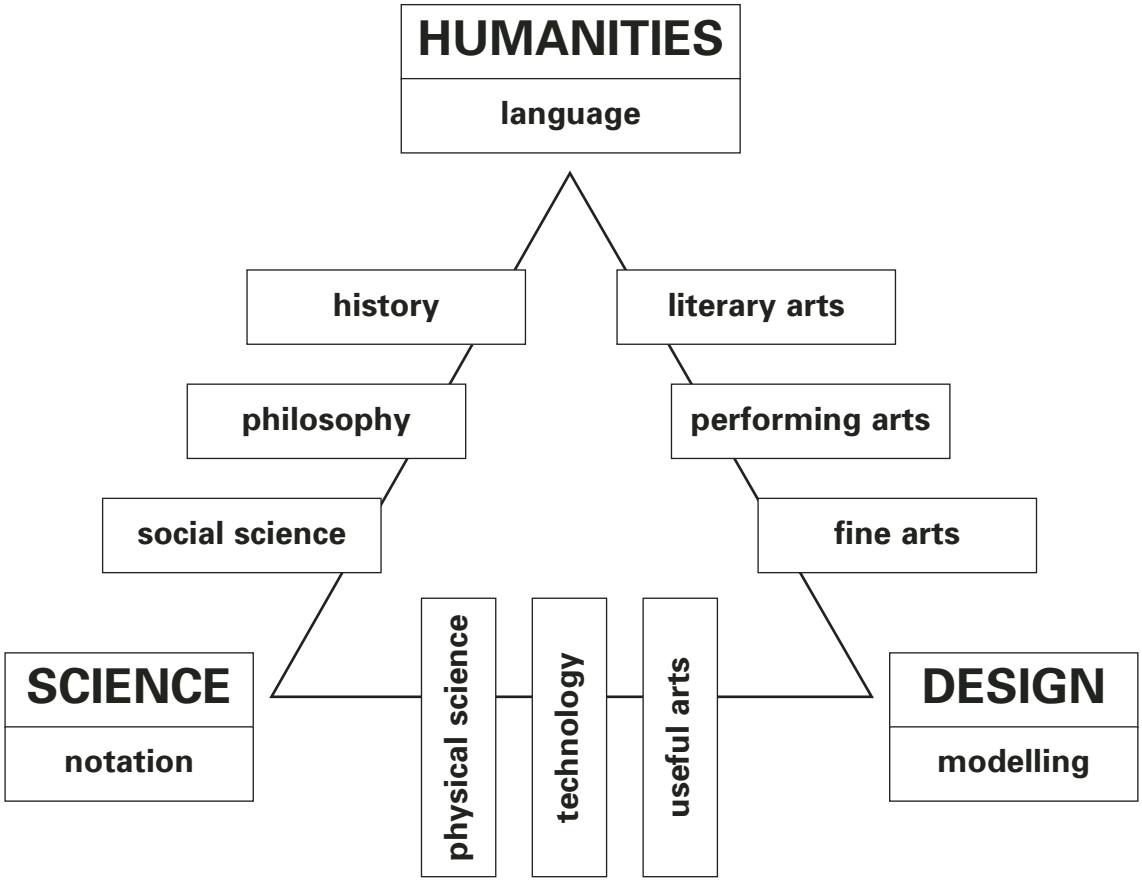

Figure 1. Proposed relationships between Humanities, Science and Design

repository of knowledge is not only the material culture and the contents of the museums but also the executive skills of the doer and maker. This is very nearly where we came in. For all sorts of reasons, although the collected body of artefacts has been valued by scientists and scholars, if only as subjects for their own kind of *post hoc* scholarship, the collected body of executive skill in the Design area has not. Both of C P Snow's two cultures have been condescending towards the executive aspects of the material culture. Hence, perhaps, British society's failure to give adequate social, political and intellectual support to its own manufacturing industries, but that is another question. Lack of scholarly regard for practical skills and the subjects associated with them is unquestionably widespread in British education. One of the consequences of lack of scholarly regard is a lack of scholarly effort. Astonishingly little work has been done to achieve understanding of design phenomena, design sensibility, the act of invention, the theory of modelling, the nature of judgement or the character of skill. Even the most centrally relevant professions, such as architecture and engineering, have done almost nothing to develop an understanding of their own skills, judgement and inventive activity. They have relied on Science for their facts, upon the Humanities for their history and philosophy, and on progressively less rigorous and less lengthy apprenticeships for their skills. Consequently, teachers of Design subjects at secondary level in school and at undergraduate level in universities have had nothing like the support from scholars at professional and post-graduate level that their colleagues in Science and the Humanities enjoy. With little in the way of curricula, knowledge, or teaching materials to work on, it is small wonder that the vicious circle of ill-informed secondary school teaching, barely relevant school examinations, few prescriptions of passes in these examinations as university admission qualifications, low-grade work at undergraduate level, little scholarly work at postgraduate level, little handed on in the way of curricula, knowledge or teaching material to secondary level, is repeated.

Tasks for research

It is sobering for those of us who are actually engaged in postgraduate research and teaching in the Design area to record that the most strenuous attempts to break that vicious circle have been made by secondary school teachers of design-related subjects. The movement which led to the introduction of the term 'Design' to describe this area of education and which caused the Minister of Education and Science to commission my department's enquiry entitled *Design in General Education* was a grass-roots movement. It was started by teachers of art, craft and technical studies, and to a lesser extent by teachers of home economics and others, all of whom were gravely concerned about the relevance of education to the major problems facing mankind today – that is, to the quality of life, the urban environment, the use of physical resources and so on. It is even more sobering for some of us who teach or practise mainstream design activities to record that it was not until these same secondary school teachers, and the educational philosophers who work with them, asked fundamental questions, that we looked seriously at the knowledge base for our own activities.

I have set out the span of the knowledge base, for the organisation of my own research programmes, as follows:

Design technology:
The study of the phenomena to be taken into account within a given area of application;

Design praxiology:
The study of the design techniques, skills and judgement applied in a given area;

Design language (modelling):
The study of vocabulary, syntax and media for recording, devising, assessing and expressing design ideas in a given area;

Design taxonomy:
The study of the classification of design phenomena;

Design metrology:
The study of the measurement of design phenomena, with special emphasis on the means for ordering or comparing non-quantifiable phenomena;

Design axiology:
The study of goodness or value in design phenomena, with special regard to the relations between technical, economic, moral and aesthetic values;

Design philosophy:
The study of the language of discourse on moral principles in design;

Design epistemology:
The study of the nature and validity of ways of knowing, believing and feeling in design;

Design history:
The study of what is the case, and how things came to be the way they are, in the design area;

Design pedagogy:
The study of the principles and practice of education in the design area.

Of these sub-disciplines, design praxiology and design language (or modelling) probably need to be studied within the field of design research itself. It seems unlikely that any sub-disciplines of Science or the Humanities would make much contribution to them. Design technology can really be lifted straight from existing sub-disciplines elsewhere. Workers in the design research field would need to lean heavily on scholars in the Humanities for help in design philosophy, epistemology and history. Science undoubtedly holds the keys to design taxonomy, metrology and axiology but a great deal needs to be done to adapt existing theory to design needs. Design pedagogy may also need development beyond existing theory. Design research methods themselves will also require original development, since there are subjects for enquiry and kinds of knowing which do not lend themselves to conventional scientific or speculative enquiry. But this is going too far into the theory, of the theory, of the teaching, of the practice, of getting to grips with reality! Let us get back to the questions with which we began.

A virtuous education today, as in St Thomas Aquinas' day or in Plato's day, is one which teaches everybody, not just budding practical people, how to know what is practicable, what is good, what is comprehensive and what is enough. Wouldn't it be wonderful if all our local government officers, politicians, managing directors, merchant bankers, shopkeepers, shoppers and men and women in white coats or blue overalls could be taught just that? Sir William Curtis did us a great disservice when he coined the phrase 'The Three R's'. He was said to be illiterate himself, and never did a hand's turn of anything practical, but made a vast amount of money out of selling ships' biscuits, so he presumably knew his 'rithmetic. It seems that my old great-aunt had the story more or less straight. Wroughting and wrighting (or 'industrial arts') were still in the curriculum in Sir William's day, albeit at a pitiful level. These never grew to attain the scholarly regard earned by the literary and numerate arts because the guilds had gone, and the universities that governed the examination system had grown from a different tradition. Those of us who work in the Design area of higher education have a challenge and a responsibility. In the face of mankind's present needs, we have to generate for the benefit of secondary and undergraduate education a knowledge base neglected for 170 years.

Some definitions

It is important to attempt to define more precisely than hitherto the meaning of 'Design' and hence of such terms as 'design awareness' and 'design education'. It was soon evident that the way in which 'Design' was defined would control the way in which its educational role could be envisaged. There appeared to be three jobs that any definition or set of definitions needed to do. Firstly, it was necessary to give substance to the notion, long and widely held that there was a 'third area' in education besides Science and the Humanities and also to distinguish it from a possible 'fourth area' devoted to Affairs, or the 'operational arts'. Secondly, it was

necessary to retain a further more particular definition to describe those studies in school which involved children in design activity and which many people already called 'design education'. Finally, it was important to retain a coherent link between what educationists thought of as 'Design' and what professional designers believed design to be about.

The definitions provided here are based on an existing measure of agreement amongst educationists but attempt to carry the synthesis a stage further.

They have been prepared primarily to serve in the context of general education. They are not necessarily applicable in an unqualified way to specialist further or higher education or to the professional practice of design. They have been framed, nevertheless, with the intention of extending the common ground between the various interests in schools, such as the teaching of art, design, craft and technology, home economics and so on, whilst maintaining maximum compatibility with common usage and professional usage.

1. The term 'Design' can be used in an academic or very general sense to describe one of the broad divisions of man's concern, competence and knowledge, thus Design is the field of human experience, skill, understanding and imagination that is concerned with the conception and realisation of new things and events and particularly with man's appreciation and adaption of his surroundings in the light of his material and spiritual needs. In particular, though not exclusively, it relates with configuration, composition, meaning, value and purpose in man-made phenomena.

2. The term 'Design' can 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 and making aspect.

   Disciplines such as art, handicraft, home economics and technical studies tend to form the broad middle ground of the Design area in schools.

3. The term 'design' can also be used in a range of more operational and more limited senses, as indicated by the definition in the *Concise Oxford Dictionary*: design, n. Mental plan; scheme of attack; purpose; end in view; adaption of means to ends; preliminary sketch for picture etc; delineation, pattern; artistic or literary groundwork, general idea, construction, plot, faculty of evolving these, invention.

   Design, v.t & i. Set (thing) apart for person – destine (person, thing) for a service; contrive, plan; purpose, intent; make preliminary sketch of; draw plan of; be a designer, conceive mental plan for, construct the groundwork or plot of.

4. 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 planning and making, together with the ability to understand and handle ideas related with them.

5. 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, making and evaluating.

6. 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 affecting and 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 planning and making at a given level of generality, and within a given field of relevance.

The Need for Design Education

Bruce Archer

This paper was prepared for a Department of Education and Science Conference in 1973. It sets out the broader context for design education and relates the argument for it both to environmental and to economic concerns.

Archer argues that British education has a long history of neglecting forms of learning relevant to contemporary industrial society. They are despised as practical or vocational. This has undermined the nation's ability to respond creatively to the challenges of pollution and depletion of resources, social change and new technologies.

The paper introduces the idea of 'design awareness' as something analagous to literacy or numeracy. Archer states 'It is my sincere conviction that a massive broadening and deepening of design education in secondary schools today is overwhelmingly the most important urgent need for the survival as well as the happiness of mankind'.

In June 1970, the Governments of the primary countries attended the United Nations Conference on the Human Environment in Stockholm. This was an important event. It was important because it was the first formal recognition of the weight of the evidence which had been accumulated by the environmental lobby over a period of years. Not the least aspect of its importance was the fact that the Governments who attended this conference had to prepare formal papers, set up study groups, create Civil Service Departments, and create the machinery to hear and react to future representations on problems relating to the environment. In this country four official preparatory papers were commissioned by the Secretary of State for the Environment.

They are:
Human Habitat – How do you want to live;
Pollution – Nuisance or Nemesis;
Natural Resources – Sinews for Survival
and
Organisations and Youth – 50 Million Volunteers.

The studies contained in these four publications reflect, although not exactly, the four great crises facing mankind: the crisis of overpopulation; the crisis of pollution; the crisis of the depletion of natural resources and the crisis of control.

I do not propose to rehearse the arguments first set out by the Club of Rome on population, pollution and depletion of resources, but I do want to quote just a couple of paragraphs from *Natural Resources – Sinews for Survival*.

Paragraph five says: 'We (that is the working party responsible for this publication) have been driven by the evidence we have assembled to the conclusion that to devote our resources to the achievement of the highest possible growth rate as conventionally measured is no longer desirable. Many of the natural resources of the world, particularly those that are peacefully available to Britain are finite. Even with a steady population they may well be insufficient to provide the raw material for the rate or the kind of economic growth and increased affluence which is almost universally assumed to be desirable for the next hundred years. If the population continues to grow as forecast, some resources are probably insufficient for the next 50 years, that is, within the lifetime of most young people. It has been argued that exhaustion of our finite resources can be faced with equanimity because the free market will solve the problems, rising prices will restrict demand and encourage the substitution of other materials. We do not agree that this process is necessarily reliable, but in any case it is the qualitative aspect of the problem that leads us to the conviction that intervention is essential'.

A little further on – paragraph 14: 'Nevertheless there are urgent things that we can and must do. We must abandon the paramount goal of the affluent society. We must check the stimulation of artificial demands that needlessly consume resources. We must get away from the belief that constant change and novelty are necessarily good and that last year's fashions and styles are not merely out of date, but automatically inferior because they were created a year ago, and we must encourage our manufacturers to abandon built-in obsolescence and to produce goods which will last longer and be designed in such a way that the resources they tie up can be readily recovered and used again. We do not suggest any of this will be easy. It implies a profound shift in the values which our society has adopted. It will demand the co-operation and education of consumers, manufacturers and Governments, and the re-framing of our system of taxation to provide incentives and deterrents'.

So for a lot of people the economic case and the resource case is made. But one of the crises I mentioned was not dealt with, except rather indirectly in the book on *Organisation and Youth*, that is the crisis of control. The crisis of control exhibits itself in the challenges to authority, the abandonment of traditional values, and the disenchantment with established institutions which is a feature of our time. The crisis of control also exhibits itself in the massive mistakes which have been made – the thalidomide disaster; the recurring economic crises; the closing down of mines and railways subsequently learning that they have to be re-opened; the sitting and abandonment of motorways; the sitting, resiting and abandonment of airports. The crisis of control exhibits itself in the deterioration of the quality of the urban environment for many people and in the stress, the violence and suicide, by which people may indirectly express their protest.

And on top of these four crises, there is a dilemma of crises; that is, the ironic fact that the more we do to control the problems of population, pollution and the depletion of resources, the more restriction we put on personal freedom, on personal participation, on the diversity of values and therefore the larger and more irksome become the institutions, which we are already somewhat disenchanted with. One reason why these crises are difficult to resolve and could be impossible to resolve, is that the profound shift of values which was referred to in *Sinews for Survival* is tending to attack instincts which are very deep in our animal natures. The animal instinct for growth and expansion is an instinct to build up resources against the coming of possible famine, pestilence and deprivation by other species. Our animal instinct for exploration is always to allow our young men to climb mountains, to explore, because there may be another green valley the other side of the mountain which we may need one day. Our instinct for exploration causes us to scatter in order that some members of our species may be in some safe havens so that when the pestilence comes there will be some survivors to redevelop the species.

The law of nature is not 'survival of the fittest', the law of nature is 'random mutation and survival of the fittest' and it is part of our biological nature to mutate in order that there shall be some variants who, will be fit to survive under changed conditions. It may be that these deep instincts underlie a lot of what we do. The community at large, for example, seems to be willing to support or at least to tolerate artists, scientists, philosophers, eccentrics in almost anything that they desperately wish to do, provided that they seem to be able to do it against almost overwhelming odds and seem to have some chance of actually succeeding. So the conventional wisdom is that what can be done should be done. If a man can climb a higher mountain this is admirable and we will provide him with the minimum he needs in order to carry out an expedition; if it is possible to run a faster mile we will applaud him. If it is possible to split the atom we will give him the apparatus to do so. This is part of a satisfaction of our primeval urges. So if we were to say now, in the light of modern environmental crises, 'there are no more green valleys', 'growth is evil', 'change, novelty and newness are not necessarily good', 'exploration is anti-social', 'consumption is contra-indicative for

survival', we are attacking instincts which are at the mainsprings of our animal life, at the mainsprings of our biological function, and can only cause deep perturbation and stress.

But the case for design education does not rest here on the ecological issue of human survival. The same two decades which have seen the community's attitudes to growth and change turn through 180 degrees from the pursuit of expansion to the questioning of expansion, from the pursuit of invention to the questioning of invention, have also seen design philosophy and design practice similarly profoundly shaken. The confidence of the designer in his own role as practical artist concerned with form, proportion, texture, colour and problems of conveniences and function; secure in his attitudes as to good taste; happy in the pursuit of rules like form should follow function, truth to materials and other Platonic ideals; clear in his relationship to the object of his creation, has been steadily eroded. First of all by the very proper turning from concern with systems, turning from concern only with form to the whole of the design's function in form, production, distribution and so on; then by a very proper recognition that he is only a member of a coalition of common interests in which there are a whole lot of other people contributing. These are proper dilutions of his interest, but his old confidence has also been undermined by the emergence of pop styles, kitsch styles, revivalist styles, fun styles of design which are now being executed by respected, professional, successful designers, accepted and applauded by people of taste yet which are quite contrary to all rules of good form and good taste which he has hitherto learned. The designer is also being shaken by the evident deterioration in relations between designer and society. The term 'planner' is now used as a pejorative term. The work of modern architects is mainly disliked. There is a general feeling that apart from some styles of design, 'what they the professional designers want to give us, is not what we the people like'. This dissolution of the old philosophies, the undermining of confidence, is so serious that both the architectural profession and the industrial design profession are at this moment engaged in a serious study of their role, their training and their effectiveness.

From 4 to 7 May 1973 at Edinburgh University, the International Congress of Societies of Industrial Design (ICSID) conducted an enquiry at which sociologists, historians, philosophers, scientists and civil servants all got together with designers to question why it is that the standards and values of designers appear to have diverged so seriously from the standards which are practised by both industry and government and appear to be desired by the ordinary population. It is no accident that whilst the design professions have been concerned with broadening and reappraising the education of designers, those who have been concerned with the education of the consumer have been similarly preoccupied by the competence of society to appreciate and comprehend its own needs and wants. The discriminating designer needs a discriminating consumer if he is to be able to bring off a design act at all. Moreover the public in the shape of local councillors, civil servants, cost accountants and so on are playing more decisive roles in what is actually done in design. Urban renewals, sitting of airports, civic design, interior design, the character of catering and so on is very often actually decided, not by designers or home economists, but by local councillors, local government officers and so on. And there is more and more demand for popular participation in decision making in planning and architecture. It is here I think we are getting close to a moral or philosophical case for a new and more general approach to design in education.

The notion of design as an activity which is separable from making seems to date from 1700. From about 1840, according to Raymond Williams in his book *Culture and Society 1780-1950*, the concept of design was bound up with a philosophical concept of proper appreciation of things beautiful, but in those terms the pursuit of beauty was for ethical reasons rather than purely sensual reasons. When Ruskin and Morris, and later the Bauhaus School, were formulating principles of good design, and when later the ideas of fitness-for-purpose, form-follows-function, truth-to-materials, economy-of-means were being expressed, it was always for fundamentally

metaphysical reasons rather than for practical reasons. Form-follows-function was intended to be symbolic of truth as well as logical. Truth-to-materials was an expression of an ethical attitude as well as being prudent. Economy-of-means was elegant as well as thrifty. The metaphysical reason has always been more important than the practical reason from the design philosopher's point of view. Indeed in its middle history the symbol often ousted the reality. One saw designers from the Bauhaus onwards designing objects which were perfect spheres, cubes or cylinders even though the cost of producing them was excessive and the convenience in handling them was poor. Today we see the adman's image ousting both ethical symbol and practical reality. The present crisis of conscience is tending to throw designers back to the ethical.

Thus, the case for a new approach to design in general education rests on two issues of major importance: first, the need for public sensibility to environmental, planning, social and aesthetic problems, and secondly, the need for a fundamental value base in general education to restore lost confidence. The purposes and problems of design education of the general population is analogous to literacy and numeracy. Literacy as we understood it is more than just the ability to read, although obviously it must begin there. Literacy includes the ability to appreciate and to be enlarged by literature. Similarly numeracy is more than just the ability to manipulate numbers, although obviously one must begin there. Numeracy includes the ability to appreciate and be enlarged by mathematical logic. Similarly design education is more than just the ability to draw or possess plastic sensibility. It is more than the ability to produce and comprehend two-dimensional and three-dimensional information. It is more than simply acquaintanceship with the contents of '*Which*' magazine. If we want to construct a pedagogic equivalent to literacy and numeracy, meaning the state of being able to appreciate and be enlarged by design, then I think we have to have a better approach. I am going to use the term 'design awareness' for design literacy in this special sense. You may ask 'What are the components of design awareness?' Clearly art is part of it. Art offers perception, sensibility and handling of emotional meaning. But aesthetic sensibility extends to other things. Athletics and home economics are aspects of dexterity. Clearly science is part of design awareness, that is to say knowledge of facts, knowledge of laws, knowledge of relationships. But knowledge and reasoning of the type we see in science extends also to mathematics, to language, to philosophy. The approach to design awareness in my view is more than just building bridges or understanding the interfaces between art and craft, science and languages. In my belief design awareness contains two additional elements: one of which is basic to the primitive nature of man; and one is at the very limits of our modern intellectual ability to reason.

The primitive element is concerned with that quality which distinguishes man from most of his fellow creatures, that is the capacity to fashion tools to adapt the environment to suit himself, instead of adapting themselves to their environment. The advanced additional element is concerned with his capacity to impose qualitative considerations upon quantative considerations; to impose aesthetic, spiritual and ethical elements upon physical, economic and rational elements.

Modern conditions made the ordinary man in advanced technological society quite incompetent to fashion his own tools. We use electric drills but we could not cut ourselves a reed whistle. We use thermostatically controlled central heating, but do not know how to survive on a mountainside. The car worker on a production line could not build himself a chair that would be both light enough to carry and strong enough to support him. We have lost our personal control over the environment. We have lost a large part of our tool making confidence and we have lost a large part of our folk knowledge about nature, survival, and dexterity. We have put layers of delegation and layers of material between us and what we want to do. Perhaps the ecological irresponsibility of society is one product of this lack of

direct contact between a man, the individual, and the natural elements. Perhaps the urge to do it yourself, the urge to get away from it all is an instinct to get back to our tool-making nature.

The crisis which calls into question all education, not just design education, relates in a similar way to what I called the second distinguishing element of design awareness, and that is our capacity to impose qualitative considerations upon quantitative considerations. Aesthetic, ethical, social, ideological considerations, (the subjective and qualitative), are not only different from economic, technical and physical consideration, (the objective and quantitative) but they also subsume them. C. West Churchman, Russell L. Ackoff, who are both distinguished operational research scientists and Peter Medawar, distinguished medical scientist, have all three in recent publications asserted that all so-called hard scientific fact rests upon value judgements, and not the other way round. Even so-called hard scientific facts rest upon an agreement about the suitability of the axioms which underlie the theories, on the relevance of the evidence which is admitted into consideration, about the appropriateness of the measuring techniques, about the quality of truth in proofs. Moreover, it is not the objective facts of systems that lead us to accept or reject them. It is not the width, the strength, or the cost of the motorway which causes us to accept it or reject it, it is its convenience, its intrusiveness, its comfort, its beauty, its ugliness. It is the subjective attributes which cause us to accept or reject, not the objective physical properties. And it is the unfortunate case that man's ability to manipulate, reason with and operate with the quantitative has completely outrun his ability to manipulate the qualitative. The fact is that quantitative relationships are simply a special case of relationships. The tools are there in New Maths which is the mathematics of relationship, in logic, in the techniques of debate, the techniques of judgement.

So the question of design education is part of a much larger and more profound question of education in the qualitative. It is no accident that all four of the Stationery Office publications call for an important effort at environmental education. *How Do You Want to Live* and *50 Million Volunteers*, each contain a whole chapter on the need for education. *Nuisance of Nemesis* contains 3½ pages on the need for education. *Sinews for Survival* has only a page but the whole book is about the question of public re-education. I just want to quote a couple of paragraphs from the one called *Human Habitat – How Do You Want to Live*.

The Working Party said 'Rural studies, art and craft have been taught in some schools since the beginning of the century, but nowadays they are clearly inadequate as a basis for the study of the total environment in an overwhelmingly urban society. But it is doubtful if the real purposes of environmental education can be fulfilled by the development of a new subject along the lines of rural studies but called environmental studies, complete with its own concepts, techniques and values and taught like history or geography or languages at every level of education from the primary school to the Research Institute. But environmental education cannot be just a matter of teaching people to see the environmental aspects of their particular subject. They must also learn judgement and discrimination. Education is pre-eminently a matter of realising values. Environmental education should be part of the moral and aesthetic education of the human being as a whole'.

I would have added home economics to that list of traditional departments, to form the basis of a new and comprehensive approach to design education.

So the focus of design education in secondary schools is therefore not just simply the setting up of joint projects between the art room and science lab. It is not simply co-operation between the geography class and handicrafts. The emphasis of design education is not to try to make everyone a first rate or second rate creative artist or craftsman, but to try to give everyone a good grounding in design sensibility analogous to literacy and numeracy.

If we are to succeed I think that we have to be very careful to pitch our response at more than merely creating interdisciplinary projects. We should not allow the idea of design education to be run away with by overenthusiastic art and craft teachers who see it as a rebirth of traditional craft teaching (though we could do with some of that). I think there is a danger we could have failed to have touched some of these deeper fundamentals. We will have failed to respond to the crisis of control, to the crisis of ecology, and we will have failed to influence events.

On the other hand if we pitch our response at too profound a level, at the level of philosophical conjecture, at the level of the discussion of the theory of aesthetics (although we could do with some of that too) then we will assuredly miss the time, we will miss the tide and add to the general disenchantment with institutions and their ability to handle the problems of the world.

Whatever we do has got to be in full co-operation with our colleagues in teacher training, and in environmental education, which is presumably why the Department of Education and Science is sponsoring this particular programme and it is certainly why I am here. It is my sincere conviction that a massive broadening and deepening of design education in secondary schools today is overwhelmingly the most important urgent need for the survival as well as the happiness of mankind.

Of Models, Modelling and Design: An Applied Philosophical Enquiry

Phil Roberts

This paper was written by Phil Roberts some time after the dissolution of the Design Education Unit and following the introduction of Design and Technology as a subject in the English National Curriculum. However, it usefully brings together a number of illuminating concepts which Roberts first developed in the 70s and 80s. It also shows decisively that NC Design and Technology was – and is – a far cry from these broader interpretations of Design Education.

One of the most useful aspects of the paper is a model viewing designerly activity from the perspectives of the user and the observer as well as the designer and maker. This is characterised as the 'transitive' mode of design and the model shows how users and observers shape their environment and give it meaning through a series of activities that exactly correspond with those of the designer and maker. In design educational activity the child should be encouraged to experience both those modes and all these roles.

The paper also discusses the nature of problem solving in relation to design activity and introduces a very useful set of diagrams intended to help practitioners move beyond simplistic notions of problem solving. The thrust here is to characterise designing as acting in and on the world and to show that it is essentially concerned with making value judgements about changing states of affairs.

The discussion in this paper is derived from a strand in a series of enquiries conducted into design phenomena and into design educational activity. It is intended as no more than a contribution towards an agenda for more specific enquiry into the nature and functions of models and modelling, and towards the construction of a practitioners' theory. The enquiry was phenomenological in its general orientation and, more particularly, applied philosophical in its approach.

Let me first locate the discussion: it is in design education; more specifically, it is in Curriculum Studies and, even more specifically, it is in the area of Design Curriculum Studies. If 'design education' is a term which is indicative of potential paradigmatic change, it is understandable that design educational theory is embryonic. Theory construction is at the stage only of the formulation of models. But a theoretic framework is in sight. If turbulence is symptomatic of paradigmatic change, or of paradigmatic competition, the absence of a generally accepted language of discourse – or even vocabulary – which would enable practitioners of different specialist communities to talk with, as distinct from past, each other is similarly no surprise. In the formulation of new paradigms, innovators necessarily construct theory and a new language: the paradigms that practitioners 'inhabit', and by means of which indeed they exist, are to a large extend predicated on specialist languages. But the languages of differing constituencies are distinctive even though they may employ the same words. It is no surprise that the members of 'old' traditions and the constructors of new ones have difficulty in making contact with each other; the surprise would be if it were otherwise.

The need to develop a shared meta-language of discourse across the areas of design practice is also evident. The need for sustained scholarly and research effort is also apparent. There is, for instance, at the heart of the National Curriculum (NC) Design and Technology documentation a model of activity which has the character of a procedural model. Because of the legislative status of the Education Reform Act and its subsequent Orders – as distinct from its academic or theoretic well-foundedness – it is possible that the central model will become part of a new

orthodoxy. Yet it is an inadequate and inappropriate model which may therefore further hinder understanding of how designerly activity, in fact, occurs and of how design thinking and technological ability develops. The relations between the model and the realities to which it is in reference are not well represented in the NC documentation. A simple model at a high level of generality together with a range of complementary lower-level models – the latter having greater specificity and stringency – would have been more appropriate. This, however, is to run too far ahead of the discussion; the NC Design and Technology documentation simply illustrates or adds to the scholarly agenda rather than resolves it.

It is convenient to use questions as a framework for this discussion. The first is: What human capacity is central to the conduct of design activity? Alternatively put, the question might be: How is it possible to design at all? (which is a matter very different from a concern with a theory or with a procedural model of *how to* design).

Central to the act of designing is the capacity to conceptualise and represent ideas, aspects of present realities and future possibilities. 'The mind' (we say) makes use of a variety of forms of knowing, and makes transformations between the modes of conceptualisation and representation. Envisaging-what – or cognitive modelling – is externalised and manifested in such familiar media and forms as words, drawings, plans, maps, 3-dimensional models, and prototypes. Work carried out in the Design Education Unit of the Royal College of Art indicated something of the nature and status of cognitive modelling:

> *The conduct of design activity is made possible by the existence in man of a distinctive capacity of mind, analogous with the language capacity and the mathematical capacity. This is the capacity for cognitive modelling. A person acting in the role of designer or appraiser of designs forms images 'in the mind's eye' of things and systems as they are, or as they might be, and evaluates them and transforms them so as to gain insights into their structure and into the likely quality of fit between alternative conceivable configurations and the interaction of perceivable requirements (…) Cognitive modelling is not limited to spatial configurations. Aspects such as colour, texture, sound, flavour and anything else relevant to the system can be imaged and manipulated. Cognitive modelling is independent of language or symbol systems, but when appropriate, the concepts modelled can be translated into or supplemented by language or notational terms. The image is usually externalised through models and simulations, such as drawings, diagrams, mock-ups, prototypes and, of course, where appropriate, language and notation, or it can be embodied in the construction of or the enactment of the emerging responses. These externalisations capture and make communicable the concepts modelled (1).*

Cognitive modelling does not have the status of language as a linguistician would define language; there are too many untested propositions for such a claim to be sustained. With that caveat in mind, however, 'cognitive modelling' can conveniently be referred to as the essential language or cognitive medium of designing and, by extension, of design educational activity. Hence it might be reasonable to expect to find explicit references in course descriptions to the development of the capacity for cognitive modelling. Illustrative instances of such expectations within the descriptions of courses, learning objectives might be, for instance:

> … to develop the ability to present and represent ideas in two-and three-dimensional forms and media;
>
> … to develop the ability to make transformations between the symbolic forms in which an idea is conceived and the forms in which it might best be represented;
>
> … to develop the ability to choose and use the symbolic form and media most appropriate to the purpose, the task, and the audience.

A scrutiny of several hundred course descriptions in art, CDT, technical/ engineering drawing shows neither any such intention nor expression – either implicit or explicit. And this finding applies both to single subject courses and across design-related subject courses. In view of the centrality of cognitive modelling in design-related activity this is interesting because surprising.

This absence for explicit attention and intention can be discerned, along with other issues, through a reflection on models and modelling. It is convenient to consider a model that is to do with design educational activity: it is a model within the language of discourse: that is, in the discourse about designing and its associated phenomena.

The model, Figure 2, is derived from schools-based practice. It uses four perspectives on the design-educational activity. These are deployed by means of four role-views: those of the designer, the maker, the user, and the observer. Figure 1 describes the roles:

The four role-views are intended to provide working perspectives towards the better comprehension of design and technological activity and of cognitive modelling.

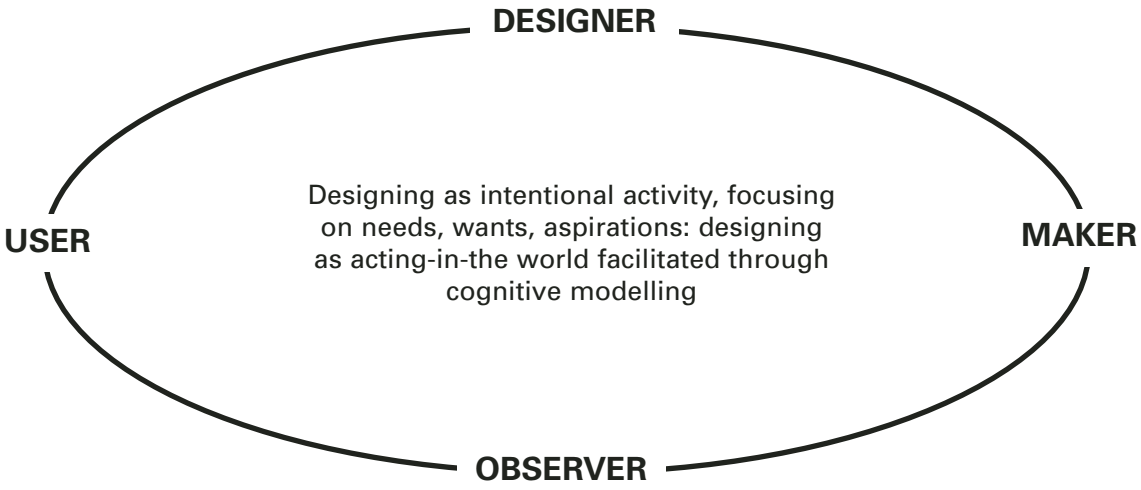

Figure 1. Four Roles (the Designer, the Maker, the User, the Observer) offering complementary perspectives on learning-through-designing

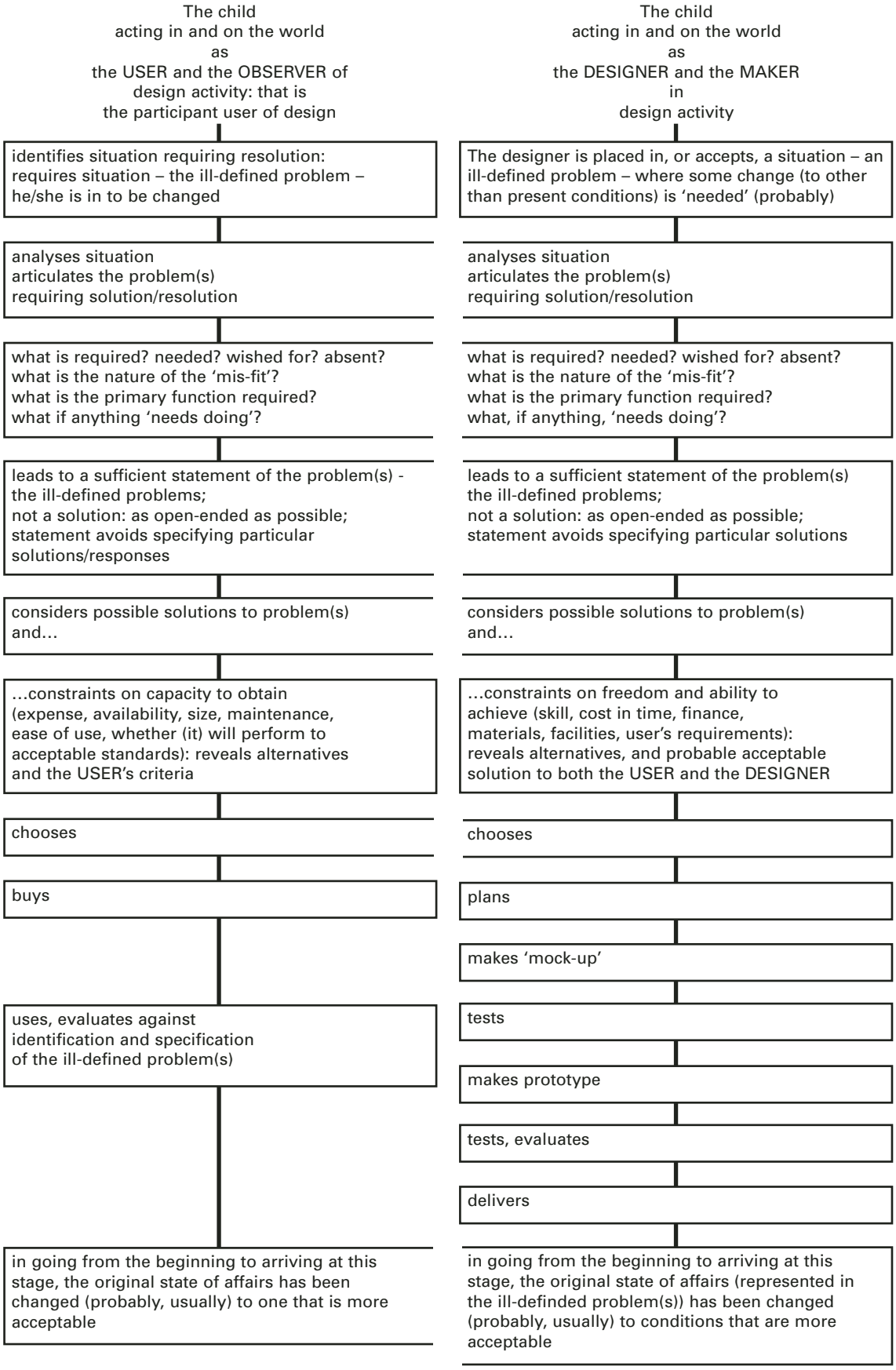

Figure 2. A model towards understanding the nature of design educational activity

Figure 2 – itself, incidentally, a model – represents cognitive modelling as active processes and functions which are within, related to, and derived from the design act. As it happens, this model makes considerable reference to artefacts, but this is not to suggest that artefacts are, or should necessarily be, the principal outcome or the principal object of the activity. In this case, the significant status of artefacts is as a possible *means* towards achieving change, rather than as a necessary end. This is to make a distinction between means and ends which ought to be important with regard to educational purposes. Making use of such a model, then, is not to assume that artefacts *shall* be made, in order for the activity to count as designerly activity. In this context the model is, rather predicated on the notion that designing is essentially concerned with change (or, better, with changing); or with bringing about some intended change both in the agent of the activity and 'out there'.

The centrality of bringing about change as one of the identifying features of designing and of design-educational activity is worth pursuing. Figure 2 presents a view of design activity as having a transitive form: that is the perspective represented by the User and the Observer.

> *... All design activity involves continual appraisal and reappraisal of the meritoriousness of existing realities and alternative propositions being handled.*
>
> *... a transitive form of the activity is wholly or largely concerned with the appreciation of states of affairs and with choosing and deciding, rather than with the creation of things and systems. All human beings rely heavily on cognitive modelling in both these forms for the pursuit of their everyday activity. (2)*

This transitive mode of design activity is under-valued – indeed, is barely recognised at all – in mainstream definitions of designing, including the conceptions found within small specialist groups of design-related practitioners. And yet it represents better the more general case of design experience and activity than does the familiar model which is essentially concerned with the making (but not always with the designing) of artefacts. Appreciation of the transitive mode is of enormous radical significance; and the operational implications would be beneficial. For instance, a particular part of this significance is in the potential for the complete transformation of so-called 'consumer education' in relation to, first, the priority often attributed to the making of tangible artefacts in the design-related school curriculum subjects and, second, the experience of design activity – predominantly transitive for the majority – in the lives of adults. Even more significant is the potential for developing a larger conception of design in schools through the formulation of a model at a higher level of generality: it would have the effect of changing the perceived exemplary status of some established and familiar curricular activities.

The modelling of Figure 2 readily accommodates the production of physical artefacts – and distinguishes between means and ends in so doing – but the functioning of design activity that it represents does not entail them, nor their making. This is so not only in the transitive form but also in the 'making' dimension. When acting in the role of 'the designer' and 'the maker', the child is not disallowed from 'changing his mind' away from an (at some earlier point) anticipated artefact in his or her evolving conception and realisation of the state of affairs which gives rise to the activity.

The phenomena, and the actions and events, that it attempts to provide a model *for* (incidentally rather than *of*) are not exclusive towards feelings or emotions. Indeed, the intention is to be inclusive towards them. It is a skeletal peg intended to make design experience more comprehensible and transparent. One function is to offer the possibility of an interpretative perspective on experience. This does not exclude other possible functions within pedagogy: of, for instance, helping pupils understand better the operational aspect of design activity. Or helping pupils to gain a better sense of a phenomenon, which essentially is not

susceptible to description in natural language. The modelling may appear to be descriptive in character but rather than being primarily descriptive – or, as a superficial reading might even suggest, isomorphic – of the activity, any apparent descriptiveness if towards developing the pupils' analytical synthesising and reflexive capacities, as mediated in design activities. There is, then, no intention to articulate an 'identity' or 'correspondence' model: it is, potentially, informative of the activity rather than representative. That is, the key function is translation: between the language of discourse and the development of operational capability.

In any event, to pursue this latter point more generally, the test of adequacy or of usefulness of a modelling mediated in natural language in the field of design-educational practice does not necessarily consist in its 'imitation' of 'the facts'. To subscribe wholeheartedly to 'imitation' might be to miss part of the metaphoric nature of language and, particularly, the functions of metaphor in modelling. Furthermore, to concentrate on 'imitation' might be to risk a distortion of the phenomena as experientially enacted. It is a modelling *for*: to be persuasive or useful, a model must differ from the subject phenomena. Models lose life, and as a consequence much of their value, as they gain in identity. Were this not so, the structure of design phenomena would be as obvious as that of the model (making the model redundant). This seems banal once stated, but the widespread failure to recognise it, and hence its significance is well illustrated in the naïve following of 'the design line', or 'the design loop', or the four attainment targets of the NC Design and Technology model, as though they provided recipes or descriptions of the structure and the structuring of designing educational activity.

In other words, the failure to understand the nature, the status and functions of models has resulted in widespread confusion between the logic of designing and the logic of the language which is used to refer to or describe designing. Alternatively put again, there is a widespread failure to distinguish between the phenomena of designing and the meta-language of discourse, in which the models are located. One of the strong criticisms of the models of design activity in education, including the one at the heart of NC Design and Technology, is that they purport to be general but are, in fact particular. (The NC model, it can be argued, sits uneasily between the two levels, and satisfies neither; the effect is confusion.) It is, however, possible to express a model at a high level of generality. Before that, it is necessary briefly to remind ourselves of the distinctive nature of designerly thinking and technological activity. The character of the action is distinguished by its treating, and conjunction, with 'ill-defined problems'.

> *…(Design) is a problem-centred activity, but it is distinguishable from some other sorts of problem-solving activity by the fact that it is chiefly concerned with 'ill-defined problems'. In this context, the term 'problems' refers to the presently existing state of affairs; it does* ***not*** *refer to the statement of requirements which a (possible) thing or system is expected to meet. Nor does the term 'solution' refer to the design arrived at. (…) Design problems are described as 'ill-defined' because there is no way of arriving at a provision description merely by the reduction, transformation or optimisation of the data in the requirement specification. By the same token, it is rarely possible to determine whether or not the finished design is 'the correct', 'the only' or 'a necessary' answer to the requirements. It must usually be possible, of course, to establish whether or not one 'proper' answer to the requirement is better or worse than some other 'proper' answer. Where such doubts do* ***not*** *exist, the problem is not 'ill-defined' and might therefore have been resolvable by scientific or mathematical methods rather than designerly methods. (3)*

With that in mind, it is possible to conceive of a model at a high level of generality. If we consider the question, '*When* is a (design) problem?' we can respond: 'A problem consists in a state of affairs, in

which we feel some unease or discrepancy or incompatibility'. The 'problem statement' consists in a description of that state, and it will be, inevitably, an approximate or tentative description; thus:

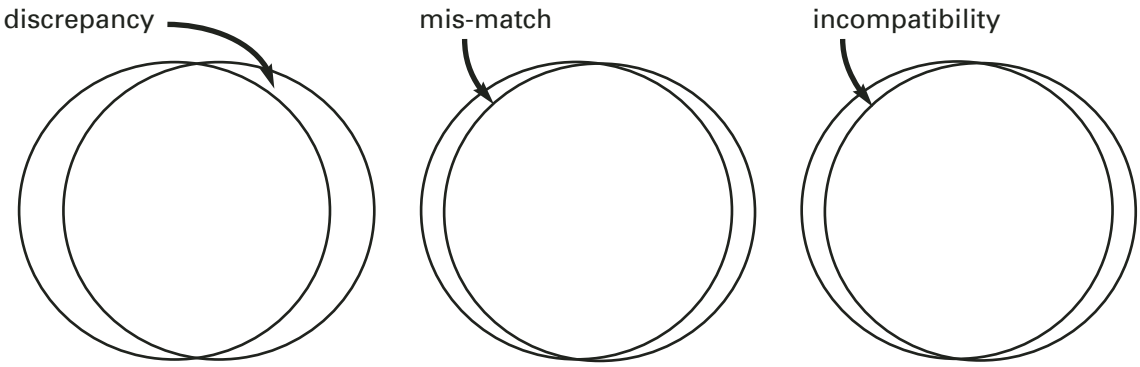

Figure 3. 'When is a problem?'

Figure 4 develops the notion:

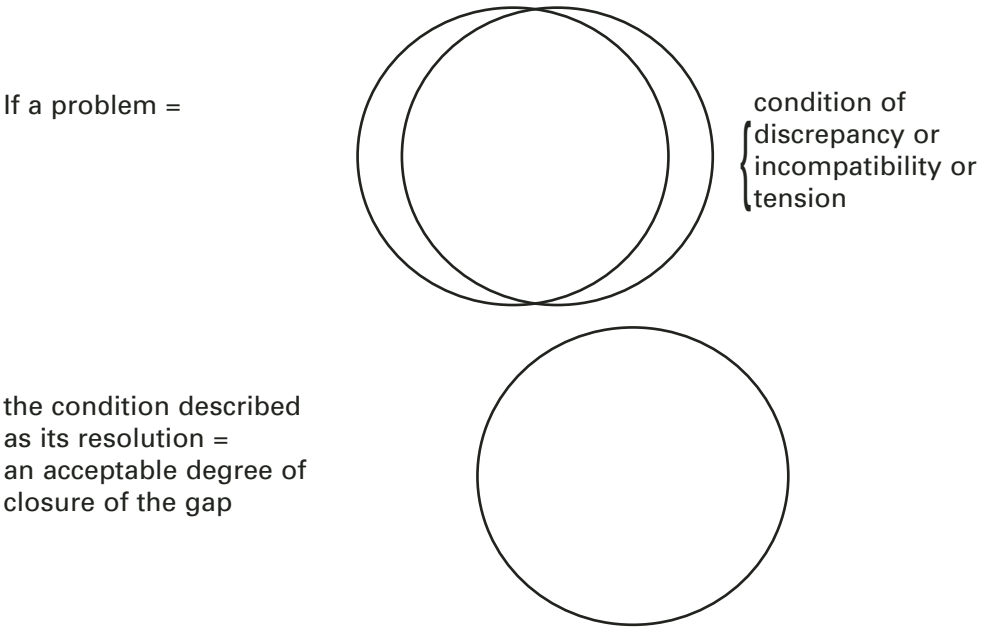

Figure 4. From problem-state to resolution

The central notion is that design and technological activity is concerned with changing (and notice the gerund); or with the achieving of some change. It might be that a change is required in circumstances 'out there'; it might be some change in the sensibility, or the capability, or the knowledge of the agent of the activity. But change does not *entail* the production of things, or systems, or environments: the essential focus of designing is on ends, not means. Most models relating to design educational activity which specify that products shall be produced have more to do with means than with ends. That is not illegitimate; but means and ends should not be confused or conflated.

In an educational context, it is then possible to construe design and technological activity as continuing activity, with educative activity construed as a continuing process; contained in the addressing a series of overlapping states of affairs grounded in pupils' lived experience.

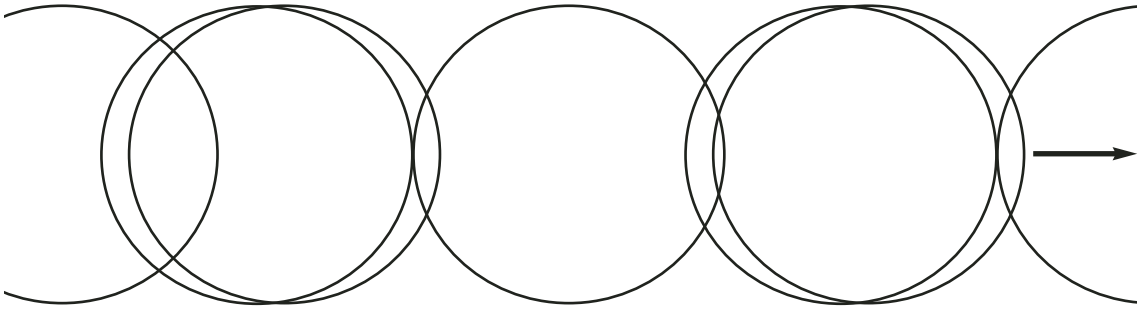

Figure 5. Design and technological activity as learning: problem solving as continuous process contained in focussing on overlapping states of affairs

Figures 3-5 provide a model upon which the model provided in Figure 2 may be imposed. Figure 2 may have some initially useful pedagogic functions, but it is more specific than that of 3-5.

In another context, Toulmin noted that some novel method of representation is always at the centre of discovery, helping us to apprehend the phenomena in a new and more fitting manner. (4) That could suggest that one of the functions of modelling can be characterised as cognitively heuristic. On such a view,

Figure 2 tends towards a 'translation-correspondence' model, translating between sets of concepts – those of nominal definitions and those of operational functioning.

This reflection on the nature of modelling in natural language and the functions of models may be taken just a little further. Our experience of misunderstandings in, for example, social affairs is a sharp reminder that the words of natural language have no clear cut boundaries to 'their' meanings. Wittgenstein said:

> *...We might, by the explanation of a word, mean the explanation which, on being asked, we are ready to give. This is, if we **are** ready to give any explanation; in most cases we aren't. Many words in this sense then don't have a strict meaning. But this is not a defect. To think it is would be like saying that the light of my reading lamp is no real light because it has no sharp boundary. (5)*

Our use of words of natural language (in modelling) can bring into focus 'parts' or aspects of our experience, the clarity of whose meaning – a functioning of the focussing – diminishes as the focus blurs towards the edges. But one man's clear meaning can be another's blurred focus, even within apparently shared experience. In principle, perhaps it is possible to achieve hard conceptual boundaries in an artificial language. The point is this: language cannot represent, unequivocally, our experience; but it can be, and is useful. If natural language were found unequivocal in the meanings carried by it, or if it were found lacking in tension or ambiguity, it would be found so only by members of a speech community who shared the same narrow set of activities, and whose activities were confined to acts whose meanings were those contained by the language's constitutive definitions. Hence, the comparative unequivocality of the formal language of scientific theories. But this absence of ambiguity, or this intended inflexibility, is the feature that makes such formal language unusable by people who are untrained in that language, or who work with subject matter the boundaries of which cannot be confined. The capacity of many possible meanings is intrinsic to evolving natural language: the unfolding form holds blurred boundaries, which is to say possibilities for meanings. And much of designing is, by definition, to do, literally with the making of meaning. Polysemy is intrinsic to and necessary in form-making. The problem, then, of description (in relation to meaning-making) perhaps lies in more appropriately 'matching' one polysemous form (language) against another polysemous form (designing), both of which are situated in an infinity of possibilities.

On this view, the call by some teachers for a 'definitive design vocabulary' – meaning definitions without ambiguity – rather than for a useful meta-language, is misinformed. (In passing, this also offers an insight into the utopian ambition of specifying what shall be the 'knowledge content' of NC Design and Technology.) But in any event if to learn is to be engaged in the active making of meaning, then learning activity, in general, has a polysemous quality; and the plea by some teachers which appears implicitly to say that this should not be the case appears as a challenging and curious proposition.

However, this is no argument at all for not trying to represent our experience as precisely as the limits and limitations of language usage will allow: we learn to treat with those difficulties as well as live with them. So, we can attempt to achieve a minimal yet firm skeleton but properly (and especially at this stage of design theory development) be less parsimonious

towards its substance in the interests of the potentialities and actualities of meaning making.

The modelling of Figure 2 presents a conception of design activity as a sub-set of human intentional activity: of action in and on the world. It also expresses the notion that learning is a function of taking action; that designerly activity is to do with bringing about change; that design educational activity is concerned also with bringing about some change in the capability, the sensibilities, or the awareness in the agent of the activity. And at the heart of the activity is the engagement of the capacity for cognitive modelling. Might reflection suggest any matters of significance for researchers, scholars and for teachers? There are several lines of response.
The first arises from the documentary evidence provided in course descriptions. That is, the development of cognitive modelling ability is not explicitly addressed by teachers of design-related subjects. The status, the nature and the functions of modelling (and of models) appear to be poorly understood and appreciated. Does that matter? The answer must be: Yes. The quality and status of the teaching of most of the techniques of modelling in design are much less than their centrality deserve, both within the field and in the public mind (as evidenced in the 'back to the Three R's tendency). And the teaching of modelling is certainly less well coordinated than it could be. Partly as a consequence, the relations between the modelling conventions employed by, for instance, art teachers and CDT teachers, are less mutually appreciated than they might be. But the absence of a theoretic base for modelling holds back the incorporation of further modelling techniques and useful concepts that might be taken from studies in artificial intelligence, systems theory, and cognitive psychology. The lack of explicit attention to and knowledge of modelling holds back the development of the design curriculum and design pedagogy.

There is also a major strand of enquiry to pursue via the history of ideas. There is a tendency to think of design as being in some special sense 'visual'. The conception and the expression of ideas, however, do not employ only one symbolic form. We may conceptualise in one mode and express in another – hence the possible objective, expressed earlier, of developing the ability to make transformations between different symbolic forms; and of developing the ability to choose and use whichever symbolic form and media might be most appropriate to particular purpose, task and audience. This is an area of philosophical-scholarly and operational importance. To present designing as being necessarily predicated on the capacity for cognitive modelling is to say also that design capability is a function of the capacity to understand a physical environment in abstract ways; and *that* is to accept the intellectual status of design. The relationship between the construing of an environment and the preparation of objects is a long-standing problem in epistemology. An alliance of enquiry between the philosophical and the operational might lead towards a response to our opening question: How is it possible to design at all?

Another line of enquiry that may perfectly well be pursued by practitioners also arises from reflection upon Figure 2. This line of enquiry would be to do with design-related curriculum subjects in relation to design educational activity. It can be summarised.

First, if the capacity to act intentionally is construed as being central to designing (and to design educational activity) it is necessary to recognise differing modes of action. That is, action in and on the world may be overt or covert. Secondly, it is necessary to distinguish between mindful activity and mindless activism. The alleged superiority of any single and particular mode of manifestation of action is not to be taken as self-evident: the criterion of superiority would be in some relation to the task, purpose, function, context, and their contingency. More specifically, four points follow.

One, overtly witnessable modes and unwitenssable modes are complementary modes of action. The grounds then for

asserting that the overt mode should necessarily be regarded as *the* exemplar, rather than the covert and transitive, are opened up for re-appraisal.

Two, in acting in and on the world, neither the making nor the using of tools is entailed. In a weak sense, it could be said that tools – when and if used – function as instrumental extensions of man's intentional activity. In a stronger sense however, tool-making and tool-using extend man's cognitive capabilities: that is, they are not to be understood as simple modifications of natural objects.

Three, the making of tangible artefacts is not entailed – except in those areas of activity which are constituted in artefact achieving, e.g. furniture making. But even there, there are exceptions to this generalisation, and even there the transitive mode is not necessarily inferior to the overt mode which is frequently displayed through artefact production. In terms of curriculum subjects, a recognition would lead to the proper recognition of Craft, Design and Technology (CDT) as a limited case. Alternatively put, CDT does not provide the paradigm case of designing, nor does art. This is not of course a value judgement: it is a conceptual issue.

Four, while it is important *that* man makes things and systems, and while it is important to understand *how* competencies in the making of things and systems may be enhanced, there is a prior question (or, at the least, an accompanying question): Why, or whether, man makes or acts. That is, the prior question is to do with mindful action. The narrowly operational, no matter how complex or simple, is insufficient by itself – and particularly with regard to educative intentions.

All this means that the often asserted or sometimes supposed exemplary status of some particular school subject is not easy to sustain. The brief summarising conclusion is that the development of the design capacity is central to would-be-educative activity. The capacity to act with intention is realised and manifested in the functioning of cognitive modelling. In treating with real-world ill-defined states of affairs, cognitive modelling engages, employs and is constituted in differing modes of conceptualising, symbolising, and presentational systems, according to the subject phenomena, the 'task situation', and the required functions or purposes. The operations encompassed by the term 'cognitive modelling' are necessarily and inevitably complex, and transformational.

References

1. Bruce Archer and Phil Roberts, Internal paper, Design Education Unit, Royal College of Art 1979

2. ibid

3. ibid

4. Stephen Toulmin, *The Philosophy of Science*, New York: Hutchinson 1953

5. Wittgenstein, *The Blue and Brown Books*, Oxford: Blackwell 1975, p 27.

Criteria, Objectives and Competencies

Bruce Archer
Phil Roberts

The establishment of the Design Education Unit coincided with a period of increasing Government concern about the content of the school curriculum and the levels of attainment reached by children and young people. There were a number of initiatives intended to improve matters. Historically, these can be seen as moves towards the emergence of a National Curriculum. The Unit contributed papers that set out to clarify the nature of learning in design and to describe the criteria, objectives and competencies that might be expected at the different levels of general education. Two papers are reprinted here.

The papers remain topical because they present alternative ways of characterising design education and design educational activity. In both cases, a determined effort was made to avoid being subject specific. It was firmly believed that the Design 'segment' did not belong to and could not be delivered by any single existing school specialism. The second paper reprinted here, ***Competencies in Design and Technological Understanding****, is particularly interesting because it attempts, with remarkable brevity, to navigate the difficult boundary between design and technology. This was, and remains, an area and interface requiring further analysis: first, philosophically, in pursuit of clarifying the epistemology of Design (and its distinctiveness); second, to consider whether 'technology' implicitly and unwittingly refers to the promotion of particular 'making' technologies; and third, to pursue exploration of its implication for curriculum practice and content.*

It is important to note that these papers had a role very different from the National Curriculum. They were not intended to be prescriptive but to promote further debate and, indeed, independent initiatives by teachers and other practitioners.

Paper One
Criteria and Objectives for Design Education

Introduction

This paper attempts to define criteria and objectives for design education in order to provide a checklist of pupil and student competences which will assist HMI, irrespective of subject discipline, to focus specifically on design education when visiting schools and colleges. Although the broad criteria are common to both general and vocational education, the more detailed criteria may be more specific to one phase than another.

The Foundations

Design education is concerned with language, envisaging and the technology associated with making. The ability to envisage, or construct, conceptually, models of existing or invented reality is an inborn human capacity. Observations of children suggest that they can erect such a model in the minds eye and, in varying degrees, manipulate it predictively. There is much evidence that this facility can develop, with appropriate education, to become a highly sophisticated cognitive process in which many related factors can be manipulated concurrently.

As a sophisticated mastery of words facilitates linguistic thought, so a knowledge and mastery of the means to understand and depict visual form can strengthen and extend this capacity to envisage. The refinement of such a model requires the facility to hold it in an external material form, such as a drawing or physical model. This can enable the visual thought to interact with the external record so that the idea is further refined and developed.

Profound connections exist between the models we envisage in our minds and which our senses inform, verbal language, the non-verbal languages of art, gesture and number and communication by drawing, diagram-making and simulating. Through the interaction of these processes and languages, pupils and students learn to internalise experience and externalise and capture design thinking.

Primary

In primary schools the curriculum needs to include applications of practical reality and opportunities to handle and understand basic materials. In mathematics and science, for example, there is a need for experimental methods in which the senses can confirm or challenge the predictions. Authentic materials need to be used so that pupils can feel natural forces directly and not rely solely on diagrams or theoretical language. An example of an unauthentic material would be the use of polystyrene blocks to construct an arch as a demonstration of the force of gravity. In history or humanities the study of some important aspects of the history of technology could be invaluable, such as the history of prime movers. In home economics, the taste, smell and look of food made in class can have aesthetic value, and the menu and its recipes be a form of design brief. In language work, the use of metaphor in relation to sensory experience can help children to hold and communicate abstract ideas. If the experience arising from the use of materials is to be usable later it needs reflection upon by means of words. A major purpose of language, shared by a number of subjects including art and English, it to make experience tangible.

Early Secondary

There is a need for the teachers of all subjects to recognise what each can contribute to design education and to make this known to the pupils. In particular, the art department will need to demonstrate the relevance of art experience to design awareness.

There are important links between art, craft, design, technology and language. There is plenty of evidence to suggest that the richer the experience provided for the pupils across a range of disciplines the richer their output.

It is also important that teachers should make pupils aware of the criteria by which their work is valued. Critical appreciation of each others work should not be left until later on in the secondary school. Pupils need to acquire over a period of time a sense of values and learn to make choices. There should be opportunities for pupils to make judgements and practice that element in design education of learning from failure.

Common Broad Criteria

In design activities there are related elements; these include practical experiences with materials and the thinking activity involved; an appreciation of the world of design; informed critical judgement about design; attitudes to information and knowledge which are helpful to the design process.

1. Practical experience should involve a range of materials and should be structured, systematic and disciplined.

2. Thinking activity: creative, organised thinking and its application; progressing from abstract ideas to a practical solution of a design task. This should often include research into the development of a design brief.

3. Pupils and students should become informed about the world of design, both in terms of existing design practice as well as the history of design.

4. Pupils and students should know the criteria by which they and their teachers evaluate their work, and should know of ways in which they may describe their own response to the work of others.

5. Pupils and students need to develop attitudes to information and knowledge which aid designing. They need to know what to find out, what sources to explore and what depth of knowledge is required for particular purposes. Equally important is their willingness to search diligently and to incorporate relevant knowledge, including that which is inconvenient to preconceptions.

Objectives

Among the objectives for design education, the development of design perceptions is central, but in order to give form to such perceptions some degree of skill is necessary. There will be wide variations of skill according to the phase of education.

Design perceptions

Bringing experience and judgement to conceiving and making functional forms (i.e. functioning both practically and aesthetically) through the integration of perceiving, feeling, thinking and visualising. This is a fundamental feature of design experience and involves two major elements:

1. Fitness for purpose: the ability to relate a design to human needs and enjoyment including the environment, ergonomic factors of scale and the sensibilities of the user. The ability to see and understand the formal relationships between the aesthetic components of a design. The ability to see and understand functional efficiency including performance (eg, economy, properties and appropriateness of materials, application of energy in product and production process).

2. Research and development: an understanding that in forming a design mental connections must be made between items of acquired knowledge, the identified design task, the visualisation process, the experience gained from the manipulation of materials and means of production.

Facilitating skills

The facilitating skills represent the range of personal resources which give access to design experience. These skills are of different kinds and, in varying degrees, are present in all learning in design.

1. Task identification: the ability to define a design task; the ability to plan and describe possible routes to a satisfactory completion.

2. Discriminatory skills: the ability to envisage and select from a range of possibilities. The ability to see nuances, similarities, differences and graduations. This can be taught, and pupils/students can develop a body of knowledge and a repertoire of skills concerning the visual, tactile and technical judgements which they can apply to design tasks.

3. Practical skills: the skills of handling materials, tools, machines and equipment. The sensitive control of materials, requiring the understanding of processes and the acquisition of appropriate manipulative skills. Successful design depends in part on the effective use of tools and/or machines and equipment in relation to materials at a level appropriate to the task. Pupils/students should understand how to select appropriate materials and working methods to achieve quality in their work and pleasure from its execution.

4. Study skills: locating and selecting appropriate resources and information; seeing the relationships and possible connections between individual items and their potential use in design tasks.

5. Skills of communication: graphic, oral and written communications concerned with the formation and sharing of concepts and the deployment of skills. The pupils'/students' knowledge of and facility with a working vocabulary; for example, the words associated with form, function and appearance or the technical terms associated with tools, materials, equipment and processes.

Knowledge and content

1. Pupils/students seeing their own work in relation to existing design practices and the history of design.

2. Factual knowledge: pupils/students being informed about other areas of knowledge, such as the arts, technology, science, mathematics and the humanities.

3. Moral and ethical considerations concerning the relationship between the work of the designer and the user.

4. Pupils/students knowing the criteria by which they and their teachers evaluate their work.

Attitudes and values

1. The ability to find value and pleasure in designing, and the stamina to maintain momentum over the necessary period for the completion of a design task.

2. Attitudes which ensure open-mindedness in the search for relevant knowledge and information and willingness to apply findings.

3. The ability of pupils/students to make informed critical judgements about their own designs and those of others.

4. The ability to make informed judgements concerning the role and function of the professional designer.

5. The recognition of the designer's role as a member of a design and production team.

6. The recognition of the economic importance of good design.

A Checklist of Pupil and Student Competencies

Their presence or absence will vary considerably according to the phase of education.

Design perception

1. Does the work demonstrate a perceived relationship between the design and various human needs (for example, environment, ergonomics, scale and the sensibilities of the user)?

2. Does the work demonstrate a perceived relationship between the various aesthetic components?

3. Does the work demonstrate an understanding of functional efficiency (for example, performance, economy, properties and appropriateness of materials, use of energy, process of making)?

4. Does the work demonstrate an understanding of the connections between the various components and stages in the development of a design?

Design skills

1. Can the pupil/student identify problems and work towards their solution?

2. Does the work show skill in seeing nuances, similarities, differences and graduations in visual, tactile and technical terms?

3. Is there sensitive physical control of materials, tools, machines and equipment?

4. Does the work display sensitivity to the nature and qualities of materials?

5. Does the work provide evidence of the selection of appropriate materials?

6. Have study skills been acquired and used in selecting appropriate information and applying it?

7. Have skills of communication been acquired and used (graphic, oral, mathematical and written)?

8. Has the pupil/student acquired a working vocabulary (words associated with form, function and appearance or the technical terms)? Can they communicate with those outside their own discipline?

Knowledge and content

1. How far is the pupil/student aware of his work in the context of the world of art, craft and design?

2. How far is the pupil's/student's own knowledge enriched by the work of designers, craftsmen and artists?

3. How far is the pupil/student informed about other areas of related knowledge (e.g., the arts, technology, science, mathematics and humanities)?

4. Is the pupil/student conscious of the relationship between the work of the designer and the user.

5. Does the pupil/student know the criteria by which his/her work is evaluated?

Attitudes and values

1. Has the pupil/student an ability to make critical judgements about his/her own work and the work of others?

2. Does the pupil/student reveal open-minded attitudes in his/her search for knowledge and information and a willingness to apply findings?

3. Is the pupil/student able to make informed judgements about the role and function of the professional designer?

4. Does the pupil/student find value and pleasure in designing; does he/she have the stamina to maintain momentum for the completion of the design task?

Paper Two Competencies in Design and Technological Understanding

The Assessment of Performance Unit (APU) Technology Working Group consider that it is possible to produce a framework for the identification of the competencies that pupils might reasonably be expected to be able to demonstrate in Design and Technology. The framework used identifies three aspects of performance: skills, knowledge and values.

The dominant feature of the design and technological dimension of human performances is the bringing together of skills, experience, knowledge, understanding, imagination and judgement, whatever their limitation, in the execution of a specific task. In practice, it involves the integration of a complex of activities that are specific, inventive, effective and evaluative.

In interpreting the framework it must be borne in mind that both the acquisition of design and technological understanding BY a child, and the detection of that understanding IN a child, are contingent on the child's engagement in purposeful and comprehensive activity.

Skills

The skills that are used in the processes of design and technological activity are distinctive. The framework identifies four categories of skill: Investigation; Invention; Implementation; and Validation.

These tend to overlap and to follow one another cyclically and repeatedly in the course of design and technological activity. Taken together, they constitute the process of recognising a need and matching available means with desired ends.

The skills of INVESTIGATION include the ability to:-

1. **Recognise** the existence of a problem, which might be amenable to solution through design and technological activity;

2. **Perceive**, or identify through investigation, the extent to which a given thing of system meets the stated need;

3. **Seek** out information and resources and/or to generate information through observation or experiment and to judge the relevance, sufficiency and reliability of the information and resources obtained;

4. **Employ** a balance of knowledge, analytical skills and judgement in arriving at conclusions in the face of ill-defined problems.

The skills of INVENTION include the ability to:-

1. **Conjure** up in the mind's eye images of proposed things or systems, and to manipulate, rotate and transform those images;

2. **Think** of alternative configurations for a desired thing or system, and to adapt, transform and select from these configurations to meet given needs;

3. **Externalise** these images through a variety of means, such as sketching, drawing, diagram making, constructing, or the use of notation or language, and to communicate information about them to others;

4. **Examine** the integrity and coherence of a product or system idea, the degree to which it matches its requirements and the extent to which the requirements themselves are appropriately defined.

The skills of IMPLEMENTATION include the ability to:-

1. **Plan** a practical activity and to see it through;

2. **Select** from available resources the most appropriate energy resources;

3. **Use** tools, materials, appliances and appropriate energy resources;

4. **Monitor** and measure the effects of operations and to control their outcome.

The skills of VALIDATION include the ability to:-

1. **Discern** the appropriate contexts for the appraisal of any thing or system and to identify the criteria by which that thing or system should be judged;

2. **Nominate** the measures appropriate to given criteria and to devise practical or logical tests to determine the performance of a given thing or system in relation to them;

3. **Form judgements** about the balance of merit of a given thing or system in respect of given criteria; to distinguish between different sorts of needs and to assign different degrees of importance or priority to given needs in different circumstances;

4. **Appraise** the efficiency of a given course of design activity.

Knowledge

The essence of design activities is that they seek to resolve specific practical problems through the use, in an integrating manner, of a wide range of knowledge and experience. The designer does not need to know all about everything so much as to know what to find out; what form the knowledge should take, and what depth of knowledge is required for a particular purpose. It is more important, for design purposes, to know how a system works, or might work, and how different knowledge disciplines relate to each other in practice, than it is to have a depth of knowledge of a single discipline in isolation.

Also, for design purposes, knowledge needs to be in such a form that it can be used to make decisions which will contribute to the creation of a device which does what is required. Scientific knowledge as such, which is essential for understanding the nature of the physical world, is not necessarily in a form which can be used for design purposes.

In a certain sense it can be said that every sort of design activity is underpinned by an understanding of its relevant technology. Most people, however, would recognise that some sorts of design activities are more technological than others, in the sense that they are more reliant upon objective information about the nature and behaviour of materials and processes particularly of the more resistant materials and the more power-using processes.

One of the most important aspects of the design process is the way in which it continually calls for the making of decisions which require information from other disciplines. The form in which this information is needed means that the questions which are asked of the disciplines may be unlike those which the disciplines themselves ask as part of their own development. For example, although scientific information may be needed, the form in which it is needed effectively requires the generation of new concepts – ie; Technological concepts. Three strands of technological concepts can be identified as constituting the essential basis of design and technological understanding.

These three strands of technological concepts are:-

1. Control: knowledge of how systems, whether static or dynamic, can be created to have a specified effect

2. Energy: knowledge of the sources, costs and forms of energy; of methods of storing and transmitting energy; of efficiency and of conversion of energy.

3. Materials: knowledge of sources and costs of materials; of their useful properties and limitations; of their methods of being processed, manipulated and connected.

The application of the skills of design activity (investigation, invention, implementation and validation) can be called technological when they operate in these concept areas. Involvement in these activities helps in the acquisition of the concepts while possession of the concepts helps with involvement in the activities.

It is demonstrable in schools that pupils are able to use their technological concepts at a variety of levels. However it is not necessary for these concepts to be CONSCIOUSLY possessed by pupils before they can be used.

To illustrate this, the concepts of energy, energy transfer, power and power matching may begin to be acquired by a 10 year old. He can experiment with energy by storing it in raised weights and stretched or twisted elastic. He can devise ways to use this stored energy to project a missile, propel a vehicle, make a noise or make something go round. Later he can work out how to use his stored energy to meet more precise requirements – maximum range, highest speed, longest duration of travel, etc. Later still he begins to qualify his energy and begins to anticipate what will happen, his design decisions become more mathematical. At about the same time, he understands the nature of energy in its different forms, mechanical, electrical, thermal etc, and, by analogy, he begins to understand the correspondence of concepts in different energy fields.

A technological solution to a problem arising in one part of the school curriculum will almost certainly need to draw on resources of knowledge and design skill acquired in other areas of the curriculum, and probably also require facilities for its successful implementation to be provided from other subject areas. It is therefore important to distinguish the technological PURPOSE, which might be provided by an individual school subject, from the technological KNOWLEDGE and SKILL resources and the opportunity for technological DESIGN IMPLEMENTATION.

Values

The pursuit of design and technological activity can rarely be entirely free from the exercise of value judgement. The questions always arise: What are the 'right' ends to be striven towards in this case? Which would be the 'better' approach? What would be a 'good' result? Sometimes the answers to such questions will be expressible in terms of technical efficiency or economic cost. Sometimes they will be concerned with ethics, or aesthetics or social responsibility. The understanding that is required of a child is the ability to recognise different sorts of values underlying different sorts of problems and the ability to apply appropriate sorts of reasoning to the kinds of value that are relevant. The framework therefore identifies five areas for assessment along the dimension of values:

Technical values: Economic values: Hedonic values: Aesthetic values: Moral values:

The pursuit of TECHNICAL VALUES might involve an appreciation and application of the concepts of:-

1. **Efficiency** and the ways in which any input is compared with the resultant output;

2. **Robustness**; flexibility and the ways in which the performance of given man-made thing or system might be sensitive to change;

3. **Precision** and the quality of fit and of fitness to purpose, valued either for their own sakes, or as means to an end;

4. **Confidence**, and the ways in which the possible reliability or unreliability of information is taken into account.

The pursuit of ECONOMIC VALUES might involve an appreciation and application of the concepts of:-

1. **The broad distinction** between the ideas of use-value, intrinsic value and value-in-exchange;

2. **The distinction** between value, price and cost;

3. **The concept** of the marginal value of one product or product variation over another;

4. **The effects of variation** in supply and demand on availability and price.

The pursuit of HEDONIC VALUES might involve an awareness of:-

1. **The role** of vision, hearing, smell, taste and touch in attaching value to phenomena through their direct appeal to the senses;

2. **The role** of appetite, desire, pleasure, pain etc in the evolution of products and systems;

3. **The demands** made on the configuration of man-made things and systems by the physiology and psychology of people;

4. **The importance** of hedonic factors in all forms of design activity and an ability to take them into account when designing or evaluating things in the man-made environment.

The pursuit of AESTHETIC VALUES might involve an awareness of:-

1. **The structures**, proportion and colours to be found in the natural world;

2. **The structures**, proportions and colours to be found the man-made world;

3. **The importance** of aesthetic factors in all forms of human communication and social and self-expression;

4. **The inter-relationship** between workmanship, tools and the aesthetic quality of the resulting environment or artefact.

The pursuit of MORAL VALUES might involve an awareness of:-

1. **Mankind's impact** on the natural environment and his growing responsibility for its and his own future survival;

2. **The inter-relationship** between the man-made world and religious, social, economic and political philosophies;

3. **The needs** of individuals in society and ways of meeting them;

4. **The importance** of ethical values in carrying out design activity and evaluating the effects of technology.

Design Education: The Basic Issues

Ken Baynes
Phil Roberts

This paper was given at an international design policy conference held at the Royal College of Art in 1982. It was an attempt to bring together many of the strands of thought that had emerged at the Design Education Unit. It set out to re-state fundamental propositions about design, design activity and design educational activity and, perhaps for the first time, to relate them directly to developments in cognitive science and cultural history.

It looked at tool making and tool-using and questioned whether these were the 'real' originating points for design. Instead, the paper put forward a 'different (and larger) conceptualisation' – that of humans making meaning by acting in and on the world. The distinction remains fiercely topical, not least in the unexamined role given to the importance of 'technology' in contemporary education. The paper also introduced the concept of a 'semantic whole'. The idea was taken from the philosopher George Steiner who used it to describe the creative relationship between readers and writers in a literate society. This took 'design awareness' a step further and suggested that one aim for design educational activity should be the creation of a semantic whole between designers, makers, users and all other parties to design activity.

The purpose of this paper is to set out briefly some of the crucial streams of thought that have contributed to our present view of design education. It is interesting that in Britain at least, many of these have first arisen in connection with general education. Perhaps this is because it is here that philosophical and educational issues come up most sharply. The fact is, however, that it is increasingly possible to view design education as a whole, from primary to tertiary, and to see that the same concerns are important throughout the spectrum.

The streams of thought we are dealing with have developed first of all as an historical phenomenon. Many have roots as far back as the Renaissance: some are older still. The industrial revolution represents another moment of critical change and upheaval. In a more immediate sense, the ideas we are dealing with have roots in the art and design experiments of the 1930s, the design explosion of the 1960s, the period of student revolt and the subsequent period of retrenchment and increasing bureaucracy. It is not our intention to deal with the history in this paper. That is an important piece of work that still remains to be done. Here our aim is to look at the 'state of the art' as it has developed and to ask: 'what are the ideas and issues for now and the future?'

In presenting this picture we shall draw on work which has been done in and around the Design Education Unit at the Royal College of Art by ourselves and our colleagues.

Design capacity as a fundamental attribute of human beings.

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

1. That design is highly specialist, complex and esoteric – that particularly the act of designing is something which people can do only after a long apprenticeship;

2. That design ability, like language ability, is something that everyone possesses at least to some degree.

We certainly take the second view. We believe it is the common sense one, borne out by ordinary experience. We hope that in time work now beginning will show just how children first develop a sense of such things as space, how they first begin deliberately to use cognitive modelling, how they first deploy tools and materials in

a purposeful way. For the moment, however, we can recognise that in play they do, in fact, do all these things, even if we do not yet understand the developmental aspect in any very coherent way. All small children display design ability and use it in their own activities even when it is neglected in formal education. This is hardly surprising because some knowledge of design, however acquired, is needed for survival.

We all, for example:

- try to create an environment which reflects our aspirations;

- use tools and materials purposefully in cooking, do-it-yourself, dressmaking and so on;

- make judgements about which objects and places we like or dislike, even attempting to say why;

- find ourselves moved and excited by the fine things that other people have made;

- choose or make clothes which make us feel at ease, which we believe are 'like ourselves';

- respond to the visual messages of advertising, products, signs, buildings, films, television;

- create visual images by photography and make qualitative judgements about which ones are 'successful' or which ones are 'unsuccessful'.

And, of course, we depend on the services of a society which uses all these sorts of ability in a deliberate way. When we carry them out we are, just as with language, creating meaning. We are making up life as we go along. We make up life through buildings, places, products and images just as much as we do through books, scientific enquiry, mathematical symbols, dramatic presentations or sport.

Cognition and cognitive modelling

We have just suggested that design is essentially to do with the ability to conceptualise and evaluate plans for the future. This can be done externally through such familiar mediums as words, drawings, plans, maps, models, prototypes and the like. Professor Archer's important contribution over the last few years has been to show that these external manifestations depend on an internal ability to model known as 'cognitive modelling'. The idea is so central that it is worth spelling out more exactly what is meant by this term.

The term 'cognition' is intended to embrace all those processes of perception, attention, interpretation, pattern recognition, analysis, memory, understanding and inventiveness that go to make up human consciousness and intelligence. Philosophers of mind and cognitive psychologists tend now to talk of cognition as the mental function of construing sense experience as conceptions, and of relating conceptions with one another. The use of the word 'construe' is significant. It is intended to acknowledge the circumstance that the individual conscious being cannot 'know' anything of the reality beyond its own skin except by the collection and interpretation of the signals received by its sense organs. These signals are overlaid by all sorts of irrelevance, interference and noise, and distorted on reception by all sorts of errors, illusory juxtapositions and omissions.

Moreover, in the neurological sense, the signals are ultimately received as electrochemical impulses scattered over different parts of the grey matter of the brain. There is no screen anywhere in the mind on to which a collected picture is projected. The conception in the mind which is built from these scattered impulses is that of a coherent set of signals betraying the presence of a supposedly equally coherent causal phenomenon beyond the sense organs. Subsequent patterns of signals may reinforce or deny the conception, or permit the useful association of conceptions into greater conceptions. When they are sufficiently integrated these constructions in the mind

become a general cognitive model of external reality. Since the cognitive model is all the individual consciousness has as evidence of external reality, then for all practical purposes the cognitive model is seen as if it were the reality. Memory and imagination are those further capacities of mind which are capable of conjuring up models of reality in the absence of causative sense data.

There is evidence that the human mind is predisposed to construe sense experience in particular ways, so that conceptions of space, form, object-coherence, colour temperature, sound and so on, are common to all human beings. These could be called categories of perception. There is also evidence that the human mind is predisposed to seek similarities within and between its accumulating conceptions, and to assign these to categories. It is from the labelling of conceptions and categories, and from the labelling of the relations between conceptions and categories that rational thought springs. It is from the recognition of pattern in and amongst conceptions and in and amongst categories, and from the recognition of pattern amongst the kinds of relations which conceptions and relations have with one another, that 'designerly' thought springs. There is a third predisposition of the human mind which lifts it above and beyond that of other sentient beings. This is the predisposition to assign symbols to represent conceptions, categories and relations. The use of symbols permits abstraction in inner thought, and the externalisation of thought for recording or communication purposes.

In the course of evolution the left half of the human brain has learned to specialise in the arts of categorisation from which is developed rational sequential thought, and in the use of digital symbol systems to construct language, mathematics and forms of notation. At the same time the right half of the human brain has learned to specialise in pattern recognition, and the use of presentational symbol systems to construct images, diagrams and other spatial forms of representation. Interplay between the two halves of the brain permits the pursuit of thought both to the highest levels of abstraction and to the further reaches of practical planning and design. (1)

To return to the issues which gave rise to this paper, the terminology used by Archer can be clarified as follows:

The expression 'cognitive modelling' is intended to refer to the basic process by which the human mind construes sense experience to build a coherent conception of external reality and constructs further conceptions of memory and imagination. The expression 'imaging' is intended to refer to that part of cognitive modelling which construes sense data and constructs representations spatially and presentationally, rather than discursively and sequentially.

This picture of the human being has many implications for design education. One of the most dramatic is that it must be an error to identify design as in any special sense 'visual'. To match the cognitive model, it needs to be holistic in its content. To enlarge on this holism it is possible to suggest a range of questions that a twelve–year-old might ask, and for which design activity might provide a focus for discussing, expanding, reflecting and developing meaning. Here they are:

What is the world like?
What am I like?
How did the world come to be the way it is?
How did I come to be the way I am?
How can I look at and analyse the world I live in and understand it?
How can I express or represent what I feel and know about the world?
What do I value?
Why do I like what I like?
Can I make the world more like what I like?
Can the world be made better?
Can I improve myself?
How can I plan to improve the world or myself or both?
Do I need to work with other people to improve the world?
How can I work with them?
How can I express or represent my plans?

How can I make my plans become reality?
What tools and materials can I use?
How can I use them?
Must I change my plans because of what I know about tools and materials?
Is what I have made a success?
What do I mean by success?
How do I find out if it is a success?
Which is more important, their judgement or mine?
What have I learnt from trying to change the world?
Have I changed?
What do I value?
How do I want to live?
What is the world like?
What am I like?

Clearly, the majority of these questions cannot be said to be only the concern of design. Many are shared with philosophy or ethics, others with art or craft or technology. But a number can only be dealt with by design. And the linkage from introspection, from an understanding of the world as it is, to the decision to act and to grasp that we are changed by acting, is at the core of what design has to offer as an educational experience at any level.

The significance of tool making and using

A number of recent statements, including some originating from the Design Education Unit, have attempted to identify tool making and tool using as the fundamental origins of design and, therefore, at the basis of any design educational experience. It is a view that has caused uneasiness and, in a recent paper for the Unit, Phil Roberts attempted to say in just what ways it represents an inadequate position. Since he linked his critique with a reassertion that 'taking action' is the fundamental element, it is worth following it in some detail. Here is a series of extracts.

The criticism directed by some in-field practitioners towards the asserted fundamentalness of tool-making and tool-using, and their criticism of the degree of significance that is attributed to tool-making and tool-using presumably imply the belief that there can be articulated a more fundamental and more encompassing model or rationale.

Or, perhaps the criticism implies that the attribution of paramount significance to tool-making and tool-using is to have displayed a subsidiary model. It says perhaps, that a particular, but nevertheless 'strong', interpretation of the capacity for tool-making and tool-using is actually or potentially partial; and therefore misleading. It is saying, perhaps, that a model that is constituted in the tool-making and tool-using capacity is lacking in explanatory power: it is not sufficiently persuasive.

Differently put, and perhaps more accurately, it is not tool-using and tool-making that is inadequate: it is rather, the inadequacies inherent in the conceptions of some practitioners that is weak, and which is demonstrated in some familiar curriculum activities. This is a hard-hitting view; but its basic proposition may be expressed easily enough.

The proposition is that the capacity for tool-making and tool-using – as commonly understood, and this is an important qualification – does not provide the constituent basis for a powerful model. However, the term 'tool-making and tool-using' is descriptive of a dimension of, or a strand in, a quite different conceptualisation. On this view, the status of tool-making and tool-using is translated from constituting a model to being a dimension of a larger conceptualisation. (2)

But what is this larger conceptualisation? Phil Roberts continued:

It is natural for the human animal to wish to 'make his mark in and on the world' or to wish to be recognised as 'a person'. The human animal is so predisposed. This predisposition may be expressed alternatively or additionally in saying that man exhibits a 'will to meaning': he wishes, necessarily, to understand himself, others, his habitat, and his place in it. The will to meaning is an aspect of the need of human beings to understand their condition and habitat – inner and external reality.

In the pursuit of that greater understanding, and through differing kinds of knowing and forms of knowledge, human beings act, individually and collectively, in and on the world. Human beings possess a fundamental capacity: the capacity for, and disposition towards, taking action in and on the world. The capacity to act is exhibited in differing manifestations that employ different models in relation to distinguishable kinds of phenomena and differing functions.

The capacity may be displayed in complex collective acts which employ high technologies, and which may be both celebratory and highly functional-operational. This is to suggest that whatever the manifestation, and whatever the mode and medium, the fundamental capacity to which any particular manifestations are in reference is the capacity for action and its associated disposition to take action in and on the world.

On this view, the fundamental conceptualisation is of man as the agent of action, whether this action is to be construed in a context of high technologies or existentially as the necessity to create or find meaning and greater understanding and in-controlness.

At a later point the paper stated the following:

Parenthetically, it might be worthwhile to attempt to relate this, which is potentially a re-conceptualisation of curriculum, to that familiar phrase 'Doing and making'. In practice, the phrase almost always carries, as understood, a 'necessary' conjunction with artefacts: 'making (some artefact)'. But on the view expressed above, the term requires extension. The term is too narrowly and too partially operational, and lacking in the human dimension. It may be extended thus. 'Doing, making and being = acting in and on the world', or, man the agent of intentional action.

Hence the status of artefacts, in an educational context, is opened up to possible re-appraisal. A model of artefact achieving is obviously legitimate when artefact achieving is the principal objective. But once it is conceded that a model of artefact achieving is not synonymous with a model of educational intent and practice, then the possible re-appraisal of the status of artefacts raises questions to do with the nature of the relations between (1) the development of the agent of action; (2) the development of mind; and (3) the achieving of artefacts.

To summarise:
Let it be accepted that man-the-agent-of-action provides the fundamental conceptualisation on which educational rationales, practices, and specific models of action might be more appropriately premised.

Let real-world ill-defined problems represent the phenomena with which man the agent of action necessarily treats.

Let it be accepted that the nature of human being in the world (or being a person) is necessarily at the core of any putative 'explanation' of human action.

Then the development of that capacity, employed and engaged-in when treating with ill-defined problems becomes central to would-be educative practice. The capacity to act with intention is realised and manifested in the functioning of 'cognitive modelling'. In treating with real-world ill-defined problem, cognitive modelling engages, employs, and is constituted in, differing modes of conceptualising, symbolising to the subject phenomena, the 'task situation', and the required functions/purposes. The operations encompassed by the term 'cognitive modelling' are necessarily and inevitably complex, inter-active and transformational. Different curriculum subjects, or curriculum areas, are intended to provide opportunities which will have the effect of developing the capacity to act, both in a general sense and in terms of specific kinds of action and in relation to particular kinds of phenomena.

The concept of literacy

When we turn to see the design capacity in a social and cultural framework, then the concept of literacy becomes important.

This, however, is a somewhat misused term, and it is necessary to say first what we intend by it.

The word literacy is much in vogue. Curriculum documents refer to such concepts as 'visual literacy' or 'technological literacy'. It is not always clear what people mean by this. Sometimes it seems that all they mean is that children and adults should spend more of the school or college day on whatever subject they are advocating. This is beside the point. Literacy has little to do with the acquisition of knowledge or skills in a narrow sense: rather it is about the growth of attitudes and confidence that will lead to participation: to, once again, the ability to 'take action' and be 'in control'.

In a brilliant article 'Classic Culture and Post-culture', George Steiner has made very clear the difference between being able to read and write and being literate in a larger sense. In the following extract he is discussing the background against which authors wrote in what he describes as the 'classical age of the book' between 1730 and 1885.

The consensus of echo on which the authority and effectiveness of books depended went deeper than schooling. A corpus of agreed reference is in fact of philosophic, social value. The economy of statement that makes possible a literary style, and the recognisable challenges to that style by the individual writer, has underlying it a large sum of undeclared but previously agreed-to social and psychological assumptions. This is especially so of the high literacy between the times of Montesquieu and of Mallarmé. The kind of lettered public they had in view is directly expressible of an agreed social fabric. Both the linguistic means and the range of matter of books – in short the semantic whole of authorship and reading - embodied and helped perpetuate the hierarchic power relations of western society. (3)

Steiner's concept of the 'semantic whole' as a bond between writers and readers and their sharing of a common frame of reference is something which we can also recognise in, for example, architectural design in the eighteenth century. But it would be wrong to assume, as Steiner seems to assume, that such 'semantic wholes' only have validity in the setting of aristocratic culture. We can see exactly the same gripping involvement in the creation of jazz in New Orleans or the jokes and songs which children tell themselves in the school playground.

In art and design the situation is particularly teasing. There is no 'semantic whole' between painters and sculptors and the mass of the public, and there is positive war between architects and planners and the people who live in the flats, houses and towns that they have created. Yet these experts are the accredited, professional guardians of design awareness. In these circumstances what can a concept like literacy mean, and how could it be brought about?

The simple answer must be that we do not know what literacy in design might mean because we have not yet experienced it in a mass industrial society. What we can say is that they are not 'semantic wholes' that can be created by a change that affects only one side of the equation. Steiner provides us with the clue: literacy is something that involved writer and reader in an active partnership. It is not a situation where the writer remains untouched by the encounter. It is a situation where writer and reader interact with one another and, as a result, build up 'a set of philosophic, social values'.

Could such a thing happen as a result of design educational activity? It is not impossible. Already the practice and experience of design work in schools has been separated from blindly copying professional designers. Teachers have been able to provide a wider framework of values than designers are normally able to consider in their day-to-day activities. Some of this thinking could seep into professional practice and those who have experienced it will be at home with it. In a similar way, the *Art and the Built Environment Project* has provided a place where architects and planners have been able to join with teachers and children in a

deliberate attempt to educate one another. Within the tiny compass of the 'semantic whole' provided by a course or conference it has been remarkable to watch the development of shared languages and the ability to think new thoughts.

How relevant is design education?

We have tried to show that the design capacity is fundamental to human beings, that through cognitive modelling it is involved in the great enterprise of 'taking action', of being 'in control'. We have suggested that socially and culturally the goal must be to increase participation and to create a 'semantic whole' between the equivalent of writers and readers – designers and users. We believe that these concepts and arguments hold together and that they provide the beginnings of a framework within which design educational activity can be planned, implemented, discussed and developed.

There remains, however, another dimension to the discussion. And that is to make it clear that, in an historical perspective, design is not just a desirable educational priority – it is a critical one. We are at a point where the deliberate development of the design ability may actually be important for survival.

It can be convincingly argued that 'design education' is simply the most recent form of one of the oldest concerns of education. It is a particular response to the conditions in which we now live, but this does not mean that education in the past ignored design. Education has always concerned itself with material culture as well as with literary and scientific culture. If specific labels are ignored, it is easy to see that what is today known as design education can trace its ancestry back to mankind's very first attempts to create shelter, tools, images and utensils.

There are, however, important qualitative differences between societies dependent on craft-based means of production and those where industrialisation is complete. These differences highlight the significance of design and clarify its role as a mediator between technology and culture. It is worth attempting to trace out these differences rather precisely.

We have now lived through nearly two hundred years of industrialisation. Its effects are widespread in spiritual as well as material things. With this as a social and historical context, it is possible to list some of the reasons why it is important to study design in primary and secondary schools, business colleges, universities and the like, as well as in design schools:

1. Design, in the broadest sense, is the bundle of techniques, skills and approaches that can be used to determine the future character of the man-made world of buildings, places, images and products. Industrialisation has vastly increased the effect of this activity on the quality of life. It now affects everyone.

2. Democracy demands that everybody has an effective say in the decisions which determine the future pattern of social life. But such an idea can only be effective if education can bring alive the issues involved and develop ways in which non-specialists can study them.

3. Technology has vastly enlarged the scope and scale of man's impact on the natural environment. The decisions taken can have a direct effect on the future survival of the planet. The issues are far from simple or clear cut. Design activity is one medium which can provide practice in dealing with the types of open-ended problem that are involved.

4. Technology has ushered in a period of continuing change. Handling change in a purposeful way is one of the main characteristics of design activity. It is important for individual and social survival to be able to control change and to foresee its qualitative results.

5. Mass production has divided the consumer from the maker. The consumer needs a broad range of skills and understanding before he or she can really take control of his or her own environment. An experience of design, which inevitably involves taking qualitative decisions between various alternatives, will help people return a personally valid answer to the question: 'how do I want to live?'

6. Most people react without much thought to the powerful and technologically broadcast visual messages of the media. Yet these affect personal attitudes and inter-personal relationships as well as providing entertainment. They are all produced by design activity and a direct understanding of what is involved will help to develop a more critical and discriminating attitude towards them.

Here then are the areas where literacy in our field would need to be effective. Here is where it needs to achieve dramatic changes in the balance of power between designers and users, between provision and participation. Literacy would indicate a general ability to understand and a willingness to take part in this crucial area of human activity: the enterprise of adapting our environment to our spiritual and material needs and, to that degree at least, being 'in control' and creating our own futures. We see that as the underlying aim of all design educational activity.

References

1. Archer, Bruce, internal memo, Design Education Unit, Royal College of Art, 1981

2. Roberts, Phil, 'Notes towards the articulation of the bases of the design dimension of curriculum', *Design Examinations at 16+*: *Discussion and Proposals*, Design Education Unit, Royal College of Art

3. Steiner, George, 'Classic culture and post-culture', *Times Literary Supplement*, October 1971

Basic issues Revisited: Agenda for the Future

Ken Baynes
Phil Roberts

The papers reproduced in this publication were, of course, the product of a particular time and particular circumstances. Many were first presented at Conferences of policy makers or practitioners: others were drafted in response to changes in Government policy, or, indeed, at the request of Government institutions. They were related to, and attempted to be instrumental in, the ferment of ideas about design, education and design education that was a notable feature of the 1970s and early years of the 1980s. So they were to a certain extent expedient. They certainly set out to argue the case for a particular point of view.

We believe that they continue to be relevant, not so much because they provide specific answers to questions of philosophy, practice and policy but because they provide a useful framework in which such questions can be addressed. In fact, we claim that if they were better known they would help to dissolve some of the more teasing questions of definitions and understanding that continue to bedevil teachers, practitioners and researchers.

There is no doubt that many of us engaged in the field believe that the RCA-based work can still offer fresh insights. At the time, they helped us to reach a better understanding of learning and teaching in design, and, in our view, still have the potential to do this. In particular, Bruce Archer's invigorating analysis broke new ground and offered a conceptual framework that went beyond existing boundaries, preconceptions and prejudices. It seemed to offer, on the largest cultural scale, a perspective that might help to reintegrate Science, the Humanities and Design and on a smaller educational scale, be able to resolve the destructive subject divisions in the school curriculum. In 2005 this seems as topical and desirable as it did thirty years ago.

The acid test is whether or not this body of work still usefully addresses what we might call the 'perennial research agenda' in the field of design education. That agenda has not changed and is to do with:

- the nature of design capacity;
- the development of design ability;
- the phenomena involved when we are 'designing';
- the relationship between these and the continuing process of teaching, learning and individual development.

There may be those readers who believe that these questions have been partially answered by the introduction of National Curriculum Design and Technology, or at least that teachers, practitioners and researchers are absolved from having to consider them because they have become a 'given'. With the introduction of the National Curriculum, it may seem the focus has moved away from the 'perennial' questions to concentrate on the requirements of implementation. This is a serious misconception because the imperatives of implementation do not necessarily coincide with the imperatives of fundamental or operational research. It is all too easy, once the perennial research questions vanish from the agenda, to wrongly define a flawed concept as an implementation problem.

It is worth spending a little more time on this issue because it has had a very negative effect on the development of National Curriculum Design and Technology. The National Curriculum revision of Design and 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 Design and Technology brings into being a range of issues which arise directly from the requirement of implementation.

It is this third point which is the one with the greatest potential for hindering progress in fundamental research and which has the effect of discouraging teachers from probing the nature of their own discipline. 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 examination of the fundamentally problematic phenomena: it is 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 ideology basis of much public policy made clear. Research projects which may be established to support the implementation of policy are also obliged to work (if they wish to continue) within the ideological framework. On this view, the introduction of National Curriculum Design and Technology can perhaps most usefully be understood as an episode in the continuing evolution of Design in education and society. *The implementation of an ideologically-loaded policy does not necessary diminish, or remove, or resolve any of the perennial and fundamental design research agenda.*

What then do the papers reprinted here have to offer in relation to the perennial research agenda and, by implication, in moving forward from the philosophical stagnation induced by identifying 'design education' solely with National Curriculum Design and Technology?

- Design is fundamental to all human beings.

- The core activity in designing is intentional activity in and on the world.

- Designing and understanding design are as much concerned with making meaning as making things and, indeed recognise that to intentionally make things is also to make meaning.

This a very broad framework. If accepted, it is possible to see that Design could deserve a place alongside Science and the Humanities as a 'third area' but equally that it could not be constrained within the boundaries or any single discipline (for example, architecture) or any single school subject (for example, Design and Technology).

Recognising the 'fundamentalness' of design can lead to a re-appraisal of those curriculum subjects that are related to designing and design awareness and, similarly, to an invigorating re-appraisal of the sufficiency of 'the three Rs' as the basis for general education. Such a re-appraisal would be especially relevant in a world where material culture and mass communications are ever expanding and where, by contrast, poverty is widespread and the environment is in crisis. It also offers the potential of dissolving the sterile comparison between 'vocational' and 'academic' areas of study.

However, none of this is likely to be achieved without engaging with the topics in the perennial research agenda. It is here that Bruce Archer's taxonomy of the Design field is particularly useful. It provides, in itself, a very challenging programme for the future. To take two examples:

DESIGN AXIOLOGY the study of goodness or value in design phenomena with special regard to the relation between technical, economic, moral and aesthetic values.

The study of 'goodness or value' in any field is clearly fundamental to understanding and practising it. To confront and interpret the relations between technical, economic, moral and aesthetic values as they affect, say, urban planning in developing countries, goes to the heart of one of the most difficult questions facing contemporary society. Equally, Western consumerism is based on a very particular model of design axiology which sometimes values individual demand and immediate satisfaction more highly than long-term social and environmental good. The list of examples could be expanded very considerably. Clearly design axiology is a critical area of understanding and clearly it goes beyond any particular ideology of design or economics. Yet the 'goodness or value in design phenomena' is not well understood or well researched and it certainly does not occupy a prominent place in general education.

DESIGN LANGUAGE (modelling) the study of the vocabulary, syntax and media for recording, devising, assessing and expressing design ideas in a given area.

As present 'modelling' in this sense remains a part-recognised topic for research and a very problematic area for teaching and learning. Yet new insights in neuroscience and computer modelling provide very productive ways of linking what goes on in the brain to the way designers think, design and communicate.

The study of modelling as the design medium or 'language' links directly into design epistemology and design history. In this area it is becoming clear that the 'thoughts that can be thought' and the 'thoughts that can be presented and shared' are shaped and determined both by the structure of the brain and humankind's evolutionary and cultural experience. Mental processes and creative action in and on the world are not abstractions but the result of decisions taken by people with real and immediate biological and physical needs as well as spiritual and aesthetic desires.

Here again, the effect of Archer's taxonomy is to place design and designing on a larger stage and to highlight the narrow confines of most approaches to design in general education.

In 'the three Rs' it is suggested that pursuing the knowledge base mapped by the taxonomy will require cooperation with other disciplines. This must be right and it is striking how little it has been done.

It is encouraging to see how the taxonomy immediately both reveals and organises the field of design and design education. It allows us to perceive the constituent areas of the field and to appreciate the different communities that could make a contribution to better understanding and better practice. It allows distinctions to be recognised between the general and the specific and particular. It helps us in the avoidance of such easy errors as arguing from a specific case as though it applied equally to the whole field and it begins the process of identifying which kind of analysis (for example, quantitative or qualitative, historical or sociological) is actually appropriate.

There is a further area where the taxonomy offers a useful framework. Although it does not directly grapple with the status of the designed world, its approach to design awareness and design activity provides new ways of analysing the issue. There is a danger – one Archer recognised – in seeing commentary and analysis as being in some way superior to the landscapes, buildings, products and media that have resulted from the act of designing. These manifestations of material culture are, of course, a design phenomenon in their own right to be placed alongside the mental, social and economic factors that helped to create them. It is clear that these are not simply 'objects' or 'places' but repositories of information and meaning that are of the essence in the field of design. They help to shape and inspire what later designers design and in many cases are actually the most potent influences linking past,

present and future through the medium of design practice. They might perhaps be called 'made meaning'. It will be entirely appropriate for researchers and practitioners to probe the design field though the medium of design activity and for this to be at the core of design in general education. However, this area of 'learning through doing' is one of the problematic elements in the design field and should itself be the subject of vigorous philosophical and academic enquiry. Archer's taxonomy offers the necessary tools for the job.

Select Bibliography

This is an extract from a more comprehensive bibliography compiled by Phil Roberts in 1991. It concentrates specifically on material closely related to the Design Education Unit at the Royal College of Art or to research or official reports that influenced thinking about design education.

L Bruce Archer, 'A Closer Look at the Relations between the Broad Concept of Design in General Education and its Component Parts'
[A paper presented to Midlands Art Advisers, Leicester, 6 May 1975]

L Bruce Archer, 'Bridges for building, bridges for crossing'
[A paper presented at the 1980 annual conference of the Association of Art Institutions, 9 October 1980]

L Bruce Archer, 'Cognitive Modelling, Rational Thinking, Language, Designerly Thinking and Imaging', Royal College of Art, Design Education Unit: internal paper 1982.

L Bruce Archer, 'Design education in schools'
[A paper presented at the conference 'Design Education and Industry', organised by the Regional Advisory Council for Technological Education, London & Home Counties, 10-14 July 1978]

L Bruce Archer, 'The Mind's Eye: not so much seeing as thinking', *Designer*, January1980, pp8-9

L Bruce Archer, 'The Need for Design Education'
[A paper presented to DES Conference H805, Horncastle, July 1973]

L Bruce Archer, 'Time for a Revolution in Art and Design Education', Royal College of Art: Occasional Papers Number 6 1978

L Bruce Archer, Ken Baynes, Richard Langdon, *Design in General Education* [Phil Roberts (ed)] (The Report of an enquiry conducted by the Royal College of Art for the Secretary of State for Education and Science), London: Royal College of Art, Department of Design Research 1979

L Bruce Archer, Ken Baynes, Richard Langdon, *Design in General Education* (Part One: Summary of findings), London: Royal College of Art, Department of Design Research 1976

Bernard Aylward (ed), *Design Education in Schools*, London: Evans 1973
[Case accounts of work developing in Leicestershire LEA; mixed in quality; historically interesting; early fore-runner of some of the matters introduced under National Curriculum Technology.]

Ken Baynes, *About Design*, London: The Design Council – Heinemann 1976

Ken Baynes (ed), *Attitudes in Design Education*, London: Lund Humphries 1969
[Includes a very good contribution by Anthony Horrocks.]

Ken Baynes, 'A Case Study in Action Research', *Design Studies*, Volume 3 Number 4 October 1982, pp 213-219

Ken Baynes, 'Designerly Play', *NADE Journal*, Spring 1986, pp 25-34

Ken Baynes, 'A Personal Retrospect: The Argument for Design Education', *Studies in Design Education and Craft*, Volume 10 Number 7 Winter 1977, pp8-11

Ken Baynes, 'Defining a Design Dimension of the Curriculum' (in Thistlewood)

Ken Baynes, 'Design and the Division of Labour – is Design Radical?' Seminar paper, RCA Design Education Unit 1979

Ken Baynes and Allan Grant (eds), *Design Education One: in Schools*, Hornsey College of Art 1966

Ken Baynes and Allan Grant (eds), *Design Education Two: Scientific Techniques*, Hornsey College of Art 1967

Ken Baynes and Phil Roberts, 'Design Education: the basis issues', RCA Design Education Unit (in Richard Langdon *et al*)

Nigel Cross, 'Design Education for Laypeople', *Studies in Design Education, Craft and Technology*, Volume 11 Number 2 Spring 1979, pp 68-72

Nigel Cross (ed), *Design and Participation*, [Proceedings of the Design Research Society's Conference, Manchester, September 1971], London: Academy Editions 1972

Nigel Cross, David Elliott, Robin Roy (eds), *Man-Made Futures: Readings in Society, Technology, and Design*, London: Hutchinson Educational – Open University Press 1974

Design 328 April 1976 [for articles on design educational developments in schools], pp 40-47

Design Council, *Design Education at Secondary Level*, (The Keith-Lucas Report), London: The Design Council 1980

Design Council, *Engineering Design Education*, (The Moulton Report), London: The Design Council 1976

John Eggleston (ed), *The Best of Craft Design & Technology*, Trentham Books 1988 [The 20th Anniversary Volume of Studies in Design Education Craft & Technology)

Peter Green, *Design Education: Problem Solving and Visual Experiences*, London: Batsford 1974

Peter Green and J Prescott Thomas, 'Look Out: Design and Environment', (Programme notes for a schools television series, for pupils aged 13-16, broadcast in Autumn 1972 and Spring 1973), London: BBC 1972

J Christopher Jones, *Design Methods*, London: Wiley-Interscience
[Chapters 1-3 would be very helpful reading]

Keith-Lucas Report: see Design Council

Richard Landgon, Ken Baynes and Phil Roberts (eds), *Design Education* (The proceedings of the Design Education section of an international conference on design policy held at the RCA, London, 20-23 July 1982), London: The Design Council 1984

Patrick Nuttgens, 'Learning to some purpose', (Burton Design Award 1977), London: SIAD
[Includes a useful passage on the nature of technology, distinguishing it from applied science.]

Oxford, University of, Delegacy of Local examinations: Advanced Level 'Design & Technology (Design)' (9883)
[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.]

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'.]

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

Phil Roberts, *Design Examinations at 16+: Discussions 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 Technology Awareness in Education', Studies in Design Education Craft & Technology, Volume 12 Number 1 Winter 1979, pp 55-56

David Thistlewood (ed), *Issues in Design and Education*, London: Longman 1990 [A collection of essays which balances those in Eggleston (1988), and more toughly refereed.]