Designerly ways of knowing

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This is the third paper in a series being published in Design Studies, which aims to establish the theoretical bases for treating design as a coherent discipline of study. The first contribution in the series was from Bruce Archer, in the very first issue of Design Studies, and the second was from Gerald Nadler, in Vol 1, No 5. Further contributions are invited.

Here, Nigel Cross takes up the arguments for a 'third area' of education - design - that were outlined by Archer. He further defines this area by contrasting it with the other two - sciences and humanities - and goes on to consider the criteria which design must satisfy to be acceptable must imply a reorientation from the instrumental aims of conventional design education, towards intrinsic values. These values derive from the 'designerly ways of knowing'. Because of a common concern with these fundamental 'ways of knowing', both design research and design education are contributing to the development of design as a discipline.

A principal outcome of the Royal College of Art's research project on 'Design in general education' was the restatement of a belief in a missing 'third area' of education[1]. The two already-established areas can be broadly classified as education in the sciences and education in the arts, or humanities. These 'two cultures' have long been recognised as dominating our social, cultural and educational systems. In the English educational system, especially, children are forces to choose one or other of these two cultures to specialise in at an early age - about 13.

The 'third culture' is not so easily recognised, simply because it *has* been neglected, and has not been adequately named or articulated. Archer[2] and his RCA colleagues were prepared to call it 'Design with a capital D' and to articulate it as 'the collected experience of the material culture, and the collected body of experience, skill and understanding embodied in the arts of planning, inventing, making and doing'.

From the RCA report, the following conclusions can be drawn on the nature of 'Design with a capital D':

- The central concern of Design is 'the conception and realisation of new things'.
- It encompasses the appreciation of 'material culture' and the application of 'the arts of planning, inventing, making and doing'.
- At its core is the 'language' of 'modelling'; it is possible to develop students' aptitudes in this 'language', equivalent to aptitudes in the 'language' of the sciences - numeracy - and the 'language' of humanities - literacy.
- Design has its own distinct 'things to know, ways of knowing them, and ways of finding out about them'.

Even a 'three cultures' view of human knowledge and ability is a simple model. However, contrasting design with the sciences and the humanities is a useful, if crude, way of beginning to be more articulate about it. Education in any of these 'cultures' entails the following three aspects:

- the transmission of knowledge about a phenomenon of study
- a training in the appropriate methods of enquiry
- an initiation into the belief systems and values of the 'culture'

If we contrast the sciences, the humanities, and design under each aspect, we may become clearer of what we mean by design, and what is particular to it.

- the phenomenon of study in each culture is
  - in the sciences: the natural world
  - in the humanities: human experience
  - in design: the man-made world

- the appropriate methods in each culture are
  - in the sciences: controlled experiment, classification, analysis
  - in the humanities: analogy, metaphor, criticism, evaluation
  - in design: modelling, pattern-formation, synthesis

- the values of each culture are:
  - in the sciences: objectivity, rationality, neutrality, and a concern for 'truth'
  - in the humanities: subjectivity, imagination, commitment, and a concern for 'justice'
  - in design: practicality, ingenuity, empathy, and a concern for 'appropriateness'

In most cases, it is easier to contrast the sciences and the humanities (eg objectivity *versus* subjectivity, experiment *versus* analogy) than it is to identify the relevant comparable concepts in design. This is perhaps an indication of the paucity of our language and concepts in the 'third culture', rather than any acknowledgement that it does not really exist in its own right. But we are certainly faced with the problem of being more articulate about what it means to be 'designerly' rather than to be 'scientific' or 'artistic'.

Perhaps it would be better to regard the 'third culture' as technology, rather than design. This 'material culture' of design is, after all, the culture of the technologist - of the designer, doer and maker. Technology involves a synthesis of knowledge and skills from both the sciences and the humanities, in the pursuit of practical tasks; it is not simply 'applied science', but 'the application of scientific and *other organised knowledge* to practical tasks…'[3]

The 'third culture' has traditionally been identified with technology. For example, A N Whitehead[4] suggested that: 'There are three main roads along which we can proceed with good hope of advancing towards the best balance of intellect and character: these are the way of literary culture, the way of scientific culture, the way of technical culture. No one of these methods can be exclusively followed without grave loss of intellectual activity and of character.'

DESIGN IN GENERAL EDUCATION

I think it is no accident that a fundamental reconceptualising of design has emerged from a project, such as the Royal College of Art's, related to the development of design in general education. Our established concepts of design have always been related to specialist education: design education has been preparation of students for a professional, technical role. But now we are exploring the ways and the implications of design being a part of everyone's education, in the same ways that the sciences and the humanities are parts of everyone's education[5].

Traditionally, design teachers have been practising designers who pass on their knowledge, skills and values through a process of apprenticeship. Design students 'act out' the role of designer in small projects[6], and are tutored in the process by more experienced designers. These design teachers are firstly designers, and only secondly and incidentally teachers. This model may be defensible for specialist education[7], but in general education all teachers are (or should be) firstly teachers, and only secondly, if at all, specialists in any field.

To understand this distinction we must understand the differences between specialist education and general education. The main distinction lies in the difference between the instrumental, or *extrinsic,* aims that specialist education usually has, and the *intrinsic* aims that general education must have. It is perfectly acceptable for architectural education, say, to have the instrumental aim of providing competent designers of buildings, but this cannot be an aim of general education.

Anita Cross[8] has pointed out that, 'Since general education is *in principle* non-technical and non-vocational, design can only achieve parity with other disciplines in general education if it is organised as an area of study which contributes as much to the individual's self-realisation as to preparation for social roles.'

Whatever government ministers or industrialists may think, the aim of general education is not the preparation of people for social work roles. In a sense there is no 'aim' to general education. Peters[9] claims that:

It is as absurd to ask what the aim of education is as it is to ask what the aim of morality is… The only answer that can be given is to point to something intrinsic to education that is regarded as valuable such as the training of intellect or character. For to call something 'educational' is to intimate that the processes and activities themselves contribute to or involve something that is worthwhile… People think that education must be for the sake of something extrinsic that is worthwhile, whereas the truth is that being worthwhile is part of what is meant by calling it 'education'.

Educational criteria

According to Peters the concept of education is one which only suggests *criteria* by which various activities and processes can be judged to see if they can be classified as 'educational'. Thus, giving a lecture *may* be educational, but it might not be if it does not satisfy the criteria; a student design project *may* be educational, but also might not be.

Peters suggests three principal criteria for education, the first of which is that worthwhile knowledge of some value must be transmitted. This first criterion seems straightforward, but actually raises problems of defining what is 'worthwhile'. The example offered by Peters is simplistic: 'We may be educating someone while we are training him: but we need not be. For we may be training him in the art of torture.' Deciding what is worthwhile is obviously value-laden and problematic. We might all agree that 'the art of torture' hardly counts as worthwhile, but what about, say, 'the art of pugilistics'? However, 'the arts of planning, inventing, making and doing' (to draw on Archer's definition of design again) are presumably clearly recognised as 'worthwhile'.

Peters' second criterion derives from his concern with the processes by which students are educated. He stresses that the *manner* in which people are educated is just as important as the *matter* which is transmitted[9]:

Although 'education' picks put no specific processes it does imply criteria which processes involved must satisfy in addition to the demand that something valuable must be passed on. It implies, first of all, that the individual who is educated shall come to care about the valuable things involved, that he shall want to achieve the relevant standards. We would not call a man 'educated' who knew about science but cared nothing for truth or who regarded it merely as a means to getting hot water and hot dogs. Furthermore it implies that he is initiated into the content of the activity or forms of knowledge in a meaningful way, so that he knows what he is doing. A man might be conditioned to avoid dogs or induced to do something by hypnotic suggestion. But we could not describe this as 'education' if he did not know what he was learning while he learned it'.

This second criterion of 'education' therefore stresses the need for the student to be both self-aware and aware of what and why he is learning. It is a process neither of imposing patterns on the student's mind, nor of assuming that free growth towards a desirable end will somehow occur without guidance. Education must be designed deliberately to

enhance and to develop students' intrinsic cognitive processes and abilities.

Peters' third criterion derives from the consideration that: 'We often say of a man that he is highly trained, but not educated. What lies behind this condemnation?... It is…that he has a very limited conception of what he is doing. He does not see its connection with anything else, its place in a coherent pattern of life. It is, for him, an activity which is cognitively adrift.'

Peters concludes from this consideration that 'education' is related to 'cognitive perspective', which 'explains why it is that some activities rather than others seem so obviously to be of educational importance. There is very little to know about riding bicycles, swimming, or golf. It is largely a matter of "knowing how" rather than of "knowing that"[10] - of knack rather than understanding. Furthermore what there is to know throws very little light on much else.'

This is therefore a challenging criterion for design education, since design is often regarded as a skill, perhaps something like bicycle-riding, swimming, or playing golf. Indeed, elsewhere we have used Ryle's distinction between 'knowing how' and 'knowing that' to emphasise the role of 'know how' in design[3]. However, I would now accept Peter's suggestion that:

> An 'educated man' is distinguished not as much by what he does as by what he 'sees' or 'grasps'. If he does something very well, in which he has to be trained, he must see this in perspective, as related to other things. It is difficult to conceive of a training that would result in an 'educated' man in which a modicum of instruction has no place. For being educated involves 'knowing that' as well as 'knowing how'.

So to satisfy this third criterion of 'education', simple training in a skill is not enough. One *is* 'trained' as a designer, or doctor, or philosopher, but that alone does not make one 'educated'.

I have considered Peters' three criteria for 'education' at some length because it is important for the proponents of design in general education to be able to meet such criteria. It entails a fundamental change of perspective from that of a vocational training for a design profession, which is the only kind of 'design education' we have had previously. Design in general education is *not* primarily a preparation for a career, *nor* is it primarily a training in useful productive skills for 'doing and making' in industry. It must be defined in terms of the *intrinsic* values of education.

The interpretation of 'education' that Peters has developed, then, stresses its intrinsic merits. To be educated is of value in and of itself, not because of any extrinsic motivating factors or advantages it might be considered to offer, such as getting a job. In order to justify design as a part of general education, therefore, it is necessary to ensure that what is learned in design classes, and the way it is learned, can meet these criteria. We have to be able to identify that which is intrinsically valuable in the field of design, such that it is justifiably a part of everyone's education and contributes to the development of an 'educated' person.

DESIGNERLY WAYS OF KNOWING

The claim from the Royal College of Art study of 'Design in general education' was that 'there are things to know, ways of knowing them, and ways of finding out about them' that are specific to the design area. The authors believe that there are designerly ways of knowing, distinct from the more usually-recognised scientific and scholarly ways of knowing. However, the Royal College of Art authors do little to explicate this belief in designerly ways of knowing. They do point out that 'it would not do to accept design as a sort of ragbag of all the things that science and the humanities happen to leave out,' but they are less than precise about what design should include. Design must have its own inner coherence, in the ways that science and the humanities do, if it is to be established in comparable intellectual and educational terms. But the world of design has been badly served by its intellectual leaders, who have failed to develop their subject *in its own terms*. Too often, they have been seduced by the lure of *Wissenschaft*, and turned away from the lore of *Technik*; they have defected to the cultures of scientific and scholarly enquiry, instead of developing the culture of designerly enquiry.

So what can be said about these ill-defined 'designerly ways of knowing'? There has, in fact, been a small and very slowly-growing field of enquiry in design research over the last 20 years or so, from which it is possible to begin to draw some conclusions.

Design processes

For example, a number of observational studies has been made of how designers work. These studies tend to support the view that there is a distinct 'designerly' form of activity that separates it from typical scientific and scholarly activities. Lawson's studies of design behaviour, in particular, have compared the problem-solving strategies of designers with those of scientists.[11] He devised problems which required the arrangement of 3D coloured blocks so as to satisfy certain rules (some of which were not initially disclosed), and set the same problems to both postgraduate architectural students and postgraduate science students. The two groups showed dissimilar problem-solving strategies, according to Lawson. The scientists generally adopted a strategy of systematically exploring the possible combinations of blocks, in order to discover the fundamental rule which would allow a permissible combination. The architects were more inclined to propose a series of solutions, and to have these solutions eliminated, until they found an acceptable one. Lawson has commented:

> The essential difference between these two strategies is that while the scientists focused their attention on discovering the rule, the architects were obsessed with achieving the desired result. The scientists adopted a generally problem-focused strategy and the architects a solution-focused strategy. Although it would be quite possible using the architect's approach to achieve the best solution without actually discovering the complete range of acceptable solutions, in fact most architects discovered something about the rule governing the allowed combination of blocks. In other words, they learn about the nature of the problem largely as a result of trying out solutions, whereas the scientists set out specifically to study the problem[12].

These experiments suggest that scientists problem-solve by analysis, whereas designers problem-solve by synthesis. Lawson repeated his experiments with younger students and found that first-year students and sixth-form school students could not be distinguished as 'architects' and 'non-architects' by their problem-solving strategies: there were no consistent differences. This suggests that architects learn to adopt their solution-focused strategy during and presumably as a result of, their education. Presumably, they learn, are taught, or discover, that this is the more effective way of tackling the problems they are set.

A central feature of design activity, then, is its reliance on generating fairly quickly a satisfactory solution, rather than on any prolonged analysis of the problem. In Simon's[13] inelegant term, it is a process of 'satisficing' rather than optimising; producing any one of what might well be a large range of satisfactory solutions rather than attempting to generate the one hypothetically-optimum solution. This strategy has been observed in other studies of design behaviour, including architects[14], urban designers[15], and engineers[16].

Why should it be such a recognisably 'designerly' way of proceeding is probably not just an embodiment of any intrinsic inadequacies of designers and their education, but is more likely to be a reflection of the nature of the design task and of the nature of the kinds of problems designers tackle. The designer is constrained to produce a practicable result within a specific time limit, whereas the scientist and scholar are both able, and often required, to suspend their judgements and decisions until more is known - 'further research is needed' is always a justifiable conclusion for them.

It is also now widely recognised that design problems are ill-defined, ill-structured, or 'wicked'[17] They are not the same as the 'puzzles' that scientists, mathematicians and other scholars set themselves. They are not problems for which all the necessary information is, or ever can be, available to the problem-solver. They are therefore not susceptible to exhaustive analysis, and there can never be a guarantee that 'correct' solution-focused strategy is clearly preferable to go on analysing 'the problem', but the designer's task is to produce 'the solution'. It is only in terms of a conjectured solution that the problem can be contained within manageable bounds[18]. What designers tend to do, therefore, is to seek, or impose a 'primary generator'[19] which both defines the limits of the problem and suggests the nature of its possible solution.

In order to cope with ill-defined problems, the designer has to learn to have the self-confidence to define, redefine and change the problem-as-given in the light of the solution that emerges from his mind and hand. People who seek the certainty of externally structured, well-defined problems will never appreciate the delight of being a designer, Jones has commented that 'changing the problem in order to find a solution is the most challenging and difficult part of designing'[20] He also points out that 'designing should not be confused with art, with science, or with mathematics.'

Such warnings about failing to recognise the particular nature of designing are now common in design theory. Many people have especially warned against confusing design with science.

> The scientific method is a pattern of problem-solving behaviour employed in finding out the nature of what exists, whereas the design method is a pattern of behaviour employed in inventing things of value which do not yet exist. Science is analytic; design is constructive. (Gregory[21])

> The natural sciences are concerned with how things are...design, on the other hand, is concerned with how things ought to be. (Simon[13])

> To base design theory on inappropriate paradigms of logic and science is to make a bad mistake. Logic has interests in abstract forms. Science investigates extant forms. Design initiates novel forms (March[22])

The emphasis in these admonitions is on the constructive, normative, creative nature of designing. Designing is a process of pattern synthesis, rather than pattern recognition. The solution is not simply lying there among the data, like the dog among the spots in the well known perceptual puzzle; it has to be actively constructed by the designer's own efforts.

Reflecting on his observations of urban designers, Levin[15] commented that:

> The designer knows (consciously or unconsciously) that some ingredient must be added to the information that he already has in order that he may arrive at an unique solution. This knowledge is in itself not enough in design problems, of course. He has to look for the extra ingredient, and he uses his powers of conjecture and original thought to do so. What then is this extra ingredient? In many if not most cases it is an 'ordering principle'. The preoccupation with geometrical patterns that is revealed in many town plans and many writings on the subject demonstrated this very clearly.

And of course it is not only in town planning, but in all fields of design, that one finds this preoccupation with geometrical patterns; a pattern (or some other ordering principle) seemingly *has* to be imposed in order to make a solution possible.

This pattern-constructing feature has been recognised as lying at the core of design activity by Alexander, in his 'constructive diagrams'[23] and 'pattern language'[24]. The designer learns to think in this sketch-like form, in which the abstract patterns of user requirements are turned into the concrete patterns of an actual object. It is like learning an artificial 'language', a kind of code which transforms 'thoughts' into 'words':

> Those who have been trained as 'designers will be using just such a code...which enables the designer to effect a translation from individual, organisational and social needs to physical artefacts. This code which has been learned is supposed to express and contain actual connections which exist between human needs and their artificial environment. In effect, the designer learns to 'speak' a language - to make a useful transaction between domains which are unlike each other (sounds and meanings in language, artefacts and needs in design) by means of a code or system of codes which structure that connection. (Hillier and Leaman[25])

Designerly ways of knowing are embodied in these 'codes'. The details of the codes will vary from one design profession to another, but perhaps there is a 'deep structure' to design codes. We shall not know this until more effort has been made in externalising the codes.

What designers know about their own problem-solving processes remains largely tacit knowledge - ie they know it in the same way that a skilled person 'knows' how to perform that skill. They find it difficult to externalise their knowledge, and hence design education is forced to reply so heavily on an apprenticeship system of learning. It may be satisfactory, or at least understandable, for practising designers to be inarticulate about their skills, but teachers of design have a responsibility to be as articulate as they possibly can about what it is they are trying to teach, or else they can have no basis for choosing the content and methods of their teaching.

Design products

So far, I have concentrated on designerly ways of knowing that are embodied in the *processes* of designing. But there is an equally important area of knowledge embodied in the *products* of designing.

There is a great wealth of knowledge carried in the objects of our material culture. If you want to know how an

object should be designed - ie what shapes and sizes it should have, what material it should be made from - go and look at existing examples of that kind of object, and simply copy (ie learn!) from the past. This, of course, was the 'design process' that was so successful in generating the material culture of craft society: the craftsperson simply copied the design of an object from its previous examples. Both Jones[20] and Alexander[23] have emphasised how the 'unselfconscious' processes of craft design led to extremely subtle, beautiful and appropriate objects. A very simple process can actually generate very complex products.

Objects are a form of knowledge about how to satisfy certain requirements, about how to perform certain tasks. And they are a form of knowledge that is available to everyone; one does not have to understand mechanics, nor metallurgy, nor the molecular structure of timber, to know that an axe offers (or 'explains') a very effective way of splitting wood. Of course, explicit knowledge about objects and about how they function *has* become available, and has sometimes led to significant improvements in the design of the objects. But in general, 'invention comes before theory'[26]; the world of 'doing and making' is usually ahead of the world of understanding - technology leads to science, not *vice versa* as is often believed.

A significant branch of designerly ways of knowing, then, is the knowledge that resides in objects. Designers are immersed in this material culture, and draw upon it as the primary source of their thinking. Designers have the ability both to 'read' and 'write' in this culture: they understand what messages objects communicate, and they can create new objects which embody new messages. The importance of this two-way communication between people and 'the world of goods' has been recognised by Douglas and Isherwood[27]. In a passage that has strong connections to the arguments for a 'third area' of human knowledge in design, as distinct from the sciences and the humanities, they say:

> For too long a narrow idea of human reasoning has prevailed which only accepts simple induction and deduction as worthy of the name of thinking. But there is a prior and pervasive kind of reasoning that scans a scene and sizes it up, packing into one instant's survey a process of matching, classifying and comparing. This is not to invoke a mysterious faculty of intuition or mental association. Metaphoric appreciation, as all the words we have used suggest, is a work of approximate measurement, scaling and comparison between like and unlike elements in a pattern.

'Metaphoric appreciation' is an apt name for what it is that designers are particularly skilled in, in 'reading' the world of goods, in translating back from concrete objects to abstract requirements, through their design codes. 'Forget that commodities are good for eating, clothing, and shelter', Douglas and Isherwood say; 'forget their usefulness and try instead the idea that commodities are good for thinking; treat them as a nonverbal medium for the human relative faculty.'

INTRINSIC VALUE OF DESIGN EDUCATION

The arguments for, and defence of, design in general education must rest on identifying the intrinsic values of design that make it justifiably a part of everyone's education. Above, I have tried to set out the field of 'designerly ways of knowing', as it relates to both the processes and the products of designing, in the hope that it will lead into an understanding of what these intrinsic values might be. Essentially, we can say that designerly ways of knowing rest on the manipulation of

non-verbal codes in the material culture; these codes translate 'messages' either way between concrete objects and abstract requirements; they facilitate the constructive, solution-focused thinking of the designer, in the same way that other (eg verbal and numerical) codes facilitate analytic, problem-focused thinking; they are probably the most effective means of tackling the characteristically ill-defined problems of planning, designing and inventing new things.

From even a sketchy analysis, such as this, of designerly ways of knowing, we can indeed begin to identify features that can be justified in education as having intrinsic value. Firstly, we can say that design develops students' abilities in tackling a particular kind of problem. This kind of problem is characterised as ill-defined, or ill-structured, and is quite distinct from the kinds of well-structured problems that lie in the educational domains of the sciences and the humanities. We might even claim that our design problems are more 'real' than theirs, in that they are like the problems or issues or decisions that people are more usually faced with in everyday life.

There is therefore a strong educational justification for design as an introduction to, and the development of cognitive skills and abilities in, real-world problem solving[28]. We must be careful not to interpret this justification in instrumental terms, as a training in problem-solving skills, but in terms that satisfy the more rigorous criteria for education. As far as problem-solving is concerned, design in general education must be justified in terms of helping to develop an 'educated' person, able to understand the nature of ill-defined problems, how to tackle them, and how they differ from other kinds of problems. This kind of justification has been developed by McPeck in terms of the educational value of 'critical thinking'[29]. A related justification is given by Harrison, particularly in the context of practical design work, in terms of the radical connections between 'making and thinking'[30].

This leads us into a second area of justification for design in general education, based on the kind of thinking that is peculiar to design. This characteristically 'constructive' thinking is distinct from the more commonly acknowledged inductive and deductive kinds of reasoning. (March[22] has related it to what C S Peirce called 'abductive' reasoning.)

In educational terms, the development of constructive thinking must be seen as a neglected aspect of cognitive development in the individual. This neglect can be traced to the dominance of the cultures of the sciences and the humanities, and the dominance of the 'stage' theories of cognitive development. These theories, especially Piaget's, tend to suggest that the concrete, constructive, synthetic kinds of reasoning occur relatively early in child development, and that they are passed through to reach the higher states of abstract, analytical reasoning (ie the kinds of reasoning that predominate in the sciences, especially). There are other theories (for example, Bruner's) that suggest that cognitive development is a continuous process of interaction between different modes of cognition, all of which can be developed to high levels. That is, the qualitatively different types of cognition (eg 'concrete' and 'formal' types in Piaget's terms, 'iconic' and 'symbolic' in Bruner's terms) are not simply characteristic of different 'stages' of development, but are different kinds of innate human cognitive abilities, *all* of which can be developed from lower to higher levels.

The concrete/iconic modes of cognition are particularly relevant in design, whereas the formal/symbolic modes are more relevant in the sciences. If the 'continuous' rather than the 'stage' theories of cognitive development are adopted, it is clear that there is a strong justification for design education in that it provides opportunities particularly for the development of the concrete/iconic modes.

From this, we can move on to a third area of justification for design in general education, based on the recognition that there are large areas of human cognitive ability that have been systematically ignored in our educational system. Because the theorists of cognitive development are themselves thoroughly immersed in the scientific-academic cultures where numeracy and literacy prevail, they have overlooked the third culture of design. This culture relied not so much on verbal, numerical and literary modes of thinking and communicating, but on nonverbal modes[31]. This is particularly evident in the designer's use of models and 'codes' that rely so heavily on graphic images - ie drawings, diagrams and sketches that are aids to internal thinking as well as aids to communicating ideas and instructions to others.

As well as these graphic models, there is also in design a significant use of mental imagery in 'the mind's eye'[32]. The field of nonverbal thought and communication as it relates to design includes a wide range of elements, from 'graphicacy' to 'object languages', 'action languages' and 'cognitive mapping'[33]. Most of these cognitive modes are strongest in the right hemisphere of the brain, rather than the left[34]. So on this view the 'neglected area' of design in education is not merely one-third of human experience and ability, but nearer to one-half!

French[35] has recognised nonverbal thinking as perhaps the principal justification for design in general education: 'It is in strengthening and uniting the entire nonverbal education of the child, and in its improvement of the range of acuity of his thinking, that the prime justification of the teaching of design in schools should be sought, not in preparing for a career or leisure, nor in training knowledgeable consumers, valuable as these aspects may be.'

DESIGN AS A DISCIPLINE

In this paper I have taken up the argument put forward in the Royal College of Art report on 'Design in general education' that there are 'designerly ways of knowing' that are at the core of the design area of education. First, I have stressed that we must seek to interpret this core of knowledge in terms of its intrinsic educational value, and not in the instrumental terms that are associated with traditional, vocational design education. Second, I have drawn upon the field of design research for what it has to say about the way designers work and think, and the kinds of problems they tackle. And third, I have tried to develop from this the justification that can be made for design as a part of general education in terms of intrinsic educational values.

I identified five aspects of designerly ways of knowing:
- Designers tackle 'ill-defined' problems.
- Their mode of problem-solving is 'solution-focused'.
- Their mode of thinking is 'constructive'.
- They use 'codes' that translate abstract requirements into concrete objects.

- They use these codes to both 'read' and 'write' in 'object languages'.

From these ways of knowing I drew three main areas of justification for design in general education:

- Design develops innate abilities in solving real-world, ill-defined problems.
- Design sustains cognitive development in the concrete/iconic modes of cognition.
- Design offers opportunities for development of a wide range of abilities in nonverbal thought and communication.

For me, something else also begins to emerge from these lines of argument. It seems to me that the design research movement of the last 20 years and the design education movement of the last 10 years are beginning to converge on what is, after all, their common concern - the discipline of design. The research path to design as a discipline has concentrated on understanding those general features of design activity that are common to all the design professions: it has been concerned with 'design in general' and it now allows us to generalise at least a little about the designerly ways of knowing. The education path to design as a discipline has also been concerned with 'design in general', and it has led us to consider what it is that can be generalised as of intrinsic value in learning to design. Both the research and the education paths, then, have been concerned with developing the general subject of design.

However, there is still a long way to go before we can begin to have much sense of having achieved a real understanding of design as a discipline - we have only begun to make rough maps of the territory. Following on from his comments on nonverbal education as the prime justification for design in general education, French also points out that there are certain implications arising from this:

> If design teaching is to have this role it must meet certain requirements. It must 'stretch the mind', and ideally this involves a progression from step to step, some discipline of thought to be acquired in more or less specifiable components, reflected in a growing achievement of the pupil that both he and his teacher can recognise with some confidence. At present, there does not seem to be enough understanding, enough scholarly work on design, enough material of a suitable nature to make such teaching possible. I believe we should strive to remedy this state of affairs.

The education path to design as a discipline forces us to consider the nature of this general subject of design, what it is that we are seeking to develop in the individual student, and how this development can be structured for learning. Like our colleagues in the sciences and the humanities we can at this point legitimately conclude that further research is needed! We need more research and enquiry: first into the designerly ways of knowing; second into the scope, limits and nature of innate cognitive abilities relevant to design; and third into the ways of enhancing and developing these abilities through education.

We need a 'research programme', in the sense in which Lakatos[36] has described the research programmes of science. At its core is a 'touch-stone theory' or idea - in our case the view that 'there are designerly ways of knowing'. Around this core is built a 'defensive' network of related theories, ideas and knowledge - and I have tried to sketch in some of these in this paper. In this way both design research and design education can develop a common approach to design as a discipline.

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