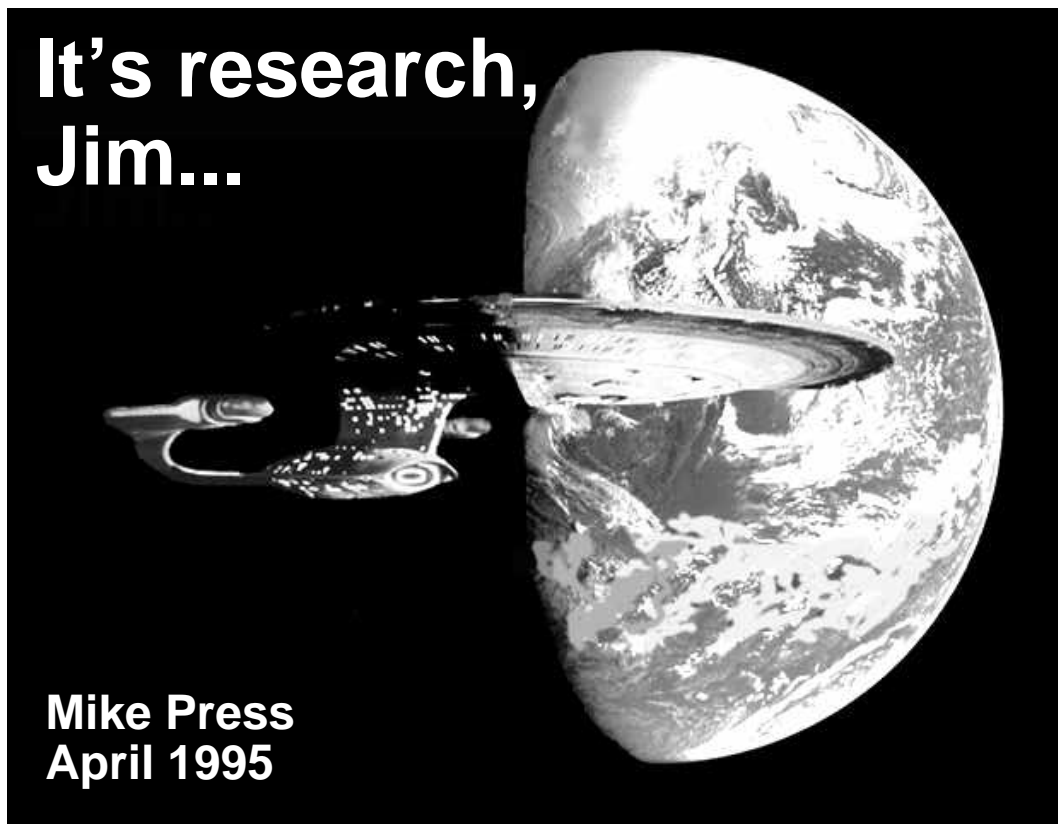


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Abstract

This paper considers the urgent need for design to develop a research culture. However, rather than passively adopting the scientific method, design should assert its 'difference' as a method of creating knowledge. Unlike science it is driven by values and contains at its core craft skill and tacit knowledge. Arguing that design is a form of research, the author proposes some priorities to develop 'human centred design research'.

There can be no field of human endeavour in which its practitioners have contributed so little to its understanding as design. It is the Marie Celeste of academia: an elegant and functional vessel slipping through the waters of culture and commerce. It is boarded with ease by historians, economists, technologists, managerial theorists, semiologists, architects and engineers, all of whom find the bridge and cabins deserted. Design, it is claimed, has no theory and thus no research methodology of its own to understand itself. The research methods of science and social science act as the only maps in the bridge of design.

I am reminded of an episode of Star Trek in which Captain Kirk beams down to a planet to find its one city apparently bereft of life. But in fact its citizens exist in a different timeframe. Their reality runs 100 times faster than ours and so to the human eye they are unseen. This is indeed analogous to the whole question of design research and to the issue of asserting the design scholars' right to steer the ship of design research. It explains the title of this paper: "*It's research, Jim. But not as we know it.*"

Design likes to be seen as the special case; the alien culture of academia, moving in mysterious ways. I am going to argue that while there is nothing mysterious, unusual or special about design, there is something 'different' about it. It is this difference that we must understand to enable us to develop the methodologies and knowledge base that we urgently require.

THE URGENT NEED FOR A RESEARCH CULTURE

Victor Margolin has made the point that if you want to know what a designer does, don't ask a designer: "Designers have given very little thought to their own self-definition" (Margolin, 1989, p.4). Our disciplines would apparently not encourage self-definition or self-examination or the ability to articulate intent. As Coyne and Snodgrass argued recently, design has perhaps fallen victim to the definition of the romantic movement: "the oppressed and misunderstood hero".

Individual creativity is considered to be at the heart of the design mystery and the rationale for its status as a special case, but how the creativity of design differs from the creativity of science, political economy or other disciplines is not rationalised. The ethos of individualism which is so dominant in the culture of design perhaps explains why it was embraced so warmly by Thatcherism in the eighties. This individualism also explains designers' reluctance to generalise, theorise and collectivise their endeavours.

This inability to understand or theorise what we do perhaps explains why we fail to adequately document it. In our educational culture, documentation of the creative process of design at best comprises some usually reworked and heavily edited sketchbooks. Documentation is somehow felt to undermine its 'magic and mystery'. Such documentation is our knowledge base and, as Agnew correctly observes, "the effect of the undocumented tradition (in design) is to leave us in the academic stone age".

From this derives a number of problems. First, it makes the understanding of the design process almost impossible. Agnew raised this issue in the context of his research into the design of the Spitfire's elliptical wing. Documentation of the design process was so poor that the factors which led to this design decision could not be identified. Along with creating problems for design historians, the opaque nature of design processes also creates lucrative work for copyright lawyers as the lack of documentation is a key factor behind many intellectual property disputes. How we are to assess poorly documented design in education is equally difficult. I am told by old hands that you get an intuitive feel of what is right. I am sure that the jury for the Birmingham Six had much the same view.

It is worth noting that the requirement to document the design process is increasingly the subject of legislation and guidelines. Product liability law, the BS 7000 guide to managing product design and the BS 5750 quality standards all make reference to this issue.

A further argument is that poor documentation necessarily leads to designers at undergraduate, postgraduate and professional levels reinventing the wheel time after time. Because design research is not documented then it must be repeated. Professor Allison alludes to a further problem much closer to our everyday concerns in design education: "Given the organisational and fiscal climate in higher education, unless research in art and design takes on a more purposeful, professional attitude, all aspects of the field will be increasingly disadvantaged".

With the £2.5 million handed out for research in art & design last time around set to rise to £7 million by 1997, then there is perhaps a temptation to see research money as something we can siphon off to buy teaching resources and the employment of research students as cheap teachers. This we do at great peril.

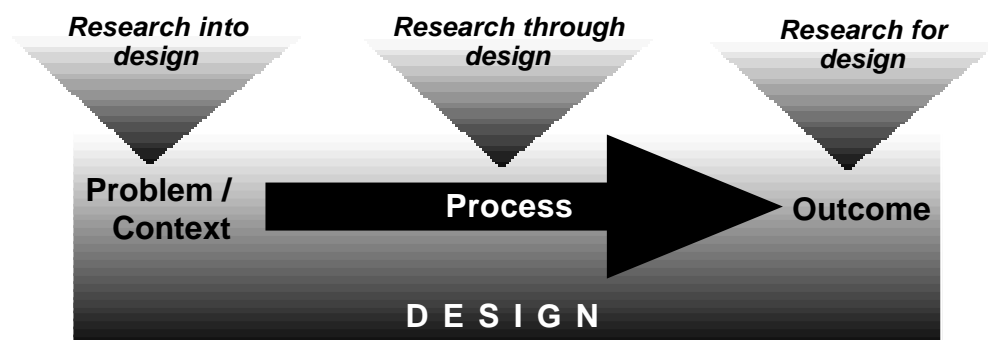
We know that the Mary Celeste of design is not only theoretically empty but is also sinking in the water in terms of core funding in higher education. Research money should not represent unnecessary spending for a new decorative figurehead on our imperilled craft. Nor should it be used to cover gaping holes in the hull. Rather, it should equip us with a vital new navigation system that will take us to the port of intellectual and material renewal.

The research culture required must be based on a clear view of the terrain and nature of design research, the methodological distinctiveness of design in relation to the natural and social sciences, and a vision of how to strengthen design's knowledge base.

THE SCOPE OF DESIGN RESEARCH

Professor Christopher Frayling recently categorised three forms of research in the field of design. The first category, research *into* art and design explores design through disciplines determined by its context. This is perhaps the most straightforward in terms of defining appropriate methodologies and justifying to the broader academic community. Research *through* art and design can take a number of forms. It may involve materials research or detailed experimental and development work. Finally, research *for* art and design aims to communicate the research embodied in a work of art or piece of design. This, according to Frayling, is the most difficult to conceptualise and justify, but it is the most crucial for us to get right because this lies right at the heart of the design process.

Figure 1
Frayling's design research categories



Research into design is consistent with the emerging field of Design Studies championed especially by Victor Margolin at Chicago. To understand design's role in culture and economy and the processes that it uses clearly requires an open and multidisciplinary approach. The study of design must connect with anthropology, sociology, with the study of management and cultural theory. It must be interpreted through, amongst other approaches, poststructuralism, semiotics and feminism. A growing range of journals such as Design Studies, Design Issues, Design Management Journal, Information Design Journal and Co-Design is communicating such research. Seldom conducted by designers, research into design adheres to the conventions of the scientific method.

Frayling's latter two categories recognise that research is a necessary feature within the territory of the design process itself. Designed artefacts are embodiments of research and knowledge often generated by the designer through ergonomic, market and materials research.

However, we can go further than Frayling and propose an additional category: research *as* art and design. To do so requires a clearer understanding of our 'difference' and the definition of appropriate methodologies. Unless we rise to this challenge then the narrow, inappropriate empiricist culture of research which dominates academia will reshape or marginalise design. So, either we come up with alternatives or we have methods imposed upon us. With this aim in mind we must be clear about what we mean by research.

RESEARCH: THE APPLIANCE OF SCIENCE?

Research can be defined as a systematic investigation towards increasing the sum of knowledge. It applies methods and possesses procedures focused upon a search or inquiry. Up to this point in the definition research would appear to be an activity shared by the questioning competitors on Blind Date, the telephonic labours of J R Hartley, and my methodical pacing of Tesco's every Friday evening. But a young man's quest for a good night out, JR's information gathering and my hunt for a week's supply of affordable groceries does not constitute knowledge. So what is knowledge?

E=mc² would appear to fit the bill. The law that energy is proportional to mass is obviously knowledge. It explains the workings of our entire universe on cosmic and sub-atomic levels throughout its history, apart from its initial stage of singularity before the big bang and of course University modularity systems, the latter appearing to be explained by Heisenberg's uncertainty principle. Laws, then, are knowledge, especially if they've got sums in them.

From ? to ! is my equation of what research is. It starts with a question, it ends in enlightenment and the bit in the middle can give you sleepless nights. Research is defined in our academic culture as the practice of the scientific method. A short history lesson will explain what the scientific method is.

There are two ways of discovering knowledge. The first, identified by Aristotle, is called deductive logic. You begin with an accepted premise or assumed truth and apply logical reasoning to it. As Leedy has explained, this was why Columbus had difficulties in recruiting sailors. They reasoned that since the earth was flat, then it had an edge to it. If you sailed a ship far enough, then it would reach the edge. When it reached the edge it would naturally fall off. Anyone on board would be lost in a cosmic void. The sailors' logic was absolutely cast iron, and their conclusion completely valid. The only problem was that the premise they started from was a little wanting in realism.

During the Renaissance, deductive logic was replaced by the notion of inductive reasoning. In seeking knowledge you do not start with a preconceived idea and deduce logically what must follow from it - but you ask questions, make observations relevant to

those questions, and reason conclusions from those observations. In other words, knowledge derived from observable and measurable fact, rather than supposition - this in a nutshell is the scientific method. Scientific research, then, deals with facts. We seek to obtain them and interpret them. From this we derive knowledge. The process involved articulates goals, defines a plan of procedure, breaks the problem into manageable sub-problems, is guided by hypotheses, determines methods of obtaining, verifying and analysing data and is a cyclical process.

The scientific method would appear the most appropriate means of deriving knowledge to facilitate oceanic navigation or the splitting of atoms, but is not a work of art also knowledge? The human experience - passion, joy, hope, love, fear, hate - in itself reveals truth, knowledge of the human condition. Unlike the knowledge derived from science, the knowledge derived from art is unverifiable, subjective and cannot be universally generalised. We can apply the procedures of research in seeking to understand the work of art as a cultural and historical object, we can analyse technique and from such research derive objective knowledge about the work. But the work in itself represents another form of knowledge, and the method that created it is significantly different from that of science.

From ! through ? to !?! At the risk of trivialising the artist's method I would suggest this as a summary of its stages. At its starting point is a personal vision or manifesto explored, researched and refined self-critically. This culminates in a body of work which, far from definitive, begs further critical appraisal from the artist and his or her audience. Unlike science, art begs interpretation and involvement with the observer.



Figure 2 - !?!

In these crude overviews I have drawn a strong contrast between the methods and outcome of the artistic and scientific methods. Perhaps in reality there are closer similarities than first appear. Can we not regard the scientific hypothesis in the same light as the artist's personal vision, which sets the agenda for research. And indeed is any scientific discovery truly objective? If the philosopher of science Thomas Kuhn is correct, then scientists can be seen to possess a collective subjective adherence to dominant value systems or paradigms which determine the problems they seek to solve and the nature of their solutions. The initial leap of faith which is explicit in the artistic method would appear to be implicit to that of science.

However, science and art, despite these observations, ask different sorts of questions about reality. Indeed, they deal with different realities. Their outcomes are different and

their relationship to the observer and the necessity and form of discourse are also different. So where does design lie between science and art?

DESIGN: THE EMBODIMENT OF KNOWLEDGE

Perhaps unfortunately for us, design straddles all these approaches to knowledge. That is what makes it fascinating and exciting as an observer, challenging as a practitioner, and frustrating in arguing its case to a University research committee.

Engineering design would appear to follow a process similar to that of science. It is systematic and applies well defined methodologies. The outcome of engineering design is, in more ways than one, an appliance of science. The design of capital goods in particular are assessed according to highly specified performance criteria. Two Dutch engineering designers, Eekels and Roozenburg, recently drew some well-observed parallels and contrasts between scientific research and engineering design.

To begin with, the aims of science and design differ. Science aims to bring about a change in the realm of the mind in the form of new or improved knowledge. Scientists look at the material world, compare their observations with available knowledge and propose changes in that knowledge. Design, on the other hand, aims to bring about a change in the material world. Designers look at the material world, compare their observations with their value preferences of how the world should be, and propose material changes. In changing 'the facts' of the designed environment, designers are driven by human values.

This is not at all to deny that science is value free, but rather that its values are less individualised than they are in design. As we move across the design spectrum from the engineering and science based disciplines to the more decorative areas, so these individual values can at times obscure functional design performance criteria. Engineers are perhaps rightly critical of product design such as Philippe Starck's famed kettle.

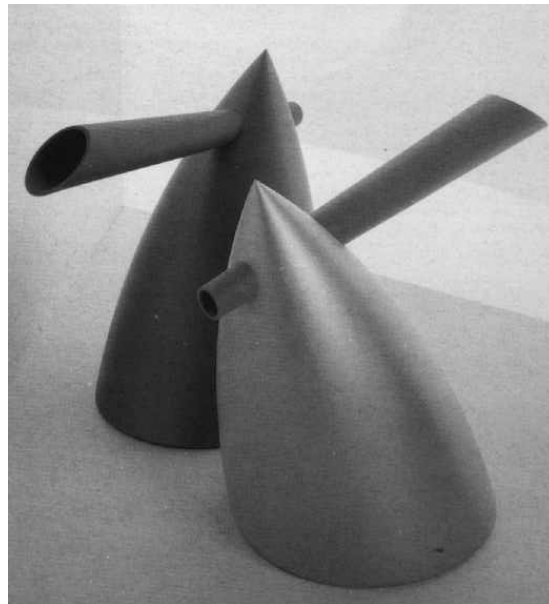


Figure 3 - 'Hot Bertaa' kettle designed by Philippe Starck

He appears, as do too many designers, to have rediscovered Aristotle's deductive logic as a design method. A wholly individual aesthetic premise, logically developed leading to a kettle guaranteed to burn a hole in your wallet and scald your hand. It simply doesn't work. Flat earth design. It is design such as this, and the pedestal that the design

community places it upon, that suggests the severity of the problem facing us. However, there are more positive examples.



Figure 4 - fashion design by Issey Miyake

The fashion designer Issey Miyake marries science and art quite spectacularly. The form, line and texture of fabric is subverted and redefined by laser cutting, advanced polyesters and exquisite craft. This enwraps and gives new form to the human body: a union that is as much performance art and sculpture for the viewer as it is a sensuous pleasure for the wearer. This example perhaps best demonstrates that a well designed artefact is a focused expression and extension of knowledge. Poor design is an admission of ignorance. Just consider the knowledge that we're looking at when we gaze upon Miyake's work: the knowledge of fabric, what it does, what it can do; the knowledge of manufacturing, of craft skills, the knowledge of the body and how it can interact with clothing; the knowledge of a personal vision; the knowledge of fashion. In synthesising this knowledge the designer's artefact itself represents new knowledge.

This makes the point that the skilled designer is a researcher. A designer without research skills is merely an aesthetic technician. I would argue that the practice of design at a postgraduate level can be, but not always is, analogous to that of research. A designed artefact is a researched proposition for changing reality.

Too often we see the designed object as the end of the design process, but in fact it is more at the stage of the hypothesis in the scientific method: a well researched, reasoned and creative theory. The next stage, the one that design largely fails to embrace, is to test the proposition. There are methods from science, from marketing, from cultural theory, from artistic discourse which apply in varying degrees to the assessment of different types of design. It is obviously not just a question of whether it will sell, but also how it will be interpreted, what impact it will have on the culture of design and tastes and how it will be received critically. For the design research process to be comprehensive it must therefore embrace appropriate methods of assessment and discourse.

To extend the definition that we used earlier, research, in our academic culture, is this: “the systematic investigation towards increasing the sum of knowledge which is reported in a form which renders both the methods and outcomes accessible to others.” In other words, research is not an invisible process manifest only in a kettle or a dress or $E=mc^2$ or a double helix. It is, rather, a fully documented and recorded process which enables its full understanding....

CRAFT: MAKING AS KNOWLEDGE

“...and reproduction,” cries the Spud-U-Like Professor of Applied Tuberosum Science chairing the University Research Committee. Professor Spud, like all good empiricists, likes his knowledge to reproduce. So does his corporate sponsor.

Design markets itself as the ‘virtually fat free milk’ of late capitalism. Industrialisation and the division of labour that it required, skimmed off craft skill, leaving behind the processed reproducible knowledge of design: in other words, thinking (design) and making (craft) were separated. Design becomes ‘lean’, scientific, amenable to empirical method, and reducible to elements that can be appropriated and reproduced by machine through CAD or written about in PhD theses. Making becomes dumb.

In asserting design’s right to determine its own research agenda, it is essential to recover the dignity of the maker. In the class struggle of knowledge it has been necessary for craft to be deskilled and deintellectualised, its status reduced to the toil of labour. Even in generally sympathetic accounts of craft skill, there is reference to the “illiterate craftsman” (Jones, 1980, p.15) as a characterization of the maker. The preindustrial artisan and the skilled working class can on no account be seen as having created knowledge, for if that were the case then it would challenge those who have claimed power over them. Design has been a willing partner in weaving this myth of the dumb maker, as if embarrassed by a mentally handicapped uncle that the family prefers not to talk about.

But as Braverman, E P Thompson and others have demonstrated, the maker was far from dumb. Thompson in particular through his history of the English working class sweeps away the myth to reveal a picture of a vibrant, rich scientific and artistic working class culture based around traditional crafts: “There are northern museums and natural history societies which still possess records or collections of lepidoptera built up by the weavers; while there are accounts of weavers in isolated villages who taught themselves geometry by chalking on their flagstones, and who were eager to discuss the differential calculus” (Thompson, 1964, p.291).

If the culture of the maker was not dumb, neither was the act of making itself: “We think of craftsmanship ordinarily as the ability to manipulate skilfully the tools and materials of a craft or trade. But true craftsmanship is much more than this. The really essential element in it is not manual skill and dexterity but something stored up in the mind of the worker. This something is partly the intimate knowledge of the character and uses of the tools, materials and processes of the craft which tradition and experience have given the worker. But beyond this, and above this, it is the knowledge which enables him (sic) to understand and overcome the constantly arising difficulties that grow out of variations not only in the tools and materials, but in the conditions under which the work must be done” (Braverman, 1974, p.136).

Craft contains its own thinking, its own knowledge, some of which is reducible to words, but most of which takes place through the physical act of making and is manifest in the crafted object. Craft knowledge is gained and passed on through the use of all the senses. It is possible to write an account of how to blow glass, but this does not constitute the

knowledge of glass blowing. This knowledge is acquired, and developed further, by understanding the material's qualities at different temperatures and sensing how the fluid material is best manipulated: through sight and touch. A glassmaker also understands the material by listening to it. An almost imperceptible 'ping' is read by the maker as stress in the material caused by incompatible colour or poor annealing.

"Very interesting," interjects Professor Spud, "perhaps they could do their PhD in the design of a computerised ping recognition device, or Pingalyser, for incompatibility analysis. I'm sure we could get sponsorship from Pilkington. There's huge market potential and great scope for publishing papers."

Sifting through craft knowledge, splitting it up, divorcing it from the context of making, turning it into a commodity and selling it is great for research ratings, and of course it is what industrial progress is all about. Except, of course, that it impoverishes craft, and in doing so it impoverishes design, for we must remember the *virtually* in the designer "fat free milk".

Despite the best efforts of some, design can never seem to rid itself totally of craft knowledge, skills and sensibilities. Indeed, it appears most innovative, relevant and vibrant (and dare I say, 'human') when served up as a pint of gold top. Understanding material and developing a creative relationship with it remains an essential part of many design processes and methods. As a recent article in Co-Design has argued, the craft of sketching is often an essential part of the tacit thinking process which is not amenable to translation into words (Temple, 1994).

This leads us into the final phantom about craft that we have to exorcise: the myth that craft knowledge is traditional, unchangeable knowledge. Materials, techniques, processes and applications all evolve, as does the craft - the knowledge - of how these fit together. The basic skill of glassblowing, for example, has changed little since the Romans perfected it. But what have changed are the development of new glasses with different qualities, computer controlled furnaces, new decorative techniques and widening sculptural possibilities with the material. Craft evolves, grows and reaches out into new domains of creative endeavour as a method of acquiring and developing knowledge. As J C Jones has argued: "the more I see of software designing the more I notice resemblance not to design in other fields but to craftsmanship" (Jones, 1988, p.219).

TOWARDS HUMAN CENTRED DESIGN RESEARCH

The position that we adopt with respect to research, will radically and irrevocably change the nature of design education, and thus the nature and status of design itself. In our general reluctance to consider the 'politics' of design, and our desperation to claw in as much research funding as we can, we face a likely scenario of design being further deskilled and its reproducible knowledge being appropriated by computer based systems. As a consequence, designers, like craftmakers before them, will become machine minders, and design education will degenerate into technical training.

The evidence that this is already taking place is plain to see. Graphic design courses are increasingly becoming Quark training courses, and job adverts in *Design Week* are replacing the job title 'graphic designer' with 'Mac operator'. Reading lists for design degree courses have more references to software manuals than Pye, Jones or Papanek. Modular degree courses, appropriate to the needs of linguistic based disciplines, effectively reduce the concentrated development and refinement of skill so essential to the acquisition and furtherance of craft knowledge. Further inroads into design education by an alien research culture will accelerate this process as resources concentrate in the 'intellectualised' areas of CAD and design management.

“We seem to have seriously underestimated the educational, cultural and other significance of skill and craftsmanship”, argued Mike Cooley fourteen years ago (Cooley, 1981, p.75). The powerful case that he made, warning of design’s impoverishment by any further erosion of its craft foundations, posed an alternative vision in which interactive computing could be used to enhance and exploit tacit knowledge rather than replace it: human centred systems. Such as perspective should provide the foundation for a new, appropriate form of design research: *human centred design research*.

I have argued above that design has three critical ‘differences’ in the way that it creates its knowledge:

- First, we are driven by values, not a search for objective truth. We aim to change reality, not just to interpret it. Clearly in some areas of design this is more important than others, but overall we need the confidence and the methods to develop, distil and articulate the values we seek to make visible through design.
- Second, our solutions are open ended. Our design propositions can and should be tested, but at best they remain well founded propositions rather than proven solutions.
- Third, the tools of our research are sometimes words, are sometimes mathematics, are sometimes experimental data, but very often they are lines, forms, patterns, textures, colours, spaces and materials. It is these that we manipulate and refine, through the exercise of craft. Part of this craft knowledge is reproducible and amenable to linguistic rationale, but another part is not. We do not ask the scientist to communicate research in pictures, so why their obsession with us using words? Yes, we must document far more effectively - but by using appropriate media.

Our priorities for asserting a new research culture, should therefore be as follows:

1 Make values explicit

Since design is a value driven process, then we must make these values explicit in design research. It is therefore necessary for us to explore more fully how methods from across the art and design spectrum, from sciences and social sciences can be used and adapted to achieve this. Articulation of the value system and assumptions determining design strategies should be encouraged from undergraduate levels upward.

2 Test propositions

Testing the design proposition - a reasoned case for changing reality - should, especially at postgraduate level, be a necessary part of design; again requiring new methodologies.

3 Recognise craft practice as research

We must argue that the practice of a craft is a legitimate form of research in that it extends knowledge. In some instances a written account of this research process may be an appropriate form of documentation, but not in all cases.

Diana Hobson is a contemporary glassmaker whose delicate pate de verre vessels are considered amongst the finest examples of British studio glass. Behind her objects is a remarkable rediscovery of knowledge involving research into a forgotten glass making technique. Unusually, Diana has done something that designers are all too often criticised of: she has carefully documented her research and design process lodging this in the Crafts Council library.



Figure 5 - Rainbow Jester (1990) by Diana Hobson

In this case written documentation is an appropriate form of recording. But other forms of craft knowledge are far more appropriately recorded visually. New technologies offer us flexible, appropriate and relatively cheap ways of doing this. Digital photography offers a low-cost method of visual recording, now available within many Design Schools. However, especially at postgraduate research level, interactive multimedia offers a particularly appropriate form for recording and reporting upon design development as researchers at Aberdeen have suggested (Gray and Malins, 1993). If we are in need of new research projects for multimedia, I would suggest an investigation of how it can be used to record and document the design process. It can also be used to record the discourse which is an essential part of the testing stage.

Craft based research could therefore legitimately comprise an interactive screen-based record of the making process which includes video sequences, scanned in sketchwork and some written up technical details. This would be considered alongside an exhibition of work.

In arguing for these priorities, I am not denying the relevance of written documentation and scientific procedures in some areas of design research. Design is a broad church embracing the orthodoxy of science and the evangelism of expressive craft. Our job must be to develop methods and procedures which validate and further this range of activity.

The key point about these priorities is that they do not attempt to dislocate the individual human designer from the unique bundle of knowledge and imagination that makes them that very individual. This is neither a mystical notion, nor does it pander to the romantic myth of the designer. It is, rather, a reassertion of design's distinctive roots. These roots are to be found in the history of the weaver, the carpenter, the engineer and the mason: women and men whose work by hand and brain linked science and imagination and created the foundation for our industrial culture.

BEWARE THE KLINGONS OF KNOWLEDGE!

In our postindustrial culture we are perhaps rightly critical of the dehumanised and brutalised world that science without responsibility, industry without morality, hand without brain has given us. There are growing indications that the design community is itself reassessing its own morality and responsibility, as the tenor of the recent symposium at New York's Cooper-Hewitt Design Museum (Yelavich, 1993) and the Design Renaissance congress suggests (Myerson, 1994). It is my contention that the form of knowledge that design creates is a far more appropriate model for other disciplines to explore in creating the sort of human-centred culture that we would appear to favour. As

the Klingon battlecruiser of empiricism and anally retentive research hoves into view, developing this debate further, more clearly defining our 'difference' and the methods appropriate to it is now an urgent priority.

But at the end of the day, if we cannot get the academic research establishment to accept our 'difference' then frankly it is better to let them keep their £7 million. If there is one value thing that history has demonstrated that design should never fall for, it is pimping for money. Our job is to demonstrate that there are life forms (maybe Jim, not as we know them) on the Marie Celeste of design. What we should not do is hang around other boats offering sailors a good time for the price of a research assistant. We are navigators of uncharted waters, not a fisherman's friend.

Perhaps more important than the prosaic concerns of higher education funding, is the future of design itself. Rationalising the values which underpin design, identifying the knowledge upon which creative decisions are made and communicating more clearly each stage in the process are surely disciplines associated with the socially responsible design that the profession has aspired to historically. The priority for all of us who care about the integrity and future direction of design is to understand, articulate and assert the 'difference' of design and the research methods which will strengthen it as a force for positive change.

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REFERENCES

- 'Dilemma on the drawing board', *The Times Higher Education Supplement*, February 18 1994.
- Agnew, K (1993) 'The Spitfire: legend or history? an argument for a new research culture in design', *Journal of Design History*, Vol 6, No 2.
- Allison, B (1993) 'Research in art and design: a developing professionalism', *Design Research Newsletter*, No 49.
- Braverman, H (1974) *Labor and monopoly capitalism*, Monthly Review Press
- Cooley, M (1981) *Architect or bee?*, Langley Technical Services
- Coyne, R and Snodgrass, A (1991) 'Is designing mysterious? challenging the dual knowledge thesis', *Design Studies*, Vol 12, No 3, July 1991
- Eekels, J and Roozenburg, N (1991) 'A methodological comparison of the structures of scientific research and engineering design: their similarities and differences', *Design Studies*, Vol 12, No 4, October 1991
- Gray C and Malins, J (1993) 'Research procedures/methodology for artists & designers', in *Principles and definitions: five papers by the European Postgraduate Art & Design Group*, Winchester School of Art.
- Jones, J C (1980) *Design methods*, John Wiley
- Jones, J C (1988) 'Softecnica', in *Design after modernism* (ed J Thackara), Thames & Hudson
- Kuhn, T (1976) *The structure of scientific revolutions*, University of Chicago Press.
- Leedy, P. D. (1989) *Practical research: planning and design*, Macmillan
- Margolin, V (ed) (1989) *Design discourse: history, theory, criticism*, University of Chicago Press
- Myerson, J (ed) (1994) *Design renaissance*, Open Eye
- Temple, S (1994) 'Thought made visible - the value of sketching', *Co-Design*, Issue no.1, pp. 16-25.
- Thompson, E P (1964) *The making of the English working class*, Penguin
- Turner, P (1994) 'Textile law: copying without infringing', *Drapers Record*, January 1994
- Whiteley, N (1993) *Design for society*, Reaktion books
- Yelavich, S (ed) (1993) *The edge of the millenium*, Whitney Library of Design