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This paper suggests two possible future lines of development for design methods. One is a continuation of the design methods 'generation game'. The other is as a part of the wider development of a post-industrial basis for design, technology and society. The latter is characterised as a paradigm shift in design. Some examples of the seeds of postindustrial design are reviewed.

Nearly 20 years ago, the design methods movement seemed to offer a clear picture of the future for design: a logical, rational, coherent activity using systematic procedures. Now, the picture is much less clear, and the movement appears to be in crisis.

I suggest two possible scenarios for the future of design methods. One is a continuation of the now well established design methods 'generation game'. The other scenario is based on the assumption that the present crisis (throughout design, not just in the design methods movement) may be indicative of an imminent paradigm shift in design. This shift is part of a larger one in technology and society from industrial to post-industrial bases.

THE GENERATION GAME

According to Archer [1], 'design methodology is alive and well'. This may have come as a surprise to many who had assumed that the subject was now (like so many of the delicate offspring of the 1960s) well and truly dead. Such an assumption was clearly premature, if he is right. However, Archer might be presumed to have a vested interest in trying to keep the subject alive on his hospital bed, since he was one of the originators of the subject and the design methods movement. However, what he argued in Design Studies was that his concern with design methods has always been:

> to find ways of ensuring that the predominantly qualitative considerations such as comfort and convenience, ethics and beauty, should be as carefully taken into account and as doggedly defensible under attack as predominantly quantitative considerations such as strength, cost and durability.

That sounds like yet another design methodologist recanting and pleading mitigating circumstances. Alexander and Jones, the other leading exponents of design methods in the early 1960s, have already recanted in similar terms, and apparently rejected design methodology.

Archer at least still suggests that there is something in methodology to be studied, taught and practised. What went wrong, he suggests, was the attempt to apply the methods of science to design, instead of developing design's own methods.

Origins of design methods

The origins of the design methods movement lay in the application of powerful scientific techniques to a wide range of novel problems during the Second World War. Operational research (OR), for instance, originated and developed in this way. The application of OR techniques in management decision-making was one model that the originators of design methods used to justify the development of new techniques for design decision-making.

It is still possible to hear references to 'the science of design' or 'design science', and it is clear that a desire to scientise designing was prevalent amongst many of the originators and followers of the design methods movement.

However, in contrast to the claims for the emergence of a major new, systematic and scientific design process, the actual achievements have been very modest. This is both in terms of impact on the conventional design process, which has continued to be an undisciplined muddling through, and in terms of products designed by the new methods. Unless, that is, one is to include as examples of systematic design such previously overlooked successes as Disneyworld, Florida, which Geoffrey Broadbent [2] recently nominated as the epitome of rational design.

Although it is a surprising example, Disneyworld is a very apt one because it also captures a Brave New World atmosphere endemic in the design methods movement. This atmosphere can be traced back to the wider Modern Movement in design, where lie the philosophical roots of the design methods movement. For instance, Theo van Doesburg, a member of the influential *de Stijl* group, wrote in 1923:

> Our epoch is hostile to every subjective speculation in art, science, technique, etc. The new spirit, which already governs almost all modern life, is opposed to animal spontaneity, to nature's domination, to artistic flummery and cookery. In order to construct a new object we need a method, that is to say, an objective system. [3]

With the language toned down a little, such a statement might equally have been made by one of the new design methodologists 40 years later.

However, many principles of the Modern Movement have recently been coming under attack. For example, Watkin [4] has criticised the movement for, amongst other things, its desire to construct 'a scientifically plotted Utopia'. Broadbent's example of Disneyworld is indeed just such a Utopia, and a prime, if not at first sight obvious, example of rational, systematic design.

It was this Brave New World atmosphere of the design methods movement that led to some of its erstwhile protagonists withdrawing their support.

In the now notorious interview of 1971, Christopher Alexander said (amongst much else):

> I've disassociated myself from the field.., there is so little in what is called 'design methods' that has anything useful to say about how to design buildings that I never even read the literature anymore... I would say forget it, forget the whole thing. [5]

Christopher Jones was to write later:

> In the 1970s I reacted against design methods. I disliked the machine language, the behaviourism, the continual attempt to fix the whole of life into a logical framework. [6]

Apart from the ethical objections to rational planning and systematic design, it also became apparent that design problems are actually resistant to the methods of science. The roots of this resistance were analysed by Rittel [7] who characterised the nature of design problems as 'wicked' problems, whereas the problems scientific method tackles are 'tamed'.

However, the design methods movement refused to die. In fact, it was saved by another suggestion of Rittel. [8] This was that we had seen only 'first generation' design methods, and these, naturally enough, looked rather simplistic with the benefit of hindsight. Rittel went on to propose and to outline the features of an emerging, more sophisticated, 'second generation'.

The idea of 'generations' of design methods was brilliant: it let the methodotogists escape with some decorum from being committed to some glaringly inadequate methods, and it opened up a guaranteed future in methodology as each generation of methods succeeded the last.

Second generation methods were characterised by Rittel as:

• assuming an equal distribution of knowledge about the problem (i.e. designers, users, and others all have valid knowledge to contribute)

• embodying an argumentative process (i.e. influenced by different values from different sides, and not subject to one remorseless logic)

• casting the designer in a 'midwife' role (i.e. there to exercise her particular skill only in assisting the interested parties to produce their own solution).

Clearly, this generation of methods was strongly influenced by the move towards design participation which was prevalent in the 1970s [9].

Nevertheless, it has to be admitted that, like the first generation methods, these second generation methods have also met with only moderate success.

One particular shortcoming of the participatory methods is that they relate principally to architectural and planning problems, and not to the problems of engineering and industrial design.

As we enter a new decade, it is inevitable that Rittel's escape clause will again be invoked, and a third generation of design methods will appear.

One suggestion already made [2] is that a common failing of the earlier generation methods was that they tried to prohibit the designer's preconceptions, hunches, or arbitrary solution ideas.

The emerging third generation view is that these inputs from the designer to the design process cannot be avoided, and are a necessary part of any design method.

This view is usually justified by reference to Popper's 'conjectures and refutations' model of scientific method [10] - that is, the scientist proceeds by formulating a conjecture

(a hunch) which is then subjected to rigorous tests. Only if it succeeds against refutation is it accepted as a valid hypothesis.
Translated into the design field, this model is attractive because it fits well with what designers already do in practice [11]. But what happened to the desire to reform designers' practices, that was so much a part of the original motivation of the movement?
I predict that a fourth generation will see a return of this reforming zeal, particularly using automatic procedures that generate designs without the meddling interference of a human designer, and a return to the premises of the Modern Movement. Remember, 'we need a method, that is to say, an objective system'. However, the emergence of a fourth generation may be overtaken by events elsewhere.

THE PARADIGM SHIFT

The generational view of design methodology is attractive. It offers a model of progress which allows research and development to continue within each generation, with only occasional upheavals as one succeeds another. It permits Young Turks within the movement their radical ideas which, from time to time, can be sifted by the Old Guard into a sanctioned next generation.
An alternative to the generational view has similarities with the view of developmental change in science proposed by Kuhn. [12] His view is that science progresses by a series of major changes in the paradigms held by scientists. Thus, for example, the paradigm based on Newtonian physics has been superseded by one based on Einsteinian physics. Within a paradigm, work proceeds on a variety of 'puzzles' suggested by the paradigm. This puzzle solving is classed by Kuhn 'normal science'.
Occasionally, a crisis will develop in a paradigm, as some experimental results and new ideas undermine its basis. When this happens, a scientific revolution will lead to a new paradigm.
Is the current generation game in design methodology a parallel of the paradigm shifts in science? One important difference is the timescale on which the changes take place, and another is the degree of radicalism in the changes.
In science, paradigms hold for a relatively long time, perhaps centuries, whereas in design methodology a new generation seems to be emerging each decade, or less. A new scientific paradigm brings radical reassessment and a fundamental change in the scientific understanding of the world, whereas in design methodology each new generation seems a fairly modest change, now that we have a perspective of such changes.
So a straightforward analogy of generation with paradigm is a false one. Instead, if we are to pursue Kuhn's view, it seems more likely that what we have been witnessing is the emergence of a crisis within the design paradigm which has been held this century.
This prevailing paradigm has been that of the

Modern Movement, which characterises design as rationalistic, reductionistic and mechanistic - 'hostile to every subjective speculation'. It has been an attempt to model design method on scientific method; but relying on what we now know to be a rather naive view of science. [13]

The Modern Movement itself is in crisis, as witnessed by the search for post-Modern styles in architecture, and the shifting sands of design methodology are a further indication of the need for a revolutionary new paradigm.

Of course, those who remain committed to the old paradigm will ferociously resist any such revolutionary change. It is, indeed, particularly unfortunate for them, since it is only recently that they have begun to gather the flowers of the seeds planted by the pioneers.

The objective, systematic design methods can now be seen as a final, rather late, flowering of the Modern Movement. It is sad that the frost of seasonal change is already upon them, although the committed 'design scientists' will nurture and protect the delicate blooms for as long as possible.

In fact, an ideological struggle between holders of rival paradigms is symptomatic of the revolutionary paradigm shift that characterises scientific progress in Kuhn's model. During the crisis period, one may witness the sudden conversion of some scientists from the old to the new paradigm. Kuhn suggests that a new paradigm 'emerges all at once, sometimes in the middle of the night, in the mind of a man deeply immersed in crisis'.

The 'conversion experience' from one paradigm to another is like 'a gestalt switch'. Have we not seen such conversions in some of the leading figures in the design methods movement?

Another symptom of the transition from one paradigm to another is 'a period of pronounced professional insecurity', such as we are now witnessing both in the practising design professions and in design methodology and design education. 'When the transition is complete,' Kuhn adds, 'the profession will have changed its view of the field, its methods, and its goals.'

Crisis in technology

Why should design be in such a crisis period now? My own view is that it is closely connected with the crisis in technology. Design, the conception and creation of new artefacts, is the central function in a technology which has been facing the crises of energy and resources, and the criticisms of the antitechnocrats and alternative technologists.

If, from these unprecedented crises and criticisms, a new technology emerges, it will need new, post-industrial design methods. Just as the pioneers of the Modern Movement recognised the need for new design concepts to match the new technology of the 20th century, so the pioneers of the post-Modern movement recognise the need for new design concepts to match the emergent technology of the 21st century.

There has been some confusion over the concept of post-industrialism. In the mid-1960s, this implied a kind

of hyper-industrial technology, based on the information revolution, automation and highly advanced technology. This was the concept as embodied, for example, in Bell's vision [14] [15] of the post-industrial society, dominated by the scientists, mathematicians, economists, and engineers of the new computer technology.
It was characterised is in terms of three main components:
In the economic sector, it is a shift from manufacturing to services;
in technology, it is the centrality of the new science-based industries;
in sociological terms, it is the rise of new technical elites and the advent of a new principle of stratification.

The concept of post-industrialism

By the mid-1970s a different concept of post-industrialism had begun to emerge, based on a radical reappraisal of the direction of technological 'progress', and associated with the alternative technology movement.
In Robertson's terms [16], the new concept embodied a shift from the 'hyperexpansionist (HE) vision' of future society to a 'sane, humane, ecological (SHE) vision' (Table 1).
Such a vision stems from a few, key, formative ideas that, according to Hall [17] and his colleagues, are gradually emerging into 'good currency'. These ideas, abstracted from Hall, are:
• Society, above all in the advanced industrial world, will need to become much more *resource-conserving*, particularly in relation to energy supplies.
• A second major feature of the future society, to borrow Illich's phrase [18], is that it will be *tool-using* rather than *machine-used*. Or, in Schumacher's equally celebrated words [19] it will use *intermediate technology*: a set of instruments vastly superior to the primitive technology of the past but much simpler, cheaper and freer than the present technology of the affluent world.
• The idea of a resource-conserving society based on parsimony, and the idea of a tool-using society seeking autonomy for the human being, come together in yet a third key concept: *quality* [20]. This notion of quality comes from within, and the quality of society can be made right only if individual values are first of all right.
• These notions, again, connect with another: the idea of *social and economic life reorganised in small-scale units*.
A resource-conserving society, since it must minimise movement of people and goods, will naturally be small and as far as possible, in a modern world, self-sufficient.
A tool-using society will allow the dismemberment of large bureaucratic structures, and so will allow production to occur in small units again.
If people are to discover the principle of quality for themselves, they are more likely to do so in small groups.
But above and beyond this, small-scale organisation is needed to reduce alienation and to allow people to come autonomously to grips with rapid change.
If we are indeed on the verge, or even in the process, of a transition from industrial to post-industrial society, and from industrial to post-industrial technology, then it is not surprising if there is a crisis in design as it, too, moves from an industrial to a post-industrial basis. What we can

expect to emerge from this uncomfortable crisis period, and what we should be looking for, is a completely new paradigm for design.
Such a paradigm would suggest a reorientation not only of the values, beliefs and attitudes of designers, but also of the goals of design (i.e. the nature of design products), and of the methods for achieving these goals.
Personality, product, and process in design are not as separable as the design methods movement has supposed; a designer does not use a process that he finds unsympathetic to his own attitudes, or that generates a product which he dislikes.

Table 1. Changes of direction implied by a shift from hyper-expansion (HE) to a sane, humane, ecological (SHE) future[16]

From	To
economic growth	human growth
polarization of sex roles in society	new balance between the sexes
increasing emphasis on rationality and the left-hand side of the brain	increasing emphasis on intuition and the right-hand side of the brain
increasing specialization	increasing self-sufficiency
increasing dependence on big organizations and professional know-how	increasing self-reliance
increasing urbanization	a more dispersed pattern of habitation
increasing centralization	more decentralization of power
increasing dependence on polluting technologies that waste resources and dominate the people who work with them	increasing emphasis on technologies appropriate to the environment, the availability of resources, and the needs of people
an industrial concept of work as jobs provided and defined by employers	a post-industrial concept of work as self-defined, self-fulfilling, socially useful occupation

New model of the design process

So a new model of the design process can only be considered as part of a larger structural model that also includes the designer and design products. The conventional design process of industrial technology tends to be autocratic, needing professional designers and generating specialised products which are aimed at short-term profitability in a mass market.
The structural preferences of post-industrial technology, however, are for democratic, non-hierarchical, participatory processes, open to everyone, and taking into consideration the long-term needs of the environment and society.
The paradigmatic features of industrial design and post-industrial design are contrasted in Table 2. Whereas industrial products tend to be specialised, single-purpose machines, post-industrial products will tend to be generalised, multi-purpose tools. Whereas industrial products tend to be short-lived and replaceable (throw-away), postindustrial

products will tend to be long-lived and repairable.
Whereas industrial products tend to be mass-produced, standardised goods, post-industrial products will tend to be short-run and customised. And whereas industrial products tend to be designed to some narrow 'optimum', postindustrial products will be designed to be 'satisfactory' over a much wider range of criteria.
Turning from products to the process, in industrial design this tends to be autocratic and internal to the designer, whereas in post-industrial design it will tend to be democratic and externalised, allowing everyone to see what's going on. The industrial design process tends to be exclusive to a select few, whereas the post-industrial design process will tend to be inclusive of everyone affected by the design decisions. Industrial design tends to be a short, intensive activity following a pre-determined path, but the postindustrial design process will tend to be a longer, extensive activity generating its own particular, ad hoc route. Industrial design process is rigid, whereas post-industrial designing will be relaxed.
Finally, designers tend to be jealous of their creativity and individuality in industrial design, whereas they will be prepared to collaborate anonymously in postindustrial design. Instead of their professional integrity, they will be concerned with exercising their participatory expertise.

Table 2. Contrasting features of industrial and post-industrial design

Industrial design	Post-industrial design
Products are:	Products are:
specialized	generalized
single-purpose	multi-purpose
short-lived	long-lived
replaceable	repairable
mass-produced	short-run
standardized	customized
optimum	satisfactory
Process is:	Process is:
autocratic	democratic
internalized	externalized
exclusive	inclusive
intensive	extensive
rigid	relaxed
Designers are:	Designers are:
creative	collaborative
individual	anonymous
professional	participatory

THE SEEDS OF POST-INDUSTRIAL DESIGN

During the crisis period before a new, mature paradigm for post-industrial design is established, we can expect to see many disparate, small-scale experiments which are outside the mainstream of normal design. Such experiments may seem to have little in common except for the fact that they are outside the mainstream, and, taken individually, may seem insignificant.

However, taken together, these little pin-pricks against the bubble of industrial design can be significant as pointers to the new paradigm.

Participatory design

Perhaps the most obvious example of a shift towards a new design paradigm is offered by the experiments in design participation. Originally seen by Rittel as just the initiation of a second generation of design methods, the participatory design techniques are growing into a generally-accepted new approach to design - particularly in architecture and environmental design.

Many examples of participatory design have been reported in the past few years. The concept now feels familiar, but we should remember that less than ten years ago it was a novelty, and only 15 years ago it was practically unheard of.

The examples now range from rather token involvement of future tenants in public housing schemes, such as the Byker housing in Newcastle, to the still-limited but detailed involvement offered by the PSSHAK system in London, to the more fundamental user involvement that was attempted at the University of Louvain, Belgium.

One of the most successful experiments appears to have been that of the small housing development built in 1974 at Klostermuren in Sweden. The neighbourhood of a dozen houses was designed in general layout and in the details of its houses by the group of future owner-occupiers, with the architect, Johannes Olivegren, playing the 'midwife' role of skilled assistant at the 'birth'.

This role is a radical change from that which architects are traditionally educated and expected to play, and is indicative of the shift in attitudes that is underway.

The motive of participatory design underlies much of the recent work of Alexander, for example as in the Oregon Experiment of university planning and design. [21] Alexander's 'pattern language' is an attempt to re-think and re-cast environmental design so that it is understandable by and accessible to everyone, like other languages. [22]

Argumentative planning

Although planning was supposed to become more open and participatory in the last decade, there are few signs of genuine structural change in the planning procedures. The most important changes of attitude have occurred not with the planners but with the planned: people have simply refused to accept that the planners know best and are working for the general welfare of the community.

The result has been a growing number of popular resistance movements against the plans for roads, airports, reservoirs, power stations and such like schemes for the disruption of communities and environments.

Protesters have taken a new, argumentative stance which has meant that planning procedures have become lengthier as the planners have been forced to justify their plans in the face of organised opposition.

Often the arguments put against the planners have

been not only reasoned discussion and debate, but also counter-propaganda and direct protest. These latter tactics take the argument to the level at which it belongs, that of politics, and can be distinctly successful, as have been the protests against the various sites proposed for a third London airport.
This kind of committed opposition may lead at last to a recognition that structural change is overdue in the planning process, and to the establishment of procedures which give as much, if not more, power to the public as to the planners. If small, local communities can effectively oppose large, national plans, this may lead to a more piecemeal, decentralised planning process altogether.

Socially-responsible design

'Don't blame me, I only work here' is a saying that only has meaning in industrial society. People's lives are fragmented, and responsibilities are divided and sub-divided until no-one can really be held responsible for anything.
People find themselves designing and making things that they would rather not, and which they would refuse to design and make if they really felt responsible for their actions; but it is easy to abdicate responsibility to 'the system'. The result, at best, is badly designed and poorly made goods; at worst it is the production of goods that are positively harmful and dangerous.
One significant pointer to a move away from this non-responsibility in industry was the initiative taken by union shop-stewards of the British Lucas Aerospace Company in 1976. These representatives of highly skilled workers employed mainly on military production began a campaign for the right to work on socially useful products [23].
Their campaign included an Alternative Corporate Plan which proposed that the company diversify into the production of goods, equipment and tools in areas such as medicine, low-energy transport, home heating, and telechiric devices for remote sensing and working in mining, fire-fighting and deep-sea diving.
The new design ideas for those alternative products came principally from the Lucas workers. Lucas management, however, has shown no interest in the ideas. Fortunately a few, at least, of the designs are being developed at the Centre for Alternative Industrial and Technological Systems at the North-East London Polytechnic, and some of the wider implications are being researched at The Open University in the UK.
This is a small, but perhaps significant, indicator of the scope for collaboration between workers, students and academics that might be possible with post-industrial approaches to design and manufacture.

Eco-design

One positive aspect of the crises faced by industrial societies has been the way these have forced a reappraisal of design criteria. An awareness is growing of how products relate to resources; how the man-made world relates to the natural world.

Interestingly, this 'new' awareness often entails the application of 'old knowledge' - for example, in relearning to design with locally available materials, and with the local influences of site and environment. But just as often it entails new knowledge and new techniques - for example, from electronics or control theory.
So, in house design, traditional construction methods such as earth walling could be used alongside novel electronic systems for the control of solar-heating devices, or a conventional-seeming, lean-to conservatory might be designed on the basis of new energy accounting techniques. In communications, democratic group processes might be assisted with portable video equipment. In food technology, the art of composting is practised alongside the science of hydroponics [24].
These examples indicate that the eco-design policies of alternative technology are not simply regressive to pre-industrial approaches, or romantically anti-industrial, but offer a post-industrial way forward that utilises the full range of appropriate human knowledge.

CONCLUSIONS

Design is changing; its products and processes are changing, so too is the role demanded of the designer. For about the last 100 years the prevailing paradigm has been derived from industrial technology and industrial society. Industrial design matured 50 years ago into the Modern Movement, whose standards and ethics we have now become used to accepting. It may be another 50 years before post-industrial design reaches a similar maturity, but its seeds are now being sown.
This rather sketchy outline perhaps serves only to suggest how much work is still needed in developing a coherent new, post-industrial paradigm for design. The underlying argument for pursuing such an arduous programme is that design as we know it is closely associated with technology as we know it; if that technology seems unlikely to see the world safely into the next century, isn't the associated view of design equally inadequate for the coming decades?

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