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SCIENTISM AND INDUSTRIAL DESIGN

by

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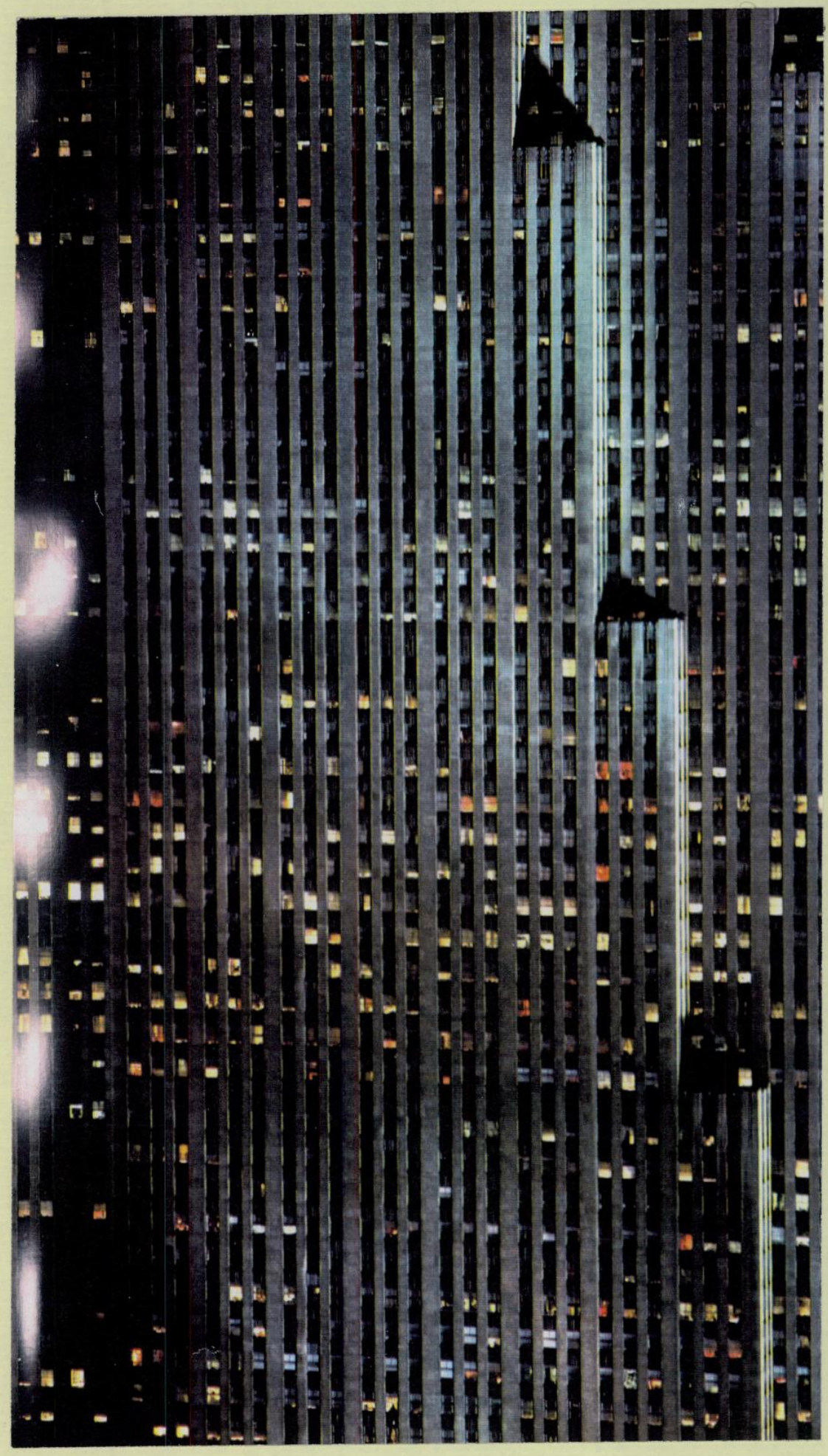
Fig. 1. The RCA building.



PREFACE

> Perhaps tommorrows metaphysics, should we feel the need to think metaphysically will begin as a critique of science, just as in classical antiquity it began as a critique of the gods.
>
> Octavio Paz

While the importance of design has grown considerably over the last decade theoretical discussion on the subject is limited. It is now recognised that to achieve its potential industrial design must have a strong theoretical platform.

It is possible that such a theoretical base may be adopted from science. This would seem to be an enormous mistake for the profession. To understand what this adaptation, more often known as scientism involves, I have endeavoured to link the Modern movement to the development of science in western Europe. This link is now accepted by numerous scholars in many professions, not just industrial design.

But it is a contention that while many designers accept that the highly rational approach comes from science and philosophy, there is an insufficient understanding of the fundamentals underlying this intellectual trend and the damage that can and has been caused by it. Nor does there seem to be a complete realisation that to adopt science is in effect, to adopt a complete ideology and view of the universe.

In response to this, this thesis attempts to track the history of science from the sixteenth century to its arrival as Modernism. In doing this I am primarily comcerned with the effects this history has had socially.

i am guilty of some misdemeanors in attempting this. First the thesis is long on theory, but I feel this is justified given current needs. Second, at least two-fifths of the thesis is concerned with material that may not be familar to designers, as it is chiefly scientific and philosophical. It is however neccessary to the argument to explain these in some detail. Third, a lot has happened in science and design in the last 400 years: the thesis is somewhat over the recommended length, but to curtail it any more would I suspect weaken the argument and therefore nullify the point of writing it. Fourth, despite this, the history is embarrissingly skeletal, if not skimpy, but I suggest that the way of it is essentially correct and therefore the knowledge of it may be beneficial in some way.

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ILLUSTRATIONS

INTRODUCTION

Science repudiates philosophy. In other words, it has never cared to justify its truth or explain its meaning.

A.N. Whitehead

INTRODUCTION

It has been accepted by the industrial design profession for some time now, that the Modern movement has ended in ideological failure and remains without replacement. In keeping with this view it seems that any current discourse about industrial design should reflect upon this failure. Not surprisingly, considerable thought has been invested in the analysis of exactly why Modernism failed. As such the general conclusion seems to be that Modernism did not meet certain human needs. Its inadequacy is social. Of course there are other facets involved (such as its increasing irrelevance to newer technology and manufacturing systems). But this human inadequacy is now accepted.

Before settling on this failure it will be useful to place Modernism's collapse in some sort of cultural framework. This is in order to understand why there has been no satisfactory replacement. François Burkhardt puts it thus:

> The profession as a whole still follows outmoded dogma; designers devote too little thought to the new aspirations of our times. Design, moreover is deeply affected by the crisis now gripping every aspect of society, and is not ready to call into question its own fundamental principles even though it now faces an unprecedentingly (sic) threatening situation. (20, p. 145)

Burkhardt does not go on to develop this aspect of his essay, 'Design and Avantpostmodernism', and one wonders why. He (among others) is no doubt correct; this juxtaposition of social flux and design paralysis is now prevalent in design commentary. But the lack of analytical depth is hardly desirable and it becomes a contention of this thesis that until the nature of Modernism (and thereby its failure) is precisely understood, the design

profession will remain unable to escape from its 'unprecedentingly threatening situation'.

In Pioneers of Modern Design, Nikolaus Pevsner claimed Modernism as the century's own, the style most befitting our times; a view for which he has regularly been attacked. But Pevsner was correct despite the rumblings of the anti-modernists. The Modern movement reflected most clearly the ideological pillars of the twentieth century in both philosophy and intellectual method, and the empathy between the two is the reason Burkhardt can associate their difficulties. To further this, it is held here that the roots underlying design's crisis are the same as society's.

The crisis of Modernism has up to now been associated with the larger crises that face society, without explanation. This connection will be fully outlined in chapters one and two. For the moment one is asked to accept provisionally that these crises and their interconnectedness exists.

Nihilism.

While there is as yet no definitive name for this crisis, there is a term for the effect it has on people in Western society.[1]

Nihilism is the term coined by Martin Heidegger to describe the emotive and psychic effects suffered by people due to an increasingly rational and technical approach to *being* (living) in this century. This approach (or as he says, 'descent'), he suggests began with the philosophical tradition in ancient Greece. For Heidegger this descent has reached its nadir in this century:

> Nihilism, thought in its essence, is, the fundamental movement of the history of the West. It shows such great profundity that its unfolding can be nothing but world catastrophes as its consequence. Nihilism is the world-historical movement of the peoples of the earth

> who have been drawn into the power realm of the modern age. Hence it is not only a phenomenon of the present age, nor is it primarily the product of the nineteenth century, in which to be sure a perspicacious eye for nihilism awoke and the name also became current. No more is nihilism the exclusive product of particular nations whose thinkers and writers speak expressly of it. Those who fancy themselves free of nihilism perhaps push forward its development most fundamentally. (5, p. 62-3)

Nihilism not only is the 'internal logic of the west,' (Nietzsche, op cit 5, p. 63)[2] it also represents the mental nausea induced by the collapse of certainty of belief and ideology into the uncertainties and conjectures of irrational concepts along with the resultant inability to defend one's beliefs rationally. Gramsci sums up the situation well: 'The crisis consists precisely in the fact that the old is dying, and the new cannot be born; in this interregnum a great variety of morbid symptoms appears.' (op cit. 20, p. 15) Thus the predicament which the industrial design profession finds itself in is that Modernism, founded on reason, has been found conceptually invalid by that same reason: therefore a rational replacement is not forthcoming. The collapse of Modernism as such symbolises the collapse of rational ideology itself. It can be seen that there is a lot more at stake here than the collapse of a design ethos.

Aside from intellectual criticisms, some commentators, notably John Thackara and Peter Fuller[3] hold that the practical failure of Modernism is sufficient to warrant its replacement. Yet while agreeing that this is correct, it is argued that no replacement for Modernism will be found satisfactory until the intellectual tradition it rose out of is unearthed for, and understood by, designers at large. And though the empirical criticism of Modernism is plentiful (Bayley, Jencks, *et al*), theoretical contributions to the current state and future of the industrial design profession are sparse. This acts as a justification for the emphasis on theory in this thesis.

Scientism and Modernity.

One of the important contentions of this thesis is that we have received the tenets of Modernism via science; more precisely from the classical scientific mode that dominated the tradition until the early part of the twentieth century. This is a result of the adaptation of the classical scientific model in areas outside of science itself. This came about as each area of endeavour attempted to align itself during the Enlightenment with the model of classical science - commonly regarded as the highest body of knowledge, as it is the most quantifiable - in order to gain a higher standing:

> When, as has happened frequently since the seventeenth century, philosophers claim to have made morals, or history, or politics, or aesthetics, or the study of the human mind into a science, they take it for granted that for a subject to become a science is for it to go up in the world. (19, p. 1)

This phenomenon is known pejoratively as *scientism*, as opposed to the neutral term, science.

For reasons that will be made evident, scientism has not only been detrimental for society, but in certain ways can become an active danger. This results from the 'objective' stance taken by scientised bodies and from the belief that science constitutes an unassailable body of knowledge, of absolute and unchanging truth, implicit in the classical model. This allows both an abrogation of ethical responsibility, and the masking of the most subjective of theories on the basis that they are 'scientific', truthful, and therefore in some way beyond human interference. From here on this notion of absolute truth will be denoted by the capitalised form, Truth.

In industrial design this tradition has resulted in an objective problem-solving methodology, despite dangers of the type mentioned above. Indeed, despite occasional claims of concern for people and their environments, there is no basis for ethical discourse in industrial design as based on the model of classical science. It may be argued that industrial

design does not exert the influence of other scientistic models, or since there is as yet no comprehensive science of design, it is in some way less responsible. And it is also true that the profession carries little weight in industry. But, accepting the view that we acquire many of our social values and personal identity through consumption, these detractions are hardly valid. Given the pervasive nature of products in a consumer society, it would seem that the industrial designer has an enormous effect not only on people's environments, but on their personal make-up. One could describe the designer's influence as psychically invasive. This tacit effect of design is another reason why the designer should be querying his or her role in both society and industry, particularly ethically, in the wake of Modernism.

Format.

With this in mind the thesis is divided into four chapters.

Chapter one deals with the consequences of the scientific outlook, first tracing the history of classical science, and then discussing the effects of its association with the concept of absolute truth. Then the development of this concept during what is now known as the Enlightenment is examined.

Chapter two deals with the loss of certainty (or Truth) in philosophy, science and mathematics. Here it will be shown that any formal system is incapable of validating itself. The conclusion from both chapters is twofold: first that the adoption of the scientific model outside science was a mistake for Western culture: and second that any system based on classical science is in itself logically inconsistent. Thus any classical scientism of design is demonstrably inadequate on two levels: the human and the rational.

Chapter three discusses the early attempts to unify art and industry and traces these through the Avant-Garde movements up to the inception of

a scientistic architecture and the attempts to scientise design (the German Functionalist movement will be dealt with in detail), analysing the effects this has had on industrial design.

Chapter four discusses current attempts to formulate a science of design. It will show the deficiencies implicit in a scientistic design by applying the arguments used against the general Enlightenment programme. The view is taken that any scientism that insists on Truth and complete quantification is an unsuitable epistemology for industrial design.

It is hoped to be shown after these chapters that any value-free scientism for industrial design is unsatisfactory, and to accept such a scientism could become an error with profound social consequences. The argument however is not levelled against all science. Twentieth century physics has seen an acceptance of the fallicitiousness of Truth, and many scientific philosophers, such as Michael Polyani, John Ziman and Karl Popper have accepted that value/qualitative factors preclude and limit science. Popper in particular is highly critical of any systems looking for Truth (in his term, uncritical rationality). However such systems continue to remain embedded in the social structure of Western society.

The calling into question of the fundamental principles of industrial design implies calling into question the fundamental principles of Western society and by extension its culture and civilisation. This perhaps is the reason for the lack of depth in the analyses of the position industrial design finds itself in today. But throughout the course of the twentieth century, the ideological edifice of Western society has steadily fallen away, and many critics (some of whom will be dealt with here) across a gamut of endeavours feel it inevitable that Western society itself will do the same, unless some form of action is taken. If one is to take the voices of these people seriously, there can be no real excuse for the industrial design profession's continued lipservice to the problem of Modernism in design and in society.

Much of the material presented here, particularly in chapters one and two, is not normally encountered in industrial design education or practice; occasionally it appears in architectural theory. This however does not imply that it is irrelevant, only that it is unfamiliar. As such I have tried to avoid explicitly technical terms or arguments where possible. Any critical terms will be defined where they first appear.

CHAPTER ONE

OVERVIEW

While it has already been mentioned that the modern tendency was toward quantification and rationalisation, it is not clear why this is a necessary requisite for science. Nor is it clear why scientism, as a pejorative term, has been damaging for Western society in general. This chapter will attempt to explain this, in two parts.

First a brief history of science will be given; concurrently but more importantly, this history will be presented as resulting in a gradual narrowing of emotional and experiential range. In effect it is a history of the consequences of the classical scientific outlook.

Second, the infusion of the classical scientific paradigm into Western society will be discussed. This infusion, more often known as the *Enlightenment,* has been attacked by many critics this century, hence the pejorative taint of the word 'scientism'. Some of the more damaging aspects resulting from scientism will be dealt with, particularly those aspects involving the *professions* as opposed to any institutional areas, such as education.

Part one
THE SCIENTIFIC REVOLUTION

Origins.

The beginnings of the classical scientific programme occurred during the sixteenth century: and while the end of the Middle Ages is most often linked to Copernicus' helio-centric theory of the universe (published in 1543) which shattered medieval conceptions of man and his place in the cosmos, the modern world and the science that fashions it began only after a 'Copernican' revolution occurred within science itself.[1]

Aside from certain social and economic imperatives[2], the scientific revolution took place due to an important realisation that, *rationalism* (the belief that pure intellect alone brings one closer to the Truth, as held by Plato) and *empiricism* (Aristotle's concept that knowledge is to be found only by careful observation) were not essentially conflicting epistemologies as had previously been believed. The combination of the two (in scientific method) allowed for a surge of creative activity in science that was not to be equalled again until the beginning of this century.

Rene Descartes (1596-1650) as the philosopher of the revolution, developed *de novo* an entire philosophical edifice, in which knowledge, and thereby Truth, are synonymous with measurement. Greater numerical accuracy allowed for greater certainty, compelling him to proclaim in the Discourse on Method, 'my entire physics is nothing other than geometry.' (op cit. 3, p. 43) His first principle for certitude, *cogito ergo sum,* reinforced a parallel development in Western consciousness, a split between

manual and intellectual work[3] also traceable to Antiquity.

In England, Francis Bacon (1561-1626) changed the agenda of scientific inquiry completely in the Novum Organon. The 'Baconian Spirit' turned science into an aggressive, exploitative device, whose aim was 'to torture nature's secrets from her,' (op cit. 16, p. 24) by putting her into constraint 'to relieve and benefit the condition of man.' (ibid.) He described this interrogative state as *Natura Vexata,* nature vexed. By this Bacon suggests that nature is to be manipulated not contemplated; at this juncture the aims of both Greek and Medieval society part with those of the modern. Since Bacon, science has developed in a profoundly anti-ecological manner.[4]

Bacon's ideas were accepted thanks to the results of two fundamental corollaries of Descartes work. The first was implicit in his mathematical view of the Cosmos, that is, that the universe is essentially a gargantuan machine, rather than the traditional view that it is an organism. The second was, that due to the *Cogito,* the mind (or I) was in fact removed from the external world as it perceived it: 'There is nothing included in the concept of body that belongs to the mind and nothing in that of mind that belongs to the body.' (op cit. 3, p. 45). This is known as *reification.* The combination of a dead universe and a mind dislocated from it, allowed a wholesale abuse of the environment by the swelling capitalist classes (without the ethical perturbation that they were 'killing' anything), that would have been unacceptable to a medieval consciousness:[5]

> It is a civilisation whose core, whether or not this is often articulated, lies in the belief in the promise of what can be done by manipulating nature. (43, p. 820)

Galileo and the quality/quantity dichotomy.

To understand the initial consequences of the Cartesian paradigm's tendency to dualise experience and favour the measurable, we can turn to

Galileo, the first great example of the modern scientist. Galileo's discourse with nature was interrogative and with increasingly refined experiments he came to associate the unearthing of scientific fact with objective investigation. This association has led to a growing confusion between what is scientifically regarded as 'real' (the generalised abstractions of science) and what is actually being experienced by people (subjective, non-scientific understanding of the 'real'). Furthermore we can realise, (as Morris Berman informs) that the notion that,

> ...nature is alive is clearly a stumbling block to this mode of understanding. For when we regard material objects as extensions of our selves, (alive, endowed with purpose) and allow ourselves to be distracted by the sensuous details of nature, we are powerless to control nature, and thus from Galileo's standpoint, can never really know it. The new science enjoins us to step outside of nature, to reify it, to reduce it to measurable Cartesian units; only then can we have definitive knowledge of it. As a result - and Galileo was not interested in ballistics and materials science for nothing - we shall supposedly be able to manipulate it to our advantage. (2, p. 27)

This dualisation has been identified by Berman as the 'fact/value' split, and it is analogous to similar dichotomies identified by other critics of science (these will from now on be generatively termed *quality/quantity)*. Science then, is in part about the reduction or elimination of quality because of its uncertifiability.

Heidegger has suggested that this search for Truth originated in Antiquity and for him it is at once a great achievement and the beginning of great decline, culminating in nihilism[6] (The emotive and psychological reasons for this search for Truth have been dealt with in detail by David Bohm and F. David Peat in Science Order and Creativity and are also explainable in terms of the *horror vacui* that can result from uncertainty).

Value.

It should be noted however that large areas of human experience are incapable of being quantified. In this qualitative region, values are those which have not been reducible to quantities. As such they have been systematically isolated into 'lesser' areas of endeavour (such as ethics, aesthetics and metaphysics). Any field in which value plays a considerable part has therefore proved a stumbling block for Western thought, ensconced as it is in quantification. In explicit terms, R.D. Laing describes the effect of value elimination in science:

> Out go sight, sound, taste, touch and smell and along with them since has gone aesthetics and ethical sensibility, values, quality, form; all feelings, motives, intentions.(...) Experience as such is cast out of the realm of scientific discourse. (op cit. 3, p. 40)

For Robert M. Pirsig the problem lies in the need to objectify everything in order to define it. When the cosmos is split into subjects (observers) and objects (observed), it follows that everything should fit in one category or the other, which is not the case for value, having never been successfully placed in either category (value is not empirically observable). Rather than attempt to restructure or replace the subject/object metaphysics, that has dominated Western consciousness (at least up to Heidegger) to accommodate value, it was eliminated.[7]

This is not however strictly a problem within the realms of science. (for the purposes of science and the applied sciences, value-elimination has proved to be of enormous benefit to mankind) It was only when scientific fact became associated with Truth, that is, absolute certainty, thereby justifying its extension beyond science, did the value-elimination of science affect society detrimentally. Pirsig however has conjectured that value is a separate category, *from which subjects and objects derive*[8] (and this is in line with some of the findings of modern theoretical physics)[9], then outside science, scientific fact has little relevance, as it is apparently incapable of drawing an inclusive 'map'.

This is the essential problem of the science that has transformed Western consciousness. With Issac Newton's synthesis of Baconian and Cartesian frameworks, the scientific revolution is complete. Newton's universe was a gargantuan machine of endlessly colliding bodies, obeying simple immutable laws. It was orderly and consistent with no place for chance or value.

Modern science thus effected a complete revolution in Western society, or in T.S. Kuhn's terms, a 'paradigm shift'. The Enlightenment marks the extension of the scientific paradigm in Western culture.

Part Two
THE ENLIGHTENMENT

Locke and the scientific society.

One of the most influential figures of the Enlightenment is the political philosopher John Locke (1632-1704). Locke held that 'natural laws' of human behaviour existed, which, if by judicious use of government were allowed to act unimpeded, would remove much of the apparent chaos of society. This was by way of explaining the obvious contradiction between the order implicit in the classical paradigm and the chaotic state of seventeenth century Europe. While no direct link on Locke's part is in evidence connecting his 'natural laws' with Newton's, he was most certainly affected by the temper of his age, which was greeting the new science with enthusiasm. Like Newton, Locke's laws were universal, and he emphasised the individual as the essential unit, or atom, of society. People he held, were ultimately concerned with the amassal and retention of property (property being defined as wealth extracted from nature, in line with Bacon's recommendations), which in turn gave pleasure. In doing this, Locke quantified the *raison d'etre* of human existence.

Locke's view of nature was profoundly Baconian. 'Land left wholly to nature...is called as indeed it is, waste.' 'The negation of nature is the way toward happiness.' (op cit. 16, p. 28) Furthermore, as what were regarded as natural laws, a moral duty to follow them was implied. Exploitation was therefore justified as long as the enterprise was profitable, and the poor had only themselves to blame for not adhering correctly to the laws of men.

In economics a direct link to science was more in evidence. Adam Smith based his mechanistic theory, outlined in the Wealth of Nations on Newtonian concepts such as equilibrium and the laws of motion. Smith's division of labour derived easily from Locke's atomistic society. And while both Locke's and Smith's theories have been greatly altered since, the scientism inherent in their work has become the ideological basis for all capitalist and socialist societies (Marx regarded the historical dialectic as a scientific theory).

On the continent, the Laplacian school dominated France at the time Napoleon dominated Europe. During the nineteenth century, others along with Laplace (who maintained that the entire universe was knowable in terms of Newtonian science), championed the classical paradigm as the path to complete knowledge and Truth. Bacon's identification of truth as utility became a powerful reality as science gradually became the highest truth of all.

Other areas of endeavour began to gain credibility by aligning themselves with science. During the nineteenth century, the wholesale infusion of science into society (as scientism) resulted in each discipline refining its epistemology quantitatively to a greater and greater extent. This implied the increasing marginalisation of value in society as its institutions and disciplines converged toward the scientific model. Sorell has indicated that this programme has continued unabated into this century and is currently undergoing a revival under the term of Naturalism.[10]

The question that needs to be asked is that, allowing for Pirsig's thesis of value elimination and that accepting to a point we have achieved a level of consensibility in our bodies of knowledge, whether to quote Ziman, 'we do, in fact, obtain from this research some truly invaluable insights that we would rather trust than many alternative sources of knowledge.' (21, p. 168) In fact Ziman's analysis of the social sciences is quite sceptical on the

use or relevance to human affairs of the proposed scientistic models, as they stand.

This compares with other critics, (notably Popper[11]) some of whom regard extreme scientism as an active danger. This danger comes not only from value elimination, but from the belief that classical science is a device for divining Truth, rather than a consensible model, or map, of reality as held by most twentieth century philosophers of science such as Kuhn and Popper.

More ominously, this insistence on an institution being a veritable body of Truth, can pave the way for the most dubious of theories being accepted, on the grounds that they are scientific. It will be seen in chapter two that as Illich has suggested, this abuse is inherent in all professional institutions and these we may expect includes industrial design.

CHAPTER TWO

OVERVIEW

By the second half of the nineteenth century the Enlightenment had ensured the almost universal adaptation of the classical scientific model as a paradigm for the West. In science itself the belief that complete knowledge would be realised was powerful. Discussing this, Sorell cites the then contemporary zoologist Ernest Haeckel:

> In general, according to Haeckel, 'the number of world riddles has been continually diminishing in the course of the nineteenth century through the...progress of a true knowledge of nature.' The clear implication was that soon there would no problems left for science to solve. (19, p. 77)

Between them, Newtonian mechanics, electrodynamics and statistical mechanics gave the overall picture of the universe. The excitement was over and now the scientist's job was to refine the results to greater levels of numerical accuracy. Admittedly some problems remained (such as radiation), but these were regarded as fine detail in the canvas of scientific knowledge.

Such hopes were dashed with a series of events in a host of areas in and relevant to science. The reduction, from Truth to uncertainty has not only been a blow to science, but has had reverberations throughout society in this century. For this part these events will be used to strengthen the argument against the primacy of classical science, by demonstrating invalidity on its own ground.

As a secondary refutation of scientism, science's involvement with the idea of Truth will be discussed. During the eighteenth and nineteenth centuries, scientific truth became absolute Truth: since then the idea of Truth and therefore certainty have been undermined. This loss of Truth constitutes a main factor in Heidegger's concept of nihilism, and is coming to play an important role in 'postmodern' design, as the lack of certitude in what constitutes 'good' design becomes critical. The chapter is divided into two parts.

First, what Sir Karl Popper calls 'uncritical rationalism' will be discussed. It represents the basis of what classical scientific knowledge claims to be. Many of the problems involved in scientism can be traced to uncritical rationalism. Aside from Popper's, four refutations of uncritical rationalism are given.

Part two briefly discusses some of the social effects resulting from uncritical rationalism. Ivan Illich's concept of professional moralisation is dealt with. The conclusion is that the idea of science as a device for obtaining the Truth is a fictitious one.

Part one
UNCRITICAL RATIONALISM

Popper and uncritical rationalism.

In his essay, *The Defence of Rationalism,* Sir Karl Popper dichotomises rationality. The first, uncritical rationalism rejects anything that cannot be defended by argument or empirical experience. This corresponds to classical science. *In extremis* the traditional view had been that anything that cannot be defended in such a manner can be discarded. But to follow Popper:

> Now it is easy to see that this principle of uncritical rationalism is inconsistent; for since it cannot, in its turn, be supported by argument or experience, it implies that it should itself be discarded. (It is analogous to the paradox of the liar, i.e. to a sentence which asserts its own falsity.) Uncritical rationalism is therefore logically untenable; and since a purely logical argument can show this, uncritical rationalism can be defeated by its own chosen weapon, argument. (15, p. 34)

Since neither logical argument or experience can establish rationalism Popper argues that 'a rationalist attitude must be first adopted if any argument or experience is to be effective.' (15, p. 35)

Popper concludes that this adoption is in fact, 'an irrational *faith in reason.*' (15, p. 35) Ironically uncritical rationalism proves itself logically untenable and irrationalism tenable. It is however important to realise that this argument is adopted to invalidate uncritical rationalism *not* to validate irrationalism.

Critical rationalism recognises that the rationalist attitude relies on a faith in reason. This is closer to the science recognised by modern scientists, particularly that recognised by theoretical physicists: it is suggested by Popper as an alternative to irrationalism. Critical rationalism at least goes as far as recognising value, though it is unclear how such a science would accommodate it.

Four refutations of uncritical reason.

The reason four refutations are given and in detail is twofold. First, the loss of Truth is crucial to understanding nihilism and the inability to replace Modernism. Second, these arguments will be referred to in chapter three where a critique of the current attempts at developing a science of design is given. There are other, more recent refutations of uncritical reason; it is suggested that these four are enough to make the case apparent.

Strictly speaking, (1) the second law of thermodynamics does not invalidate uncritical reason, but does throw the scientistic outlook into question in its view of the concept of Progress (which in turn is of great importance to industrial design). The other three are, (2) Hume's critique of induction; (3) the advent of non-euclidean geometry; (4) Russell's paradox and the history of logical analysis early this century.

(1) The second law of thermodynamics.

This marks the first serious break away from the conceptual underpinnings of classical science. The law, which states - the mechanical energy available in a system is diminishing with time - implies an irreversible trend; mechanical energy moves from hot to cold in a system. For example, hot and cold water are mixed to give lukewarm water, but cannot be separated to give hot and cold water again. Boltzmann later qualified the law by making it statistical:

there is a possibility that they may separate spontaneously, but such a chance is less than negligible.

In human terms this implies a procession from order to disorder, conflicting directly with classical physics which holds that the cosmos is fundamentally one of order. On a broader level the law suggests that the universe will eventually cease activity, when the energy in it is evenly distributed throughout (there would be no cold for hot to go to). It is also the first physical law to contradict the notion of Progress, which is fundamental to the scientific paradigm as a motivator to action.[1]

Progress as formulated by Turgot in 1750, is probably the most important non-scientific concept in Western society.[2] Any implication that Progress is non-existent, or illusory, implies a pointlessness to Western civilisation that not surprisingly would be countered with great effort.[3]

However, the law remains intact. If the second law (also known as the entropy law) were an exception or of little broad effect, it could be perhaps passed over but as Einstein held, 'it is the only physical theory of the universe which I am convinced, that within the framework of its applicability of its basic concepts will never be overthrown.' (op cit. 16, p. 55) A.S. Eddington predicted 'humiliation' for any theory that contradicted the passage of entropy. Entropy also augments nihilism, by reducing the will to Progress to an awareness of the pointlessness (as distinct from meaninglessness) of action. Ironically the laws we have based our society on, seem on one level to have concluded that the aims of our society are pointless.

(2) Hume's critique of induction.

In 1740 David Hume's radical scepticism did irreparable damage to science by invalidating the principle of induction.[4] Induction is the process

whereby from observation we come to make generalisations (or laws, or maps) about the world we inhabit. Induction is critical to science for as Einstein pointed out, a science without generalisations is of little consequence.

For example from experience we see that vertebrae either suckle their young at birth or they are hatched from an egg. We come to the conclusion that all vertebrae conform to this observation (as biologists did in the past). This is inductive reasoning. Hume would argue that there is nothing that can allow us to conclude that *all* vertebrae are in one category or the other. The possibility exists that there is an exception to our category (or law), such as a platypus which confutes the categorisation. As such, any inductive law is deprived of certainty. Hume is not denying the usefulness of inductive reasoning: he denies its status as a method of unearthing empirical certainties, or Truths[5]. This seems sensible enough: however serious difficulties arise when the extent of this critique is realised.

The common-sense idea of cause and effect, for example, is thrown into doubt by this line of thought as the 'cause' itself is not empirically observable. The inference of a causal relationship between things (such as the notion that falling is caused by gravity), and indeed all inferences that come under Hume's scepticism, are reduced to nothing more than articles of faith.

Ultimately, Hume's scepticism arrives at the position where it becomes impossible to demonstrate one action, or belief superior to another:

> There is no intellectual difference between sanity and insanity. The lunatic who believes he is a poached egg is to be condemned solely on the ground that he is in a minority; or rather, since we must not assume a democracy - on the ground that the government does not agree with him. (44, p. 646)

As Russell goes on to say, this is a 'desperate point of view.' (ibid.)

The attempt to place reason on an unimpeachable pedestal, has been confounded by reason itself. Reason cannot eliminate the qualitative and is thereby rendered less powerful. To quote Adorno: 'The qualitative moment is preserved in all quantification, as the substrate of that which is to be quantified.'[6]

(3) Non-euclidean geometry.[7]

One of the significant mathematical discoveries of the nineteenth century was the realisation that there are different and valid geometries aside from Euclid's, whereas before it had been presumed that geometry was what Euclid had formulated (euclidean geometry as Truth). Euclid's axioms are:

1. any two points may be joined by a line segment
2. any segment may be extended to form a line
3. a circle may be drawn with any given centre and distance
4. any two right angles are equal
5. if a line m intersects two lines p, q, such that the sum of the interior angles on the same side of m is less than two right angles, then the lines p and q intersect on the side of m on which the sum of the interior angles is less than two right angles

As can be seen, the fifth axiom is unwieldy and not immediately obvious in the sense that the other four are. Euclid himself seemed to have some reservations about it. Down the ages mathematicians have continually attempted to verify it or reduce it to simpler postulates.

In Russia, Nicolai Lobachevski reasoned that by inverting the axiom

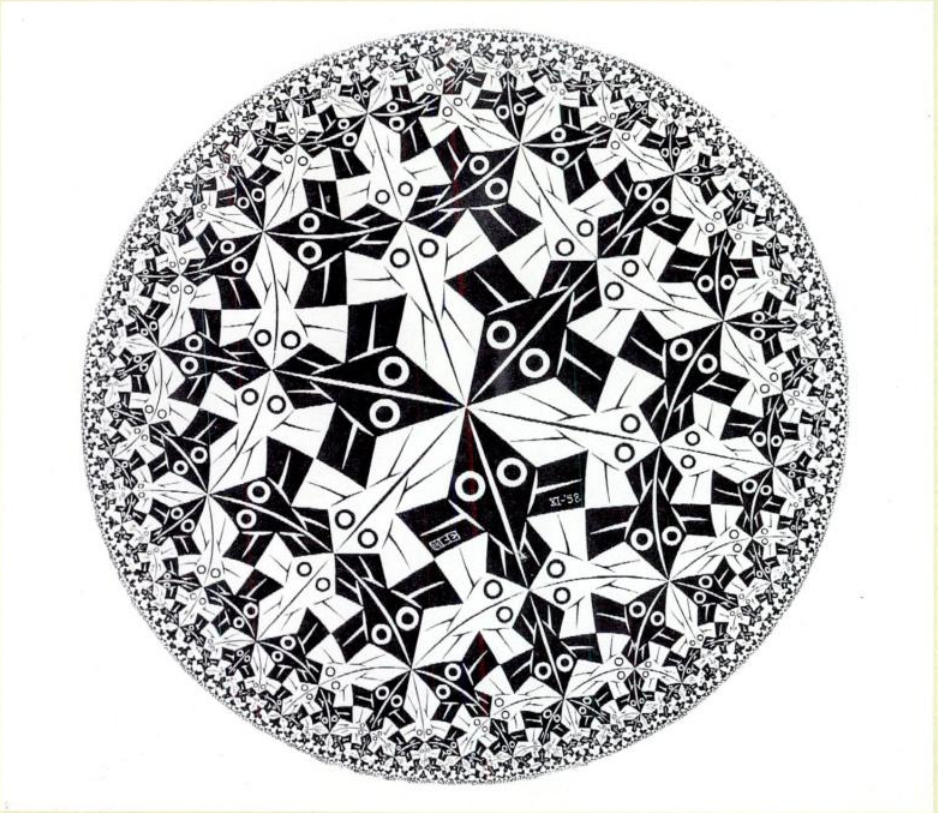


Fig. 2 M.C. Escher's representation of Lobachevskian space, Circle limit 1. The distortion results from trying to represent Lobachevski's geometry on a euclidean plane.

and attempting to construct a geometry around it, two things could occur. (1) The geometry will be logically inconsistent and the axiom will be reducible. (2) The geometry will be logically sound suggesting that the axiom is irreducible. Lobachevski found his geometry consistent and the issue seemed closed.

But now there were two logically consistent geometries, neither of which was demonstrably inferior. In Germany, Riemann inverted the fifth and second axioms to create another, flawless geometry.

Thus began a crisis in mathematics; the notion that mathematicians were contemplating the 'real' world and producing mathematics about it came into question. Truth was no longer sure to be a product of mathematics. Beyond plane geometry, in 1904 Helge van Koch created a curve whose perimeter was infinite but whose enclosed area was finite (fig. 3). The Menger sponge (fig. 4) has an infinite surface area, but zero volume. Both are logically absurd but mathematically sound.

Fig. 3 The Koch Curve.

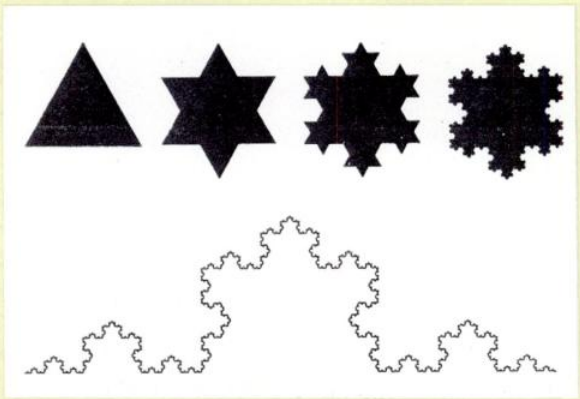
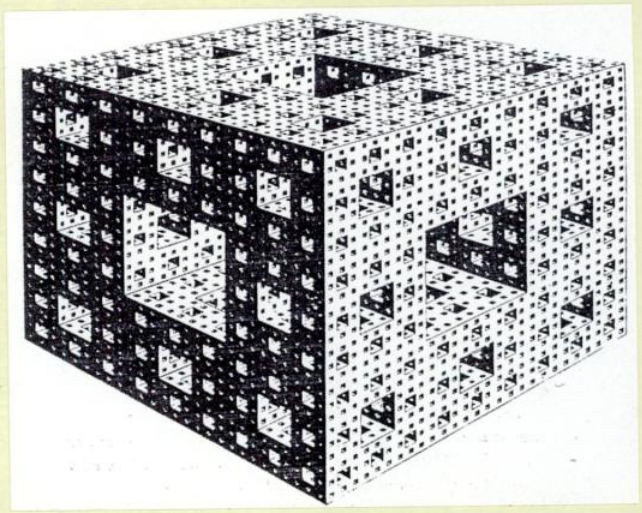


Fig. 4 The Menger Sponge.



On these matters, Poincare, a contemporary mathematician concluded that geometrical axioms were conventions, not Truths as had been supposed. A geometric or mathematical system was a body of consistency. Asking the truth of these systems was like asking whether Metric or Imperial scales of measurement were true. Poincare extended this thinking into other areas involving measurement, showing that there isn't any way of measuring that is superior to the others, only that they may be more *convenient* in certain applications (Poincare, in doing this predicted in part Einstein's special relativity).

(4) Russell's paradox.

In 1902 Bertrand Russell outlined a paradox that indicated a flaw in the structure of logical thinking. Russell's paradox has a limited application, but to quote A.J. Ayer, 'what is at stake is not at all trivial, because what these examples show is that there is, or was, something wrong with our underlying assumptions in mathematics or logic.' (10, p. 307) The paradox can be put in the following way:

-

This sentence is false.

Is this sentence true or false? The sentence cannot be true, as this would mean it is no longer false. Nor can it be false as this would mean it would have to be true and therefore contradictory. Thus it constitutes a paradox.[8]

The problem, and others like it suggest faults *within* logic itself; with this in mind Russell and A.N. Whitehead attempted to purge logic of inconsistency in the mammoth *Principa Mathematica.* At the same time in Germany, David Hilbert was attempting a similar programme. But in 1931 Kurt Godel's Incompleteness Theorem demolished both programmes. The theorem states that no formal system can validate its constituent elements completely. The system must always rely on some factor outside itself for verification. No formal system is self-complete and any system that claims completeness can be shown to be self-contradictory.

Douglas Hofstadter has suggested that while a direct application of the theorem would be of little use to areas outside mathematics, the theorem's essence is applicable to these areas.[9] For industrial design this seems to indicate that a programme attempting to become a complete, scientific body of knowledge (in the sense that uncritical reason would indicate) is certain to fail.

Part two
THE CHURCH OF REASON

The illusory definitiveness of classical science has been seen. There are some things it seems that cannot be quantified and total knowledge is therefore a myth given impetus by the dogma of Progress. Science is not giving *the* truth; it, after Poincare, is giving *a* truth.

This truth since it is not particularly useful or beneficial outside science, should it seems be taken out of its position in society's institutions. Instead of this the notion of Truth has been used as a moral imperative. This moralisation is vital to scientism as a justification. To quote Sorell:

> What is crucial to scientism is not the identification of something as scientific or unscientific but the *thought* that scientific is much more valuable than the non-scientific, or the thought the non-scientific is of negligible value. (19, p 9: italics mine)

We can see that any system that proclaims its alignment with the classical paradigm attempts to exert a *moral* right to dictate to others (that is, non experts) the Truth. Thus anybody outside a particular discipline can hold only a subjective opinion, which by scientific criteria is invalid as knowledgeable. Given the invalidity of the classical epistemology this moral stance seems to be the only option open to uncritical rationalism. In effect scientism as it is found in society today constitutes a religious belief system.

It is correct to say that the classical paradigm has been suspended in science as a model and in scientific epistemology as a valid knowledge

base; however, *ideologically* it remains intact in most of our social structures.

The most effective critic of this moral scientism has been Ivan Illich. In Tools for Conviviality, Illich gives the medical profession as an example: 'People have lost the right of declare themselves sick; society now accepts their claims to sickness only after certification by medical beaurocrats.' (7, p. 6) Illich claims that this removal of power is not unique to medicine: 'The crisis of medicine lies on a much deeper level than its symptoms reveal and is consistent with the present crisis of all industrial institutions.' (7, p. 7) In architecture, this situation has been criticised by Nigel Coates: 'The general view seems to be that all architects are irresponsible, uptight professionals who have manipulated people and the cities they live in.' (20, p. 95)

It seems reasonable to suggest that the environments modern man has created for himself are by definition of the criteria of scientism, not going to hold human needs primary. Rather, as Skolimowski suggests, uncritical rationalism has compelled us to produce 'inhuman environments which are alright technologically and economically, for technology and economics do not have human needs (....)

> The quest for the illusory definitiveness of science has caused us to reduce complex phenomena to the level of the simplified models of science. Scientific reason has suppressed in us the general faculty for reason and judgement. Scientific reason has become the demon who possessed us and made us worship the idols of precision, quantity, measurement, and number, so that we try to measure what is unmeasurable, and we try to quantify what can only be assessed on the scales of our souls.
>
> Physics has conquered us, not because it has found physical explanations of all phenomena (it has not), but because it has imposed on us its structure of rationality as universal. (18, p. 165)

To conclude: the rationality of classical scientism is non-inclusive and suppressive of that which cannot be quantified. Its position as the highest form of human knowledge is a moral stance. Scientism as has been understood by the west is a religion. Professional abuse can be hidden behind a curtain of objectivity.

In the next two chapters, Modernism shall be treated (chapter two) as not just an ideology, but as a religion, and the current moves to develop a science of industrial design (chapter three) as attempts to convert industrial design to the religion of classical science. This is not an argument against religion in general, but an argument against a particular religious system which, it is held, is unsuitable for the structure of design and society.

CHAPTER THREE

OVERVIEW

Charles Jencks, in The Language of Postmodern Architecture has termed the Modern movement, 'son of the enlightenment.' (8, p. 10) Accepting this helps clarify one important problem in dealing with the Modern movement: locating a historical starting point. If Modernism is properly regarded as a branch of the Enlightenment programme, it can be viewed as an historical tendency rather than a cogent movement. To speak of a Modern *movement* then is a misnomer.

There is a further difficulty in defining what one means when using different variations of the word 'modern'. In All That is Solid Melts into Air, Marshall Berman identifies three aspects: *Modernity*, which is effectively about existing in the modern era (in Heidegger's language, this would be equivalent to *being* in the modern); *Modernisation*, which is linked to technological development and capitalist economics, is closely associated with the notion of Progress; finally there is *Modernism*, normally associated with the arts, architecture, design and the humanities.[1]

In this chapter, we shall be concentrating on Modernism, as it is the aspect most closely related to industrial design and architecture. It is recognised however, that Modernisation in the form of industrial capitalism has an enormous part in the development of design and in its relationship to society. This may not be apparent in the discussion, as it is content to deal with the underlying process of rationalisation in the ideology and methodology of design, rather than on design's relationship with industry. This chapter is divided into two parts.

First, a history of the use of quantification as a solution to unify art and industry. This will then be traced through the avant-garde (which is conceived as the entrance of the scientific paradigm into art) up to the development of a formal architectural system (immortalised as the 'International Style' of Hitchcock and Johnson) and the similar epistemological development of the Bauhaus.

Secondly, the formalisation of industrial design will be discussed. The discussion concentrates on the development of industrial design in Europe, as this is where the earliest attempts to scientise the profession were located. Using similar criticisms to those levelled against science as Truth, and the resulting pseudo-sciences, the German Functionalist movement shall be analysed as it is the most advanced design scientism.

It should be pointed out that moral and ethical arguments are not condemned as a whole. The criticism is directed at the contradictory nature of Modernism, which claims objectivity and universality, while having neither.

Part one

ART AND INDUSTRY

During the nineteenth century it was recognised that an ever widening gulf existed between ornament (form) and utility (function). This had come about due to the Modernisation of industrial production, which allowed a greater availability of what were previously exclusive craft items to the burgeoning middle classes. In order to entice, manufacturers plundered the previously exclusive styles of the past and plastered them injudiciously on their wares. Cooley has identified the root of this problem as the separation of design from production. This can be traced back as far as the sixteenth century, where the tendency to separate manual and intellectual work and place manual work below the intellectual began:

> Gradually there evolved the view which put the objective above the subjective, the quantitative above the qualititative. That the two should and can interact was not accepted. (20, p. 198)

This dichotomy/hierarchy *replicates exactly* the conditions that allowed for a value free science during the same period. Thus the schism that allowed science to ignore qualitative issues also resulted in conditions convivial to the inception of design.

For men like Henry Cole, the founder of The Journal of Design such a unification was imperative - this was to be achieved by the formation of a suitable contemporary style. As one article from the Journal, puts it :

> The acme of beauty in design is only to be attained when the system of ornamentation is conducted in strict accordance with the scientific theory of production' (op cit. 6, p. 21)

Against this suggested subjugation stood people such as Ruskin and Morris, who in line with the artists and poets of the time, rejected industrial production outright.[2]

Near the turn of century, the debate centred on the disparity between form and function: the arbitrary dictum, 'form follows function' became a locus for discussion. In architecture, the role of ornament came to be questioned, particularly by Sullivan and Loos. In products a more ornamentally restrained approach was in evidence, notably in the work of the proto-modernist Christopher Dresser (fig. 5).

Fig. 5: Glass claret jug for Hukin and Heath of Bermingham. Designed by Christpher Dresser, 1882.

The unification of art and industry proved intrinsically difficult during the nineteenth century: the first major attempt of the twentieth was the Deutsche Werkbund founded in Germany in 1907. Typically the movement quickly fell into two opposing camps led by Herman Muthesius and Henri Van de Velde. Finally, Muthesius' *Zeitgeist*, based on formal standards, commerciality and a strong sense of nationalism, and van de Velde's artistic purity and scepticism of industrial exploitation came to a head. Muthesius' programme was rejected.

Despite this, the driving force of the age was toward the rational (van de Velde recognised this but his rationality extended beyond commercial concerns). As the proliferation of industry was generally regarded as inevitable the question was always asked of the aesthetic adaption rather that the industrial (the quotation taken from the Journal can be regarded as early evidence of this).

At the time many concepts were being recognised as fundamental to all art, such as the laws of optics (first investigated by the impressionists, notably Seurat), and geometry (explored systematically in the work of Cezanne). This can be regarded as the beginning of the rational objectification of art in the search for universal principles.

This is hardly surprising. As has already been seen, objectification requires quantification: and certainly two quantitative areas (industry and the theories of the avant-garde) were easier to reconcile than a qualititative and a quantitative (art and industry). Heskett describes this tendency as an attempt 'to put art on an objective, even scientific basis.' (6, p. 92)

The Avant-Garde and Early Modernism.

With the avant-garde, the rationalisation of art, architecture and design became extreme. In 1910 the first art manifesto was delivered by the Italian Futurists. Members such as Gino Severini hailed the machine as a liberator, the harbinger of a new age. Severini came into contact with the Paris avant-garde in 1916; as a result he rejected his earlier ideals of speed and dynamism in favour of Synthetic Cubism's precepts of function and efficiency. In 1917 he wrote: 'the process of constructing a machine is analogous with the process of constructing a work of art.' (12, p. 37). Antonio Sant'Elia extended this to the city, saying that, 'it must be similar to a giant machine.' (12, p. 37)

In the Novembergruppe, Moholy-Nagy and Mies van der Rohe, were to give this foetal scientism a strong, politically socialist bias, that would later be used to justify the most astonishing of architectural endeavours. In Russia, Torubukin and Malevich attempted to place art on a scientific foundation in order to unify it with technology. Backed by the assurance that science was Truth, such abstractions became accepted as the

essence of art, rather than a map of it.

By the early 1920s the *elimination* of the qualitative in the search for absolute criteria, such as colour, form and function had become systematic. In 1922, Bruno Taut's 'Red Front' worker housing was ridiculed and condemned as 'Bourgeois', primarily it seems, on the basis of its colour. The systematic elimination of all ornament, in favour of displaying the material and structural aspects of designs and buildings was very much in evidence.

Le Corbusier brought this thinking a stage further, with Purism. In direct homage to Descartes, Darwin and Locke, Purism was founded on the notions that man was a machine, perfected by natural selection, functioning according to natural laws of 'economy'. Thus Le Corbusier arrived at the precept that the house is 'a machine for living in', that would augment man's supposedly mechanical nature.

In short complete quantification was the goal. Through the avant-garde, art was fast becoming a branch of knowledge, to be disseminated throughout the visual environment. All this was in order to obtain social/utopian goals that were given credence by the now almost total belief in Progress.

The Death of Ornament.

Adolf Loos' infamous essay 'Ornament and Crime', sums up the temper of the day. In it ornament was condemned for two reasons: its cost and its vulgarity. On observation it is clear that both reasons are moral stances. Ornament added to the cost of an article thereby depriving the majority of access to it:

> Lack of ornament means shorter working hours and consequently higher wages. Chinese carvers work

> sixteen hours, American workers eight. If I pay as much for a smooth box as a decorated one, the difference in labour time belongs to the worker. (op cit. 20, p. 125)

Initially a socialist outlook, it presumes that ornament is a crime because it deprives: thus it is a moral argument.

As for its vulgarity, Loos was at pains to convey that the more lacking a culture was in ornament, the more civilised it was. Thus ornament is condemned for its barbarity and the idea of Progress is used to substantiate his thesis. In fact Loos does not have one non-moral argument to validate his case against ornament: this is in spite of its 'objective' stance (he presents his case as matter of fact). As Peter Fuller notes,

> ...it is instructive to consider the reasons Loos gave for his objections to ornament. In the first place, he did not like it because, he said, it was erotic. He regards all forms of decoration as sexually regressive or 'polymorphously perverse'. (ibid. p. 24)

Ultimately ornament is condemned for its eroticism. It seems clear, that despite rationalisation of the argument, Loos is forced to contend his thesis religiously, that is, morally not factually. Given the nature of uncritical rationalism, this does not come as a surprise. While it is accepted that 'Ornament and Crime' is renowned for its extremism and that it has been difficult to obtain for much of this century, Reyner Banham suggests that this is the first and most influential condemnation of ornament[3] and as he also points out: 'It is the probably the first appearance of that pugnacious moral tone that was to characterize the writings of the 20s and 30s.' (18, p. 27) Much of the rest of the early modernist writing ultimately is reducible to religion as well. Yet this apparent contradiction seems lost upon the modernists.

In the manner of the early scientists, the modernists were eliminating the qualitative and the subjectively experiential from their dialogue in order to align themselves with classical science. As Galileo had done 300 years ago, the modernists were reducing experience to quantity. R.D. Laing's

quote is worth repeating:

> Out go sight, sound, taste touch and smell and along with them since has gone aesthetics and ethical sensibility, values, quality form, all feelings, motives, intentions. (...) Experience as such is cast out of the realm of scientific discourse. (op cit. 6, p. 40)

If one replaces the word 'scientific' with 'modernist', the quote becomes contextually appropriate.

To exacerbate this, Hitchcock and Johnson in the International Style, made a demarcation between *building* and *architecture*. Following the tradition in such dichotomies the intellectual pursuit, architecture was placed above the manual, building. Architecture implied certainty, and certainty implied quantification. Building, to paraphrase Socrates, was condemned as a form of pandering.

Naturally, many of the people inhabiting and using such reified abstractions were far from happy about the situation. At Pessac (fig. 7) in Bordeaux, workers decorated Le Corbusier's 1926 compound architecture in order to make it livable. Inevitably, given Illich's thesis, the workers, as non-experts could not be taken seriously. Gropius and Le Corbusier described them as 'undereducated' and 'intellectually underdeveloped', respectively.[4] The modernists, as experts, could refute people's basic dissatisfaction as subjective irrelevance, on the basis that what they were doing was an objective affair, virtually a science.

The most famous example of this is the Pruitt-Igoe scheme in St. Louis, Missouri (fig. 6). Pruitt Igoe was designed with the most progressive of Modern

Fig. 6: Minoru Yamasaki, Pruitt-Igoe Housing, 1951. 'Mankind arrives at a solution to the problem of worker housing.' (Tom Wolfe)

Fig. 7: Pessac Housing, Le Corbusier.

ideals (enshrined in the ideology of the congress of International Modern Architects). It won an award from the American Institute of Architects, before it was built. In 1972, several blocks were demolished at the insistence of the residents and the local authorities, after suffering years of crime and vandalism that was much higher than in neighbouring estates. In Defensible Space, Oscar Newman attributed this to poor design and the fact that Modernism is at variance with peoples experience and expectations.

The Bauhaus and Modern Architecture.

Many of the foremost avant-garde minds of the day lectured at the Weimar Bauhaus. After 1923 the programme swung towards objectivity and ultimately it became a hot-house for the rational approach. The classes

were termed 'laboratories', and the role of art united with industry towards the achievement of a social Utopia was stressed.

Rather than uniting art and industry, The Bauhaus quantified the role and method of art into a rational aesthetic based on euclidean geometry (mainly through the influence of Kandinsky and Klee). Instead of analysing the social issues that concerned them, they were swept away with powerful exhortations on the universality of the rational aesthetic, presuming its wholesale adoption would miraculously achieve these goals.

The new aesthetic sensibility was of course to be imposed from above with the justification that since it was rational it was True. In a vicious irony the early modernists (and not only those at the Bauhaus) had developed their theories, grounded in socialism, into a totalitarian aesthetic. At the previously mentioned compound in Pessac, the planners returned to rid the workers of their 'degenerate' ornament. Thus it is we can today speak of Left and Right wing Modernism.

Architects in particular have adopted the mantle of 'high priests of taste' this century. Hitchcock and Johnson for example denied the import of both inhabitant and client. In his introduction to the book edition of The International Style, Barr asked 'whether we are to take seriously the architectural taste of real-estate speculators, renting agents and mortgage brokers!' (op cit. 49, p. 40) Despite the exclamation the comment is meant in all seriousness. Importantly, Barr is referring to 'taste' not knowledge. Naturally we do not expect real estate speculators to have a sound knowledge of building construction or engineering. But we may expect that they might have have something to add in the area of visual appearance. The same applies for the inhabitants and in the case of civil architecture, the public.

Since such people are not within the intellectual realm of architecture, they by definition do not know anything about architecture.

Therefore, in a scholastic twist of logic they can have no right to complain about the architecture they experience, or interact with the architect in any manner that would suggest the questioning of an architect's competence. Outrageous as it seems, since Purism the architecture profession has been allowed to dismiss the public opinion.

Such a view is extreme. But the point should nevertheless be taken that the logic of uncritical rationalism may allow a profession to adopt this position in defence of their work. When one realises that uncritical rationalism does not in fact reveal the Truth, this approach becomes a real danger, since without the Truth, there is no infallibility. And it is the general opinion, as well the opinion of a large number of current critics that this situation has been disasterous during this twentieth century. To say, in the case of architecture, that the majority of Modern people are unhappy with the majority of Modern architecture would be an understatement. It seems, as Henryk Skolimowski points out, that uncritical rationalism has allowed us 'to produce the worst architecture in history with the best possible means.' (18, p. 164)

Richard Rodgers in Architecture: a modern view (40), is willing to accept some blame for this 'fiasco'; but in citing 'form follows profit' as the aesthetic principle of our time, is keen to lay the blame on the shoulders of industrial capitalism, that is, on Modernisation rather than Modernism.

'It is nonsense to suggest that the ideas of the Modern movement can be held *principally* responsible for the despoliation of our cities.' (40, p. 19) Further on, he suggests that 'most modern architecture is therefore the product of stark economic forces rather than the work of a designer; it represents the logical product of a society which sees the environment in terms of profit.' (ibid. p. 21)

This is hardly tenable. While it must be accepted that Modernisation is often detrimental, Modernism is, in architecture and even

more so in industrial design an ethos which by its very nature is capable of almost total fluency with industrial capitalism. Rather than attempting to create a priority of responsibility and hence reduce the blame of a 'misguided' Modern tendency, it seems that the architects would do better to query their fallaciousness in developing Modernist architecture in the image of science. Rodgers describes the Modern movement as initially 'reformist and humanitarian', an innocent adrift a sea of iniquity. It seems more accurate to describe Modernism as reductionist and totalitarian. Furthermore the implication involved, that Modernism could not hope to succeed in the arena of capitalism, belies the fact that Modernism is grounded in the same principles that resulted in industrial capitalism, and thus is tailormade for it. For example the Everson Museum (fig. 8) in New York was not subject to the monetary rigours of developers; yet the visual appearance is extremely crude and impoverished. It can hardly be suggested that Modernisation is the culprit here.

To suggest that Modernism is in some way less responsible than Modernisation for the state of our cities may well be true. But this does not reduce the responsibility of Modernism, nor should Modernism be excused because it had good social intentions and is in some way a victim. Any

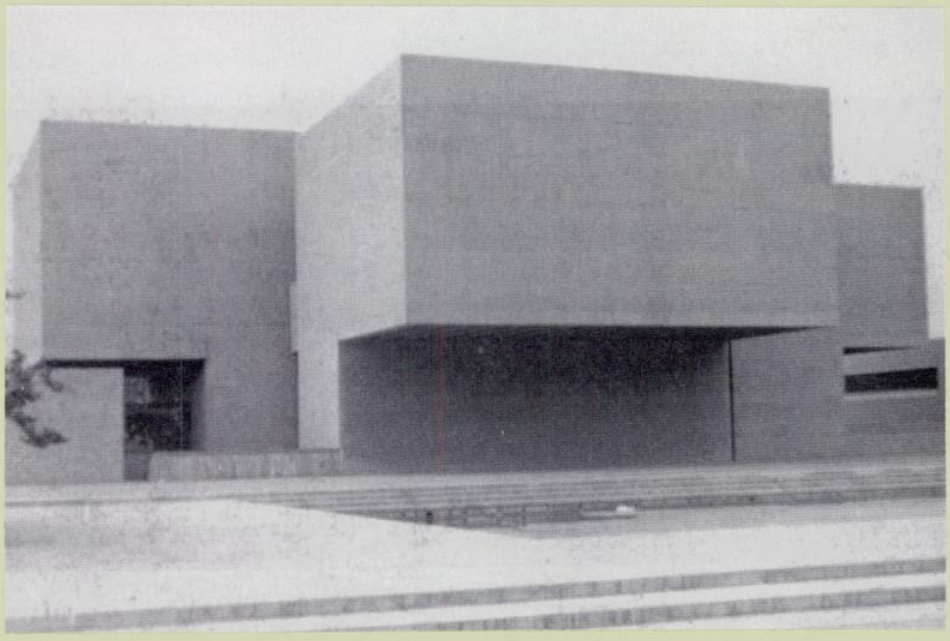


Fig. 8: The Everson Museum, I.M. Pei, Syracuse, 1968.

institution that develops itself scientistically leaves itself open to manipulation from its members and from Modernisation, since being value free it has no way to protect itself from ethical abuse. It is not sufficient for architecture to abrogate its responsibility on the grounds suggested by Rodgers.

Part two

INDUSTRIAL DESIGN

In industrial design, the Bauhaus' contribution is hardly sufficient to warrant the attention it has garnered; its inventory of industrial products is insignificant. In design education however, the Bauhaus' contribution is unsurpassed.

In 1955 the Hochschule fur Gestaltung at Ulm, in Germany was founded. It was a more rigorous extension of the Bauhaus, with a greater focussing on method. When Thomas Maldonado took over its directorship an emphasis was placed on mathematics and sociology. Ulm was certainly enlightened to, and critical of, industrial capitalism's stress on wants rather than needs: its programme however centred itself on the methodology of design.

Functionalism.

The most radically quantitative of the design schools was the primarily German, Functionalist movement, a movement closely associated with Ulm. Herbert Ohl as a leading theoretician of the movement declared in the title of his thesis, that 'all design is measurable', a statement that aroused considerable interest at the time.

If so, design could for once and for all be placed on a scientific footing. The corollary, that anything that isn't measurable isn't design,

seemed to be of little concern. Functionalism is analogous to positivism, a scientific doctrine which suggests that all meaningful questions are answerable with certainty. The corollary of this is that there are meaningless questions which may be eliminated by purging language of its inherent anomalies, was apparently first suggested by Wittgenstein in his Tractatus Logico Philosophicus, but in fact results from a misunderstanding of his book. Wittgenstein actually held that there are questions that cannot be adequately answered by language, so we should endeavour not to ask them and eliminate confusion; an essentially mystical, or qualitative view.

Questions that do not have quantifiable answers are held to be meaningless or metaphysical, as are their answers. Positivism represents an extreme marginalisation of value (as meaningless). Functionalism suggested that we should concentrate on quantitative elements, such as cost and materials, size, weight and so on, but in particular on the function of an object. A parallel approach in architecture was that of Mies van der Rohe.

The elimination of quality or uncertainty was the goal of Functionalism. In this search, the argument of excellence in design was centered on its *logos* (quantity). The *pathos* (quality) was 'eliminated' as meaningless, or in the extreme as non-existent. Thus a product no longer has a colour, it has a visible wavelength: it no longer has form, but a volume, expressed in length breadth and height.

Function is a word that is problematic in design. Broadbent has noted that 'it is surprisingly difficult to find a coherent and consistent definition of "Functionalism."' (18, p. 144) He explains this anomaly by suggesting that rather than being an absolute ideal, function is in fact subject to criteria that vary from era to era. This is a sharp refutation of the Functionalist viewpoint, which conceives function as timeless, objective and permanent. In this respect it resembles the laws of nature sought by science. This view of Function has existed since Socrates, as has its association with efficiency.

It is desirable to explain how this relative functionality might be so, in order to remove the myth of objectivity from the process of industrial design.

Fig. 9 shows a Braun Kitchen Machine, designed by Dieter Rams, a leading Functionalist.[5] Clearly the function of the product is to mix food. But a craftsperson may note how well (efficiently) the mixer mixes, and decides to mix casting plaster in it. Thus the Kitchen machine becomes a plaster-mixer, and the product now has two possible functions. The argument could be circled by asserting that the mixer is still mixing, and therefore still carrying out its function. All that is necessary is to rename the product. But for the company of Braun, a function of the machine is to retail in order to generate an income to continue the company's existence. One may assert that indeed the mixer was designed with sales in mind, but that is not the function of the mixer. But a shareholder in Braun, or an accountant in the company, may disagree. So, the machine has two functions and if one is semantically minded, three. It is suggested that this argument goes on *ad infinitum,* for any product, thus the possible functions are infinite, despite the fact that designer (Rams) had a finite number of functions in mind (one?) while designing it, or else he would have never finished it.

Fig. 9: Braun Model Km321 Kitchen Machine, 1957.

Another approach would be to say that that the Kitchen Machine's true function is mixing food and any other use is a misuse. This however is an ethical not a factual (scientific) argument, and is not verifiable for the reasons given by Popper and Hume (see chapter two). Thus before designing, the designer must perform an act of faith, in deciding for his or herself, what the function of the product shall be. Therefore, any objective method of design is preceded by a subjective (irrational) judgement. If the function is subjective, it can only be measured for the relative case, and not for all cases, as suggested by the Functionalists. Rather, the concept of function in this case seems to correspond with Broadbent's

On the point of aesthetics the Functionalist stance has already been outlined. This stance contradicts the existence of the same product, with a multiplicity of visual appearances. A classical scientism of design would imply a convergence of form toward an ideal of perfect function. In the universe of products this clearly not the case. An apology such as Rodgers' would suggest the interference of modernisation, which cannot be denied. But if it was the case that function was universal, the interference shouldn't be possible. The very fact that Modernism can be interfered with, suggests that it is dealing with something less than the Truth. Also in terms of visual style, truly functional products should not be recognisable as aesthetically existant at all. This not the case with the black box type of product whose visual language is instantly recognisable as of a particular style (all Braun's products are designed on a grid). Furthermore, this suggests that an ideology is being conveyed semiotically (as is certainly the case with the Braun line), which should not be possible in a value-free design methodology.

Design's scientism, compared to architecture is more apparent in method, than in visual appearance (although Ulm originated the widely imitated 'blackbox' appearance). Method has more importance in industrial design than architecture, due to a compression of time allowed for designing a consumer product. In Japan for example, designers may have

as little as two weeks to bring a product to conceptual level.

Method requires certain features such as repeatability and objectivity, but the prime factor is the elimination of uncertainty. If we remember what classical science terms uncertain, there is ample reason to believe that a scientism of design is not going to be able to deal with the complexity of people's wants and needs, the resulting effect for society being a detrimental one. Cooley outlines the characteristics of a scientistic design:

> We can also detect in the written form form the basic elements of that which we regard as scientific - namely a process must display the three predominant characteristics of what subsequently came to be known as Western scientific methodology, that is, prediction, repeatability and mathematical quantifiability. These, by definition, tend to preclude *intuition, subjective judgement* and *tacit knowledge*. Further more we begin to regard design as that which reduces or eliminates uncertainty; and since human judgement, as distinct from calculation, is itself held to constitute an uncertainty, it follows from some kind of Jesuitical logic that good design is about eliminating human judgement and intuition. Furthermore by rendering explicit the 'secrets' of craft, we prepare the way for a rule based system'. (20, pp. 200-1)

Industrial design has not yet reached these extremes, or those of modernist architecture, but this has not been, nor is, for the want of effort.

Of course there is much more going on in industrial design than Functionalism. The *profession* of industrial design was inaugurated in the environment of American liberal capitalism which identified 'new with good and defended planned obsolescence as sound economics.'[6] Since this, the profession has always been associated with surface appearance and 'style', epitomised in the work of Raymond Loewy, a Frenchman who forefronted the drive to make the profession in America one of importance to manufacturers. Thus the profession has traditionally been subservient to industry and involved in the increase of sales. *Contra* Papanek it is nonsense to talk about industrial design today without a consumer

population (although this is not to suggest that a greater autonomy of the profession away from the dictates of Modernisation would be undesirable).

So while the American situation dominates the designers position and motives within the industrial structure, 'it would difficult to maintain that there has been a marked *Americanisation* of Western styles. American style does not dominate design.' (4, p. 44) The same can be said for design methodology. So the point should not be lost in describing (admittedly extremely, but uncritical rationalism tends to veer to the extreme) the Functionalist stance as it represents the foremost expression of the Enlightenment programme to date in industrial design and gives an indication where a fully blown, fully institutionalised scientism of design may lead to.

One concludes that a classical scientism of industrial design would be seriously flawed, for a number of reasons. Epistemologically, it would imply an adherence to the fictitious notion of Truth with all its inherent problems (such as those detailed by Illich and outlined earlier in the architecture profession). The elimination of value would be unsuitable for the profession; given the level of complexity involved in design, classical science could not and should not be asked to deal with it. Because positivism claims there are meaningless questions in language, it does not follow that this reductionism should have any bearing on industrial design, since design is not demonstrably just a language. A classical scientism would allow the design to be interfered with, or be designed in a certain manner, which, if the interference or design could be rationally justified, however detrimental it was to the manufacturer or consumer, would not be prevented In such a situation there would be no room for ethical thought in industrial design other than personal conscience, which would probably not have a forum in which to express itself. The creativity of a designer would be restricted by uncritical rationalism, as would his/her ability to refect upon a problem differently (uncritical rationalism always implies a monistic framework and industrial designers

are prized for their unique and varied approaches to problems). Industrial designs are generally for people, and uncritical rationalism does not generally cater for people. Ultimately uncritical rationalism is a fiction and it does not seem rational to base industrial design on an epistemological fallacy.

Between the Bauhaus and Functionalism, the goal of design shifted from Utopian socialism to efficiency. While the collapse of certainty had not as yet reached industrial design, the Heideggerian trend toward efficiency is in evidence in the Functionalist movement. Heidegger has observed that with the death of Truth Western society has embarked on a program of increased efficiency for its own sake: and it should be pointed out that an extreme, narrow efficiency does not always benefit people. What is meant by narrow is an emphasis on the efficiency of *parts* of the system, which classical science tends towards, rather than the whole, which is often inefficient. This striving towards efficiency is a notable feature of current practice and has always been a dogma of Functionalism. Rams has continually argued for the reduction of the design equation to functional efficiency. This is the nature of Modern 'efficiency' that Heidegger, and more recently eco-philosophers such as Henryk Skolimowski have become critical of.

It can be legitimately asked, if given the fact that uncritical rationalism is 'dead' and that industrial design is not a full science, why this critique is necessary. There are two reasons. First, as uncritical rationalism ceases we are left in its wake, and Western society drifts towards nihilism and irrationality. The reaction to this may be strong enough to force the profession back toward the arms of a dogma that is poorly understood and profoundly comforting when unquestioned. Second, given the position of society at present, industrial design has the choice of being one of the last Enlightenment bodies, or in preferring to search for an alternative to uncritical rationalism, nihilism or irrationalism, one of the first to be involved in a new paradigm.

CHAPTER FOUR

OVERVIEW

Design seems poised to become the darling of industry. The growing inability of manufacturers to control their markets is becoming increasingly evident, as is the reaction against the global homogenisation of products and the media through which they are signified. In his introduction to Design After Modernism, an anthology of theoretical essays on design, John Thackara observes that 'design has started to be regarded by some companies as a magic ingredient that can resolve the contradictions thrown up in this world wide struggle for markets.' (20, p. 20) It is accepted now that to merely *keep* sales at current levels, manufacturers are forced to advertise incessantly. The further effort required to increase sales is Herculean. Furthermore if advertisers are to be believed, we are breeding new generations of consumers who are 'immune' to advertising, fed up with dissatisfying products and perpetual innovation. Advertising no longer sways people as it did in the past. The very fact that market pull now dominates consumerism indicates that marketing's influence or predictive ability is rapidly waning. Sharp now release over 5000 new products on to the Japanese market each year, and they are by no means unusual in this regard. Those which retail are kept on and analysis is carried out as to why each product sells as it does. The fact that Japan's consumer population is is at what is known as the infantile stage (fickle and dictated by novelty) similar to that of the United States in the late 1950s, should not cloud the point that marketing is no longer omnipotent in the universe of products.

What remains is industrial or product design. In the 1980s the word 'design' was appropriated by marketing as a value added concept ('designer'

jeans). Now design has and is becoming extremely important in innovation and product strategy. It is being used to improve product quality, particularly by manufacturers who have opted out of the frenetic area of mass production in favour of smaller, local markets. It is also being used to display product or company ideology, as well as giving 'meaning' to increasingly diminutive and two dimensional electronic goods (these in turn give rise to the concept of the product as a signifier, hence the pseudo-science of product semantics, fig. 10).

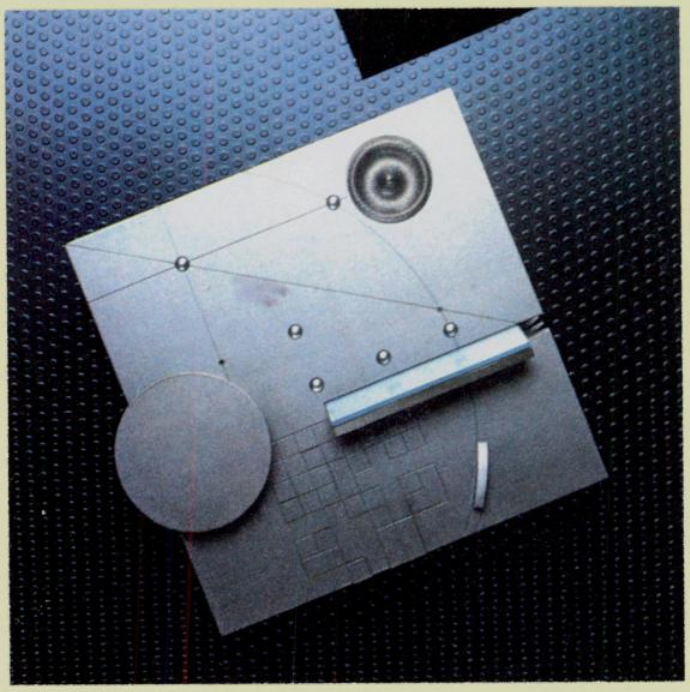


Fig. 10 Semantic answering machine, Smart Design, New York, 1989

There is no doubt about the increasing importance which design is being given by both manufacturer and consumer. Ironically at the very time when industrial design could quite conceivably become a powerful player in industrial capitalism (designers have often grieved over their marginal position in the industrial structure) it finds itself conceptually barren since the collapse of Modernism. That industrial design never successfully managed to develop a conceptual sub-stratum is a moot point: in the past it has managed with an ad-hoc mixture of Modernism and Modernisation, neither of which are valid or suitable today.

The need for an epistemological base for design is clear. What is not so clear is what it should be, or where it is going to be found. In chapter three it was suggested that given the nature of nihilism, a reaction back

towards uncritical rationality or some equivalent system might be a possibility. Now the view that will be advanced is that such an occurrence is perhaps more than a possibility: Peter Dormer has written that a revised Modernism, 'more stylish but with durability and excellent build-quality as part of the design,' (4, p. 171) now seems to be the order of the day (1990).

But Modernism does not have as its essence style and build-quality. Modernism as has been dealt with in this thesis has science and quantification as its essence, and any epistemology that exhorts these is ultimately detrimental for industrial design, for manufacturers and for consumers.

Without being alarmist, it is possible that in the rush to develop a conceptual platform for industrial design, a system that excludes or cannot converse with value may be adopted. It may not be Modernism, or a 'modernised' Modernism, but its effects would be similar. With this in mind, the chapter is broken into two parts.

Part one surveys the current attempts to develop an epistemology for industrial design, virtually all of which are scientistic. Particular attention is paid to developments in the United States and to the sciences of Naturalism.

Part two will attempt to clarify what criteria should and should not be present in a knowledge base for industrial design. Obviously, such a task is beyond the scope of a single thesis, however some general conclusions may drawn from the overall argument.

Part one

THE NEW SCIENTISM AND DESIGN

Debate about design and the theory of design seems to have shifted from Europe to the United States. Since the Ulm school disbanded after being unable to agree on the role of scientific method in design, a complete separation of theory and practice has resulted. Burkhardt suggests that this has its roots in scientification. 'Through the scientising of design, the theory of design has retreated into a very few institutions.' (11, p. 49) Burkhardt's overview of German design theories since Ulm is illuminating. He claims that:

> The strength of German design lay in the unity of Positivistic science and quantifiable production. The fact that positivistic science did not worry about the ethical, anthropological, and social consequences of its research brought on the reproach that it gave up the claim to wholeness and left only a distorted picture of a dismembered world. (11, p. 50)

This and specialisation have killed German design theory. Concluding, he claims that a new German design theory must avoid the rationalism and monocultural nature of positivist design. The reductionism inherent in Functionalism, Burkhardt suggests should also be avoided. But he does not seem optimistic on the possibility of any solutions coming from within Germany itself, and fears a relapse into the positivist mode of design for want of an adequate theoretical replacement.

Typically, Burkhardt's essay appears in an American anthology, Design Discourses. The editor, Victor Margolin is adamant that a theoretical base is necessary for all the design activities, not just industrial

design. Indeed, considerable effort is going into the theory and research of design in the United States. Only last year, the first Doctorates of design in the world became available, in Chicago.

Margolin notes that in 1968, economist and AI expert, Herbert Simon offered the following definition of design:

> Everyone designs who devises courses of action aimed at changing existing situations into preferred ones. The intellectual activity that produces material artifacts is no different fundamenally from the one that prescribes remedies for a sick patient or the one who devises the new sales plan for a company or a social welfare plan for a state. Design, so construed, is the core of all professional training: it is the principal mark that distinguishes the professions from the sciences. (11, p. 3)

Simon was confident that a science of design would ensue. But as Margolin points out, the translation of this hope has not been forthcoming. He cites self-definition as a problem, as well as the 'inadequate recognition that the study of design is a valuable practice.' (11, p. 5) It does not follow that such a discipline would necessarily be a science but in order to be held in the same regard as the social sciences seems to imply that industrial design would have to become one.

It should be noted however that the emphasis is on finding an epistemology: more accurately on *choosing* one. What is important here seems to be that industrial design is elevated, not the question whether it actually constitutes a science or not. Sorell's statement on scientism, that whether something is or is not a science is a secondary consideration (see introduction, p. 8) seems to be correct in this instance. And as Gallie has observed, the principle application of the term scientific is honourific.[1]

The best way for industrial design to elevate itself in the West is for it to become a science. Academically, the sciences and the applied sciences are held in higher esteem than the humanities.

Naturalism.

Returning to Simon's quote, it can be seen that it is not so much a definition as a generalisation. Gathering food becomes design as does sleeping (an attempt to move from a current situation of tiredness to a preferred one of untiredness) as do a host of activities. It is not surprising that there is a difficulty in translating such 'a broad definition of design such as Simon's into pragmatic terms.' (11, p. 5) This is largely due to an insufficient demarcation between design and non-design, on Simon's part.

The phrase 'intellectual activity' is noteworthy coming from an expert in Artificial Intelligence (AI). What exactly constitutes intellectual activity for AI is to say the least problematic, and extremely narrow. The AI conception of mind is that of a machine that operates algorithmically on received data. This concept descends from Descartes' belief that mind is mechanical. AI is about imitating human mental activity as closely as possible, if of course one concedes that the human mind is algorithmic in the first place.

In 1952, W. Grey Walter built a machine which when its batteries ran low, headed for the nearest power socket to recharge them. The analogy to hunger is obvious. AI protagonists go further than this; they suggest that the machine is, in some sense, actually hungry. The crucial question is, does the machine (Grey's tortoise) *feel* hungry? Or, does the tortoise have a mind? A particular school within AI, known as 'strong' AI, answer this affirmatively and extrapolate, saying that any mechanical device (for example a thermostat) has intelligence and some form of mind, infringing on sensibilities as to what life or mind is.[2]

For strong AI the only difference between human and non-human brains (and all their conscious manifestations) is the level of complexity. Most importantly all mental qualities - thinking, feeling, intelligence, understanding, are to be regarded as aspects of an algorithm. The fact that

the human brain is biological is irrelevant to a science that believes people are machines.

The philosophical and ethical issues are extraordinarily complex, but have been dealt with comprehensively by Roger Penrose (1990) who is against the AI conception of mind and by Douglas Hofstadter (1983) who is a proponent. One aspect of this, the expert system is highly relevant to design and requires some mention.

Expert systems are packages in which the essential knowledge of a profession is coded and computerised. The problem (or in the case of design, the brief) is fed in, analysed and a solution is derived. The question whether designers can be replaced by expert systems clearly has a profound social impact. Expert systems are already in use in psychoanalysis and medicine for diagnosis. 'Deep Thought' a chess expert system has a grandmaster rating of (Elo) 2500 and in 1988 defeated a human grand master, the first time such a package had done so (for comparison, Gary Kasparov has a rating of 2700).

The example of AI introduces the issue of Naturalism in science. Naturalism is a scientific approach that incorporates value orientated issues (ethics, metaphysics, aesthetics, design, art) previously inaccessible to science and reduces them to logic and number. This has come about by the explosion in scientific knowledge of the chemical, electrical and mechanical workings of the brain, and through the science of genetics. Naturalists claim that by knowing the physical workings of the mind and body they are preceding philosophy, or design, or any subject that isn't immediately quantifiable because these subjects are the result of the workings of the mind. Naturalists are not strictly confined to AI: other fields include Behaviourism (psychology), Cybernetics, Genetic Engineering, Knowledge Engineering, Information Technology and particular schools of logic and philosophy.

The epistemological stance of these in fields is to say the least, ultra-

positivistic. John Thackara views it thus:

> Because computers are ideally suited to the manipulation of symbols (which some experts suggest is the fundamental activity of the 'information sector') - far more suited that one of today's robots to the manipulation of things - there is tremendous pressure for scientists to reduce all human knowledge and experience to symbolic form. Knowledge engineers, high on technology, and institution-bound, are reluctant to concede that *real* understanding requires the common sense that human beings have by virtue of having bodies, interacting skillfully with the material world, and being trained into a culture. AI experts are confident that most human skills can be codified into rules and heuristics, and immortalised on magnetic disks; they fail to ask whether this is actually desirable. The gap between design and experience is set to widen and with it our alienation and anxiety. (20, p. 30)

To respond to Thackara's querying of desirability, the Naturalist school would probably suggest that this is a meaningless question (ethical). If it is possible it should be done; issues like desirability have no place in scientific Progress.

Cybernetics suggests that creativity might not exist: 'It may be argued that all creative acts and insights merely represent rearrangements of elements in experience.' (op cit. 20, p. 30) This is how cyberneticist James Albus puts it. 'Design, diagnosis, process control and flying are regarded as skills that are ripe for incorporation into expert systems' (20, p. 30) notes Thackara. Naturalism has the backing of a floundering Modernisation and investment is unprecedented. Tom Sorell has argued convincingly against the Naturalisation of philosophy in Scientism, but not for either the social sciences or the potential sciences such as industrial design. It is critical to note that as soon as industrial design becomes scientised, it will be capable of being assimilated in to an expert system. Therefore there are two levels to the quantification of design: its scientising and its incorporation into an expert system. For certain reasons this is not neccesarily a desirable scenario.

First of all there is no overwhelming proof or evidence that the human mind is *nothing* but an algorithm (though it is equally difficult to demonstrate that it is anything more). Second, as has already been pointed out a possible science of industrial design will most likely exclude large areas which are pertinent to design. Third such a science will therefore cope inadequately with the complexity involved in design, as has already been the case with Modernism. Fourth, given the rush to formulate such a science, an inappropriate scientific doctrine may be picked. Fifth, design 'knowledge' thus incorporated into an expert system, implies that the expert system would be flawed conceptually.

One of the reasons Modernism and other flawed ideologies have been able to be rejected is that there have always been people to act critically against it, most importantly within the realm of the ideology itself. Where a critical body can lie in an expert system is far from clear. It is much more likely that there would be no position for self-criticism in an expert system. Furthermore, Goedel's Theorem implies that no systemology can be complete. One wonders how this would affect an expert system.

As Thackara points out, as humans we may use our *selves* to interact with the environment. This is not the case for a computer. Remember that the mind/body split is a concept *not* neccesarily a reality (Philosopher of science Michael Polyani and anthropologist Gregory Bateson have both argued convincingly for the 'intelligence' of the body).

Part two

CRITERIA FOR A SCIENCE OF INDUSTRIAL DESIGN

It is possible that an expert system for design may not arise, though it is certain that a scientism of design based on value elimination and/or uncritical rationality would serve the ends of Naturalism. The possibility of a design scientism is quite apparent and for reasons already outlined may prove to be detrimental.

Rather than conjecture on the possible effects (though this is important) of scientism or Naturalism, it is suggested that the criteria necessary for an epistemology of industrial design, based on the previous chapters could be of some relevance.

As has been pointed out in the overview, defining the profession is problematic as is the demarcation of design. Although in the traditional Western sense we do not 'know' what design is (that is, we cannot precisely define it) it seems clear that to some extent we understand design: or else how could we 'do' design? Therefore it seems reasonable to consider what and what not to include in an epistemology for design, on the basis of our understanding.

From this thesis it should be clear that value will have to be accommodated in some form. What is not clear is how this to be done. Certainly the classical paradigm is not the answer. Nor is Naturalism, unless one concedes certain assumptions on the workings of the human mind and body.

Critical rationalism goes some way toward accommodating value by at least admitting that some regions are not accessible to number and axiomation. This moves away from the positivist/Functionalist posture of refusing to admit value as real, or meaningful. It does not however tell us how to handle issues that have traditionally plagued Western man. Some of these are:

(1) Ethics. Given what potentially may become of the profession, given the sometimes appalling effects of the combination of Modernism and Modernisation, given the sheer complexity of issues that have come to the fore of the profession in the last four years (such as recycling and product saturation), it seems that industrial design is in need of an ethical forum. The issues are too complex and too important to be left to the individual. Neither is legislation to be considered a satisfactory regulator.

(2) Technics. Designers are far too complacent about the effects and supposed benefits of technology and its inclusion into society. Technology will have to reduced to the level of the tool, as there can be little doubt that society is ill-equipped to deal with technology as it dispensed currently.

(3) The role of design. What is design for? What should design be doing today? This not quite the same as the definition of design, but is crucial all the same. The goals of Modernism, the Bauhaus and Ulm are not the goals of society anymore. In the case of 'green' design, do we understand the issues? To be truly green, do we cease to design?

(4) The role of external knowledge. What effect should the other areas of human endeavour have on industrial design? Science as we have seen has traditionally been used as an epistemology: Naturalism, the scientism of the future, must now be considered in its relevance to design epistemology. Science is a lens for viewing nature. Science properly conceived is a tool. It is not an oracle nor should it be a religion. Perhaps the same might apply for other bodies of knowledge. The role of *knowledge* as a tool seems to be an idea that is necessary for society.

(5) Aesthetics. Aesthetics is almost completely value-orientated. Ornament is now seen as an emotional necessity for mankind. Which

ornament is the problem. Should aesthetics be used to sell products or enrich human experience? Can it do both? The issue is as relevent today as it was during the nineteenth century.

(6) The position of industrial design within society and industry. There seems little doubt that the position of industrial design is set to change. Now is the time to ask where to, and how.

(7) Education and Training. How are we to train designers? In what faculty? Or should they move between faculties? Should industrial design be located within any faculty? What are we going to teach them, because it is realised now that the Bauhaus model is insufficient. Graduates do not seem to be equipped to deal with the issues and developments pending on their profession.

(7) Industrial designers. Should humans design? This is the ultimate question that Naturalism forces industrial designers to contend. Would computers be better designers? Is uncertainty a problem in design? What does it mean to create? Does the idea of expert systems controlling the running of society augment nihilism, or even complete it?

There are other issues. It can be argued that some of these questions are not within the scope of industrial design. Designers perhaps should design, not philosophise. Theory is all very well but what about practice? But these issues are forced upon designers today; just as the issue of art and technology was forced on the early modernists. There is no option but to address them.

Design is not neutral. It is a tool that aids us. Design is dictated by questions and problems. Furthermore, unlike Modernism, design can be a tool that controls other tools, like science. Or like Modernism it can be manipulated by other tools, like science. Design can be anything we want. But before we design, what we want has to be considered. Thought precedes action and if industrial design is going to successfully remove the garb of Modernism and everything that has resulted from it, we are going to have to think very hard indeed.

CONCLUSION

Tam ethice quam physice.

Alchemical Maxim

CONCLUSION

It is clear that a scientism that eliminates value in whatever guise and insists on its own Truth is something to be combated. The damage done by the last invasion of scientific thinking, the classical model, is most likely immeasurable. The mental damage inflicted by it, in the mind/body dichotomy, in the fear of 'these infinite spaces' as expressed by Pascal, and in its death, with nihilism, is incomprehensible. Western society is still reeling from it. So is the environment, which we now know to be a living organism, or more accurately which was conveniently forgot to be a living organism.

It is painful to realise, as Niels Bohr said, that 'the guiding story of the Enlightenment, that knowledge can be gradually built up by careful observation of reality (from the superior standpoint of pure reason) is seen to be precisely that: a story.' (op cit 20, p. 31) The result is nihilism in every facet of society.

From chapter one and two we can as Koyre suggests hold science responsible for something:

> it is the splitting of our world in two. I have been saying that modern science broke down the barriers that separated the heavens and the earth, and that it unified the universe. And that is true. But as I have said too, it did this by substituting for our world of quality and sense perception, the world in which we live love and die, another world - the world of quantity, of reified geometry, a world in which, though there is a place for everything, there is no place for man. Thus the world of science - the real world - became estranged and utterly divorced from from the world of life, which science has been unable to explain - not even to explain it away by calling it

> 'subjective'. (...)
>
> Two worlds: this means two truths. Or no truths at all.
>
> This is the riddle of the modern mind which 'solved the riddle of the universe,' but only to replace it another riddle: the riddle of itself. (op cit. 42, pp. 35-6)

From chapter three Modernism and Modernisation can be held responsible for a similar reification and impoverishment of the urban landscape (fig. 11).

There is of course the benefit of hindsight. But if the modernists had kept abreast of the science they so valued, neither industrial design nor architecture would find itself in the predicament they are in today. All four refutations of uncritical rationalism in chapter two were widely propounded before the avant-garde ever existed. It is almost impossible to conceive that such worshippers of science did not know about the radical developments of either relativity or quantum physics. And it is known that Le Corbusier read Nietzsche, whose diatribes against reason are infamous. Knowing this, one is left with increasing doubt as to either the purity of the motives for the adoption of uncritical rationalism in Modernism, or the real scientific understanding held by the early modernists.

In chapter four we see that with Naturalism lies the attempt to explain mans 'riddle of himself'. After classical science man retreated into himself: after Naturalism where will he go?

Perhaps part two of chapter four is unnecessary to this thesis. But the need to find a way out of nihilism but not into the arms of Naturalism or uncritical rationalism, or perhaps worse, irrationalism - It is difficult to think of a more important task for society or industrial design. The need to end the *a priori* distinction between quantitative and qualitative regions is imperative. It is only with questioning do we find a way. Not questioning for answers we already know or can know: these are questions that are answerable by number. But the questioning of that which, though perhaps

fig. 11 The New York urban landscape. Victim of both Modernism and Modernisation. The shadows are those of the world trade centres at noon: they extend for two miles.

we can never be sure of its certainty, we can be sure of *direction* - for this civilisation, like industrial design, has lost its way. Therefore the second part is included.

On the issue of science in industrial design, the core of this thesis, it is concluded that while science has undoubtedly a wealth of information to offer designers, scientism is to be explicitly avoided as it is an unsatisfactory map. This qualification is vital: science after Heidegger is no more than a tool for human use as it sees fit. Tools are neither right nor wrong, but they are wielded. And the problem of worshipping one's tools is a metaphor for the problems of society today.

Also to condemn science outright is to run the risk of promoting anti-science or irrationalism, neither of which are to be greeted favourably given the unimaginable power of today's technics.

The future solution to the problems of and caused by, industrial design are beyond the scope of this thesis. The call to questioning and the reenchantment of value however are not.

NOTES

Full details of the references are given in the bibliography

Introduction.

1. This term will be capitalised throughout the thesis. It loosely signifies the technologically developed countries.

2. In fact Nietzsche was one of the first to coin the term nihilism, as Heidegger acknowledges in the essay 'The word of Nietzsche.' But Heidegger's conception is the one most relelvent to the current malaise of the west.

3. See Thackera (1988), pp 7-31 and pp 114-37 respectively.

Chapter one.

1. A Copernican revolution is a mental one. When people for example realised that the world was round, though the visual facts remained the same, the interpretation and therefore perception of the facts themselves were affected by the *a priori* concept of roundness.

2. See Morris Berman (1988) pp. 37-57 and Rifkin (1985) p. 80-8.

3. Mike Cooley in 'From Brunechelli to Cad/Cam.' From Thackera (1988) pp. 197-8.

4. This aspect of the classical paradigm is dealt with in Carolyn Merchant's The Death of Nature. N.Y.: Harper and Row, 1980.

5. The medieval outlook saw nature as alive and themselves as inexorably connected to her. See Berman (1988) pp. 38-9

6. See 'The Word of Nietszche: "God is Dead"', in The Question Concerning Technology

7. See Pirsig (1991) pp. 30-84

8. Pirsig outlines this in parts three and four of Zen and the Art of Motorcycle Maintenence.

9. See David Bohm's dialogue, 'Mathematics: the scientist's magic crystal' in Weber (1990) pp. 139-57. Also see Capra (1990) pp. 64-7.

10. Naturalism is the belief that philosophy should becoms a branch of the hard and natural sciences (such as molecular biology and cybernetics) because they give the 'real' insight into the physical workings of the mind and are therefore pre-empting philosophy.

11. See The Poverty of Historicism. Cambridge: Cambridge University press, 1979

Chapter two.

1. Modern Progress implies 'that history demonstrates an overall advance toward the perfection of life here on earth.' (16, p. 25) Capitalisation is used to denote the term.

2. This has been articulated by a number of people, such as E.F. Schumacher, Edward de Bono, Jeremy Rifkin (16) and Fritjof Capra (3).

3. For an account of these refutations, see Prigogine (1990) chapter one.

4. Popper has salvaged induction somewhat from from Hume's logic, but only for critical rationalism. He explicitly denies the possibilty of justifying ones beliefs by reason. See 'The Problem of Induction' in Popper (1982) pp. 101-8.

5. The medical sciences now claim that inductive reasoning plays an important part in the process of pattern recognition in the brain.

6. Adorno, Theodor W. Negative Dialectics. Frankfurt: Suhrkampverlag, 1966; english trans., N.Y.: The Continuum Publishing Company, 1973: p. 143

7. The adjective 'euclidean' is not normally capitalised.

8. In fact, this is a rewording of Epimenedes paradox of the Cretan, which is almost as old as philosophy itself. Russell's version- {the set of all sets} - provokes the question: does this set contain itself? Rather than merely being an ancient anomaly, Russell's paradox hinted at flaws within the structure of logic.

9. See Hofstader (1983) p. 696

Chapter three.

1. Berman (1985) pp.1-11

2. Klingender (1975) has linked this to the adoption of Malthusian population principles by industrial capitalists chiefly through the economics of David Ricardo. See p. 100

3. Reyner Banham, 'Adolf Loos: Ornament and Crime', in Sharpe (1978) pp.26-33

4. See Wolfe (1989) p. 26

5. It should be noted that Rams' positivism has abated somewhat since the Ulm school. But he still claims that design is about reducing the chaos of modern existence, hence the clean and orderly appearance of his products. Rams to my knowledge has not so far considered the posibility that large numbers of products create visual chaos no matter how orderly they appear individually.

6. Kathryn B. Hiesinger; op cit. Dormer (1990) p. 35

Chapter Four.

1. See Sorell (1991) p. 178

2. I am not aware whether Herbert Simon is of the strong AI school or otherwise.

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