INTRODUCTION

The logic of design and the question of value

LIONEL MARCH

'We believe it is possible to define design in such a way that the rightness or wrongness of a building is clearly a question of fact, not a question of value.'
Christopher Alexander and Barry Poyner (1967)

'Virtually all decision making activities in engineering and elsewhere are concerned with what I shall call *questions of fact*. A special kind of question of fact is a question of value.'
Peter Fishburn (1966)

Over the last ten years significant contributions have been made concerning the nature of the design activity. In its most general form the design activity is what happens between the receipt of a request to draw up a practical plan which will satisfy certain needs or requirements and the production of instructions on the basis of which the plan can be carried out. Clearly the design activity can be done well or badly in its own bounded terms, but even if it is done well the impact on the environment as a whole of a good executed design may quite possibly be detrimental to the general welfare. Take an example. The designer is briefed to accommodate a large number of office workers and executives on a small central site. The architect prepares a design, and issues instructions to the contractor who puts up a tall building which answers the brief in every way. The client, the architect and the contractor are all well satisfied with the result – in their own interests. However, the tower rises above the trees of a local park so that it is no longer possible to sustain the illusion that being in the park is just like being in the country: 'Who would believe, standing here, that we are in the middle of a city?' Also the traffic generated by the new building noticeably worsens the congestion on the surrounding streets. Some benefits have been created, some costs have been incurred. Who gains? Who loses? The inevitable end of every design achievement is the redistribution of wealth in its widest sense. A design is a statement about values. Designing is inextricably bound up with evaluation.

It would seem to be self-evident that the design activity involves evaluation. But whereas one school of thought on design methods in architecture accepts this in common with the mainstream of engineering practice, there is another school which positively seems to eschew the issue. For English readers the first school is conveniently represented by the writings of Bruce Archer which are associated with developments in design theory and operational research: the second school is inspired by Christopher Alexander.[1] The influence of Alexander's work has been pervasive among students in discussions on design during the last decade. It cannot be ignored even by those, such as ourselves, who are not taken in by his arguments and who sympathise more with the approach of the first school of thought. This is not the place to criticise Alexander's contribution in any representative way. Nevertheless, to draw the necessary distinctions between the argument pursued here and Alexander's, a number of illustrations will be chosen from his writings. Consequently an outcome of this essay is to suggest that issues raised by Alexander can be studied most promisingly from the point of view of developments in micro-economics and in decision and utility theories.

The question of value

Alexander and Poyner (1967) have written in *The Atoms of Environmental Structure*: 'We believe it is possible to define design in such a way that the rightness or wrongness of a building is clearly a question of fact, not a question of value.' They then go on to describe the development of a pattern language for design which consists of relations or *patterns*, defined as typical arrangements in space of physical objects (or parts) which allow behavioural tendencies to coexist without conflict; *tendencies* which are observable human drives towards satisfying needs, and *conflicts* which occur when tendencies come into apparent opposition. Duffy and Torrey (1970) in 'A Progress Report on the Pattern Language' have reaffirmed this attitude towards value:

> Design methods based on 'operational research' incorporates the idea of weighting. Goals are set, criteria formulated, and the relative weights given to each criterion. Criteria are used not only to find the best way to reach a goal but also to evaluate solutions after they have been completed...any approach based on the idea of the compromise of values or tradeoffs is antithetical to the pattern language which attempts in each situation to achieve the best of all possible worlds by resolving all conflicts.

Such is the irrepressible optimism of this school! 'The pattern language... is based on the assumption that arguments about values are unnecessary.'

The approach seems to hanker after the rationalism of Descartes, Leibniz and Spinoza: it appears to be a search for a *modo geometrico*

appropriate to design. Indeed the use of terms such as 'tendency', 'atom', 'relation', 'hierarchy', 'mechanism', echoes the efforts of seventeenth-century physicists to understand the components of human nature and society. Be this as it may, it seems evident that Alexander was at some time influenced by the logical atomism of Wittgenstein, whose *Tractatus Logico-Philosophicus* (1922) reads like a matrix for the audacious programme that Alexander and his colleagues appear to have set themselves.

For Wittgenstein there are simple indivisible objects in the world which combine together to form complexes. These atomic objects hold the possibilities of all their potential configurations, and they are independent in so far as they can occur in all *possible* complexes. Such atoms are what is unalterable and subsistent, their configurations are what is changing and unstable. The determinate way in which objects are connected in a configuration is its structure. Every statement about complexes can be resolved into a statement about their atomic constituents and into propositions, or pictures or models of reality, that describe the complexes completely. The sum total of depictions is a language. Such pictures are facts, and a picture agrees with reality or fails to agree, it is correct or incorrect, true or false. However, all propositions (models, pictures) have equal value. 'In the world everything is as it is, and everything happens as it does happen: *in* it no value exists –.'

Alexander seeks a pattern language, an exhaustive catalogue of environmental atoms or patterns. Patterns are spatial pictures which, in Wittgenstein's terms, 'can depict anything spatial'. Patterns are conceived as being independent of their ultimate configuration or design. Patterns are true or false. They depict a statement of fact in which conflicts among tendencies are or are not prevented. The patterns are themselves realisable or not. All patterns have equal value. In a design, patterns fit together like the links of a chain, all have equal strength. As with Wittgenstein's configurations, there is an implication that designs are independent of one another, that they are different in a profoundly structural way and that they cannot be compared in any meaningful sense.

In *The Atoms of Environmental Structure*, Alexander and Poyner describe a process of design which has two steps, both involving the stating of a testable hypothesis: (1) the identification of a conflict – for example, under certain specific conditions such and such conflicting tendencies occur; and (2) the derivation of a pattern – for example, under these same conditions the pattern is both necessary and sufficient to prevent the conflict. Thus 'to create a building in which no tendencies conflict, the designer must try to predict all the conflicts that could possibly occur in it, define the geometric relations [patterns[2]] that prevent these conflicts, and combine these patterns to form a cohesive whole'.

Alexander and Poyner claim that the scheme they propose is impartial, that it contributes to a rational, constructive and evolutionary approach to design, and that it creates an opportunity for cumulative improvement of design ideas. Alexander and Poyner continue: 'The traditional point of view about design says that the rightness or wrongness of a pattern is a question of value. A designer with this point of view will claim that a pattern can be judged only by subjectively chosen criteria or values.' This is an unsatisfactory state of affairs for a pattern language promoted on the Periclean ideal that although a few may originate patterns, everyone should have the opportunity to test them. That is to say, the hypothesis that the pattern is both necessary and sufficient to prevent conflict between these tendencies should be open to being accepted or rejected as matters of fact by any potential user. If neither hypothesis can be shown to be false then it must be assumed 'that any building where the conflict can occur must [*sic*] contain the pattern specified'. The pattern cannot be ignored because it is disliked. Thus Alexander and Poyner conclude: 'The body of known patterns must, therefore, grow and improve. Design, if understood as the invention and development of patterns, is no longer merely a collection of isolated and disconnected efforts. It becomes a cumulative scientific effort.'

There is a very earnest wish in all this to follow the hypothetico-deductive system of scientific enquiry in which the hypotheses are creative acts of the informed imagination which experiment can support or prove wrong. In an earlier formulation, Alexander proposed to bridge the rift between requirements and form by means of a *constructive diagram*. 'Like a hypothesis, it cannot be obtained by deductive methods, but only by abstraction and invention. Like a hypothesis, it is rejected when a discrepancy turns up and shows that it fails to account for some new force in the context.'[3] In his more recent work, Alexander seems to recognise what Karl Popper calls the dualism of propositions and proposals.[4] Alexander's statements concerning conflict among tendencies are propositions and as such are statements of fact which ought to be testable. But his patterns are proposals for action. Proposals only become facts when carried out. There is then no longer the symmetry which made the constructive diagram so attractive an idea. Indeed since it is logically impossible to derive a sentence stating a proposal from a sentence stating, for example, a sociological or psychological fact,[5] it would seem equally impossible to derive a form diagram from a requirement diagram, or a formal pattern from a functional statement of conflicts. The coexistence of a requirement and form diagram in a single constructive diagram is surely a happy coincidence rather than a general rule. All that can be said is that the pattern *pertains* to the functional statement. The pattern cannot be judged right or wrong by reference to the requirements to which it pertains. In fact, rather the

reverse, the statement of behavioural facts is evaluated by the proposed pattern. A pattern cannot avoid being normative: it represents a proposal to establish a norm or a standard. Inherently, then, Alexander's approach involves evaluation, but he insists that this be zero–one – wrong or not-wrong – with respect to a minimum code based, it would seem, on Popper's adaptation of the Golden Rule: 'Do unto others, as they *want* to be done by.'[6]

It is certain that not everyone will agree with Alexander's presumption of a single dominant value, and it is certain, even if this permissive value were accepted, that a realised pattern would not be judged universally right with respect to it. Any scientific[7] approach to design must confront the issues raised by the pluralism of individual values and the autonomy of social choice; and must accept the conditionality of degrees of conviction about truth, rightness and goodness.

Before turning to an alternative approach it may be helpful to discuss particular examples of Alexander's work, using our criticism constructively to point forward to the ideas which follow this intermission.

Alexander's patterns

In *The Atoms of Environmental Structure*, Alexander contributes an appendix illustrating four patterns for the entrance to a suburban house. Pattern 2 concerns the problem of making it possible for people inside the house to know who is coming to the house. It is stated that the following tendencies conflict:

1. People like to hear visitors coming before the doorbell rings.
2. Visitors tend to take the shortest path off the street, the path to the door is usually within range of street noise, and the noise of arrival is often unnoticed.
3. People tend to 'live' away from the street, or if they do live on the street side they tend to keep the windows closed.
4. People do not want the inside of the house to be visible from the street.

The pattern which eliminates the conflicts has an area outside the main door of at least 200 square feet enclosed by walls on three sides and shielded from the street. Kitchen windows and living room windows open onto this area, and are thus screened from the street. The visitor's parking places are within or immediately adjacent to this area which is itself surfaced in noisy material like gravel or wood.[8]

Take the statements of tendencies first. They are supposed to be testable scientific statements. They are no such thing! Without quantifiers these statements are mere clichés. At the very least we must know whether the

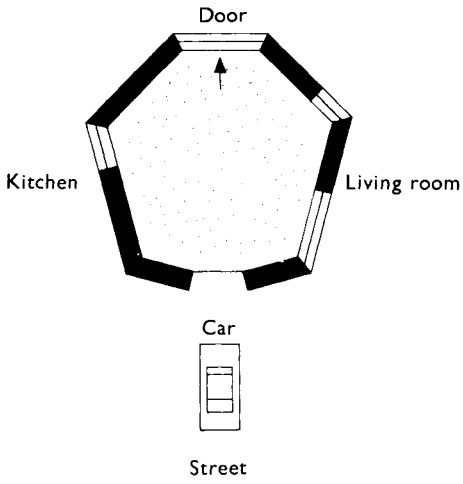

Fig. 1

statements are universal or existential, whether they refer to all the people, or some of the people.

Finding one person who dislikes hearing visitors arrive will falsify the universal statement, and finding *just* one person who likes hearing visitors arrive will verify the existential statement.[9] It would be possible to introduce plural quantifiers, 'nearly all', 'few', or 'many',[10] but according to Popper's argument such statements would remain metaphysical rather than empirical, for only universal statements are falsifiable.

Statements 1 to 4 *are* about values. Each can be re-written '*X* prefers . . .' and is therefore a statement about preferences. It is always possible to give such preferences a partial ordering and the design task can then no longer avoid the problem of evaluation. Alexander might argue that, since the proposed pattern resolves all the conflict situations equally well, questions about preferences are made redundant. This might be acceptable if the statements of requirements *were* universal. Pattern design would then be design by satiation 'in the best of all possible worlds'. However, the universality of the statements must be rejected, and hence the problem of evaluation needs to be faced.

Next take the pattern. A pattern is a proposal, a decision. It may be implemented or not. According to Alexander a design must include all the patterns necessary to eliminate 'all conflicts between tendencies which might possibly occur'. Leaving aside clairvoyance, the inclusion of a pattern in a design is not unlike the inclusion of an economist's 'good' in a 'bundle of goods'. Certainly in 'the best of all possible worlds' it would

be nice to satiate the consumer with a bundle of goods which would satisfy all desires that might possibly arise. But this is the cornucopian economy of Cockaigne – a fairy tale! In reality, accepting the notion of patterns, a design would necessarily be the outcome of choice among patterns. Again the theory of value cannot be circumvented. Indeed, making decisions with respect to matters of value *is* designing, and the argument here is that this issue can be investigated scientifically.[11]

However, aside from scientific niceties, it is clear that Alexander's pattern does *pertain* to the statements about conflicting tendencies in some intuitive sense. In what way can it be said that the pattern evaluates the sociological and psychological facts? That an entrance to a house needs to be as convoluted a design as that proposed does – again in some sense – criticise the social state, the *status quo* of urban society. That there are people who need to be warned when someone is visiting them, that there are people who must hide away every aspect of their home life from public view, indicate by some other standards[12] the social and personal impoverishment of their lives. In another paper, almost contemporary, 'The City as a Mechanism for Sustaining Human Contact', Alexander (1966) actually suggests another set of patterns which would be conducive to ameliorations in the psycho-social state. These patterns do not pertain to matters of fact, but to matters of fiction – another set of proposals which outline a new order of urban society. Whereas in *The Atoms*... Alexander and Poyner adopt the philosophy of piece-meal engineering, in 'The City as a Mechanism...' Alexander is holistic and utopian.[13] In the former there is concern for what people appear to want, and in the latter what they ought to want (for their own good).

Thus in the second paper Alexander argues this way about the problem of arriving at a front door:

> if you go and knock on someone's door, and it turns out to be a bad moment, your visit is already too far advanced for you to withdraw, gracefully. Once you are on the doorstep, the hosts feel obliged to invite you in.
>
> It is therefore essential to see the people you intend to visit inside the house, from your car. You wave to them; you sound the horn; you shout a few words. By then you have had a chance to react. If it is the right moment for a visit, they will invite you in. If it is not, you talk for a few moments, without leaving your car – and you can then drive on, without embarrassment to either side. It is therefore essential that the house is transparent and directly visible from passing cars.
>
> The part of the house which is visible must be indoors – so that it can be used year round: and since it is indoors it must have windows on both the street side, and on the far side, so that people inside can be seen from the street. It must therefore be a transparent room. The room must be designed in such a way that people will go there whenever they are feeling sociable, and likely to welcome a casual visitor. But if the room is merely facing the street, people won't want to sit there: the street is far less pleasant than it used to be. That is why the porch is obsolete. Nowadays people tend to

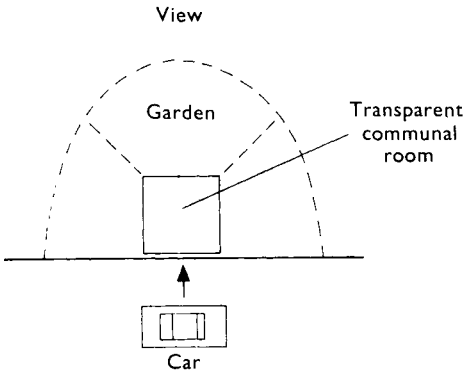

Fig. 2

build their living rooms facing away from the street, towards some kind of view or garden. The transparent room, though visible from the street, must therefore be orientated towards a private court or garden, with a view beyond. Under these circumstances it will be a natural place for people to go for family meals, when they want to read the paper, have a drink or gossip. In warm seasons they may also sit in the court beyond, where they will be visible from the street.

Here we have both the requirement and the form statements taken together.[14] The requirements are no longer actual – they do not describe an observed state of affairs. The requirements have become ideal – they refer to some imaginary state. The pattern is thus speculative rather than normative.

Supposing some houses were built which included this pattern, we must assume their unacceptability to owners whose preferences agree with the earlier statements 1 to 4.

Only a massive campaign of persuasion could hope to change existing psycho-social behaviour to accord with the proposed design innovation. It is our belief that design innovation, to be effective, needs to be dealt with much more seriously than it is here.

By way of introduction to the approach which we recommend, one further example is taken. The housing design proposed by Alexander in 'The City as a Mechanism...' is defined by twelve patterns or specific 'geometric characteristics'. We may abstract these characteristics as pertaining to

1. identification,
2. transparency,
3. privacy,
4. accessibility,

5. community,
6. traffic segregation,
7. landscape variety,
8. neighbourliness,
9. social interaction,
10. spaciousness,
11. territoriality,
12. location.

Now the specification for pattern 8 is that 'each house must be within 100 yards walk of twenty-seven other houses'. This is a thoroughly determined and precise[15] statement. How is it arrived at?

> Let us assume that there are two children per household in the areas where children live (the model figure for suburban households), and that these children are evenly distributed, in age from 0 to 18. Roughly speaking, a given pre-school child who is x years old, will play with children who are $x-1$ or $x+1$ years old. Statistical analysis[16] shows that in order to have a reasonable amount of contact, and in order for each child to have a 95 % chance of reaching five such potential playmates, each child must be in reach of twenty-seven households.
>
> If we assume that pre-school children are not able, or allowed, to go more than about 100 yards in search of playmates, this means that each house must be within 100 yards of twenty-seven other houses.

All this may seem to be rigorously scientific. It is, we think, quite the opposite. It is an example of the use of ostensibly hard data, and the employment of 'false precision' – treating what is known to be vague as if it were precise – to justify an intuitive proposal, which in the end encourages men of sound commonsense to dismiss all quantitative analysis as a waste of time except, occasionally, to provide a presentable gloss of objectivity and impartiality to their own prejudiced opinions.

What is wrong with the argument? There are five independent variables:
X_1: the proportion of children who are the right age to be playmates;
X_2: the percentage chance of a child reaching X_3 playmates;
X_3: the desired number of playmates in a group;
X_4: the acceptable radius within which a playmate may seek his friends;
X_5: the average number of children in a household.
We formulate a model of 'neighbourliness' in the form

$$Z_1 = f_1(X_1, X_2, X_3),$$

where Z_1 is the size of the children's population required to ensure an X_2 chance of a child finding X_3 playmates of the right age in the group. X_1 is a variable which itself is dependent on the definition of the age range of children (0–16 years?, 1–21? or as Alexander has it 0–18 years?), the distribution of the population over this range (Alexander assumes this to be rectangular so that for every child aged one year, say, there is just one

child in each of the other groups),[17] and the age range for playmates (Alexander suggests ±1 year so that a child aged 3 years might be expected to play with children 2–4 years old, but this range is open to modification).[18]

The model may be extended as follows:

$$Z_2 = f_2(Z_1, X_4),$$

where Z_2 is the maximum[19] area per child to ensure that the playmates are within a radius of X_4. And then

$$Z_3 = f_3(Z_2, Y_1),$$

where Z_3 is the maximum area per household, given that there are Y_1 children in each household.

The general form of the model

$$Z = f(X_i, Y_j)$$

equates a dependent variable Z, the output, with a function of the inputs, the independent decision variables X_i whose values are determined by the decision maker, and independent state variables Y_j whose values are assumed to be beyond the decision-maker's direct control.

TABLE 1. *Values of variables in the 'neighbourliness' model. The 'range' is the ratio of the smaller value to the largest*

	a	*b*	*c*	Units	'Range'
X_1	10	16.7	20	percentage	2
X_2	90	95	99	percentage	1.1
X_3	4	5	6	children	1.5
X_4	120	100	80	yards	1.5
Y_1	2.5	2	1.5	children	1.67

In Table 1 we give values for the variables. Column *b* sets out Alexander's figures, while columns *a* and *c* assign values which seem to be at least as plausible. Fig. 3 shows a tree-like diagram of the model with the extreme output values along the top and bottom branches. Alexander's solution lies between these extremes. The diagram is only partial and many branches are not shown. The most obvious point about the output results is their wide range of values, indeed the values of Z_3 vary by a factor of 15 over the extremes, and yet the values of the input variables individually do not vary by more than a factor of 2.[20]

On closer examination it can be seen that, whereas the output Z_1 from the hypergeometric distribution sub-model varies by a factor of just over 5, the next step which includes an 'assumption' about the distance children