THE ATOMS OF ENVIRONMENTAL STRUCTURE

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Christopher Alexander and Barry Poyner

Center for Planning and Development Research
University of California, Berkeley

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INTRODUCTION

The atoms of environmental structure are relations. Relations are geometrical patterns. They are the simplest geometrical patterns in a building which can be functionally right or wrong. A list of the relations required in a building replaces the design program, and the first stages of sketch design.

At present there are two things wrong with design programs. First of all, even if you state clearly what a building has to do, there is still no way of finding out what physical kind of building will actually be able to do it. The geometry of the building is still a matter for the designer's intuition; the program doesn't help with the geometry.

Secondly, even if you state clearly what a building has to do, there is no way of knowing if this is what the building really ought to do. It is possible to make up a very arbitrary program for a building. There is, at present, no way of being sure that programs are themselves not arbitrary.

As far as this second point goes, most designers would maintain that no program ever can be made non-arbitrary. The rightness or wrongness of a program is not a factual matter, but a moral one; it is not a question of fact, but a question of value. These same people argue in the same way about the physical environment itself. They say that an environment is never right or wrong in any adjective sense, but that it can only be judged according to criteria, or goals, or policies, or values, which have themselves been arbitrarily chosen.

We believe this point of view mistaken. We believe that 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. We also believe that if design is defined in this way, a statement of what a building ought to do then yields physical conclusions about the geometry of the building, directly. We

believe, in other words, that it is possible to write a program which is both objectively correct, and which yields the actual physical geometry of buildings.

We shall now describe this kind of program. Our argument will have three parts. First, we shall replace the idea of need with its operational counterpart--which we call a tendency. Second, we shall show that a single need, when operationally defined, makes no demands on the physical environment--and that the environment requires a specific geometry only to resolve conflicts between tendencies. Third, we shall show that once a conflict between tendencies is clearly stated, it is then possible to define the geometrical relation which is required to prevent the conflict, and to insist that this relation must be present in any building where the conflict might occur. Finally, we assert that the environment needs no geometrical organization, over and above that which it gets from combinations of relations so defined.

1. WHAT IS A NEED

Let us begin with the kind of programs which people write today. It is widely recognized that any serious attempt to make an environment work, must begin with a statement of user needs. Christopher Jones calls them performance specifications; Bruce Archer calls them design goals; in engineering they are often called design criteria; at the Building Research Station they are called user requirements; at the Ministry of Public Building and Works they have been called activities; they are often simply called "requirements" or "needs." Whatever word is used, the main idea is always this: Before starting to design a building, the designer must define its purpose in detail. This detailed definition of purpose, goals, requirements, or needs, can then be used as a check list. A proposed design can be evaluated by checking it against the check list.

But how do we decide that something really is a need? The simplest answer, obviously, is "Ask the client." Find out what people need by asking them. But people are notoriously unable to assess their own needs. Suppose then, that we try to assess people's needs by watching them. It is still impossible to be sure what is really needed. We cannot decide what is "really" needed, either by asking questions, or by outside observation, <u>because the concept of need is not well defined</u>.

At present the word need has a wide variety of meanings. When it is said that people need air to breath, it means that they will die within a few minutes if they don't get it. When someone says "I need a drink," it means he thinks he will feel better after he has had one. When it is said that people "need" an art museum, the meaning is almost wholly obscure. The statement that a person needs something--whether he makes it himself or not--has no well-defined meaning. We cannot decide whether such a statement is true or false.

We shall, therefore, replace the idea of need, by the idea of "what people are trying to do." We shall, in effect, accept something as a need if we can show that the people concerned, when given the opportunity, actively try to satisfy the need. This implies that every need, if valid, is an active force. We shall call this active force, which underlies a need, a tendency.

A tendency is, therefore, an operational version of a need. If someone says that a certain need exists, we cannot test the statement, because we don't know what it really claims. If someone says that a certain tendency exists, we can begin to test the statement.

Here is an example: Suppose we say "People working in offices need a view." This is a statement of a need. It can be interpreted in many ways. Does it mean "It would be nice if people in offices had views"? Does it mean "People will do better work if they have a view?" Does it mean "People say they want a view from their offices"? Does it mean "People will pay money to get a view from their offices"? There are so many ways of interpreting it, that the statement is almost useless. We don't know what it really says.

But if we replace it by the statement "People working in offices try to get a view from their offices," this is a statement of fact. It may be false; it may be true; it can be tested. If observation shows that people in an office actively try to get those desks which command a view, it is clearly reasonable to say they need a view. If, on the other hand, people make no effort to get a view, even when they get the chance, we shall naturally begin to doubt the need.

Now, every statement of a tendency is a hypothesis. It is an attempt to condense a large number of observations by means of a general statement. In this sense, a statement of a tendency is like any scientific theory.

Since a statement of a tendency is always a hypothesis--that is, a way of interpreting observations--we must try as hard as possible to rule out alternative

hypothesis. Suppose we have observed that people in offices try to get desks near the window when they get the chance. It is possible to infer from this, that they are trying to get a view. But we might equally well infer the existence of other tendencies. They could be trying to get more light; or better ventilation; or direct sunshine. Or they may be trying to get something far more complicated; they may want to be in a position from which they see the light on the faces of their companions--instead of seeing these companions in silhouette against the window.

In order to be confident that people really seek a view, we must make observations which allow us to rule out such alternative interpretations, one by one. For example, suppose we construct an office in which light levels are uniform throughout, because windows are supplemented by artificial light. Do people still try to work near the window in such an office? If they do, we can rule out the possibility that they are merely trying to get more light.

Ruling out all the alternative interpretations we can think of, is a laborious and expensive task. Furthermore, in order to make the hypothesis more accurate, we must try to specify just exactly what kind of people seek a view from their offices, during what parts of their work they seek it most, just what aspects of "view" they are really looking for,.... Again, this is a laborious and expensive task. It is like the task of forming any scientific hypothesis. A good hypothesis can't be invented overnight; it can be created only by refinement over many years, and by many independent, different observers.

It is, therefore, vitally important that we do not exaggerate the pseudo-scientific aspects of the concept of tendency. Since a tendency is a hypothesis, no tendency can be stated in an absolute or final form. The ideal of perfect objectivity is an illusion--and there is, therefore, no justification for accepting only tendencies whose existence has been "objectively demonstrated." Other

tendencies, though they may be speculative, are often more significant from a human point of view. It would be extremely dangerous to ignore such tendencies, just because we have no data to "support" them. Provided that they are stated clearly, so that they can be shown wrong by someone willing to undertake the necessary experiments, it is as important to include these tendencies in a program, as it is to include those tendencies which we are sure about.

II. CONFLICTS

We now face the central problem of design. Given a statement of what people need, how can we find a physical environment which meets those needs?

In order to answer this question we must first define clearly just what we mean by a meeting needs. This is not as easy as it seems. So long as we are using the word need, the idea seems fairly obvious. However, once we replace the idea of need by the idea of tendency and try to translate the idea of meeting needs into the new language, we shall see that its meaning isn't really clear at all.

The idea of needs is passive. But the idea of tendencies is highly active. It emphasises the fact that, given the opportunity, people will try to satisfy needs for themselves. When we try to interpret the idea of meeting needs in the light of this new emphasis, we see that it is highly ambiguous. How much of the work of meeting needs are people expected to do for themselves, and how much of the work is the environment expected to do for them?

Take, for example, a simple situation: a man sitting in a chair. He has various needs. He needs to shift his position every now and then, so as to maintain the circulation in his buttocks and thighs. If he is trying to read, he needs enough light to read by. If he sits in the chair for long enough, he will need food or refreshment. He needs ventilation. Under normal circumstances, he is perfectly able to meet these needs for himself. But if we define a good environment as one which meets needs, we should logically be forced to design an environment which meets these needs for him. This conjures up an image of a man lying in an armchair, food being fed to him mechanically, windows opening automatically when the room gets stuffy, light being switched on automatically as evening comes, pads in the chair massaging his buttocks to keep the pressure from building up too much in any one place....

The idea is absurd. It is absurd because the man is perfectly capable of meeting these needs for himself. Indeed, he is not only capable of meeting them--but it is almost certainly necessary for his well being that he be left the job of meeting them. Man is an adapting organism. The daily, hourly, process of adapting is the process of life itself; an organism which is no longer adapting is no longer alive.

It is, therefore, clear that a good environment is not so much one which meets needs, as one which allows men to meet needs for themselves. If we define a need as a tendency, as something which people are trying to do, then we must assume that they will do it whenever they get the chance. The only job which the environment has is to make sure they get this chance.

Now, it may seem, at first sight, as though this argument leads to a dead end. Go back to the example of the chair. Under normal conditions each one of the tendencies which arises in this situation can take care of itself. There is no problem in the situation. The environment does not require redesign. If needs are defined as tendencies, and if tendencies are capable of taking care of themselves, then why does the environment <u>ever</u> require design by designers? Why can't tendencies always be left to take care of themselves? Why can't people simply be left to adapt to the environment and to shape their own environment as they wish, with the help of carpenters, contractors electricians and so on. If tendencies are active forces, then people will presumably take action whenever the environment isn't satisfactory; they will always meet their own needs for themselves. Why does the environment need design? Why should designers ever take a hand at all.

The answer is this. Under certain circumstances, tendencies conflict. In these situations, the tendencies cannot take care of themselves, because one is pulling in one direction, the other is pulling in the opposite direction. Under these

kinds of circumstances, the environment does need design: it must be rearranged in such a way that the tendencies no longer conflict.

Let us go back to the example of the chair. There are certain chairs, made of canvas slung between wire supports, in which you cannot move about at will, because your body always sinks to the lowest position, and is held there by the canvas. After sitting in one of these chairs for a few minutes you begin to feel uncomfortable; the pressure on certain parts of your body builds up, but you cannot move slightly to reduce this pressure. You try to shift position, but you can't. At first sight it might seem that this is a case where a single tendency simply has no outlet and that a well designed chair must provide this outlet. But this is not so. Indeed, the tendency to try and reduce the pressure on your body has a very simple outlet. You can simply get up and walk about. The trouble is, of course, that in many cases there will be another tendency operating, which makes you want to stay sitting where you are (because you are talking to somebody, or because you are in the middle of reading something). It is the conflict between the fact that you want to stay sitting where you are and the fact that you want to shift position, which makes a problem. In a properly designed chair, this conflict does not occur.

We may, therefore, replace the simple-minded definition of a good environment as one which meets needs, by the following definition:

A good environment is one in which no two tendencies conflict.

Of course, the conflicts which occur in buildings and cities are much more complicated than the one which we have just described. There can be conflicts between tendencies within a single person, or between tendencies in different people, or between a tendency in one person and a tendency in a group, or between a tendency in a person and some larger tendency which is part of a mass phenomenon. But the principle is always the same. Provided that all the tendencies which

occur can operate freely, and are not brought into conflict with other tendencies, the environment in which they are occurring is a good one. It follows then, that the environment only requires design in order to prevent conflicts occurring, and if we wish to specify the pattern which an environment ought to have, we must begin by identifying all the conflicts between tendencies which might possibly occur in that environment.

In summary: Until we have managed to see design problems in terms of conflicts between tendencies, there is nothing for the designer to do. So long as we see nothing but isolated tendencies we must assume that they will take care of themselves. We have only succeeded in stating a design problem in a constructive way, at that moment when we have stated it as a conflict between tendencies. Since the tendencies in conflict may often be hidden, this is a difficult process which requires deliberate and inventive search for conflicts.

III. RELATIONS

We design the environment, then to prevent conflicts. We must now start talking about the features of buildings which can help us do this. The features which cause and prevent individual conflicts are not concrete pieces like bricks, or doors, or roofs, or streets; they are instead geometrical relationships between such concrete pieces. We call these relationships, relations. Here are five examples of well-known, typical, relations from a supermarket:

1. Check-out counters are near the exit booths.
2. The stack of baskets and trolleys is inside the entrance, and directly in front of it.
3. Meat and dairy refrigerators are at the back of the store, and all other goods on display are between these refrigerators and the check-out counters.
4. Display shelving has a tapering cross section, narrow at the top, and wider at the ground level.
5. The store is glass fronted, with aisles running back to front at right angles to the street.

A relation in a building is only necessary, and therefore, only likely to become widely copied, and "typical" if it prevents some specific conflict. Even the commonest relations in our environment are made necessary by the fact that they prevent specific conflicts. Here, for instance, are the conflicts behind the five supermarket relations:

1. Check-outs near exit doors. This relation prevents a conflict between the following tendencies:
   a. Management has to keep all goods on the sales side of the check-outs.
   b. Management is trying to use every square foot of selling space.

2. A pile of baskets or trolleys inside the entrance and directly in front of it. This relation prevents a conflict between the following tendencies:

   a. Management tries to encourage shoppers to use baskets, so that they are not reluctant to pick up extra goods.

   b. Shoppers tend to make as fast as possible for the goods, and are, therefore, likely to miss the baskets.

3. Meat and dairy products at the back of the store so that all other goods are between these counters and check-outs. This relation prevents a conflict between the following tendencies:

   a. Management tries to get every shopper to walk past as many goods as possible.

   b. Shoppers visit meat and dairy sections almost every time they go to the supermarket.

4. Display shelving with tapering cross section, so that all goods are clearly visible to shoppers. This relation prevents a conflict between the following tendencies:

   a. People tend to walk around the supermarket without bending down constantly to look for goods.

   b. People want to be able to find the goods they are looking for without having to ask where they are.

5. Glass fronted supermarket with aisles running back from the street and at right angles to it. This relation prevents a conflict between the following tendencies:

   a. The management is trying to get passers-by to have a view of the entire inside of the supermarket so as to draw them in.

b. If the supermarket is on a street, most of the passers-by are walking past the front.

A relation, then, is a geometrical arrangement which prevents a conflict. No relation can be regarded as necessary to a building, unless it prevents a conflict which could otherwise occur in that building. A well designed building is one which contains enough relations to prevent all the conflicts which might possibly occur in it.

So far we have discussed only known relations--those which exist already. How do we invent a new relation? Obviously we have to start by stating a conflict But how do we invent a relation which prevents the conflict?

The key fact is this: Tendencies are never inherently in conflict. They are brought into conflict by the conditions under which they occur. In order to resolve the conflict, we must invent an arrangement where these conditions don't obtain. Here is an example: Where a public path turns round the corner of a building, people often collide. The following tendencies conflict:

a. People are trying to see other people some distance ahead, so they can avoid bumping into them without slowing down.

b. Going round a corner, people try to take the shortest path.

At a blind corner the first tendency makes people walk away from the corner, the second tendency makes them hug the corner. The tendencies conflict.

In order to define a relation which prevents this conflict, we must use a fundamental rule: It is not possible to invent a geometrical arrangement which prevents a conflict, <u>at all</u>, unless we can first identify the aspects of arrangement which <u>cause</u> the conflict.

In our example there are several aspects of blind corners which we can blame for the conflict: The fact that the corner is solid, the fact that the corner

is square, the fact that the ground is unobstructed all around the corner. To eliminate the conflict we must get rid of one or more of these features. If we make the corner transparent, not solid, people will be able to see through it, and can, therefore, see far enough ahead. If we round the corner with a gradual curve, people will be able to see round the corner. If we place a low obstruction at the corner, like a flower tub people will have to walk around it and will see each other over the top.

It is plain from the example that there are certain arrangements which cause the conflict and certain "opposite" arrangements which prevent the conflict. These two classes of arrangements are mutually exclusive. Our task, given any conflict, is to define the class of arrangements which prevent that conflict. This is always difficult. In theory, the class is infinite; even in practice it is very large. We must, therefore, define the class abstractly. We must define an abstract geometric property, shared by all arrangements in the class, and by no others. This is what we mean by a relation. A relation is a precise geometric definition of the class of arrangements that prevent a given conflict, so worded that it includes all the arrangements that do prevent the conflict, and <u>excludes</u> all those which don't.

Let us continue our example. We have described certain arrangements which cause a conflict at corners, and others which prevent the conflict. Those which prevent it, include a corner made of transparent material, a rounded corner, and a tub of flowers so placed that people have to walk out from the building. What is the common property which all these good arrangements have, and which the bad arrangements lack? Roughly speaking, the property is this:

> If we define a path round the corner at a distance of one foot out from all walls and objects which stick up above ground level and examine all chords on this path which are less than fifteen feet long, we shall

find that none of these chords are, at eye level, obstructed by anything opaque.

This is the relation which prevents the conflict. In a building which contains this relation at all its corners, the conflict will not occur.

The conflict in this example happens to be a simple one. However, even when the conflicting tendencies are large in scale, or subtler, the logic is the same. We state the conflict, give examples of arrangements which cause it and prevent it, and then try to abstract the relation which defines the latter class.

Two minor points remain. First, since a relation is required only in conditions where the conflict specified might possibly occur, the conditions under which the conflicting tendencies occur must be presented as part of the relation. Thus, the final form of a relation will always be: "If such and such conditions hold, then the following relation is required."

Second, the actual process of inventing a relation will not follow the process of defining tendencies and conflicts in strict sequence, as it has been presented here. In practice, the statement of tendencies, the statement of conflict, and the statement of the relation, all develop together.

Let us summarize what we have done. We have described a process which has two steps:

1. Identifying a conflict.
2. Deriving a relation from it.

This process for obtaining a relation is objective in the sense that each of its steps is based on a hypothesis which can be tested. The two hypotheses are:

1. Under certain specified conditions, such and such potentially conflicting tendencies occur.

2. Under these conditions, the relation R is both necessary and sufficient to prevent the conflict.

If we cannot show that either of these hypotheses is false, we must then assume that any building where the conflict can occur must contain the relation specified.

In order to create a building in which no tendencies conflict, the designer must try to predict all the conflicts which could possibly occur in it, define the geometrical relations which will prevent these conflicts, and combine these relations to form a cohesive whole.

IV. THE SCIENTIFIC ATTITUDE TO RELATIONS

The point of view we have presented is impartial. This is its beauty. Because it is impartial, it makes possible a sane, constructive, and evolutionary attitude to design. It creates the opportunity for cumulative improvement of design ideas. The whole thing hinges on a simple question: What does a designer do when faced with a relation which someone else has written?

The traditional point of view about design says that the rightness or wrongness of a relation is a question of value. A designer with this point of view will claim that a ~~relation~~ pattern can only be judged by subjectively chosen criteria or values. Since people value things differently we can never be certain that one designer will accept another designer's opinion, and there is, therefore, no basis for universal agreement. With this point of view the cumulative development of design ideas is impossible.

Our point of view is different. We believe that all values can be replaced by one basic value: Everything desirable in life can be described in terms of the freedom of people's underlying tendencies. Anything undesirable in life--whether social, economic, or psychological, can always be described as an unresolved conflict between underlying tendencies. Life can fulfill itself only when people's tendencies are running free. The environment should give free rein to all tendencies; conflicts between people's tendencies must be eliminated.

In terms of this view, the rightness or wrongness of a ~~relation~~ system of patterns is a question of fact. Either the ~~relation~~ patterns does prevent a conflict between tendencies which do occur, or it does not.

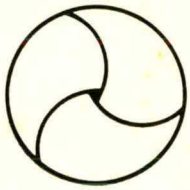
As we have said, each relation is based on two hypotheses:

1. That the conflicting tendencies do occur as stated, under the conditions specified.

2. That the relation proposed is both necessary and sufficient to prevent the conflict between these tendencies.

Faced with a relation stated in this form, the designer has two choices: either he must accept it, or he must show that there is a flaw in one of the hypotheses. Whatever he does, he cannot merely reject the relation because he doesn't like it.

The body of known relations must, therefore, grow, and improve over time. Design, if understood as the invention of new relations, is no longer merely a collection of isolated, disconnected efforts. It becomes a cumulative effort-like science.



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