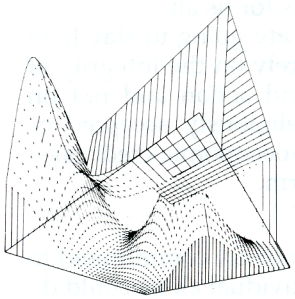


The Science of Design: Christopher Alexander's Search for a Generative Structure

Stephen Grabow

A fundamental premise of science is that nature abides by objective laws. Accordingly, the principal reason for scientific research is to discover and manipulate those laws appropriately. This perspective is so common that it hardly seems worth singling out. And yet we rarely find it applied to any field outside the natural sciences. The following paper introduces the remarkable work of an architect who applies the scientist's perspective to architectural and environmental design. He believes that, just as in nature all things can ultimately be reduced to processes, so in environments all things can be reduced to *patterns*; and that just as in nature these processes are subject to objectifiable laws, so these patterns are subject to generative "rules." According to Christopher Alexander, the extent to which we design using these rules is the extent to which we design beautiful, hospitable environments. The extent to which we ignore these rules is the extent to which we make alienating and inhumane buildings. The article narrates his search for these underlying rules.

Architects and scientists are alike in that their vision of the world depends as much upon what they are looking *at* as upon what their previous experiences have taught them to look *for*. During revolutions, however, scientists actually see new and different things when looking in familiar places. The question is whether architects do the same.

Christopher Alexander is a scientist (trained in physics and mathematics) and an architect, and he approaches the question—What is design?—with a kind of scientific rationalism not normally associated with architecture. Modern architecture had been called "rational," for example, but it was the kind of rationality that Karl Mannheim called "functional": shaped exclusively by external realities and void of any final purpose (1937). On the other hand, Alexander's rationality is obviously substantive, the kind of pure rationality that distinguishes extraordinary from normal science and which seems to flow naturally from his training as a mathematician.

Although architecture is, by definition, both the art *and* science of building, the "science" side of the equation is usually interpreted to mean *applied* science—the realm of structure, materials, construction, and the technological hardware of building operations. Occasionally a structural engineer or a technologist will conceive of the problem of design in terms of their particular disciplines; but this is quite different from the perspective of pure science or mathematics. [1] Nevertheless, the "art" side of the equation is usually reserved for the question of design—the realm of the synthesis and generation of architectural form. In terms of tradition then, the architect is fundamentally an artist, but one who understands science and can apply it to the problem of building. Although he may have great respect for science, even be fascinated or inspired by it, he is not a scientist. Even the few scientists who were also architects, like Leonardo da Vinci and Christopher Wren, treated the question of design as a purely artistic problem. Architectural history records few, if any instances of architects treating the question of design as a scientific problem.

The current role of theory in architecture illuminates this distinction. In the making of buildings and towns, the crucial test of the reality of a theory is the extent to which practical work depends on its existence. But in the case of modern architecture, most of what passes for "theory" is really just a manipulation of design concepts and ideas already derived from the experience of building. In other words, it exists in a peculiar relation to the final product. Such theory does not help create designs; it only explains them—a fact which always comes as a shock to most students of architecture. For this reason the act of design has remained a creative mystery, somehow transferable but not rationally communicable. As a science however, such theory is primitive. It cannot really be used by anyone else; each designer must re-invent the act himself; and as a result, there is practically no internal, cumulative body of architectural knowledge. In that sense, modern architectural design is very similar to pre-Newtonian optics where, says Thomas Kuhn, "being able to take no common body of belief for granted, each writer on physical optics felt forced to build his field anew from its foundations" (Kuhn, 1970, p. 13).

On the other hand, treating the question of design as a scientific problem presupposes a totally different kind of theory. Such theory would first of all have to precede the act of design. Secondly, it would have to lead directly to the act of building in much the same way that the purely intuitive process, regardless of its shortcomings, does generate an end product. In other words, it would have to *generate* designs rather than just explain them. And thirdly, it would have to be general enough to permit its applicability to an endless variety of individual circumstances. In other words, it would have to be compatible and congruent with the freedom and creativity necessary to produce a work of art.

Such presuppositions are enormous. The possibility of such a theory in architecture is both exciting and disturbing. No one really knows what buildings and towns generated by theory would be like. Most informed architects know that the popular image of the architecture of the future—the space-age fantasies of Hollywood, comic strips, and science

"I'm claiming that environments are generated by systems of rules. They do not have systems of rules which 'constrain' their creators. They are actually generated by them."

fiction—is fundamentally incorrect, a misuse of science. A truly scientific (as opposed to technological) theory of architecture would be much more concerned with unlocking the creative processes that produce buildings than with the application of scientific technologies to buildings already produced. Yet the idea of discovering a set of steps or even "rules" which actually creates something is profoundly disturbing. Even the obvious benefits of the accumulation and expansion of knowledge that such discovery would permit are overshadowed by the belief that somehow such processes can never be known, only constrained or modified. But this is not only true for architects; it exists in other, more scientific fields as well.

For example, prior to the discovery of the structure of DNA molecules in biology, the "laws" of nature were considered to be unknown except insofar as they were constrained or modified by natural selection. Natural selection could not account for genetic processes, but it could explain their characteristic behaviors. Similarly, prior to the discovery of generative grammars in linguistics, the origin of language was considered to be unknown except insofar as it was constrained or modified by the rules of grammar. You could not invent a sentence by following such rules, yet the rules seemed to explain their characteristic behaviors. The same distinctions could be made in architecture. Prior to the discovery of a generative theory of building, the act of design would appear as an unknown creative process except insofar as it was constrained or modified by architectural "rules" like "commodity, firmness, and delight." Of course one cannot design a building by simply following such rules, although they do help to explain the final product. But the building itself is presumed to come from somewhere else—a presumption which ironically reinforces its dependence on external realities.

The idea that a set of known rules could actually generate a building is as disturbing as the idea that a human being is generated by a few genetic rules operating on chromosomes or that a poem is generated by a few grammatical rules operating on language. And yet that is precisely what Alexander is claiming. For him, the two examples just cited—genetics and linguistics—are not just analogies. In each case there is a principle of "generativity" involved, and Alexander is not just interested in a theoretical equivalent of this principle. He is actually interested in generativity itself and therefore serious about a set of rules which generates buildings—not as a mechanical technique (as might perhaps be naively understood in the automobile industry) but as a structural principle of natural creation as it is understood in modern science.

These ideas are of course disturbing because they challenge the long-standing separation of art and science into "two cultures," as C. P. Snow put it (Wilson, 1965). It is precisely this "bifurcation of nature" that is so disturbing to Alexander. In an allusion to Herman Hesse's great imaginary game in which all structures—musical, mathematical, social, political, physical, chemical, biological, and visual—could be represented in a single way, he posited what he called the "Bead Game Conjecture." "It is possible," he wrote "to invent a unifying concept of structure within which all the various concepts of structure now current in different fields of art and science can be seen from a single point of view" (1968). This was a fascinating conjecture, if taken seriously, but it isn't until one sees Alexander's work over the ten-year period following the publication of his first work, *Notes on the Synthesis of Form* (1964), that these connections between theory, scientific paradigms, architectural paradigms, and the relationship between art and science can be made.

From *Notes* on, Alexander's work has been characterized by a gradual but intensely persistent honing-in on the very heart of the creative process in what appears to be the search for a generative theory of architecture. For him, this search takes the form of several basic questions that need to be answered: What is environment? How does it affect us? Is there any objective sense in which it can be good or bad? How is it generated? And under what conditions is the process which generates it capable of making the kind which is good?

This last question, however, seems to suggest that it isn't just any generative

Stephen Grabow, Ph.D., is Professor and Director of Architecture at the University of Kansas. He spent seven months in Berkeley, California as a Fellow of the National Endowment for the Humanities to interview Christopher Alexander. He is author of several scholarly and professional publications on architecture and planning, a member of the editorial board of the *Journal of Architectural Education*, and a Regional Director of the Association of Collegiate Schools of Architecture.

theory of architecture that is important. It is a particular kind of generative theory—one that generates processes that produce "good" environments. And as it turns out, the search for a generative theory is incidental to this other search. In fact, the "theory" is simply a device which has to be created along the way because it is necessary in enabling Alexander to get where he wants to go—to make beautiful buildings. But in the light of the effort which eventually went into the creation of such a theory, this is a bit like inventing the calculus simply to solve a particular equation, or creating the laws of motion simply to be able to ride in a car. Yet this is close to what Alexander has had to do in the case of architecture.

In *The Timeless Way of Building* (1979), *A Pattern Language* (1977), and *The Oregon Experiment* (1975), Alexander and his associates have published the first of several works which attempt to lay the foundation for an entirely new approach to architecture. At its core is a scientific attempt to account for the act of design—"an age-old process by which the people of society have always pulled the order of their world from their own being." For Alexander, this account takes the form of several basic facts: that the actual substance of which the environment is made consists of patterns rather than things; that the distinction between good and bad patterns is not arbitrary but can be arrived at objectively; that if you ask, "Where does the environment come from?" you'll find it is generated by language-like systems called pattern languages; that its successful adaptation to a complex system requires an enormous amount of minute local adaptations which insist that large numbers of people have to be engaged in the process; and finally, that the environment properly constituted has an objectively definable morphology to it with specific geometric properties that must be present if it is to be beautiful.

The procedural consequences of these facts include practical changes in the relationship between the architect and society, in the relationship between the architect and the building contractor, in the processes of construction, in the flow of money through the environment, and finally, in the politics of land ownership and control. Taken as a whole, this work forms a new paradigm of architecture because it leads directly to a fundamentally different way of perceiving and making buildings and towns than current theory and practice requires.

The indented passages that are not credited in this article are excerpts from interviews Grabow conducted with Alexander.

THE GENERATION OF PATTERNS: LINGUISTICS AND GENETICS

For Alexander, a generating system is like a kit of parts or components, together with rules for combining them to make wholes—"a way of focusing attention on some particular holisitic behavior in a thing, which can only be understood as a product of interaction among the parts" (Alexander, 1968, p. 40). By pursuing this line of inquiry he was able to make two paradigm-shattering observations. First, that the actual substance out of which the environment is made consists of relations, or patterns, rather than "things," and second, that it is actually generated by the implicit, language-like system of rules which determines their structure. The first observation took years to develop:

> During the early years of formulation of the pattern language we had a very peculiar problem. We had both "things" and "patterns" which were connecting those things. This seemed like a very inelegant formulation. In discussing this with mathematicians it was intuitively clear to them it would be better if there were "patterns of patterns" rather than "patterns of things." In 1967 this seemed like a beautiful idea but it did not seem to have any reality. It seemed too abstract. It finally became clear that it was much more lucid to say that there were just patterns.
>
> It's one thing to say in a kitchen, for example, you have a certain relationship between a counter, a refrigerator, a sink, and a stove. Everyone can see that. But in that view of the thing, you still consider the kitchen to be *made of* the counter, refrigerator, sink, and stove and their relationship is kind of playing a secondary role in trying to organize it. But when you look more closely you realize that the stove is a relationship between an oven, some heaters, and some switches and furthermore, that the switch is a relationship between something you can turn with your hand and some electrical contacts, and so on. Finally you realize that the whole substance of all this is in fact made of these patterns and that the "things" are just convenient labels which we give to bundles of patterns, or patterns themselves.
>
> Although this is a pretty difficult thing to realize, it is consistent with modern mathematics and physics. In that sense it's not a surprising development. But from the standpoint of common sense it is not completely natural. To some extent it's counterintuitive. It's startling. It seems to contradict common sense. Language is involved here. We give names to things but we don't give names to relationships. Our language is full of nouns. The idea that the noun is merely a label for a bundle of relationships that are real is not supported in verbal experience, although Whorf suggests that there are some

A truly scientific theory of architecture would be much more concerned with unlocking the creative processes that produce buildings than in the application of scientific technologies to buildings already produced.

traditional languages where the opposite is the case. Most Western languages tend to perpetuate the illusion that it's the object which is real. This is a problem in modern physics—the incompatibility of the language with some of the concepts that are currently used. The idea that an atom, for example, is a "thing" is a popular view, when actually it is not. So there are quite a few problems involved in seeing patterns rather than things as fundamental, and not merely adjuncts to reality.

The second observation—that the patterns in the environment are generated by a language-like system of rules, or "pattern language"—actually goes against architectural dogma:

> The idea that the structure comes from these languages rather than from the creative brilliance of designers is initially repulsive. Architects imagine they are *creating* buildings and, by extension, towns or parts of towns and that these entities are the products of the fertility of the imagination. To have a theory which claims that there are these systems of rules and that we, by embodying these rules, produce particular versions of the structure implicit in the rules—but no more than versions—and that it is really the implicit structure which governs, is pretty much of a shock to the ego. Even lay people tend to think that architects control the environment. The basic attitude is that architects bring order into an otherwise chaotic situation—instead of recognizing that order comes through this system of rules which, in some version or other, exists anyway. It's the same difficulty one has in understanding that a bird can be made from a set of rules. People just won't believe it.
>
> The first observation says that relations are fundamental; the second one says that these relations are generated by rules. In nature, a particular robin is ultimately a product of the rules inherent in the gene system and that those rules interacting create an egg, and then a chick, and then a robin. But such a process is not real for most people. It's not even that real for biologists. It's intellectually real, but not emotionally real.
>
> It is now known that even humans are produced by the interactions of certain genetic systems and that the generative rules are relatively simple in comparison to the complexity of the end product. This is now accepted as a part of biology, but for most people it is not emotionally real. It's just too incredible. And I think the reason is that we have not yet succeeded in simulating the process. So the idea that there can be a set of rules which ultimately generates the environment is difficult to take. But the simple fact is that the structure of the environment comes from the languages that the people who make it are using. And the difficulty with accepting that is similar to the difficulty we have in accepting that a robin is made by a set of rules. But that is what is going on. Yet one feels that somehow the miracle of creation is not fully accounted for by these interactive rules.
>
> In architecture, everyone knows that there are rules, but the current view is that they are "constraints"—which is very different. In the literature you will find no mention of anyone believing these rules are *generative*. In genetics itself the idea is only ten to fifteen years old. In linguistics it's only ten years old. As far as I know the topic has not yet been discussed in architecture. Consequently, the idea of systems of rules actually generating structure is not widely shared. It is different from the idea, normally accepted, that rules merely restrict the field of possibilities until there is just one structure, essentially created by a process of elimination. In the generative sense, however, the rules actually create the thing. The question is whether or not anyone seriously believes you can generate a whole building or town by such rules.
>
> It is a touchy subject in architecture because it fundamentally touches the ego of the creator. So long as you view the rules as constraints, it's as though the creative core was still lying independent and the constraints are merely impinging on them and shaping it. But once you admit that the rules are generative then you have got right into the heart of the creative core and one starts to wonder what exactly is the role of the creator in all this. A generative system is one in which the interaction of the rules, and nothing else, will create the thing. There is no intermediate force of any kind.
>
> It was not until Chomsky's work that anybody succeeded in formulating the rules which actually generated sentences—which is quite a different thing from saying that a sentence has to obey certain rules of grammar. That is why Chomsky's systems are so different from "grammars" evolved over the past two

hundred years. Earlier grammatical rules did not generate sentences. They merely put constraints upon what a sentence has to be. But the crux of the issue is generativity.

Suppose we agree that there are these rules, by all means. The conventional architectural attitude to all that is, indeed, there are all those rules and, working within those rules, I create something as an architect. But I'm making the statement that I can actually set up those rules so that if you follow a sequence of them in the order prescribed you will have a building. Furthermore, you will have created a building which has never been seen before and which is also capable of being as beautiful as any other building. Now that is the sort of extreme of what I mean by "generative." But if you say that was how the cathedral at Chartres was made, people will freak out. They will say, "My God! Are you trying to mechanize great works of art?" But the crucial thing is that in an embryo, for example, that is precisely what happens. You have these systems, and they come into play in an absolutely established order during the course of embryonic development and eventually you get a robin. And the fact that I'm claiming to put out here is that environments are also generated by systems of rules. They do not have systems of rules which sort of "constrain" their creators. They are actually generated by them.

As an empirical fact about my own work and experience of the last few years, this is definitely the hardest thing for an architect to swallow. Lay people find it amazing and feel they just won't be able to do it, but they have no prejudices against the idea. Architects, on the other hand, do not want it to be true, don't want to try it, don't want to believe that other people can do it, and have a vested interest in this not being true because conceptually it threatens to replace them—although the practical question of what an architect should be doing and what makes architecture a great creative art is actually another question.

With the onset of computers, for the first time it has actually been possible to study the effects of certain interacting rules. Suppose you take the shape of a wave breaking, for example. You can ask, "Do I understand what is happening?" So you write a set of rules—an algorithm—which is supposed to depict the history of a wave. Then you can run these rules through the computer and generate a pattern of dots on a cathode ray tube. It might be no more than a dozen rules, but if you keep going through those rules, over and over again, in different combinations of sequences, and you are successful, you will actually see this pattern of dots forming a breaking wave. But to write a set of rules which actually generates a life-like wave is incredibly difficult. It might take two years of mathematical research playing around with those rules until you generate a breaking wave, complete with a curl. Yet it is a very simple case of interacting hydrodynamic rules. It does not involve the sort of complexities going on in a linguistic system or an embryonic system. But it is nonetheless tremendously exciting because you feel that you have sort of entered into the heart of nature. So, far from mechanizing the environment, or belittling the architect, it does nothing of the sort. It is a miracle that all of these interacting rules can produce a complex fabric rather than chaos.

A few years ago, mathematicians became aware, purely on a childish level, that even if you were to take three or four rules, you could already generate orders of complexity much greater than any mathematically describable geometry. Now when we talk about things like the breaking of a wave, which is a bit more complicated, we might be up to a dozen rules. In the case of an organism, there are about fifty thousand genes responsible for an incredible number of interactive rules. In the case of environments, there are hundreds. This kind of complexity cannot be accounted for by the kind of mathematics which D'Arcy Thompson is speaking about (Thompson, 1966). And indeed, it is only by studying the process which consists of the interaction of the set of rules that you can begin to generate that kind of complexity. So the fact that the environment is created like this—generated like this—is a very remarkable thing. It is miraculous and beautiful.

Now, once we get into linguistic systems, and pattern languages specifically, you not only have these very complex rules that generate things but you also have the power of choice—so that you are free to make something that has not been made before by allowing the system of rules in your mind to do it. This is another step which goes further than saying that, indeed, nature is produced by interacting rules. In a linguistic system or in a pattern language you not only have very complex sets of interacting rules but you have choice. You can say any sentence you want to say at a particular moment in order to make a response to something and, similarly, you can create something that is appropriate to a particular environmental situation which was never made before. But it is the structure of your rule system or language that is enabling you to do this. And that same structure ultimately resides in the finished product, although you have still made it and have created a thing never before created in that specific framework. But to realize that there is no opposition between the immense creative power and the power of the rules—that is difficult to grasp.

In the two examples—the wave and the sentence—there is an important distinction. Being able to write generative grammars was not a trick, as in the case of the wave. With the wave it is just a trick—a simulation of the processes that are going on in the real world. In the case of the grammars there is an important difference. There it is fairly widely considered to be true

For Alexander, the idea that there might be some sort of phenomenological event occurring when something was "beautiful" was not an attractive option. Yet...there seemed no other alternative.

> that these generative rules are actually the ones that we have in our heads. In other words, it is not a sort of cute description of something. The assumption is that this system of rules is real and actually exists in the brain in that form. In the wave, however, it is merely presumed that the natural processes have a structure which is similar to the rules which are used to simulate the wave—it's a model, although a generative one. But in the case of linguistics and genetics, we are saying that the rules actually exist. They are not just a conceptual model to explain what is going on—they are in the real thing, although you have to discover them by inference. This is very important in the case of the environment because what I am claiming to have discovered is that there are rules operating in this same way in the environment. I am not saying that this is a handy simulation. I am saying that these rules are actually there, in people's heads, and are responsible for the way the environment gets its structure.
>
> Chomsky's work on generative grammar will soon be considered very limited. It happened to be brilliant in the sense that it was the first part of linguistics to receive this attention. But in fact, it does not deal with the interesting structure of language because the real structure of language lies in the relationships between words—the semantic connections. The semantic network—which connects the word "fire" with "burn," "red," and "passion"—is the real stuff of language. Chomsky makes no attempt to deal with that and therefore, in a few years, his work will be considered primitive. In that sense, pattern languages are not like generative grammars. What they are like is the semantic structure, the really interesting part of language which only a few people have begun to study. The structure which connects words together—such as "fire" being connected to "burn," "red," and "passion"—is much more like the structure which connects patterns together in a pattern language. So pattern languages are not so much analogous to generative grammars as they are to the real heart structure of language which has hardly been described yet.

The question of what Alexander means by the "real heart structure" of a system—analogous to the semantic connections in language—goes back to his work in cognitive psychology at Harvard and his association with Jerome Bruner at the Center for Cognitive Studies in the late 50s and early 60s. The connection is important for two reasons. First, it broadens Alexander's credibility in terms of these obvious cross-disciplinary references, especially to linguistics.[2] Harvard and MIT were real hotbeds of this kind of thinking and Alexander (as a member of the Joint Center for Urban Studies as well as The Center for Cognitive Studies) was in touch with these ideas around the time they were being formulated.

The second reason the connection is important is that it brings the inquiry back to the ultimate intent of *Notes*—the attempt to discover and describe the structural correspondence between a good form and its context. The good form, it was observed, not only fits its context well but also clarifies the life it accommodates. We perceive this clarity by the richness and wholeness of its structure. But what about the bad forms—the so-called misfits that confuse the life they accommodate and which we perceive as static and fragmented?

At the time of *Notes*, Alexander suspected that the source of the difference had something to do with how forms were perceived and represented in the brain and what the difference was between the ones that seemed whole and the ones that were not whole.

The results of his work at the Center for Cognitive Studies, published in four journal articles between 1959 and 1968, connect up to the question posed by the need for the techniques in *Notes* to become generative and prefigure his later work on the geometry of unified space (Alexander, 1960, pp. 357-371; 1962, pp. 207-226; 1964, pp. 235-253; 1968, pp.73-77). The connection comes from the observation that the spatial structure of certain forms is congruent with the basic cognitive structure in the brain out of which other structures are built—that there is a correspondence between the holistic behavior of a thing and its perception. The observation is paradigm-shattering because it ultimately leads to the conclusion that the distinction between good and bad forms is a matter of fact, not value. The idea, however, is more widely shared than one might think possible within the prevailing nominalism of the

current paradigm, although most of the research has been at the level of urban rather than architectural form.[3] In architecture, Christian Norberg-Schultz's concept of spatial structure as a concretization of environmental schemata or images that form a necessary part of man's general orientation in the world is an important step in the same direction, but it is primarily speculative (Norberg-Schultz, 1971). Alexander is unique in actually attempting to carry the idea to its inevitable empirical conclusions.

THE SEARCH

After 1965, the main ingredients for a full-scale investigation had been assembled. The idea that the real structure of the environment comes from overlapping sets of interacting rules—rules representing relations between patterns in the environment and which correspond to the holistic perception of structure—provided Alexander and his colleagues with the basis for thrashing out a general theory of the "pattern language" over the next few years. The immediate questions that had to be answered dealt with the need to identify such rules operating at all levels of the environment, the overall structure which binds them together and makes them whole, and the problem of generativity—the actual production of objects which embody those rules with infinite variety.

In one essay, "From a Set of Forces to a Form," he compared the process of generativity in design to the formation of sand ripples in nature. Drawing upon the physics of blown sand, he showed how the wave-like rippled form is generated by the interaction of five rule-like forces working upon any level surface. "With the wind blowing, the level sand surface is an unstable form because it gives rise to forces which ultimately destroy it. The rippled form is stable because the forces which it gives rise to maintain the form" (Kepes, (ed.), 1966, p. 97). The key process here is the interaction of forces to maintain the stability of the system.

In the realm of design, the comparable question is: "Given a set of needs, how can we generate a form which meets those needs?" If one could replace the concept of "need" by the concept of an active "force," it might be possible to study the interaction of human needs in space as a generative process comparable to and with the same precision as the form-generating processes in nature.

These questions were first pursued formally during a year-long seminar in Berkeley between 1966 and 1967 and discussed in various journal articles during the same period.[4] The idea to continue the work in the context of an ongoing research institute emerged in 1967 with financial support from the Edgar J. Kaufmann Foundation and from the National Bureau of Standards (and later from the National Institute for Mental Health). "The Center for Environmental Structure" was created in Berkeley with Alexander as Director. Its statement of goals listed three main activities. First, to undertake contracts to develop specific patterns and systems of patterns within a pattern language, and to design buildings and parts of cities according to the language; second, to undertake basic research concerning the pattern language itself; and third, to publish and distribute the coordinated pattern language as it would evolve.

For Alexander, the feeling of commitment to see this work through to the end had now solidified. With the formation of the Center an intense period of experimentation and testing began. In three projects—a multi-service community center in New York City (for the Human Resource Administration), an educational research facility in Southern California (with the architectural firm of Skidmore, Owings, and Merrill), and a low-income residential district in Lima, Peru (for a United Nations Competition)—the strengths and weaknesses of the ideas which had developed since *Notes* would emerge.[5] Reviewing the work of this period, Roger Montgomery said that "already, in the three years or so that it had been in development, the pattern language has proven effective in practice. At the same time, its conceptual basis has been strengthened and enriched by further analysis" (1970, p. 53).

Progress had been made on the format for writing patterns and on the language of rules for their combination into complete environments. Each pattern consisted of an "if-then" statement representing a context-form ensemble. The "if" statement defined precisely the situation in which the pattern applied; the "then" statement contained the spatial configuration which was necessary to the life of that situation; and both were accompanied by a problem statement giving the background for the pattern and any specific data on which it was based. This format seemed to make each pattern open to criticism, modification, and continual reassessment. In Montgomery's opinion, "the importance of these three fundamental aspects of patterns, which give them a certain formal rigor, stands out sharply in the experience which has been built up in using them, as well as in the intensive theoretical effort carried out over the last few years at the Center" (1970, p. 54). But the structure of their interactions was still unaccounted for. Particularly in the multi-service center project, the way in

"The idea that the structure [of architecture] comes from these languages rather than from the creative brilliance of designers is initially repulsive."

which the patterns were combined took the form of a "cascade" representing sequential combinations of progressively smaller configurations. But it was not yet a language:

> It was completely clear that there was really no language—that the word "language" was in some sense a hope, a promise, rather than a fulfillment. In other words, if one actually presented another person with this, that person would have to be an architect in order to be able to do it. That was the crux of the matter.

This weakness became clear because in each of the projects a final design was required and so it became necessary to "bridge the gap" intuitively—by the traditional methods:

> Of course, our own designs and sketches were themselves made without any real knowledge of building. They certainly were not diagrams; but they were not ordinary plans of buildings either. They had some of the whacky character of modern architecture; on the other hand they were sort of faintly just beginning to move into some new realm. But they were actually quite thin. We did not yet have the muscle within ourselves. We did not have the substance to actually present a coherent and solid and definite thing that had to be done.

During the next two years these problems would be hammered out, but the investigation splits at this point. The need to continue to expand the collection of patterns and the question of a generative structure which binds them together into complete environments became both a purely technical as well as an intuitive concern. It was clear that the key to the structure was somehow contained in the free functioning of a system and its ability to come to terms with itself internally. In the case of the multi-service center project and in the Peruvian housing scheme, an intuitive grasp of this ability had permitted the design to be completed in the absence of a clear analysis of the structure. The problem, therefore, was not exclusively structural. Something was going on that appealed to the intuition more than to formal logic. But what was it?

One source of discovery was an intense desire on Alexander's part for basic improvements in the institutions of society and his belief that the work he was doing had the power to help put things right socially. There was a general feeling in the 1960s that both society and the environment mirror each other and that if one starts to take the structure of the environment seriously enough one inevitably becomes involved in the reconstruction of society. This is not a particular social philosophy, just a recognition that by "patterns" one means patterns of behavior as well as patterns of space and that if an institution is basically dysfunctional, nothing that is done soley to the physical environment will bring it to life. The free functioning of a system therefore was not only the key to its structure but the source of any holistic properties that it might have.

In *Notes*, Alexander said that a good design was one in which form and context were in frictionless coexistence. This now goes a step further. In this view, a building is basically a living organism in which certain things are happening—as opposed to being a shell made of glass, bricks, and mortar. And the things that are happening are patterns of behavior as well as patterns of space. Consequently, by searching for what is the correct structure of the environment, one is led to uncover what is the proper form of social institutions. [6] At the same time it was also clear that social institutions are themselves only large-scale patterns of millions of very minute events. In the work on the pattern language, therefore, there was an attempt to build up a fabric of such events—like opening a window and taking a deep breath, walking down a garden path and picking a flower and putting it in a buttonhole, having a cup of coffee and a piece of toast and talking to someone at the same time, all the way through everything that is going on in the city and all through its various institutions, but always built up out of very minute events—much as a novelist, like Tolstoy for example, would describe a human life. And it was an intuitive sense of the structure of such a fabric that, in a very limited way, enabled the early projects to be completed and, to a greater extent, guided the work on the structure of the pattern language itself.

The idea that a building is as much the life

that goes on inside as it is the "shell" which encloses that life is of course congruent with the observation that the environment is made of patterns, not "things." But it is equally paradigm-shattering because it leads logically to the conclusion that the correct adaptation of the environment requires an enormous amount of minute local adaptations between the buildings and the users. It completely rules out, for example, pre-fabricated, standardized, and modular construction—the hallmarks of modern architecture. Although this incompatibility would not become completely clear to Alexander until he actually started to build, it was a source of friction between the Center and other professional architects engaged in the work of the early projects. But the idea is paradigm-shattering in another way.

The modern, so-called objectivist view of aesthetics insists that the source of beauty of an object is contained primarily within its formal properties. In the case of a building, this means *how it looks*, independently of the life that goes on inside. The exclusive appeal of this view is evident in the tendency for modern buildings to be photographed for publication without people in them. The so-called subjectivist view, however, is equally unsatisfactory. It holds that what makes something aesthetically valuable is not in its own properties but its relation to the personal preferences of its perceivers.

This antimony has no place in Alexander's view. For him, the beauty of a thing does not rest entirely in its appearance but rather in its *existence*:

> For me, the beauty of a thing is not purely in how it looks. It has to do with how it is. Now how it "is" essentially involves a relationship between the various events that are going on there. It happens to be true that when a thing is transparently true to itself we then somewhat naively think of it as beautiful. The naive part actually consists in attempting to analyze that intuition and mistaking it for being a comment on how it looks. But when it is correctly understood it happens to be only a comment on how it looks *in passing*. Appearances can be deceptive. If you are looking at a racehorse naively, for example, you might mistake the saccharine quality of the beauty of the horse for the actual appearance of things like the flaring of the nostrils or other characteristics which are present in a horse that is going to run like hell. Such a horse is certainly not going to be ugly; but it is not going to be that saccharine look for which somebody might naively paint a picture of a racehorse either. In the human realm we are clearly aware of this. We distinguish between the saccharine exterior and the appearance of a person who is actually resolved. So it is ultimately the inner life which is the thing that matters. And when I say that basically I am concerned with making things beautiful, that is what I am speaking about.

Here again the inquiry comes to rest on some holistic property of structure. In this case it is the internal resolution that occurs when something is "transparently true to itself." As in the "goodness of fit" between form and context, or in the correspondence between the structure of a problem and the design program, or in the free functioning of a system, or in the overlapping structure of interactions, or in the "real heart structure of a language," or in the congruence between the holistic perception of a thing and its behavior, all of Alexander's investigations during this ten-year period come down to this property of wholeness or richness or vitality that is present in beautiful buildings. To anyone trained in scientific method this would seem to suggest two possibilities. Either the investigations have been incorrectly biased from the start, in which case the pattern of coincidence is nothing more than an interesting tautology, or there is some objective phenomenon at work which shows up no matter how one approaches the problem.

In science, the discovery of such phenomena is rarely sudden. Usually the investigator is driven to conclude its existence only after repeated efforts to explain something else come to rest on its probability. For Alexander, the idea that there might be some sort of phenomenological event occurring when something was "beautiful" was not even an attractive option. First, it places one in the extremely awkward situation of claiming something to exist when that existence seems highly problematic. Second , the burden of proof is enormously time consuming and often impossible within the lifetime of the person making the discovery. And yet, by the end of the late 60s there seemed no other alternative. It was clear that although progress on the pattern language was evident, each attempt to explain what was meant by the holistic property of structure opened up new questions. The results seemed to suggest some sort of hermetic circle of inquiry that led inexorably to the existence of some objective feature of reality that was logically accessible only by inference. If indeed there was such a phenomenon, by what means could one be precise enough to systematically predict its consequences?

There are precedents in architectural theory and practice for the discovery or even the claim that there is such a phenomenon. A careful examination of Wright's discussion of "organic" architecture or of Le Corbusier's remarks about "in-

From the forthcoming book by Stephen Grabow, *Christopher Alexander: The Search for a New Paradigm in Architecture*, Routledge & Kegan Paul, 9 Park St., Boston, MA 02108. Reprinted by permission of author and publisher.

effable space" suggests that both believed that what they were referring to were objective features of reality.[7] Eliel Saarinen believed that the search for form would result in objective conclusions—which he described in terms of a spatial "aura"—and that its fundamentals were "always the same, all the time, unchangeable and firm" (Saarinen, 1948, pp. vii, 3). There is, however, no precedent for a systematic description of the consequences of such phenomena. Although such descriptions constitute the basis and prerequisite of scientific paradigms, their existence in architecture would radically alter the current conception of the field and shatter the prevailing constellation of facts, values, and methods upon which it is based. Because such an event seems so improbable, and because of Alexander's specific answer to the question, his inquiry itself constitutes an examination of the entire field.

NOTES

1. I particularly have in mind Pier Luigi Nervi and James Marston Fitch. The former is a representative of the "structuralist" movement in architecture; the latter the "environmentalist" movement. Cf. Nervi, *Aesthetics and Technology in Building* (The Charles Norton Lectures, 1961-1962), trans. by Robert Einardi (Cambridge: Harvard University Press, 1965), and Fitch, *American Building: The Environmental Forces That Shape It* (New York: Schocken Books, 1975).

2. In fact it was Bruner who first nominated Alexander to Harvard's Society of Fellows of which he became a Junior Fellow in 1962.

3. See Kevin Lynch, *The Image of the City* (Cambridge: MIT Press, 1960); Francois Vigier, "An Experimental Approach to Urban Design," *Journal of the American Institute of Planners* 31:1 (February, 1965); Stephen Carr, "The City of the Mind," in William Ewald (ed.) *Environment for Man* (Bloomington: Indiana University Press, 1971); Carl Steinitz, "Meaning and Congruence of Urban Form and Activity," *Journal of the American Institute of Planners* 34:4 (July, 1968); Donald Appleyard, "Styles and Methods of Structuring a City," *Environment and Behavior* 21:1 (June, 1970); and Gyorgy Kepes, "Notes on Expression and Communication in the Cityscape," in Rodwin (ed.), *The Future Metropolis* (New York: George Braziller, 1961).

4. "Atoms of Environmental Structure," Ministry of Public Buildings and Works (London: 1966); "The Coordination of the Urban Rule System," *Regio Basiliensis Proceedings* (Basle: December, 1965), pp. 1-9; "Twenty-Six Entrance Relations for a Suburban House," Ministry of Public Buildings and Works (London: 1966); "Design Innovation: An Exchange of Ideas," *Progressive Architecture* (November, 1967), pp. 126-131; and "The Pattern of Streets," *Journal of the American Institute of Planners* 32:5 (September, 1966).

5. Two of the projects were described in *A Pattern Language Which Generates Multi-Service Community Centers* (Berkeley: 1968) and *Houses Generated by Patterns* (Berkeley: 1969).

6. These ideas were explored in several articles published in the late 1960s: "The City as Mechanism for Sustaining Human Contact," in William Ewald (ed.), *Environment for Man* (Bloomington: Indiana University Press, 1967), pp. 60-109; "Cells of Subcultures," a paper of the Center for Environmental Structure (Berkeley: 1968); and "Major Changes in Environmental Form Required by Social and Psychological Demands," *Ekistics* (August, 1969).

7. Cf. Frank Lloyd Wright, *An Autobiography* (New York: Duell, Sloan, and Pearce, 1943) and Le Corbusier, *New World of Space* (New York: Reynal & Hitchcock, 1948), pp. 7-9.

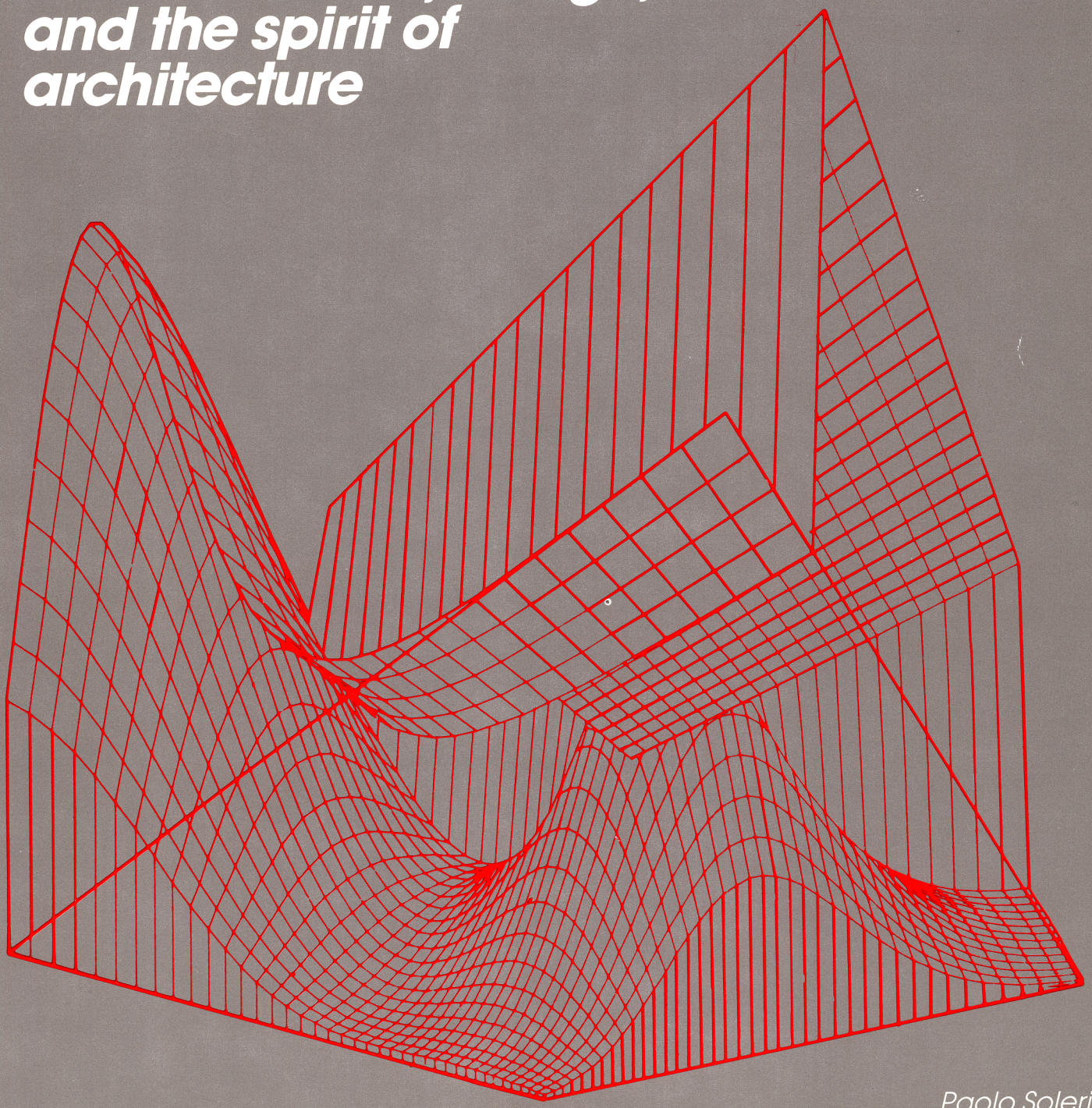
REFERENCES

Alexander, C. A result in visual aesthetics. *British Journal of Psychology* October, 1960, pp. 357-371.
_____The origin of creative power in children. *British Journal of Aesthetics* 2:3, July 1962, pp. 207-226.
_____On changing the way people see. *Perceptual and Motor Skills* Vol. 19, July 1964, pp. 235-253.
_____*Notes on the synthesis of form*. New York: Oxford University Press, 1964.
_____Subsymmetries. *Perception and Psychophysics* 4:2, February 1968, pp. 73-77.
_____The bead game conjecture. *Lotus* 5, 1968, pp. 151-154.
_____*The Oregon experiment*. New York: Oxford University Press, 1975.
_____*A pattern language*. New York: Oxford University Press, 1977.
_____*The timeless way of building*. New York: Oxford University Press, 1979.
Kepes, G. (ed.). *The man-made object*. New York: George Braziller, 1966.
Kuhn, T. *The structure of scientific revolutions*. 2nd ed. Chicago: University of Chicago Press, 1970.
Mannheim, K. *Ideology and utopia*. 1937.
Montgomery, R. Pattern language: The contribution of Christopher Alexander's center for environmental structure to the science of design. *Architectural Forum*. January/February, 1970.
Norberg-Schultz, C. *Existence, space, and architecture*. New York: Praeger, 1971.
Saarinen, E. *Search for form*. New York: Reinhold, 1948.
Thompson, D.W. *On growth and form*. Cambridge: The University Press, 1966.
Wilson, C. *Beyond the outsider*. London: Pan Books, 1965.

ReVISION

FALL 1983 A JOURNAL OF CONSCIOUSNESS AND CHANGE VOL. 6 NO. 2

consciousness, design, and the spirit of architecture



Paolo Soleri
Buckminster Fuller
Christopher Alexander
Rudolf Steiner