# Christopher Alexander
# A Much Asked Question about Computers and Design

Since I use computers to solve both practical and theoretical problems in design, I have received a large number of enquiries from people who are interested in "The Application of Computers to Design." The most recent enquiry of this kind has come from the magazine *Landscape*, which is now kind enough to publish this reply:

In my opinion the question all these questioners ask, namely, "How can the computer be applied to architectural design?" is misguided, dangerous, and foolish.

We do not spend time writing letters to one another and talking about the question, "How can the slide rule be applied to architectural design?" We do not wander about our houses, hammer and saw in hand, wondering where we can apply them. In short, adults use tools to solve problems that they cannot solve without help. Only a child, to whom the world of tools is more exciting than the world in which those tools can be applied, wanders about wondering how to make use of his tools.

This would, of course, not be worth saying if there were hundreds of significant problems which the computer could help us solve. But there are not.

A digital computer is, essentially, the same as a huge army of clerks, equipped with rule books, pencil and paper, all stupid and entirely without initiative, but able to follow exactly millions of precisely defined operations. There is nothing a computer can do which such an army of clerks could not do, if given time.

Since the IBM 7090 takes $10^{-5}\left(\frac{1}{100{,}000}\right)$ seconds to do an elementary operation that might take a clerk about 10 seconds, it works about a million times as fast as a single clerk. One hour's operation on the computer (costing only a few hundred dollars) can therefore achieve the same as an army of a thousand clerks could achieve in a thousand hours, or five months of working days.

In asking how the computer might be applied to architectural design, we must, therefore, ask ourselves what problems we know of in design that could be solved by such an army of clerks, if we could afford to pay them.

At the moment, there are very few such problems. Although we speak a great deal about the complexity of problems, the complexity of architecture, and the complexity of the environment, this talk, so far, is rarely more than hand waving. In the present state of architectural and environmental design, almost no problem has yet been made to exhibit complexity in such a well defined way, that it actually *requires* the use of a computer.

Until we have thought these problems through so far at the conceptual level that we encounter unanswerable complexities in them, and until we have managed to describe these complexities so precisely that an army of clerks could help us unravel them, there is no sense in trying to use a computer.

Indeed, until then, efforts to apply the computer to design represent only the desire to be up-to-date, and the wish to believe that we have already reached this level of complexity in our understanding. If you use a computer to solve an equation that you can solve in your head, or that you really didn't need to solve in the first place, you are only kidding yourself, or trying to kid someone else.

But there is a danger in the currently fashionable preoccupation with computing machinery which goes far beyond irrelevancy. The effort to state a problem in such a way that a computer can be used to solve it, will distort your view of the problem. It will allow you to consider only those aspects of the problem which can be encoded—and in many cases these are the most trivial and the least relevant aspects.

Do not regard this as an empty possibility. Experimental psychology, obsessed by the idea of rigorous mathematization

and hypothesis testing, has for the last forty years, by-passed the significant problems of human behaviour, and dealt only with those trivial aspects that happen to be the easiest to make precise. I am not saying that we should not wish to be accurate. That is the aim of all scientific or creative work. But if the love for precision outweighs our ability to pick significant problems, and our ability to distinguish the relevant from the irrelevant, then we must admit that this compulsion to be precise has made us bankrupt.

This is just what happens when a designer puts his desire to use the computer first, and his desire to understand form and function second. It will happen whenever someone sets out to *apply* the computer to design. We may see it, for example, in a recent study of computer aided planning in hospital design.*

In this study the computer was used to compare different plan arrangements, from the point of view of the total amount of walking done by patients, nurses, suppliers, and visitors. To do this, the authors defined a series of possible room types in a hospital, and gave ways of estimating the amount of traffic between rooms of different types, so that they could compute the relative amounts of patient, nurse, supplier, and visitor traffic for any given layout. There is no doubt about the technical ingenuity of the simulation. But it is not informative or relevant. First of all, the fact that the computer had to be used, forced the authors to deal with phenomena which could be measured and encoded. That is why they analyzed walking distance and volume, instead of the well-being of the patients, the effects of the sharp differences between home life and hospital life, the effects of patients on one another, the rapidity of cure, the problem of preventative medicine, the conditions under which doctors can most easily and successfully diagnose disease, the advantages of out-patient clinics, or any of the hundred other significant problems which cooperate to make the hospital a complex form.

Secondly, even if we take the traffic problem seriously, we find that the helpfulness of the computer is only apparent, not real.

Any intelligent designer could examine the various hospital plans examined by the computer, and could tell roughly what relative amounts of different traffic they would generate. The key word here is "roughly." It is unnecessary to know the amounts of walking generated by a plan to the second decimal place, because it is irrelevant—and only has the appearance of accuracy. It is insignificant accuracy. It is like measuring the size of a cooking apple with a micrometer. Yet it is only in the second decimal place that the computer can do better than the designer's experience.

It will be said that the point of using a computer is to examine a much larger range of alternatives than a designer would have the time or patience or insight to examine. In theory this is a reasonable objective. But in practice, although the number of alternatives the computer can examine is large, the range of these alternatives is small, because the computer can, at present, only examine a very restricted type of solution.

Suppose you are looking for a block of wood to put under the wheel of your car, to stop it running away when you change the tire. You may look at a few different bits of wood to find a bit that works. But there is no point in examining a hundred, or a thousand, different bits of wood, each different from the others only by a matter of millimeters. This procedure would give the impression of greater scope. It is in fact spurious. Yet, this is the kind of variation which the apparently great variety of different hospital plans actually have.

It is only worth examining large numbers of alternatives, if the differences between the alternatives are significant, and there is some chance of discovering truly unexpected alternatives among those examined. Our present ability to construct domains of alternatives does not permit this. At the moment, the computer can, in effect, show us only alternatives which we have already thought of. This is not a limitation in the computer. It is a limitation in our own ability to conceive, abstractly, large domains of significant alternatives. Yet, until we overcome this conceptual limitation the use of the computer will remain spurious. Like the hospital results, its results will not be genuinely informative.

Apart from trivial over-precision then, the results of the hospital study did not really require the use of a computer. The investigators' underlying motive was apparently a wish to use the computer, rather than their need for results which they could not get without it. As a result of this motive, the problem itself—the design of hospitals—was absurdly distorted, merely so that the computer could be used to solve it.

The distortion and triviality were not caused by an incompetence on the part of the authors. It is bound to occur whenever people *try to apply* the computer to design, rather than waiting until they *have* to use the computer because they are confronted by a complexity which they cannot resolve without it.

There is no doubt that a hospital is a complex form, which has arisen in response to a complex pattern of needs. Any designer may rightly feel perplexed by this complexity. But if he strips the hospital design problem down to those of its aspects which can be measured or encoded, he will eliminate just that complexity which made the problem seem difficult to begin with.

It is ironic that the very tool which has been invented to unravel complexities imposes such severe restrictions on the de-

*J. J. Souder, W. E. Clark, J. I. Elkind, M. B. Brown; *Planning for Hospitals, A Systems Approach Using Computer-aided Techniques;* American Hospital Association; Chicago, 1964; especially pp. 113-163.

sign problems it can solve that the real source of complexity has to be eliminated before the tool can even get to it. But for the moment that is the situation. Our effort, therefore, must be to learn to see the actual complexities of design so clearly, that we can make use of a machine to help us unravel them. When we have done so, we shall very likely discover that the kind of computer we really need is not like the present digital computers at all.

Meanwhile, any use of the digital computer which does not entail conceptual progress invites only suspicion, not respect.

Lastly, I should distinguish my fear of over-zealous interest in the computer, very sharply from the much more widespread fear which leads designers to exclaim, irrationally, both that the computer threatens intuition and creativity, and that it cannot replace them.

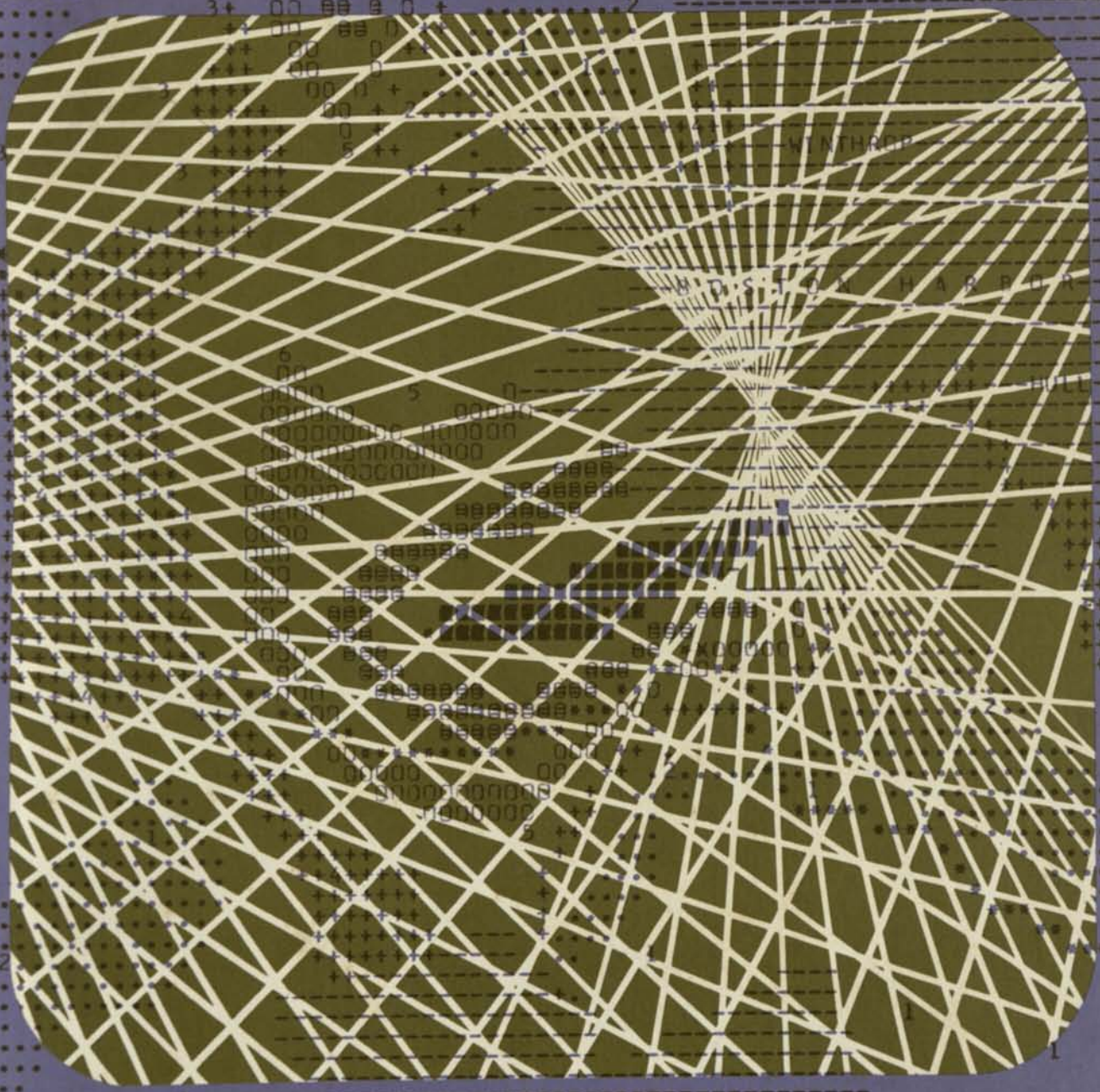
Those that fear the computer itself, are invariably those who regard design as an opportunity for personal expression. The computer is a threat to these people because it draws attention to the fact that most current intuitive design is nothing but an outpouring of personal secrets in plastic form. The computer cannot imitate these outpourings. But serious designers do not want to imitate them anyway.

A form has a definite, substantial, functional structure. As we begin to understand this structure it becomes clear that it is very complex, and that sheer computational speed can be a tremendous help in dealing with it. When the inner relationships which go to make a form are better understood, it is unthinkable that the computer could be anything but helpful. The computer is a tool. It is a wonderful, almost miraculous invention. The more we understand about the complex nature of form and the complex nature of function, the more we shall *have* to seek the help of the computer, when we set out to create form.

But understanding form, and creating form, in this sense, are not well served by those who want to use the computer first, without really having any reason to. In fact these enthusiasts do the same disservice to design, as the ravings of the very expressionists whom they are trying to replace. Both delay our understanding of form and function, and our ability to create deeper theoretical conceptions.

Anybody who asks "How can we apply the computer to architecture?" is dangerous, naive, and foolish. He is foolish, because only a foolish person wants to use a tool before he has a reason for needing it. He is naive, because as the thousand clerks have shown us, there is really very little that a computer can do, if we do not first enlarge our conceptual understanding of form and function. And he is dangerous, because his preoccupation may actually prevent us from reaching that conceptual understanding, and from seeing problems as they really are.

# Architecture and the Computer



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