NOTES ON THE SYNTHESIS OF FORM
NOTES ON THE SYNTHESIS
OF FORM / Christopher Alexander

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TO MY DEAREST JAN
Today, almost ten years after I wrote this book, one idea stands out clearly for me as the most important in the book: the idea of the diagrams.

These diagrams, which, in my more recent work, I have been calling patterns, are the key to the process of creating form. In this book I presented the diagrams as the end results of a long process; I put the accent on the process, and gave the diagrams themselves only a few pages of discussion. But once the book was finished, and I began to explore the process which I had described, I found that the diagrams themselves had immense power, and that, in fact, most of the power of what I had written lay in the power of these diagrams.

The idea of a diagram, or pattern, is very simple. It is an abstract pattern of physical relationships which resolves a small system of interacting and conflicting forces, and is independent of all other forces, and of all other possible diagrams. The idea that it is possible to create such abstract relationships one at a time, and to create designs which are whole by fusing these relationships—this amazingly simple idea is, for me, the most important discovery of the book.

I have discovered, since, that these abstract diagrams not only allow you to create a single whole from them, by fusion, but also have other even more important powers. Because the diagrams are independent of one another, you can study them and improve them one at a time, so that their evolution can be gradual and cumulative. More important still, because they are abstract and independent, you can use them to create not just one design, but an infinite variety of designs, all of them free combinations of the same set of patterns.

As you can see, it is the independence of the diagrams which gives them these powers. At the time I wrote this book, I was very much concerned with the formal definition of "independence," and the idea of using a mathematical method to discover systems of forces and diagrams which are independent. But once the book was written, I discovered that it is quite unnecessary to use such a complicated and formal way of getting at the independent diagrams.

If you understand the need to create independent diagrams, which re-
solve, or solve, systems of interacting human forces, you will find that you can create, and develop, these diagrams piecemeal, one at a time, in the most natural way, out of your experience of buildings and design, simply by thinking about the forces which occur there and the conflicts between these forces.

I have written about this realization and its consequences, in other, more recent works. But I feel it is important to say it also here, to make you alive to it before you read the book, since so many readers have focused on the method which leads to the creation of the diagrams, not on the diagrams themselves, and have even made a cult of following this method.

Indeed, since the book was published, a whole academic field has grown up around the idea of "design methods"—and I have been hailed as one of the leading exponents of these so-called design methods. I am very sorry that this has happened, and want to state, publicly, that I reject the whole idea of design methods as a subject of study, since I think it is absurd to separate the study of designing from the practice of design. In fact, people who study design methods without also practicing design are almost always frustrated designers who have no sap in them, who have lost, or never had, the urge to shape things. Such a person will never be able to say anything sensible about "how" to shape things either.

Poincaré once said: "Sociologists discuss sociological methods; physi­cists discuss physics." I love this statement. Study of method by itself is always barren, and people who have treated this book as if it were a book about "design method" have almost always missed the point of the diagrams, and their great importance, because they have been obsessed with the details of the method I propose for getting at the diagrams.

No one will become a better designer by blindly following this method, or indeed by following any method blindly. On the other hand, if you try to understand the idea that you can create abstract patterns by studying the implication of limited systems of forces, and can create new forms by free combination of these patterns—and realize that this will only work if the patterns which you define deal with systems of forces whose internal interaction is very dense, and whose interaction with the other forces in the world is very weak—then, in the process of trying to create such diagrams or patterns for yourself, you will reach the central idea which this book is all about.

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C.A.
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“First, the taking in of scattered particulars under one Idea, so that everyone understands what is being talked about . . . Second, the separation of the Idea into parts, by dividing it at the joints, as nature directs, not breaking any limb in half as a bad carver might.”

Plato, *Phaedrus*, 265D
I / INTRODUCTION:
THE NEED FOR RATIONALITY

These notes are about the process of design; the process of inventing physical things which display new physical order, organization, form, in response to function.

Today functional problems are becoming less simple all the time. But designers rarely confess their inability to solve them. Instead, when a designer does not understand a problem clearly enough to find the order it really calls for, he falls back on some arbitrarily chosen formal order. The problem, because of its complexity, remains unsolved.

Consider a simple example of a design problem, the choice of the materials to be used in the mass production of any simple household object like a vacuum cleaner. Time and motion studies show that the fewer different kinds of materials there are, the more efficient factory assembly is — and therefore demand a certain simplicity in the variety of materials used. This need for simplicity conflicts with the fact that the form will function better if we choose the best material for each separate purpose separately. But then, on the other hand, functional diversity of materials makes for expensive and complicated joints between components, which is liable to make maintenance less easy. Further still, all three issues, simplicity, performance, and jointing, are at odds with our
desire to minimize the cost of the materials. For if we choose the cheapest material for each separate task, we shall not necessarily have simplicity, nor optimum performance, nor materials which can be cleanly jointed. Writing a minus sign beside a line for conflict, and a plus beside a line for positive agreement, we see that even this simple problem has the five-way conflict pictured below.

\[
\begin{array}{c}
\text{performance} \\
\text{simplicity} \\
\text{jointing} \\
\text{economy}
\end{array}
\]

This is a typical design problem; it has requirements which have to be met; and there are interactions between the requirements, which makes the requirements hard to meet. This problem is simple to solve. It falls easily within the compass of a single man’s intuition. But what about a more complicated problem?

Consider the task of designing a complete environment for a million people. The ecological balance of human and animal and plant life must be correctly adjusted both internally and to the given exterior physical conditions. People must be able to lead the individual lives they wish for. The social conditions induced must not lead to gross ill-health or to gross personal misery, and must not cause criminal delinquency. The cyclical intake of food and goods must not interfere with the regular movements of the inhabitants. The economic forces which
develop must not lead to real-estate speculation which destroys the functional relation between residential areas and areas supporting heavy goods. The transportation system must not be organized so that it creates a demand that aggravates its own congestion. People must somehow be able to live in close cooperation and yet pursue the most enormous variety of interests. The physical layout must be compatible with foreseeable future regional developments. The conflict between population growth and diminishing water resources, energy resources, parklands, must somehow be taken care of. The environment must be organized so that its own regeneration and reconstruction does not constantly disrupt its performance.

As in the simpler example, each of these issues interacts with several of the others. But in this case each issue is itself a vast problem; and the pattern of interactions is vastly complicated. The difference between these two cases is really like the difference between the problem of adding two and two, and the problem of calculating the seventh root of a fifty digit number. In the first case we can quite easily do it in our heads. In the second case, the complexity of the problem will defeat us unless we find a simple way of writing it down, which lets us break it into smaller problems.

Today more and more design problems are reaching insoluble levels of complexity. This is true not only of moon bases, factories, and radio receivers, whose complexity is internal, but even of villages and teakettles. In spite of their superficial simplicity, even these problems have a background of needs and activities which is becoming too complex to grasp intuitively.

To match the growing complexity of problems, there is a
growing body of information and specialist experience. This information is hard to handle; it is widespread, diffuse, un-organized. Moreover, not only is the quantity of information itself by now beyond the reach of single designers, but the various specialists who retail it are narrow and unfamiliar with the form-makers' peculiar problems, so that it is never clear quite how the designer should best consult them. As a result, although ideally a form should reflect all the known facts relevant to its design, in fact the average designer scans whatever information he happens on, consults a consultant now and then when faced by extra-special difficulties, and introduces this randomly selected information into forms otherwise dreamt up in the artist's studio of his mind. The technical difficulties of grasping all the information needed for the construction of such a form are out of hand — and well beyond the fingers of a single individual.

At the same time that the problems increase in quantity, complexity, and difficulty, they also change faster than before. New materials are developed all the time, social patterns alter quickly, the culture itself is changing faster than it has ever changed before. In the past — even after the intellectual upheaval of the Renaissance — the individual designer would stand to some extent upon the shoulders of his predecessors. And although he was expected to make more and more of his own decisions as traditions gradually dissolved, there was always still some body of tradition which made his decisions easier. Now the last shreds of tradition are being torn from him. Since cultural pressures change so fast, any slow development of form becomes impossible. Bewildered, the form-maker stands alone. He has to make clearly conceived forms without the possibility of trial and error over time. He has
to be encouraged now to think his task through from the beginning, and to “create” the form he is concerned with, for what once took many generations of gradual development is now attempted by a single individual. But the burden of a thousand years falls heavily on one man’s shoulders, and this burden has not yet materially been lightened. The intuitive resolution of contemporary design problems simply lies beyond a single individual’s integrative grasp.

Of course there are no definite limits to this grasp (especially in view of the rare cases where an exceptional talent breaks all bounds). But if we look at the lack of organization and lack of clarity of the forms around us, it is plain that their design has often taxed their designer’s cognitive capacity well beyond the limit. The idea that the capacity of man’s invention is limited is not so surprising, after all. In other areas it has been shown, and we admit readily enough, that there are bounds to man’s cognitive and creative capacity. There are limits to the difficulty of a laboratory problem which he can solve; to the number of issues he can consider simultaneously; to the complexity of a decision he can handle wisely. There are no absolute limits in any of these cases (or usually even any scale on which such limits could be specified); yet in practice it is clear that there are limits of some sort. Similarly, the very frequent failure of individual designers to produce well organized forms suggests strongly that there are limits to the individual designer’s capacity.

We know that there are similar limits to an individual’s capacity for mental arithmetic. To solve a sticky arithmetical problem, we need a way of setting out the problem which makes it perspicuous. Ordinary arithmetic convention gives
us such a way. Two minutes with a pencil on the back of an envelope lets us solve problems which we could not do in our heads if we tried for a hundred years. But at present we have no corresponding way of simplifying design problems for ourselves. These notes describe a way of representing design problems which does make them easier to solve. It is a way of reducing the gap between the designer's small capacity and the great size of his task.

Part One contains a general account of the nature of design problems. It describes the way such problems have been solved in the past: first, in cultures where new problems are so rare that there are no actual designers; and then, by contrast, in cultures where new problems occur all the time, so that they have to be solved consciously by designers. From the contrast between the two, we shall learn how to represent a design problem so that it can be solved. Part Two describes the representation itself, and the kind of analysis the representation allows. Appendix 1 shows by example how the method works in practice.

The analysis of design problems is by no means obviously possible. There is a good deal of superstition among designers as to the deathly effect of analysis on their intuitions — with the unfortunate result that very few designers have tried to understand the process of design analytically. So that we get off to a fair start, let us try first to lay the ghosts which beset designers and make them believe that analysis is somehow at odds with the real problem of design.

It is not hard to see why the introduction of mathematics into design is likely to make designers nervous. Mathematics, in the popular view, deals with magnitude. Designers recognize, correctly, that calculations of magnitude only have
strictly limited usefulness in the invention of form, and are
therefore naturally rather skeptical about the possibility of
basing design on mathematical methods. What they do not
realize, however, is that modern mathematics deals at least
as much with questions of order and relation as with questions
of magnitude. And though even this kind of mathematics may
be a poor tool if used to prescribe the physical nature of
forms, it can become a very powerful tool indeed if it is used
to explore the conceptual order and pattern which a problem
presents to its designer.

Logic, like mathematics, is regarded by many designers
with suspicion. Much of it is based on various superstitions
about the kind of force logic has in telling us what to do.
First of all, the word "logic" has some currency among
designers as a reference to a particularly unpleasing and func­
tionally unprofitable kind of formalism. The so-called logic
of Jacques François Blondel or Vignola, for instance, referred
to rules according to which the elements of architectural style
could be combined. As rules they may be logical. But this
gives them no special force unless there is also a legitimate
relation between the system of logic and the needs and forces
we accept in the real world. Again, the cold visual "logic" of
the steel-skeleton office building seems horribly constrained,
and if we take it seriously as an intimation of what logic is
likely to do, it is certain to frighten us away from analytical
methods. But no one shape can any more be a consequence of
the use of logic than any other, and it is nonsense to blame
rigid physical form on the rigidity of logic. It is not possible
to set up premises, trace through a series of deductions, and
arrive at a form which is logically determined by the premises,
unless the premises already have the seeds of a particular
plastic emphasis built into them. There is no legitimate sense in which deductive logic can prescribe physical form for us.

But, in speaking of logic, we do not need to be concerned with processes of inference at all. While it is true that a great deal of what is generally understood to be logic is concerned with deduction, logic, in the widest sense, refers to something far more general. It is concerned with the form of abstract structures, and is involved the moment we make pictures of reality and then seek to manipulate these pictures so that we may look further into the reality itself. It is the business of logic to invent purely artificial structures of elements and relations. Sometimes one of these structures is close enough to a real situation to be allowed to represent it. And then, because the logic is so tightly drawn, we gain insight into the reality which was previously withheld from us.12

The use of logical structures to represent design problems has an important consequence. It brings with it the loss of innocence. A logical picture is easier to criticize than a vague picture since the assumptions it is based on are brought out into the open. Its increased precision gives us the chance to sharpen our conception of what the design process involves. But once what we do intuitively can be described and compared with nonintuitive ways of doing the same things, we cannot go on accepting the intuitive method innocently. Whether we decide to stand for or against pure intuition as a method, we must do so for reasons which can be discussed.

I wish to state my belief in this loss of innocence very clearly, because there are many designers who are apparently not willing to accept the loss. They insist that design must be
a purely intuitive process: that it is hopeless to try and understand it sensibly because its problems are too deep.

There has already been one loss of innocence in the recent history of design; the discovery of machine tools to replace hand craftsmen. A century ago William Morris, the first man to see that the machines were being misused, also retreated from the loss of innocence. Instead of accepting the machine and trying to understand its implications for design, he went back to making exquisite handmade goods.\textsuperscript{13} It was not until Gropius started his Bauhaus that designers came to terms with the machine and the loss of innocence which it entailed.\textsuperscript{14}

Now we are at a second watershed. This time the loss of innocence is intellectual rather than mechanical. But again there are people who are trying to pretend that it has not taken place. Enormous resistance to the idea of systematic processes of design is coming from people who recognize correctly the importance of intuition, but then make a fetish of it which excludes the possibility of asking reasonable questions.

It is perhaps worth remembering that the loss of intellectual innocence was put off once before. In the eighteenth century already, certain men, Carlo Lodoli and Francesco Algarotti in Italy and the Abbé Laugier in France, no longer content to accept the formalism of the academies, began to have serious doubts about what they were doing, and raised questions of just the sort that have led, a hundred and fifty years later, to the modern revolutionary ideas on form.\textsuperscript{15} Oddly enough, however, though these serious doubts were clearly expressed and widely read, architecture did not develop from them in the direction indicated. The doubts and questions were forgotten. Instead, in late eighteenth century Europe, we find evidence of quite another atmosphere developing, in
which architects based their formal invention on the rules provided by a variety of manners and "styles" like neo-Tudor, neoclassicism, chinoiserie, and neo-Gothic.\textsuperscript{16}

It is possible to see in this course of events a desperate attempt to ward off the insecurity of selfconsciousness, and to maintain the security of innocence.

Lodoli and Laugier wanted to know what they were doing as makers of form. But the search for this knowledge only made the difficulty of their questions clear. Rather than face the responsibility of these difficult questions, designers turned instead to the authority of resurrected "styles." The architectural decisions made within a style are safe from the nagging difficulty of doubt, for the same reason that decisions are easier to make under tradition and taboo than on one's own responsibility. It is no coincidence, in my opinion, that while the Renaissance had allowed free recombinations of classical elements, the neoclassicism which replaced it stuck as closely as it could to the precise detail of Greece and Rome. By leaning on correctness, it was possible to alleviate the burden of decision. To make the secession from responsibility effective, the copy had to be exact.\textsuperscript{17}

Now it looks as though a second secession from responsibility is taking place. It is not possible today to escape the responsibility of considered action by working within academic styles. But the designer who is unequal to his task, and unwilling to face the difficulty, preserves his innocence in other ways. The modern designer relies more and more on his position as an "artist," on catchwords, personal idiom, and intuition — for all these relieve him of some of the burden of decision, and make his cognitive problems manageable. Driven on his own resources, unable to cope with the compli-
cated information he is supposed to organize, he hides his incompetence in a frenzy of artistic individuality. As his capacity to invent clearly conceived, well-fitting forms is exhausted further, the emphasis on intuition and individuality only grows wilder.\textsuperscript{18}

In this atmosphere the designer's greatest gift, his intuitive ability to organize physical form, is being reduced to nothing by the size of the tasks in front of him, and mocked by the efforts of the "artists." What is worse, in an era that badly needs designers with a synthetic grasp of the organization of the physical world, the real work has to be done by less gifted engineers, because the designers hide their gift in irresponsible pretension to genius.

We must face the fact that we are on the brink of times when man may be able to magnify his intellectual and inventive capability, just as in the nineteenth century he used machines to magnify his physical capacity.\textsuperscript{19} Again, as then, our innocence is lost. And again, of course, the innocence, once lost, cannot be regained. The loss demands attention, not denial.
PART ONE
The ultimate object of design is form.

The reason that iron filings placed in a magnetic field exhibit a pattern — or have form, as we say — is that the field they are in is not homogeneous. If the world were totally regular and homogeneous, there would be no forces, and no forms. Everything would be amorphous. But an irregular world tries to compensate for its own irregularities by fitting itself to them, and thereby takes on form.¹ D'Arcy Thompson has even called form the "diagram of forces" for the irregularities.² More usually we speak of these irregularities as the functional origins of the form.

The following argument is based on the assumption that physical clarity cannot be achieved in a form until there is first some programmatic clarity in the designer's mind and actions; and that for this to be possible, in turn, the designer must first trace his design problem to its earliest functional origins and be able to find some sort of pattern in them.³ I shall try to outline a general way of stating design problems which draws attention to these functional origins, and makes their pattern reasonably easy to see.

It is based on the idea that every design problem begins with an effort to achieve fitness between two entities: the form in question and its context.⁴ The form is the solution to the problem; the context defines the problem. In other words,
when we speak of design, the real object of discussion is not the form alone, but the ensemble comprising the form and its context. Good fit is a desired property of this ensemble which relates to some particular division of the ensemble into form and context.⁵

There is a wide variety of ensembles which we can talk about like this. The biological ensemble made up of a natural organism and its physical environment is the most familiar: in this case we are used to describing the fit between the two as well-adaptedness.⁶ But the same kind of objective aptness is to be found in many other situations. The ensemble consisting of a suit and tie is a familiar case in point; one tie goes well with a certain suit, another goes less well.⁷ Again, the ensemble may be a game of chess, where at a certain stage of the game some moves are more appropriate than others because they fit the context of the previous moves more aptly.⁸ The ensemble may be a musical composition — musical phrases have to fit their contexts too: think of the perfect rightness when Mozart puts just this phrase at a certain point in a sonata.⁹ If the ensemble is a truckdriver plus a traffic sign, the graphic design of the sign must fit the demands made on it by the driver’s eye. An object like a kettle has to fit the context of its use, and the technical context of its production cycle.¹⁰

In the pursuit of urbanism, the ensemble which confronts us is the city and its habits. Here the human background which defines the need for new buildings, and the physical environment provided by the available sites, make a context for the form of the city’s growth. In an extreme case of this kind, we may even speak of a culture itself as an ensemble in which the various fashions and artifacts which develop are slowly fitted to the rest.¹¹
The rightness of the form depends, in each one of these cases, on the degree to which it fits the rest of the ensemble. We must also recognize that no one division of the ensemble into form and context is unique. Fitness across any one such division is just one instance of the ensemble's internal coherence. Many other divisions of the ensemble will be equally significant. Indeed, in the great majority of actual cases, it is necessary for the designer to consider several different divisions of an ensemble, superimposed, at the same time.

Let us consider an ensemble consisting of the kettle plus everything about the world outside the kettle which is relevant to the use and manufacture of household utensils. Here again there seems to be a clear boundary between the teakettle and the rest of the ensemble, if we want one, because the kettle itself is a clearly defined kind of object. But I can easily make changes in the boundary. If I say that the kettle is the wrong way to heat domestic drinking water anyway, I can quickly be involved in the redesign of the entire house, and thereby push the context back to those things outside the house which influence the house's form. Alternatively I may claim that it is not the kettle which needs to be redesigned, but the method of heating kettles. In this case the kettle becomes part of the context, while the stove perhaps is form.

There are two sides to this tendency designers have to change the definition of the problem. On the one hand, the impractical idealism of designers who want to redesign entire cities and whole processes of manufacture when they are asked to design simple objects is often only an attempt to loosen difficult constraints by stretching the form-context boundary.

On the other hand, this way in which the good designer keeps an eye on the possible changes at every point of the
ensemble is part of his job. He is bound, if he knows what he is doing, to be sensitive to the fit at several boundaries within the ensemble at once. Indeed, this ability to deal with several layers of form-context boundaries in concert is an important part of what we often refer to as the designer’s sense of organization. The internal coherence of an ensemble depends on a whole net of such adaptations. In a perfectly coherent ensemble we should expect the two halves of every possible division of the ensemble to fit one another.

It is true, then, that since we are ultimately interested in the ensemble as a whole, there is no good reason to divide it up just once. We ought always really to design with a number of nested, overlapped form-context boundaries in mind. Indeed, the form itself relies on its own inner organization and on the internal fitness between the pieces it is made of to control its fit as a whole to the context outside.

However, since we cannot hope to understand this highly interlaced and complex phenomenon until we understand how to achieve fit at a single arbitrarily chosen boundary, we must agree for the present to deal only with the simplest problem. Let us decide that, for the duration of any one discussion, we shall maintain the same single division of a given ensemble into form and context, even though we acknowledge that the division is probably chosen arbitrarily. And let us remember, as a corollary, that for the present we shall be giving no deep thought to the internal organization of the form as such, but only to the simplest premise and aspect of that organization: namely, that fitness which is the residue of adaptation across the single form-context boundary we choose to examine.13

The form is a part of the world over which we have control, and which we decide to shape while leaving the rest of the
world as it is. The context is that part of the world which puts demands on this form; anything in the world that makes demands of the form is context. Fitness is a relation of mutual acceptability between these two. In a problem of design we want to satisfy the mutual demands which the two make on one another. We want to put the context and the form into effortless contact or frictionless coexistence.

We now come to the task of characterizing the fit between form and context. Let us consider a simple specific case.

It is common practice in engineering, if we wish to make a metal face perfectly smooth and level, to fit it against the surface of a standard steel block, which is level within finer limits than those we are aiming at, by inking the surface of this standard block and rubbing our metal face against the inked surface. If our metal face is not quite level, ink marks appear on it at those points which are higher than the rest. We grind away these high spots, and try to fit it against the block again. The face is level when it fits the block perfectly, so that there are no high spots which stand out any more.

This ensemble of two metal faces is so simple that we shall not be distracted by the possibility of multiple form-context boundaries within it. There is only one such boundary worth discussion at a macroscopic level, that between the standard face (the context), and the face which we are trying to smooth (the form.) Moreover, since the context is fixed, and only the form variable, the task of smoothing a metal face serves well as a paradigm design problem. In this case we may distinguish good fit from bad experimentally, by inking the standard block, putting the metal face against it, and checking the marking that gets transferred. If we wish to judge the form
without actually putting it in contact with its context, in this case we may also do so. If we define levelness in mathematical terms, as a limitation on the variance which is permitted over the surface, we can test the form itself, without testing it against the context. We can do this because the criterion for levelness is, simultaneously, a description of the required form, and also a description of the context.

Consider a second, slightly more complex example. Suppose we are to invent an arrangement of iron filings which is stable when placed in a certain position in a given magnetic field. Clearly we may treat this as a design problem. The iron filings constitute a form, the magnetic field a context. Again we may easily judge the fit of a form by placing it in the magnetic field, and watching to see whether any of the filings move under its influence. If they do not, the form fits well. And again, if we wish to judge the fit of the form without recourse to this experiment, we may describe the lines of force of the magnetic field in mathematical terms, and calculate the fit or lack of fit. As before, the opportunity to evaluate the form when it is away from its context depends on the fact that we can give a precise mathematical description of the context (in this case the equations of the magnetic field).

In general, unfortunately, we cannot give an adequate description of the context we are dealing with. The fields of the contexts we encounter in the real world cannot be described in the unitary fashion we have found for levelness and magnetic fields. There is as yet no theory of ensembles capable of expressing a unitary description of the varied phenomena we encounter in the urban context of a dwelling, for example, or in a sonata, or a production cycle.

Yet we certainly need a way of evaluating the fit of a form
which does not rely on the experiment of actually trying the form out in the real world context. Trial-and-error design is an admirable method. But it is just real world trial and error which we are trying to replace by a symbolic method, because real trial and error is too expensive and too slow.

The experiment of putting a prototype form in the context itself is the real criterion of fit. A complete unitary description of the demands made by the context is the only fully adequate nonexperimental criterion. The first is too expensive, the second is impossible: so what shall we do?

Let us observe, first of all, that we should not really expect to be able to give a unitary description of the context for complex cases: if we could do so, there would be no problems of design. The context and the form are complementary. This is what lies behind D'Arcy Thompson's remark that the form is a diagram of forces.14 Once we have the diagram of forces in the literal sense (that is, the field description of the context), this will in essence also describe the form as a complementary diagram of forces. Once we have described the levelness of the metal block, or the lines of force of the magnetic field, there is no conceptual difficulty, only a technical one, in getting the form to fit them, because the unitary description of the context is in both cases also a description of the required form.

In such cases there is no design problem. What does make design a problem in real world cases is that we are trying to make a diagram for forces whose field we do not understand.15 Understanding the field of the context and inventing a form to fit it are really two aspects of the same process. It is because the context is obscure that we cannot give a direct, fully
coherent criterion for the fit we are trying to achieve; and it is also its obscurity which makes the task of shaping a well-fitting form at all problematic. What do we do about this difficulty in everyday cases? Good fit means something, after all — even in cases where we cannot give a completely satisfactory fieldlike criterion for it. How is it, cognitively, that we experience the sensation of fit?

If we go back to the procedure of leveling metal faces against a standard block, and think about the way in which good fit and bad fit present themselves to us, we find a rather curious feature. Oddly enough, the procedure suggests no direct practical way of identifying good fit. We recognize bad fit whenever we see a high spot marked by ink. But in practice we see good fit only from a negative point of view, as the limiting case where there are no high spots.

Our own lives, where the distinction between good and bad fit is a normal part of everyday social behavior, show the same feature. If a man wears eighteenth-century dress today, or wears his hair down to his shoulders, or builds Gothic mansions, we very likely call his behavior odd; it does not fit our time. These are abnormalities. Yet it is such departures from the norm which stand out in our minds, rather than the norm itself. Their wrongness is somehow more immediate than the rightness of less peculiar behavior, and therefore more compelling. Thus even in everyday life the concept of good fit, though positive in meaning, seems very largely to feed on negative instances; it is the aspects of our lives which are obsolete, incongruous, or out of tune that catch our attention.

The same happens in house design. We should find it almost
impossible to characterize a house which fits its context. Yet it is the easiest thing in the world to name the specific kinds of misfit which prevent good fit. A kitchen which is hard to clean, no place to park my car, the child playing where it can be run down by someone else’s car, rainwater coming in, overcrowding and lack of privacy, the eye-level grill which spits hot fat right into my eye, the gold plastic doorknob which deceives my expectations, and the front door I cannot find, are all misfits between the house and the lives and habits it is meant to fit. These misfits are the forces which must shape it, and there is no mistaking them. Because they are expressed in negative form they are specific, and tangible enough to talk about.

The same thing happens in perception. Suppose we are given a button to match, from among a box of assorted buttons. How do we proceed? We examine the buttons in the box, one at a time; but we do not look directly for a button which fits the first. What we do, actually, is to scan the buttons, rejecting each one in which we notice some discrepancy (this one is larger, this one darker, this one has too many holes, and so on), until we come to one where we can see no differences. Then we say that we have found a matching one. Notice that here again it is much easier to explain the misfit of a wrong button than to justify the congruity of one which fits.

When we speak of bad fit we refer to a single identifiable property of an ensemble, which is immediate in experience, and describable. Wherever an instance of misfit occurs in an ensemble, we are able to point specifically at what fails and to describe it. It seems as though in practice the concept of good fit, describing only the absence of such failures and hence
leaving us nothing concrete to refer to in explanation, can only be explained indirectly; it is, in practice, as it were, the disjunction of all possible misfits.\textsuperscript{16}

With this in mind, I should like to recommend that we should always expect to see the process of achieving good fit between two entities as a negative process of neutralizing the incongruities, or irritants, or forces, which cause misfit.\textsuperscript{17}

It will be objected that to call good fit the absence of certain negative qualities is no more illuminating than to say that it is the presence of certain positive qualities.\textsuperscript{18} However, though the two are equivalent from a logical point of view, from a phenomenological and practical point of view they are very different.\textsuperscript{19} In practice, it will never be as natural to speak of good fit as the simultaneous satisfaction of a number of requirements, as it will be to call it the simultaneous nonoccurrence of the same number of corresponding misfits.

Let us suppose that we did try to write down a list of all possible relations between a form and its context which were required by good fit. (Such a list would in fact be just the list of requirements which designers often do try to write down.) In theory, we could then use each requirement on the list as an independent criterion, and accept a form as well fitting only if it satisfied all these criteria simultaneously.

However, thought of in this way, such a list of requirements is potentially endless, and still really needs a "field" description to tie it together. Think, for instance, of trying to specify all the properties a button had to have in order to match another. Apart from the kinds of thing we have already mentioned, size, color, number of holes, and so on,
we should also have to specify its specific gravity, its electrostatic charge, its viscosity, its rigidity, the fact that it should be round, that it should not be made of paper, etc., etc. In other words, we should not only have to specify the qualities which distinguish it from all other buttons, but we should also have to specify all the characteristics which actually made it a button at all.

Unfortunately, the list of distinguishable characteristics we can write down for the button is infinite. It remains infinite for all practical purposes until we discover a field description of the button. Without the field description of the button, there is no way of reducing the list of required attributes to finite terms. We are therefore forced to economize when we try to specify the nature of a matching button, because we can only grasp a finite list (and rather a short one at that). Naturally, we choose to specify those characteristics which are most likely to cause trouble in the business of matching, and which are therefore most useful in our effort to distinguish among the objects we are likely to come across in our search for buttons. But to do this, we must rely on the fact that a great many objects will not even come up for consideration. There are, after all, conceivable objects which are buttons in every respect except that they carry an electric charge of one thousand coulombs, say. Yet in practice it would be utterly superfluous, as well as rather unwieldy, to specify the electrostatic charge a well-matched button needed to have. No button we are likely to find carries such a charge, so we ignore the possibility. The only reason we are able to match one thing with another at all is that we rely on a good deal of unexpressed information contained in the statement of the task, and take a great deal for granted.20
In the case of a design problem which is truly problematical, we encounter the same situation. We do not have a field description of the context, and therefore have no intrinsic way of reducing the potentially infinite set of requirements to finite terms. Yet for practical reasons we do need some way of picking a finite set from the infinite set of possible ones. In the case of requirements, no sensible way of picking this finite set presents itself. From a purely descriptive standpoint we have no way of knowing which of the infinitely many relations between form and context to include, and which ones to leave out.

But if we think of the requirements from a negative point of view, as potential misfits, there is a simple way of picking a finite set. This is because it is through misfit that the problem originally brings itself to our attention. We take just those relations between form and context which obtrude most strongly, which demand attention most clearly, which seem most likely to go wrong. We cannot do better than this. If there were some intrinsic way of reducing the list of requirements to a few, this would mean in essence that we were in possession of a field description of the context: if this were so, the problem of creating fit would become trivial, and no longer a problem of design. We cannot have a unitary or field description of a context and still have a design problem worth attention.

In the case of a real design problem, even our conviction that there is such a thing as fit to be achieved is curiously flimsy and insubstantial. We are searching for some kind of harmony between two intangibles: a form which we have not yet designed, and a context which we cannot properly describe. The only reason we have for thinking that there must be some
kind of fit to be achieved between them is that we can detect incongruities, or negative instances of it. The incongruities in an ensemble are the primary data of experience. If we agree to treat fit as the absence of misfits, and to use a list of those potential misfits which are most likely to occur as our criterion for fit, our theory will at least have the same nature as our intuitive conviction that there is a problem to be solved.

The results of this chapter, expressed in formal terms, are these. If we divide an ensemble into form and context, the fit between them may be regarded as an orderly condition of the ensemble, subject to disturbance in various ways, each one a potential misfit. Examples are the misfits between a house and its users, mentioned on page 23. We may summarize the state of each potential misfit by means of a binary variable. If the misfit occurs, we say the variable takes the value 1. If the misfit does not occur, we say the variable takes the value 0. Each binary variable stands for one possible kind of misfit between form and context.\textsuperscript{22} The value this variable takes, 0 or 1, describes a state of affairs that is not either in the form alone or in the context alone, but a relation between the two. The state of this relation, fit or misfit, describes one aspect of the whole ensemble. It is a condition of harmony and good fit in the ensemble that none of the possible misfits should actually occur. We represent this fact by demanding that all the variables take the value 0.

The task of design is not to create form which meets certain conditions, but to create such an order in the ensemble that all the variables take the value 0. The form is simply that part of the ensemble over which we have control. It is only through the form that we can create order in the ensemble.