

THE
NATURE
OF
ORDER

*An Essay on the Art of Building
and
The Nature of the Universe*

CHRISTOPHER ALEXANDER

BOOK TWO

THE PROCESS OF
CREATING LIFE

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THE
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LIFE

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AUTHOR'S NOTE

THE CONCEPT OF LIVING STRUCTURE

In order to provide a background for Book 2, it is necessary to summarize what I have, I believe, accomplished in Book 1, *THE PHENOMENON OF LIFE*.

The basic idea is this: *Throughout the world, in the organic as in the inorganic, it is possible to make a distinction between living structure and non-living structure.* In nature, most structures which appear (whether organic or inorganic) are living structures to a fairly high degree. This is a class of structures which does not pertain exclusively to organisms or organic life. It is a more general class of structures, existing within the very much vaster class of all possible three-dimensional structures.

As I use it, the term "living" applied to structure is always a matter of degree. Strictly speaking, every structure has some degree of life. The main accomplishment of Book 1 is in making this distinction precise, in providing empirical methods for observing and measuring degree of life as it occurs in different structures. Perhaps most important, I gave in Book 1 a partly mathematical account of living structure, so that we may see the content of living structure, its functional and geometric order, as an established and objective feature of reality.

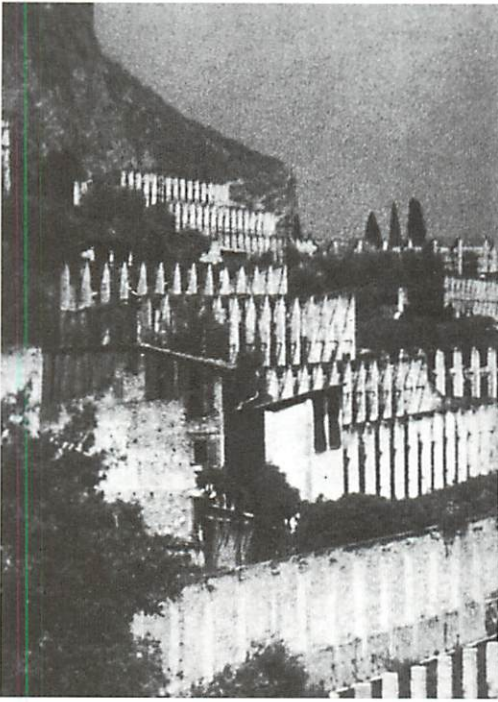
In nature, almost *everything* has living structure: waves, sand, rocks, forests, thunderstorms, birds, snakes, and moss. That is why, I think, scientists have not previously drawn attention to the existence of the class of living structures, nor to the distinction between living and non-living structure. It has not, in physics, or geology, or biology, or chemistry, so far been a necessary distinction.

In primitive society builders also needed no distinction, because within the processes available to them, nearly everything made by people had living structure, just as systems in nature do. By and large, traditional builders, even as recently as a hundred years ago, also still made buildings, fields, and artifacts which had living structure.

But in the past century, we have, for the first time, become able to conceive, design, make, manufacture, and produce non-living structure: kinds of things, arrangements of matter, buildings, roads, artifacts which do not belong to the class of living structures and which, for the first time, focus our attention on the distinction.

Thus the objects, buildings, and landscapes created by human beings in the past century have, very often, been outside the class of living structures. More exactly, they are often systems with significantly low levels of living structure, much lower than occurs in nature. That is something new in human history.

For reasons which will become clear in the next chapters, I believe that many of these new artifacts and buildings — including, for instance, the apparently harmless developer-inspired motels of our era or our mass housing projects — are structures which can be *thought*, invented, created artificially, but they cannot be generated by a nature-like *process* at all. Thus they are, structurally speaking, monsters. They are not merely unappealing and strange. They belong, objectively, to a class of non-living structures, or less living structures, and have thus, for the first time, introduced a type of structure on earth which nature itself could not, in principle, create.



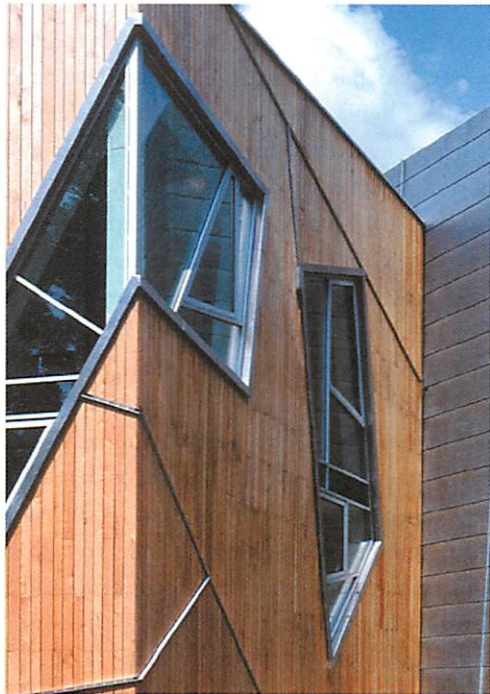
Living structure: Lemon groves, Lake Garda



Non-living structure: Technology center, Amsterdam



Living structure: Shelter for the homeless, San Jose



Non-living structure: Nussbaum museum, Osnabrück

It is this event which has stimulated my investigation into these structures, and encouraged me to attempt a definition of the difference between living and non-living structure. The distinction compels attention because — if the arguments I have put forward in Book 1 are legitimate — it is important that we, as a people on Earth, learn to create our towns, buildings and landscapes so that they too — like nature — are living structures, and so that our artificial world is then a nature-like system. As I have suggested in Book 1, the consequences of living our daily lives and maintaining human society in a world composed chiefly of non-living structure, are nearly catastrophic.

But I am jumping ahead of myself, since

what I have just said already depends on the conclusions of this book. My present starting point is simply this: there is such a thing as living structure, and there is an objective distinction between systems which have relatively *more* living structure and systems which have relatively *less* living structure.

The distinction has been brought to the fore by the history of 20th-century design and construction, which forced our attention — for the first time — on the fact that not all structures made by human beings are living ones.

The question is, How is living structure to be made by human beings? What kind of human-inspired processes can create living structure?



REAL LIFE CREATED BY A PROCESS IN THE CARIBBEAN

In the photograph opposite, we see a situation which would, normally, be classified as poverty. The houses are rudimentary, the road is roughly paved, two of the men are barefoot. Yet for all its poverty, which is certainly real, we can detect the residue of living process in this scene. The men are happy, evidently. They are talking and smiling and dreaming with quiet enjoyment. The road goes just where it is needed. It interferes little with the land, and leaves it harmonious. The houses, made of wood and corrugated iron, are placed in convenient spots, the right distance apart, making a lively spot between. The vegetation of the mountain is largely untouched. In this scene — both in its human happiness and in its architecture — we see a case of wonderful life. We see the impact of hundreds of acts, done by different people, making a living street where, rich or poor, people are truly comfortable. The ordinary old porch, steps, windows, and doors — how pleasant the way they sit with the street. One man sits happily, half on his side, comfortable, looking at his friend, and leaning on the ground. The trees, the columns, the deck chair, the tree branches have all happened step by step, with the

hardly conscious adaptation of each fence-post, path, seedling, each season of painting. Buildings and plants, even the people with them, have unfolded together, making something comfortable, ordinary, and profound.

It should be repeated again and again, and understood, that the capacity of a society to create living structure in its architecture is a dynamic capacity which depends on the nature and character of the processes used to create form, and to create the precise sequence and character of the unfoldings that occur during the daily creation of building form and landscape form and street form.

For this purpose I shall, in the chapters of this book, move from the technical language of structure-preserving process to the broader and more intuitive language of living process. I shall define a living process as any process that is capable of generating living structure. But, as we shall see in the book, the concept — and its implementation — require a wider and more everyday understanding of what is involved, an understanding which fits with the daily acceptance of day-to-day process and generic process — in



Ease of living, Guadeloupe, French West Indies. Modesty of means matters much less when the environment has grown in support of ordinary things. Here there is charm, comfort, joyfulness in the buildings as a part of life.

short, one that can be compatible with everyday individual and social process and with the institutionalized process of professions like architecture, and of the other social activities which play a major role in shaping the environment.

Above all, the living processes which I shall describe, are — as it turns out — enormously

complex. The idea that all living processes are structure-preserving turns out to be merely the tip of a very large iceberg of hidden complexity. The subject of living process is a topic of great richness, which is likely to keep us occupied for centuries as we try to master its variety of meanings and its attributes and potentialities.



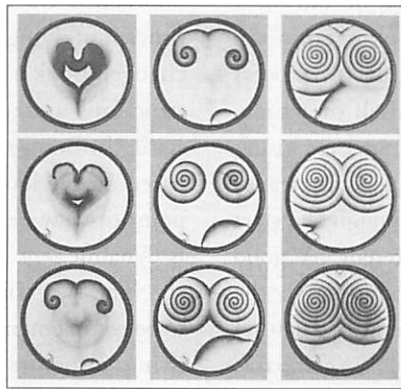
A SOURCE OF LIFE

All this will have direct meaning in the world around us. If carried out, it will change our conception of our own life, and of our world. Above all it will change the character of our results. What may appear superficially as an informal, relaxing, rambling roughness of the Caribbean photograph is actually a far deeper order than the norm. It is what we experience as *life*. That is where real stories are made; where human beings experience a measure of the freedom, and difficulty, and incongruity of being human. It is not hard to be at ease in such places. They invite us to be what we are, and they allow us to be what we are.

It must be recognized that — morphologically speaking — to generate such complexity is a different task from generating the lifeless hulks portrayed in chapter 4, which have been the aspirations of too many clients and developers and architects in the modern age. This real life is an *entirely* different matter. The means needed to create this real life, to create living structure in the true meaning of the word — that has an order of difficulty we architects have almost never contemplated yet. Indeed, the small example of the street in Guadeloupe gives only a tiny glimpse of the true nature of complexity.

PREFACE

ON PROCESS



*The Belousov-Zhabotinski process
See chapter 1*



1 / A DYNAMIC VIEW OF ORDER

In Book 1, I tried to rearrange our definition of architectural order in such a way that it forms a basis for a new view of living structure in buildings and landscapes, escaping from the mechanistic dilemma.¹

Book 1 invited us to see the world around us — buildings, plants, a painting, our own faces and hands — as field-like structures with centers arranged in a systematic fashion and interacting within the whole. When a structure is living we will feel the echo of our own aliveness in response to it.² Book 2 takes the necessary next step of investigating the process of how living structure creates itself over time. A child becomes an adult without ever losing uniqueness or completeness. An acorn transforms smoothly into an oak, although the start and endpoint are radically different. A good building or city will unfold according to the living processes that generate living structure. What I describe throughout Book 2 is a comparably new view of architectural process, with a focus on architectural processes that are capable of generating living structure. It is my hope that a world of architecture, more suitable for human life, will emerge from this new view of living process and of what process is.

Book 2 invites us to reconsider the role and

importance of process and how it is living or not. It is about the fact that order cannot be understood sufficiently well in purely static terms because there is something *essentially* dynamic about order. Living structure can be attained in practice, and will become fully comprehensible and reachable, only from a dynamic understanding. Indeed *the nature of order is interwoven in its fundamental character with the nature of the processes which create the order.*

When we look at order dynamically, the concept of living structure *itself* undergoes some change. Book 1 focused on the idea of *living* structure, and the viewpoint was geometric, static. In Book 2, I start with a second concept, based on the idea of an *unfolded* structure. The point of view — even for the structure itself — is dynamic.

The two conceptions of structure turn out to be complementary. In the end we shall see that living structure and unfolded structure are equivalent. All living structure is unfolded and all unfolded structure is living. And I believe the concept of an *unfolded* structure is as important, and should play as essential a role in architecture, as the concept of *living* structure. Thus we shall end up with two equivalent views — one static, one dynamic — of the same idea.



2 / THE NECESSARY ROLE OF PROCESS

The task of architecture may be simply stated. We seek to make a living architecture: that means an architecture in which every part, every building, every street, every garden, is alive. It has tens of thousands of living centers in it. It has rooms, gardens, windows, each with their own life. It has stairs, passages, entrances, terraces,

columns, column capitals, arches. In a living environment, each of these individual places is a living center in its own right. The window is a glorious living center with light, comfort, view, and so on. The window sill is a living center, with shape, seat, a place for a vase of flowers. Even the smallest part of the most insignificant

room, a forgotten corner, has the quality of a living center. Even the smallest part of the physical structure, a brick, the mortar between two bricks, the joint of one piece of wood with another, also has this living character.³

What process can accomplish the subtle and beautiful adaptation of the parts that will create a living architecture? In a certain sense, the answer is simple. We have to make — or generate — the ten thousand living centers in the building, one by one. That is the core fact. And the ten thousand centers, to be living centers, must be beautifully adapted to one another within the whole: each must fit the others, each must contribute to the others, and the ten thousand centers then — if they are truly living — must form a coherent and harmonious whole.

It is generally assumed that doing all this well is the proper work of an architect. This is what an architect is supposed to do. It is what an architect is trained to do. And — in theory — it is what an architect knows how to do. There is a general belief that *how* it is done by the architect and others is part of the mystery of the art; one does not ask too many questions about it. Questions about *how* it is best done — by what process — are rarely raised. Yet in this book I shall argue that careful thought about the adaptation problem shows that it *can* only be done successfully, when following a certain very *par-*

ticular kind of process. This does not mean that there is one ideal process which must be used. There are many thousands of different processes which can succeed. But to succeed, these processes must meet definite conditions — defined in the chapters which follow. Processes which meet these conditions, even though there may be thousands of them, are limited. They are rare and precious, compared with the millions upon millions of processes which are used daily for conceiving, designing, and building by architects and builders all over the world.

Many of the processes used today, sadly, are nearly *bound* to fail. We see the results of this failure all around us. The lifeless buildings and environments which have become common in modern society are not merely dead, non-living, structures. They are what they are precisely because of the social *processes* by which they have been conceived, designed, built, and paid for. No matter how skillful the architects, no matter how gifted, no matter how profound their powers of design — if the process used is wrong, the design cannot save the project.

Thus we shall see that processes (both of design and of construction) are more important, and larger in their effect on the quality of buildings, than the ability or training of the architect. *Processes* play a more fundamental role in determining the life or death of the building than does the “*design*.”⁴



3 / ORDER AS BECOMING

In many sciences, it has become commonplace to consider process as an inescapable part of order. In physics, for example, forces themselves are now seen as processes, and the structure we observe in the world of atoms and electrons is known to come about as a result of the continuous play of subatomic processes defined by quantum mechanics.⁵ In biology, the structure of an organism is understood to be inseparable from

the process which creates and maintains it: an animal, at any instant, is the ongoing result of certain genetically controlled processes which create the organism to begin with, and which continue to create that organism throughout its life. A cloud is a transitory by-product of the condensation of water in the atmosphere. The waves of the ocean are the flowing product of the process of interaction between wind and water.

The sand ripples in the Sahara are the product of the process by which the wind takes sand, picks it up, and drops it. The mountain is the temporary product of the folding and heaving of the earth. The flower is the temporary product of the unfolding of the bud and seed pod under the driving influence of DNA. In each case, the whole system of order we observe is only an instantaneous cross section, in time, of a continuous and ongoing process of flux and change.

These insights originated 2,500 years ago with Heraclitus and his assertion that we can never step into the same river twice. But arriving at this understanding in modern science has been a difficult affair. D'Arcy Wentworth Thompson, describing the origins of biological form in 1917 as a necessary result of biological growth, had to struggle intellectually, showing again and again by example that biological form could only be understood as a product of the growth process.⁶

Much more recently, the physicist Ilya Prigogine took decades, and many books and papers, to show that physics must be understood as a directional process — and that the way classical physics viewed phenomena without the orientation of time was fundamentally at odds with

reality and was incapable, therefore, of describing some of the most important physical phenomena. As Prigogine wrote in 1980: “*in classical physics change is nothing but a denial of becoming and time is only a parameter, unaffected by the transformation that it describes.*”⁷

Now, at the turn into the 21st century, the “process” insight has finally arrived in most scientific disciplines. Gradually, a modern view has come into focus where we understand that it is the transformations from moment to moment which govern order in a system.

However, despite the great progress made in many sciences and humanities, the concept of process has not yet become a normal part of the way we think about architecture. The words Prigogine used in 1980, criticizing mainstream 20th-century physics, could still be applied equally to contemporary mainstream architecture. *Our current view of architecture rests on too little awareness of becoming as the most essential feature of the building process.* Architects are much too concerned with the design of the world (its static structure), and not yet concerned enough with the design of the generative processes that create the world (its dynamic structure).



4 / PROCESS, THE KEY TO MAKING LIFE IN THINGS

I think of my friend Bill McClung making his meadows in the hills of Berkeley.⁹ The near-wasteland of brush and eucalyptus, an overgrown and damaged landscape on the fringes of Berkeley becomes under his hand, something beautiful, alive.

Day after day, he goes up, gathers wood. He cuts poison oak and brush and thorn. He mows grassland, takes out bushes which have overgrown, takes out a tree which prevents another tree from having the light, from having its magnificence. He makes a pathway where I can walk, where he can walk.

Gradually, by cutting and removing, with a careful eye, he forms meadow: patches of grassland where the light falls, bounded by trees, looking toward a landscape, looking out toward the bay.

From something nearly destroyed, beautiful patches of land are formed. He clears the land of that scrub which makes the land too vulnerable to fire. He opens it, concentrates its beauty. Under the hand of this embellishment, each part becomes better; its uniqueness is preserved; its character intensified.

When he is done, each meadow has a different character. Each is ordinary, but a jewel,



Meadow in the Berkeley hills, mown and taken care of by Bill McClung, 1996

an individual jewel. The fabric of the jewel-like living meadows all together, if he succeeds, will cover the ridge of the Berkeley hills.

When I ask him what makes him keep doing it, he answers, “The knowledge that I am making life: that something living is being enhanced. That keeps us inspired. It makes it worthwhile. It is a tremendous thing.”

But then I ask him, pushing, “Isn’t it really more the actual pleasure of each day? You go, and go again, because each day, each hour, is satisfying. It is simple work. You enjoy the sunshine, the open air, the physical sweat of carrying, and cutting. The smell of the grass as it opens up, the dog running in the grass, the comments of the neighbors.” And there is also the feeling of community, as people living near this bit of park begin to recognize Bill as a fixture, hope that he will keep on coming back; they appreciate what he does. His act makes him part of a community. And most of all, it is just pleasant, worth living for. The hours and minutes spent are rewarding in themselves.

I ask him if this pleasure in the process he is following is not worth almost more than the

knowledge that he is making something come to life? He acknowledges my comment and admits, “Yes, this daily ordinary thing is almost more important than the other.”

But it is the two together: the daily pleasure, breathing in the smell of the newly cut grass, with the deeper knowledge that goes with it that in this process he is making a living structure, up there on the ridge of the Berkeley hills.

On the other hand, processes which work against the existing life of a place, which fragment it, ignore it, cut across it, do damage. Even when they only *ignore* the wholeness or defy it with the best intentions, damage is done, disorder begins to occur. And as we watch the progress of the world, its growth, its change, we find that various acts—coming either from outside or from inside the thing itself—may be helpful or unhelpful to this wholeness which exists. This happens because the wholeness of any given thing may be helped or hindered by the character of the parts which it contains.

Once we recognize the possibility that some centers will be helpful to the life of an existing wholeness, while others will be antagonistic to



A 15th-century Hispano-Moresque tile, made by the cuerda seca technique, the use of rope to form the lines

it, we then begin to recognize the possibility of a highly complex kind of self-consistency in any given wholeness. The various centers within a wholeness may be in harmony with one another in different degrees, or at odds with one another in different degrees. And this is where the degree of life, or degree of value, in any given thing comes from.

Thus we see that each given wholeness has a certain history: the wholeness becomes more valuable if the history allows this wholeness to unfold in a way that is considerate, respectful, of the existing structure, and less valuable if the steps which are taken in the emergence of the wholeness are antagonistic to the existing structure.

What is fascinating, then, is the hint of a conception of value which emerges dynamically from respect for existing structure. We do not need any arbitrary or external criterion of value. The value exists within the unfolding of the wholeness itself. When the wholeness unfolds unnaturally, value is destroyed. When the wholeness unfolds naturally, value is created.

That is the origin of living structure.

Look at this Hispano-Moresque tile of the 15th century. When we first look at it, we see a beautiful design, harmonious, orderly, well-conceived, beautiful space and color. In contemporary terms, all this would appear to be part of the design of the tile, since it is the geometry of the finished tile, it seems to us, that causes this. We think of its beauty as a result of design.

But when I handled this tile, looked at its surface, held its weight, looked at the glaze, and started to ask myself how I would make a tile like this, the thing took on quite a different character. I saw that the particular lines of the design are formed by raised ridges in the clay. The separate colors of the different glazes are kept separate by these ridges, so that the liquid glaze, at the temperature of the kiln, cannot "run." As I thought more about how to do it — if I were actually making such a tile — I began to see that the sharp, almost hard design, the brilliant separation of glazes which makes the colors beautiful, and even the design itself, the character of straightness, curvature, and the formal quality of the line, are all by-products of a



San-ju-san Gen Do, temple of the thirty-three bays, Kyoto, 13th century. Here, too, the beauty of this building, the wonderful harmony of its construction, arise as value that appears in the process of craft, from a gently unfolding wholeness. The unfolding of the woodwork is so complex, and yet so pure, that it reaches great spiritual depths.

particular kind of process which must be used to make such a tile.

I believe the design was made by laying thick rope into the soft clay. It is the *rope* which allowed the maker form such complex shapes, with perfect parallel lines, and perfect half-round troughs. In my studio my assistant went further to understand how it had been done, and made a clay impression of the tile's surface in reverse. This reverse — a raised embossed impression taken in modeling clay — was even more impressive, and more beautiful than the tile itself. I realized that this — the negative impression — must have been the actual thing which the maker made, and that the tile was then cast from it in clay.

The further I went to understand the actual process which had been used to make the tile, the more I realized that it was this *process*, more than anything, which governs the beauty of the design. Perhaps nine-tenths of its character, its beauty, comes simply from the process that the maker followed. The design, what we nowadays



Interior, San-ju-san Gen Do, Kyoto. The interior is empty, except for one thousand golden Buddhas, carved, carefully placed, and revered.

think of as the design, followed. It was almost a residue from the all-important process. The design is indeed beautiful, yes. But it can only be made as beautiful as it is within the technique, or process, used to make it. And once one uses this technique, the design — what appears as the sophisticated beauty of the design — follows almost without thinking, just as a result of following the process.

If you do not use this technique — process — you cannot create a tile of this design. An attempt to follow the same drawing, but with different techniques, will fall flat on its face. And if I change the technique (process), then the design must change, too. This design follows almost without effort from this *technique*. It is the process, not the design, that is doing all the hard work, and which is even paving the way for the design.

Thus the making, the physical processes of shaping, carving, drying, glazing, and firing the tile, are the ways in which this tile gets its form, its life, even its design. The “design” of this beautiful work is not more than a tenth of what gives it its

life. Nine-tenths come from the process. We see the same phenomenon in a far more complex work from 13th-century Kyoto. In San-ju-san Gen Do, the temple of the thirty-three bays, we see the imprint of years, the imprint of care in the pieces of wood that have been lovingly matched to their position so well that seven hundred years later they still impress the heart. It is the mark of the plane on the wood which makes the wood, hundreds of years later, touch our hearts. It is the process used by the temple priests to lay out the foundations and cornerstones which places the building so beautifully in the land. It is the care of the goldsmith — the carving process and the carving tools, the process of making the mold — which gives each of the one thousand buddhas its unique personality, yet allows it to be ultimately the same and so, capable of teaching us, through one thousand manifestations, that we feel the true nature of all things.

This gradual rubbing together of phenomena to get the right result, the slow process of getting things right, is almost unknown to us today.



5 / OUR MECHANIZED PROCESS

During the 20th century, we became used to something very different.

Consider the “normal” building process we have become used to in recent decades. A client specifies a program in which building areas are mechanically set out as requirements. In the case of a large building, this program is then made more precise (and often more rigid) by a professional programmer who sets it forth arithmetically in a table of square footages. An architect designs the building at a drawing table and is held to the program, rigidly, not to the evolving whole. The drawings are then checked by an engineer who is separate from the process and responsible for making the building stand up. A soils engineer very possibly works out the foun-

dition, separately again. The final engineering drawings are then checked by a building inspector and by a zoning officer — again a separate process. In many cases, the zoning officer who checks them has not been to the site. Even if the officer has done a site visit, he or she has little or no authority to create any coherent relation between the building and the site, in relation to the site’s special conditions. Once the drawings are approved, they are sent out to bid, by a contractor who has not been part of the design process, looks only at the drawings, but shares none of the vision. The drawings are also checked by a bank. The individual parts of the drawings may be sent out to bid by subcontractors, who are even more remote from the task at hand. Many of the ob-

jects, components, which will be used in the construction of the building are factory-made. They have been designed and constructed with no knowledge of the building at all; they are mentally and factually separate from its existence, but are brought into play only by a process of assembly.

During the building process, corrections cannot be made without huge expense to the client. Thus the assembly process is insensitive to almost any new wholeness which appears during construction. The landscape work is done by a separate architect, who specializes in plants. The actual gardening — that is, the preparation of the ground, planting of trees, flowers — is done by yet another person acting under orders, and once again contractually removed from the human feeling, light, and action of the building.

The interior, very often, is done by yet *another* person — an interior decorator. This person, *again* remote from any previous reality, will also assemble pre-constructed components and modules to try and produce a whole. But the elements are, at the end, almost inevitably separate and cold in feeling, harsh in content, without origin in human meaning. They do not reflect the feelings of the building's occupants; nor do they arise naturally from the wholeness of the building shell and from the seeds of a direction which that shell already contains. Even the building's paint is often applied as an afterthought, as if it were an independent act. And the very paint, itself, is once again chosen from among a system of mechanically component-like colors, none of which was conceived in the context of the building, but which exist, precooked, in a catalog.

Present-day town-planning practice — mainly based on zoning — is equally mechanical in character. It is largely independent of the people most directly affected, and is controlled by appointed officials, who often do not even visit the site where a particular building is to be built. The zoning ordinance — a map of an imaginary future, used as a control device — is prepared by others. The process is based, in considerable part, on the needs of the developer-controlled,

profit-oriented marketplace, and on the assumption that agreement about deep value is impossible in principle. Achievement of subtle or spiritual character in a town under these conditions — which are a large-scale replica of the conditions surrounding smaller-scale mechanical building process — is once again hardly possible.

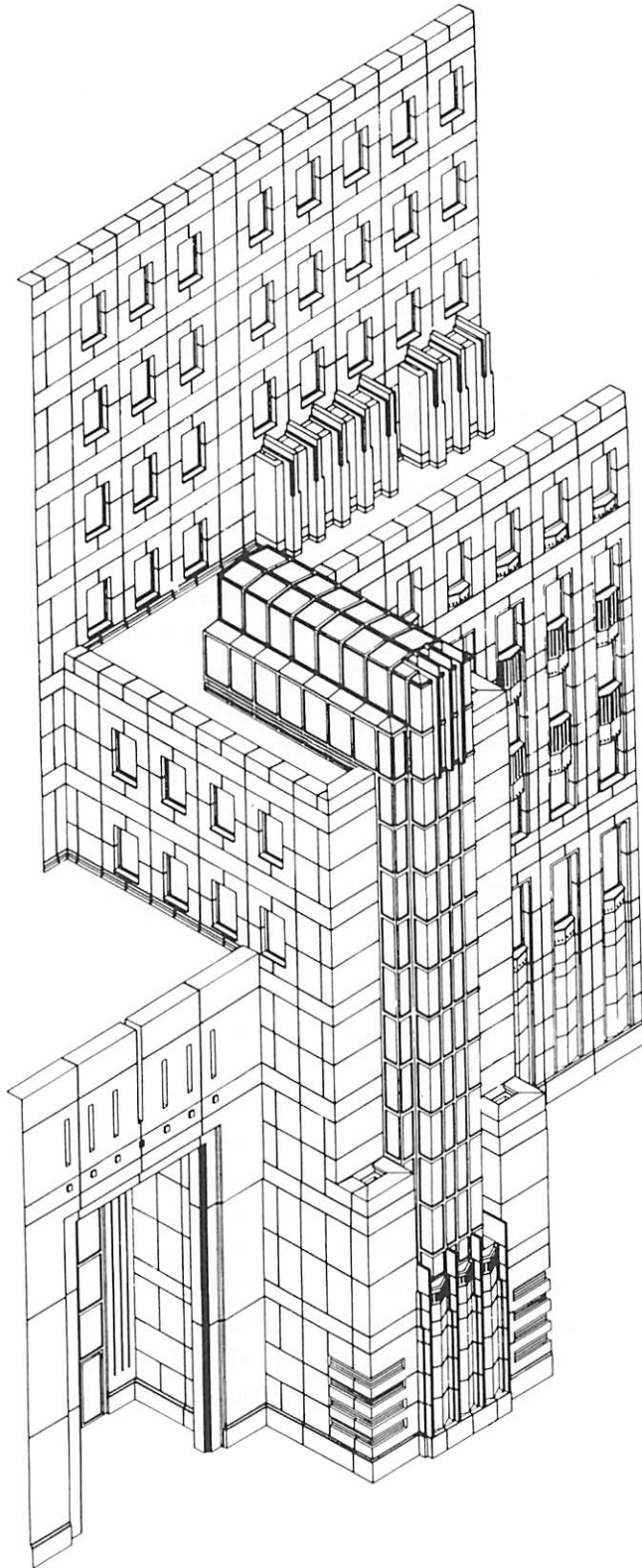
You might say of these examples, "But this surely is all process. Isn't that good?" The trouble is that it is *mechanical* process only, something which subverts the inner fire of true living process.

In a mechanistic view of the world, we see all things, even if only for convenience, as machines. A machine is intended to accomplish something. It is, in its essence, goal-oriented. Like machines, then, within a mechanistic view processes are always seen as aimed at certain ends. We think of things by the end-state we want, and then ask ourselves how to get there.

This mistake was widespread in the 20th century. For example, in the extreme 20th-century view of some mechanistic sociology, even kindness might have been seen as a way of achieving certain results: part of a bargain, or a social contract, which had the purpose of *getting* something.¹⁰

Real kindness is something quite different, something valuable in *itself*. It is a true process, not guided by the grasp for a goal, but guided by the minute-to-minute necessity of caring, dynamically, for the feelings and well-being of another. This is not trivial, but deep; sincerely related to human feeling; and not predictable in its end-result, because the end-result is not a goal. Unlike the goal-oriented picture, which is imposed intellectually on our substance as persons, real kindness is a process true to our essential human instinct and to our knowledge of what it means to be a person. But the machine-age view showed a process like kindness as being oriented toward a *goal*, just as every machine too has its purpose — its goal, what it is intended to produce.

Like the mechanical 20th-century view of kindness, the 20th-century mainstream view of



Our mechanized process: a building designed and made by a process which is mechanical

ON PROCESS



Our mechanized process: a building planned and designed and made by a process which is not only mechanical technically, but which is also mechanical in human terms, bureaucratic and corporate

building was goal-oriented and mechanistic, aimed mainly at end-results, not on the inner good of processes. Building was viewed as a necessary way to achieve a certain end-result. The design drawn by the architect — the master plan drawn by the planner — was the purpose, these were the goals of the art. The process of getting to the goal was thought to be of little importance in itself, except insofar as it attained (or failed to attain) the desired goal.

The mechanistic view of architecture we have learned to accept in our era is crippled by this overly-simple, goal-oriented approach. In the mechanistic view of architecture we think mainly of *design* as the desired end-state of a building, and far too little of the *way* or *process* of making a building as something inherently beautiful in itself. But, most important of all, the background underpinning of this goal-oriented view — a static world almost without process — just is not a truthful picture. As a conception of the world, it roundly fails to describe things as they are. It exerts a crippling effect on our view of architecture and planning because it fails to be true to ordinary, everyday fact. For in fact, everything is constantly changing, growing, evolving. The human body is changing. Trees bear leaves, and the

leaves fall. The road cracks. People's lives change from week to week. The building moves with wind and rain and movement of the earth. Buildings and streets and gardens are modified constantly while they are inhabited, sometimes improved, sometimes destroyed. Towns are created as a cooperative flow caused by hundreds, even millions, of people over time.

Why is this process-view essential? Because the ideals of "design," the corporate boardroom drawing of the imaginary future, the developer's slick watercolor perspective of the future end-state, control our conception of what must be done — yet they bear no relation to the actual nature, or problems, or possibilities, of a living environment. And they are socially backward, since they necessarily diminish people's involvement in the continuous creation of their world.

In all this, *process* is still not present as something essential, only as something mechanical.¹¹ In our profession of architecture there is no conception, yet, of process *itself* as a budding, as a flowering, as an unpredictable, unquenchable unfolding through which the future grows from the present in a way that is dominated by the goodness of the moment.



6 / POSSIBILITY OF A NEW VIEW OF ARCHITECTURAL PROCESS

I shall argue that every good process in architecture, and in city planning also, treats the world as a whole and allows every action, every process, to appear as an unfolding of that whole. When living structure is created, what is to be built is made consistent with the whole, it comes from the whole, it nourishes and protects the whole.

We may get some inkling of this kind of thing by considering what it means to *design* a building, and to compare it with what it means to *make* a building. Naively, I make a building if I actually do it myself, do it with my own hands.

This sounds like fun. But of course that is impossible for all but the very smallest buildings. More deeply, what it means for me to *make* a building is that I am totally responsible for it. I am actually responsible for its structure, its materials, its functioning, its safety, its cost, its beauty, everything. This is in marked contrast with the present idea of architecture, where as an architect I am definitely *not* responsible for everything. I am only responsible for my particular part in the process, for my set of drawings, which will then function, within the system, in a strictly limited fashion that is shut

off from the whole. I have limited responsibility. Like a bureaucrat, I play my role, but “don’t ask me to be responsible for anything — I am just doing my job.”

When I *make* something, on the other hand, I am deeply involved with it and responsible for it. And not only I. Whether I am head of some project, or a person making some small part of it, the feeling of total responsibility is on my shoulders. In a good process, each person working on the building is — and feels — responsible for everything. For design, schedule, structure, flowers, feeling — everything.

I remember a few years ago meeting an old man who told me he had put the last I-beam on the Empire State Building. He had also placed the highest steelwork on the towers of the Golden Gate Bridge. As he told me about the riveters and welders he used to work with, he described a kind of special ethic they carried with them: while doing their work, five hundred or a thousand feet above the ground, they were conscious, among themselves, that whatever they did — every rivet, every weld — was their responsibility and theirs alone. It was up to them to make a thing that was to last forever. It was in their hands, and there were no excuses.

This was vastly removed from the “I-am-just-doing-my-job” attitude which exists in the fragmented and mechanical process most often followed today, where the demarcation of responsibility is socially and legally drawn to make sure each person does *not* feel responsible for the whole.

I do not suggest that making should be re-introduced for reasons of nostalgia. But I shall prove that a process which is not based on making in a holistic sense, *cannot create a living structure*. And I shall demonstrate hypermodern processes, many using the most advanced techniques of the present and of the future, in which a new form of *making* dominates our attitude.

In every sphere of nature, and in every

sphere of human effort, there are trillions upon trillions of possible processes. Of these trillions, only a few are *living* processes — that is, actually capable of generating living structure. That does not mean that living processes are rare. There are, of course, still billions of them among the trillions. All the processes which generate nature — including what we understand as physics, chemistry, biology, geomorphology, hydrodynamics — they are *all* living processes, because they do virtually all generate living structure, at least most of the time. However, there is an even larger number of *possible* processes which fail to create living structure.

Since human beings are the first creatures on Earth who have managed to create non-living structure, the need to focus on non-living processes is new. Indeed, we have only even *seen* non-living structure and non-living process for the first time in relatively recent decades.

Traditional society almost never saw these non-living processes. Although traditional society was filled with human-created processes — human-inspired and human-invented — it was dominated by living process. Human beings in traditional societies, by and large, used living processes.

Non-living process is a recent arrival on the planet Earth. It is only in the modern era, and chiefly in the last 50-100 years, that human beings have given widespread use to processes of all kinds which are non-living, which therefore generate quantities of non-living structure.

However, since the distinction between living process and non-living process has now become visible, and since, for the time being, we have no precise conception or definition of living process, it has become urgent that we try to get one.

In this book I make an effort, perhaps for the first time, to make this distinction and to lay a basis for a theory — and for a form of daily practice — which allows for a world in which living process, hence living structure, dominates the world and its creation.

NOTES

1. Wholeness, defined structurally, is the interlocking, nested, overlapping system of centers that exists in every part of space. For definitions, see Book 1, chapter 3, and Book 1, appendix 2.

2. For a precise definition and analysis of living structure in buildings, see Book 1, throughout, and especially chapters 1, 2, 4, 5, 8 and 11.

3. Also explained and argued in detail throughout Book 1.

4. One of the few texts, and perhaps the first, to make a dramatically clear statement about the vital role of process in building was Halim Abdelhalim's *THE BUILDING CEREMONY* (doctoral thesis, University of California, Berkeley, 1981). Another striking exception is the book by Stewart Brand, *HOW BUILDINGS LEARN: WHAT HAPPENS AFTER THEY ARE BUILT* (New York: Viking, 1994), which clearly identifies the dynamic history of the building as one of its most salient features.

5. Richard Feynman, *THEORY OF FUNDAMENTAL PROCESSES* (New York: W. A. Benjamin, 1961).

6. D'Arcy Wentworth Thompson, *ON GROWTH AND FORM* (Cambridge: Cambridge University Press, 1917; reprinted volumes 1 and 2, 1959). Also Brian Goodwin, *HOW THE LEOPARD CHANGED ITS SPOTS* (New York: Simon and Schuster, Touchstone, 1994).

7. Ilya Prigogine, *FROM BEING TO BECOMING* (San Francisco: W. H. Freeman, 1980), p. 3.

8. I am aware of one provocative counter-example, in the following passage by a philosopher, Bruno Pinchard: "It is on the subject of architecture that Aristotle achieves great precision in the presentation of his dynamics, when he analyzes the reality of the buildable as such and distinguishes it from the finished construction. Now the architecture is not only in the house that is built, but in the act of building itself. The mover in architecture is

not only the mental image of the project in the architect's mind. Particularly for the great theorists of Vitruvian humanist architecture, who tried hard not to reduce the origins of architecture to the primitive hut, it is the architect's job to direct work on the site and so to transform the plan according to the necessities of the climate of the materials at his disposal. This amounts to drawing a distinction between the idea of the house and its form, its programming and the carrying out of the opus. In other words, the architect's final cause is not simple (the architect is not just a space technician), and it may be said that there is no classical architecture that does not carry in its realization the trace of the processes of its construction." From Bruno Pinchard, Appendix to René Thom's *SEMI-PHYSICS, A SKETCH* (Boston: Addison Wesley, 1990), pp. 237-38.

9. Bill McClung, my friend and editor, is a fire commissioner in the city of Berkeley and spends much of his life now making meadows in the Berkeley hills, converting fire-hazardous brush to something more alive and beautiful.

10. See, for example, Evans Pritchard and other early 20th-century functionalist discussions of social contracts.

11. See the preface to Book 1. Our understanding of process, like our understanding of order, has been severely compromised by the value-neutral Cartesian picture, and in a similar fashion. In the case of static order at least, everyone knows that things have value; the mistake has been in the fact that we have been encouraged to think that the value of an object is subjective. Process presents a deeper problem since, in our time (with some exceptions), we are not used to evaluating it at all, even in subjective terms. We have yet to learn that, objectively, there is life-creating process and life-destroying process.

PART ONE

STRUCTURE-PRESERVING
TRANSFORMATIONS

I start with an overview of a scientific question. Throughout the natural world, one sees myriad examples of systems which “come into being.” Indeed, as we think about it, in natural systems there is nothing else BUT this “coming into being.” Everything is coming into being, continuously.

Yet we have relatively little theory that allows us to grasp this process of coming into being. Although there have been many discussions in the last two decades about chaos, catastrophes, bifurcation, and emergence, about the generation of complexity from interaction of simple rules, about the processes that have become known as chaos theory, and the way that new structures emerge by differentiation and bifurcation, still, even now, there is not enough coherent scientific theory that tells us how these processes really work geometrically.

In the first four chapters I focus on the idea that a living process always has enormous respect for the state (and morphology and form) of what exists, and always finds a next step forward which preserves the structure of what exists, and develops and extends its latent structure as it creates change, or evolution, or development. This is the process which is “creative.”

In chapters 1 and 2, I address these issues for cases in the natural world, and provide the outline of a tentative approach that helps us understand the unfolding of geometry in biology and physics. This theory provides the underpinning for what follows. In chapters 3 and 4, I turn my attention to the BUILT world, to towns and buildings and to the way the emergence of living structure in towns and buildings may be understood within the context of theory.

The searchlight on nature will show us that many of the processes we have come to accept as normal in architecture and city planning and development are, from a process point of view, deeply flawed. They are, as matters stand today, incapable in principle of generating living structure. For this reason the near absence of living structure in our built contemporary world cannot be a surprise to us. It follows, inevitably, from the flaws of the processes we have come to accept as a normal part of our society, and it will change only when the processes we use in our society, are changed.

CHAPTER ONE

THE PRINCIPLE OF
UNFOLDING WHOLENESS
IN NATURE



1 / INTRODUCTION

How does nature create living structure?

Living structure, as I have defined it, is not merely the structure we find in living creatures — organisms and other ecological and biological systems. It is, in a more general sense, the character of all that we perceive as “nature.” The living structure is the general morphological character which natural phenomena have in common.

In Book 1, I have tried to describe and characterize this living structure in very general terms. In the sense introduced in Book 1, the living centers which appear in any given physical system have varying degrees of life. They have life because they are composed of other living centers that support and sustain and intensify each other. I remind the reader that in this way of thinking, living structure refers not to the biological systems in the world, but is a general character, appearing through all systems, organic and inorganic, of the natural world.

The way that centers manage to support and intensify each other in such living structure is chiefly governed by the repeated occurrence of fifteen geometric properties defined in Book 1.¹ They are identified as: 1. LEVELS OF SCALE, 2. STRONG CENTERS, 3. BOUNDARIES, 4. ALTERNATING REPETITION, 5. POSITIVE SPACE, 6. GOOD SHAPE, 7. LOCAL SYMMETRIES, 8. DEEP INTERLOCK AND AMBIGUITY, 9. CONTRAST, 10. GRADIENTS, 11. ROUGHNESS, 12. ECHOES, 13. THE VOID, 14. SIMPLICITY AND INNER CALM, 15. NOT-SEPARATENESS.

What I call the living structure of nature — that which we see in the natural world around us — is also largely governed by these fifteen properties and their interaction and superposition. Chapter 6 of Book 1 contains many examples that show the field of centers and its associated fifteen properties in rocks, animals, plants, clouds, rivers, landscapes, crystals. Again and

again, throughout the worlds studied in physics, chemistry, biology, geology, fluid dynamics, ecology, crystallography, cytology, and molecular biology, we find densely packed structures of centers in which thousands of centers support each other.² Thus nature creates living structure every day, in sand, in rivers, in clouds, in birds, in running antelopes. It does it, both in the organic and inorganic realms, apparently without effort.

But why does living structure, with its multiplicity of centers and their associated fifteen properties, keep making its appearance in the natural world? *Why*, and *how*, does living structure keep recurring in these widely different domains? What is the mechanics of the process by which living structure is made to appear, so easily, in nature? What is the process by which this kind of structure repeatedly, and persistently, occurs?

Oddly enough, the persistent appearance of living structure in nature is not easy to explain. That is why, in this book about architecture, I start by trying to understand nature in a new way. Once we have that understanding, we may have a basis for thinking about architectural process and for identifying processes which are capable of creating a living world in the realm of architecture. In a good building, as in nature, there is also living structure. Each living center contains thousands of living centers; and the centers support each other in an intricate pattern. But as we see from the many 20th-century buildings which lack this structure, there is — at least in modern society — some kind of immense practical difficulty in creating such a living structure in the real world of buildings. Indeed, the very large number of recently built buildings which lack living structure suggests that for some reason it is especially hard for us in our present period of history.

Yet nature manages the task rather easily. That is why I say, "To learn how to create living

structure in buildings, we had better start by looking at nature."



2 / NOTE FOR THE SCIENTIFIC READER

In what follows, I shall argue that the emergence of new structure in nature, is brought about, always, by a sequence of transformations which act on the whole, and in which each step emerges as a discernible and continuous result from the immediately preceding whole.

This thought, obvious if taken naively, but profound and difficult if taken literally as a piece of science, relies entirely on the possibility that we can form a coherent and well-defined idea of what is meant by "the whole," and of what is meant by a structure which grows from the whole, and preserves the wholeness while it is moving forward. Such a thought is well-nigh impossible today, because in spite of the uses provided by David Bohm of the word "wholeness," there is in science today no concise or well-defined idea of wholeness as a structure. Yet without a well-defined idea of the whole, the thought I have expressed here cannot be completed or used. The nub of the point which governs the thinking of this book, is that we *are* able to approach clear thinking about this issue, and have enough of a well-defined formulation of what wholeness "is" to see the outline of a new theory built on this foundation.

Although I cannot claim to have fully solved the problem, I believe that in Book 1, I have given a sufficient description and definition of "the wholeness" so that it may be understood as a well-defined structure which occurs in all configurations.

Briefly, recapitulating passages of Book 1, the wholeness is what we think of as the "gestalt," the broad gestural sweep of a figure, or of a configuration. In the Belousov reaction (images shown on page 27 below), it is the "curly-Y" figure — the lily-shaped figure — which has two

halves sweeping away from each other, and containing between them a V-shaped center. That is what exists in picture 2, and what exists, already, in an earlier form, in picture 1. The 2nd stage has emerged from this wholeness, and has preserved it, even as it introduces other structure. In the stages 2 and 3, we see another gestalt, which emerged from the first — a pair of round whorls or spirals — partly present in the picture 2, and fully developed in picture 3. As we go from picture to picture, or from stage to stage of the reaction, we see a continuous series of such configurations, in which the deep gestalt of each stage forms, grows, swells, develops, and gives rise to a new configuration.

It is this process, which I mean by "emergence of the wholeness" and by "emergence of the configuration from the wholeness."

What I have said, in Book 1, is that this wholeness is in principle amenable to mathematical treatment and description. A wholeness consists of a recursively nested system of centers, all more or less living ones (according to the definitions of Book 1). It displays the fifteen properties, and in a sense one might say that the fifteen properties are the primitive configurations from which all wholeness is built. In more detail still, considering the arguments and examples of Book 1, appendix 3, the wholeness may always be viewed as a nested system of local symmetries, and it is the *configuration* of the system of nested local symmetries which gives us the character of any particular wholeness, in any particular configuration.

I claim that even in continuous phenomena (such as curves, curved surfaces, organic forms in three dimensions such as leaves or organs, or in configurations of subtle gestalt such as gradi-

ents and smoothly meandering curves) *it is always the wholeness, as defined here*, in terms of the strong centers which appear, and in terms of local symmetries, which provide the handle of this wholeness.

What I call the wholeness is, to a very rough degree, a mathematical representation of the overall gestalt which we perceive, or which we are aware, which gives the character to the configuration, and which forms, what an artist might call, his most intuitive apperception of the whole.

Now, in simple outline, what I claim in this chapter, and in many succeeding chapters, is that natural process — and all living processes — come about as a result of sequence of transformations which emerge from, and act upon, this wholeness — bearing in mind that the wholeness is a well-defined thing, not an artistic

thing — and that it is indeed from this wholeness, not previously identified in science with precision, that all growth and morphology emerge.

And yet I must apologize. Although I have given a nearly adequate definition of what this means, I have not given precise enough treatment, yet, to provide a strict mathematical treatment. What follows then, should be understood as proto-mathematics, where a structural idea, mathematical in principle, is available, and may guide our thought — but the hard work of formulating a mathematics with which one can calculate, has only just begun.

With this shortcoming in mind, please regard the following discussion, and presentation of examples, with some forgiveness. I have come as close to being accurate as, at present, I know how.



3 / THE NEED FOR A GENERAL EXPLANATION OF THE WAY THAT LIVING STRUCTURE IS CREATED

When we look at nature, we can nearly always find an explanation for any *one* of the fifteen properties as it appears in any *one* particular instance. Take BOUNDARIES, for example. Conventional plasma physics can be used to explain the appearance of the plasma boundary layer that forms around the sun. Hydrodynamics can be used to explain the silting up of the mouth of a river like the Rio Negro, where it flows into the Amazon, to form a pattern of streams bounded by great swaths of silted mud deposited by stream flow. Biological studies suggest why a cell is constructed to have a thick boundary layer, larger in volume than the nucleus of the cell. It is needed as the zone where chemical exchanges happen.

But it is quite another matter to give a general explanation which tells us why massive and substantial boundaries *will, in general, tend to occur again and again, throughout nature, within three-*

dimensional systems. This question involves a level of morphological thinking which has no familiar language in contemporary mathematics.

I have argued in Book I that the fifteen properties are necessarily associated with living centers and are the ways in which centers appear in the world, come to life, and cooperate to form other living centers. But that, in itself, does not explain why they keep appearing. We need a more systematic, general explanation. It is extremely hard to formulate a general rule for any one of the fifteen properties which gives us a convincing explanation as to why that property appears again and again and again throughout nature.

This issue is far from trivial. Although recent developments in complexity theory have shown how linked systems of variables, under the right conditions, will cooperate to form emergent order, that in itself does not yet tell us why the particular kind of order formation I have