8 / FIFTEEN TRANSFORMATIONS

Let us now consider the fifteen properties, not merely as *results* of structure-preserving transformations, but *as the names of particular types of structure-preserving transformations themselves.*

Take, for example, LEVELS OF SCALE. We have seen in the previous section that levels of scale (viewed as a geometric property) will arise in a system naturally, as a result of structure-preserving transformations. We may, alternatively, think of LEVELS OF SCALE as a *transformation itself* which *introduces* levels of scale into a given structure. Thus, for any given structure, this transformation may be thought of as injecting into it, new centers which provide more beautifully articulated intermediate LEVELS OF SCALE. This transformation, whenever applied to a structure S_1, is likely to create a new structure S_2 that is a structure-preserving extension of S_1.

Similarly, LOCAL SYMMETRIES may be viewed as a transformation which injects local symmetry into emerging centers, strengthening weaker centers by injecting local symmetry into them. And BOUNDARIES may be thought of as a transformation applied to a structure S, which strengthens one or more centers in S by providing fat boundaries (themselves consisting of centers), to intensify and better define the coherence of the original centers. All three — LEVELS, SYMMETRIES, BOUNDARIES — are both property *and* transformation.

In general, all the geometric *properties* identified in Book 1 are also associated with dynamic *transformations* which will inject these geometric properties into the system of centers of any emerging, growing whole.

Let us consider in a little more detail, how the transformations work.

The LEVELS-OF-SCALE transformation introduces intermediate-sized centers to fill out the hierarchy of scales that exist in a given wholeness. In this case, some zone that has been loosely distinguished, is differentiated further into smaller parts. This can happen so that these new parts are similar in size to one another, but one level smaller than the center which is being differentiated. In another application of this transformation, a large center is made more coherent and distinct by the introduction of smaller parts, which then act together with the large center to form a recognizable and distinctive hierarchy.

The STRONG-CENTER transformation is the most fundamental transformation of all (and will be discussed further in chapter 7). Any weak center which exists is made more emphatic by this transformation. It may be more strongly differentiated, more strongly defined, more strongly integrated by virtue of its differences, or more sharply drawn and distinguished. Of course, all the transformations help, in some form, to achieve this fundamental goal. However, the transformation itself, in a primitive form, acts to give weight and definition and distinction and centeredness, to any weak center which has begun to crystallize in any given field.

The BOUNDARY transformation. Here the evolution of a given wholeness may take this form: First a zone of space is slightly different from its surroundings — a cloudy but distinctly differentiate zone with some "character" appears. How then, may this be further differentiated. One thing that can occur, is that the boundary transformation is applied. In this case, the zone (a ring zone, or spherical zone) becomes more distinct, and a thick boundary zone starts forming in a discernible way.

The ALTERNATING-REPETITION transformation generates a repeating pattern of similar entities, within a previously undifferentiated field. The way it works, though, it simultaneously generates

a second pattern of repeating centers, interlocking and alternating with the first. This transformation is the most basic way that a large system may be given a structure as a repeating field of many repeating smaller entities.

The POSITIVE-SPACE transformation makes strong positive space by creating new centers in the space between other centers, thus strengthening and shaping spaces between the other centers that are not yet centers themselves. This is one of the most powerful of the fifteen transformations.

The GOOD-SHAPE transformation takes an existing center or system of centers (often formed by earlier application of the ALTERNATING-REPETITION transformation). The transformation intensifies the products of the alternating repetition, by strengthening them, making them more distinctive — and this is done by applying the GOOD-SHAPE transformation and POSITIVE-SPACE transformation in the weakly existing centers in such a way that any loosely formed shape which exists in the space, is made more marked, stronger, by giving more life to the centers within the shape. The effect is to make a more beautiful, more living, shape.

The LOCAL-SYMMETRY transformation strengthens a center (or system of centers) by making the center (or each center in the system) have an internal axis of symmetry. The symmetries induced are only local, and do not extend beyond the limits of the center, and may sometimes even be used only to strengthen or "symmetrize" the kernel of the center. This is often the way in which an emerging center first receives its strength. Shortly after an entity is differentiated and made to stand out from its ground the symmetry transformation then sets it up as a strong center in its own right.

The DEEP-INTERLOCK transformation takes an existing structure, especially in its boundary zones, and weaves the distinct opposing parts at the boundary into a tighter, less separated, union by physically creating connections in which part of one enters into the other, and vice versa. This imbrication of the boundary cements the whole (the structure plus its context); the transformation helps to unify the growing whole. It would be unusual for this transformation to happen at the outset of a differentiating process.

The CONTRAST transformation is a kind of sharpening which occurs. In a system where two types of centers occur the transformation works to increase the distinction between the two kinds; it separates them more sharply from one another, thus creating a field of more strongly contrasting entities. The contrast may be achieved by color, darkness, polarity, or by other physical characterics. The polarity of the two, generates a more well-knit system as a whole in which the two kinds of centers can complement each other better.

The GRADIENT transformation creates transitions of size and character. In response to an uneven, or non-homogeneous field, certain aspects of size, shape, weight, darkness, spacing, are made to vary systematically — thus introducing coherence of a new kind into an almost random-like field of structure. The gradient transformation thus begins to create structure where none was visible before. In other cases, a simple polarity or position, or axis, engenders a gradient, and the inner parts and centers are then given features which vary systematically according to this gradient. In this case the GRADIENT transformation can have a very large, global, field effect within an extended zone. It has a surprising ability to order complex and inchoate structure, without greatly bending or changing circumstance.

The ROUGHNESS transformation. In the course of making positive space, strong centers, local symmetries, or alternating repetition, it is often necessary to introduce or pack in irregular variants of repeating centers, to make things work

out. The roughness transformation uses intentional irregularity to find the most regular fit possible for a given configuration, and one which permits things to work out successfully and simply in the large. It is of enormous importance. Wholeness would not be possible without it.

The ECHOES transformation applies procedures, angles, and shapes and shape-character of certain repeating centers to other centers in the field, thus generating a widespread family resemblance among different centers and so strongly unifying the whole.

The VOID transformation is at work getting rid of garbage. Areas which are relatively undifferentiated, and which do not need their differentiation, are cleaned out and made more homogeneous, and defined by a boundary zone which is attached, surrounded, by more differentiated structure. The transformation also preserves an imitation of the greater undifferentiated VOID.

The SIMPLICITY transformation, like the void transformation, also cleans, simplifies. However, it works by removing unwanted centers, differences, and other kinds of complexity, throughout the structure, where the void does it by creating a single homogeneous zone in one place. The simplicity transformation gets rid of unnecessary structure by reducing it.

The NOT-SEPARATENESS transformation may be thought of as a kind of knitting. In applying this transformation to an existing object or system of centers, modifications are made to the centers and their surroundings so that the center gains more of the subtle substance from its surroundings; and at the same time the surroundings gain more of the substance inherent in the center. The effect is that the two are brought closer together, forming a more indissoluble unity. All in all, the purpose of the transformation is to unify, to knit together, to create a texture in which the separateness of any given entity is reduced.

The way the NOT-SEPARATENESS transformation most typically works is somewhat similar to the effect of the color transformation called MUTUAL EMBEDDING (Book 4, chapter 7, page 192). When operating on two major areas, A and B, that are differentiated from one another, the transformation takes pieces of A and copies them inside B, and takes pieces of B and copies them within A. The result is that A and B become more associated, more allied, more united, and less distinct from one another. The not-separateness transformation may occur early or late in the differentiation of a structure. Essentially this transformation binds the entity which is being created and its surroundings more tightly. This may be accomplished by a variety of specific means including ECHOES, DEEP INTERLOCK, BOUNDARIES and so on. However, the overall unification of an entity and its surroundings, is a transformation in which the two distinct entities (a center and its context) are made more connected, more similar, more different, more interlocked, more reminiscent of each other, more complementary, more distinct, less distinct, and more united. The transformation stretches them apart and binds them together, making inside and outside less distinguishable.

Even under circumstances where the general principle of unfolding wholeness governs, what is it that makes these specific transformations occur? I do not know exactly how to answer this question. But loosely, one may compare it to the way that there are geometrical limits on the number of possible arrangements that can occur in space — as, for instance, in the limited number of different ways regular elements can be repeated to form crystals.

The inherent limitations of space have the effect that, for purely mathematical and geometrical reasons, there are only a certain small number of ways that a given wholeness can be extended, while preserving its essential structure. I have discussed this issue a number of times in Book 1, also

in chapter 1 of this book. Although I cannot claim to give a rigorous proof that the fifteen transformations are the only ways to extend and conceive a given wholeness, I believe that this is true, and that a more sophisticated mathematical treatment will one day be able to show why it is true.

The fifteen transformations form a coherent system. We have in them, a limited palette of transformations which may be made to act on a given system. These are the fifteen most basic ways in which structure-preserving transformations can be made to occur. Every differentiating process is accomplished, in a structure-preserving way, by successive application of these fifteen transformations. The range of possible sequences and combinations, and the range of results which can be achieved by this type of differentiation, is amazingly rich and varied.

We see now that the fifteen properties are not merely observable end-products of structure-preserving transformations. They provide the base transformations from which, in practice, *all* structure-preserving transformations are made. The world of nature — what we think of as nature, and what we think of as natural (whether it is brought into being by the innocent operations of nature, or made carefully by the thoughts and hands of men and women) is that world which is brought into being by repeated application of these fifteen transformations, applied again and again, to enlarge, and deepen, and evolve, and magnify the beauty of the world which exists.[11]

We shall return to the subject of these transformations throughout this book, and especially in chapter 7 and in chapter 16.

9 / A NEW VIEW OF THE NATURAL WORLD

As wholeness unfolds under the fifteen structure-preserving transformations, these fifteen associated geometric properties necessarily appear more and more often, and more densely, while latent centers are progressively being differentiated and intensified. This is why the living structure appears in nature.

Living structure appears in the wholeness as a direct result of repeated unfolding. If the evolution of the natural world follows a step-by-step

Mountain landscape after millions of transformations

Detail of mountainside after millions of transformations

Water drop splashing under the impact of the fifteen transformations

process in which each step is structure-preserving, it will then follow that the fifteen properties will appear more and more often, and that the life or degree of life in the wholeness will increase steadily.

This is true for an evolving waterdrop, as shown above. It is true for a mountain. Let us consider the existence and development of a mountain over eons. At any given moment, the mountain has a certain wholeness. This wholeness is the huge system of centers with their relative degrees of life. To make the description more complete, we add dynamics: the fact that the wholeness is changing and evolving in a systematic way with time. At any moment we have the wholeness of the mountain as it exists, and in addition, the mountain is subject to glacier movement, mud slides, erosion by wind and water, earthquake activity, plants growing, animals moving. Daily, as a result of these processes, the mountain undergoes change in shape. Let us try to understand these processes in terms of centers. The wholeness of the glacier sliding in the valley, includes the angle of slide, the rocks being crushed by the grinding motion, the flow of water coming out of the melting glacier, the eroded banks of the stream caused by the flow of water, and so on. All these features of the system inhere in systems of centers, and we can ascribe to each center a saliency according to its degree of coherence. The glacier itself exists as a center. So does the moraine beneath it. So does the stream of water, and so do the eroded riverbanks.

As the mountain moves forward in time, old centers are preserved, new centers are generated, often in a way that intensifies the old centers. The structures of greatest coherence tend to preserve themselves in this action of the mountain. As the centers continue the process of helping one another in their wholeness, the mountain changes, and evolves.

To grasp the underlying nature of this process clearly and systematically, we need just the one assumption: *Throughout the process, centers will always tend to form in such a way as to preserve and enhance previous structure — and this means, in such a way as to help sustain other existing and emerging centers.* Mathematically, this structure-preserving process will then be embodied in the fifteen possible transformations I have described.

As the mountain follows the principle of unfolding wholeness, the fifteen transformations will be applied again and again, and as this happens the fifteen properties will show up again and again, simply because they emerge when an evolving system follows this law.[2] These are the geometric properties which arise in space when centers increase their centeredness by following a path in which they get intensified. If we remove our Cartesian blinders, that is exactly what we do observe.

Most of the time, the mountain — or equally, the star, frog, river, crystal — unfolds in a way which exhibits the fifteen properties more and more as centers get established, and as the centers help intensify each another. We get ALTERNATING REPETITION in the smaller valleys down the major valley. We get LEVELS OF SCALE in the different valleys, peaks, and rocks. We get STRONG CENTERS in the peaks and valleys. We get BOUNDARIES between the glacier and the valley floor. We get LOCAL SYMMETRIES in the peaks. We get POSITIVE SPACE in the valley spaces between the hills. We get ROUGHNESS developing within the local symmetries.

For every natural system which evolves, we see the fifteen properties developing as the trace of the system's evolution, a product of the field of centers' gradual intensification and of the action of the fifteen transformations. So the fifteen properties define not only the different ways a system can be whole, statically, but — as transformations — the various ways in which any system evolves naturally — *provided that it is allowed to become whole naturally, under the gradual rubbing together of its processes.* In any case, nature has these fifteen properties, and has the field of centers in it, because, at least for the most part, it demonstrates an undisturbed unfolding process in which each wholeness gives way to a next wholeness that is consistent with the previous one.

This, I believe, is an essential model which teaches us the real meaning of living structure, and which shows us these phenomena as naturally existing phenomena of beauty which will occur without effort *in any world where the wholeness is allowed to unfold smoothly and truthfully, without disturbing previously existing centers.*[13] Once this is clear, we shall then have a vision of the world in which the world itself — *all of it* — animals, plants, mountains, rivers, buildings, roads, terraces, rooms, and windows — is part of a single system and a single way of understanding.

10 / IN BUILDINGS, TOO, ALL LIVING STRUCTURE GROWS NATURALLY FROM STRUCTURE-PRESERVING TRANSFORMATIONS

In the world of building, specifically, this insight also has much to say. It means, too, that at each step forward the next step in an evolving building or in an evolving design, the system should (to preserve and generate a living character) do as much as possible to maintain the structure of the wholeness where it occurs, intact, and introduces the minimum new structure which is absolutely necessary, nothing more. The wholeness, then, can be preserved, enhanced, extended, and intensified. It is occasionally pruned and trimmed; and only very rarely destroyed altogether.

As we shall see next, this concept will greatly deepen our appreciation of human actions in the art of building.

During the past century we have been used to understanding value as a subjective, culturally influenced phenomenon which depends on private individual judgment. However, within the framework of wholeness, we may begin to conceive of value as an objective phenomenon which arises inevitably from the existence of the wholeness as a structure. Distinctions of value — the distinction between one thing which is more valuable, and another which is less valuable — come directly from the wholeness, and from the degree to which unfolding has been "truthful" — by that I mean, guided by the fifteen transformations I have identified as structure-preserving, and by combinations of these fifteen transformations.[14]

This is a startling and new conception of ethics and aesthetics. It describes good structure as a structure which has unfolded "well," through these transformations, without violating the structure that exists. The structure we know (from Book 1) as living structure, is just that kind of structure which has unfolded smoothly and naturally, arising step by step from what exists, preserving the structure of what exists, and allowing the "new" to grow in the most natural way as a development from the structure of "what is." This startling view provides us with a view of ethics and aesthetics that dignifies our respect for what exists, and treasures that which grows from this respect. It views with disfavor only that which emerges arbitrarily, without respect for what exists, and provides a vision of the world as a horn of shimmering plenty in which the "new" grows unceasingly from the structure that exists around us already. That this horn of plenty is inexhaustible, and that we may conceive an everlasting fountain of novelty without ever having to beat ourselves over the head for the sake of novelty per se — that may perhaps be one of the greatest potential legacies of this new view of the world.

NOTES

1. Living centers are defined in Book 1, chapter 4.

2. Although, like the judgment and perception of wholeness, accurate observation of this fact is highly dependent on the observer's degree of *awareness*.

3. Ian Stewart and Martin Golubitsky, FEARFUL SYMMETRY: IS GOD A GEOMETER? (Oxford: Blackwell, 1992), throughout, especially pp. 51–52.

4. Ibid., p. 13.

5. Ibid., pp. 20–21.

6. First introduced in Book 1, chapters 5, 6, and in chapter 1 of the present book, page 18.

7. Again, this hinges on points developed in Book 1. To see this in more detail, check back to the explanation of the fifteen properties in Book 1, chapter 5, pp. 143–242. These are the ways in which wholeness-enhancing transformations occur.

8. Another instance of the symmetry-breaking argument discussed on page 63.

9. This process of increasing differentiation has been extensively discussed in the literature on cognition as "leveling and sharpening." See, for instance, Christopher Alexander, "The Origin of Creative Power in Children," BRITISH JOURNAL OF AESTHETICS, Vol. 3, No. 2, July 1962, pp. 207–26, reprinted in Hilda Present Lewis, ed., ART FOR THE PREPRIMARY CHILD, Spring 1972, pp. 33–49.

10. Lee Smolin, THE LIFE OF THE COSMOS (New York: Oxford University Press, 1997).

11. A view of this process as a basis for ecology, coupled with the idea of structure-preserving transformations as the fundamental approach to ecological architecture and to man-made ecology is briefly discussed by Sim van der Ryn and Stuart Cowan, ECOLOGICAL DESIGN (Washington, D.C.: Island Press, 1995), p. 72. As Van der Ryn and Cowan describe it, a design works when it articulates new relationships that preserve the relevant ecological structure.

12. As I have suggested in chapter 1, I believe that the theory of structure-preserving transformations, and unfolding of wholeness to form new wholeness, is consistent with, and extends, catastrophe theory and bifurcation theory and helps to show how new living forms arise from complex dynamic systems in a fashion that is consistent with much recent mathematical thinking. However, the detail of a mathematical connection, showing how both theories are part of one, consistent picture, has yet to be determined.

13. See discussion of chapters 5, 6 and 7.

14. We shall see later that the differences of value we are familiar with in different cultures, or among individuals, all arise naturally as the result of different wholenesses which lead to different healing and development. In every case, what is good is simply the superposition of natural unfolding from one wholeness to another, repeated thousands upon thousands of times.

CHAPTER SEVEN

THE FUNDAMENTAL DIFFERENTIATING PROCESS

1 / DEFINITION

We are ready to examine the general nature of all living process, and to give a definition of living process in the world of building. Let us define as follows: *A living process is any adaptive process which generates living structure, step by step, through structure-preserving transformations.*

As I said in the last chapter, there is a great deal more to generated structures than mere trial-and-error tinkering. When living structure is generated in a building, somehow useful elements of global order slowly make their appearance at many levels of scale, and further, this seems to happen through what I have earlier called structure-preserving transformations. The process by which this occurs has complex aspects. Some are dealt with in chapters 8 to 17. But it will be difficult to understand these aspects without a broad general overview of what is going on.

In general terms, we may put it like this. When living structure is generated, it is not merely done by trial-and-error, rather the process has the feature that a coherent whole emerges, step by step. At each step, the process preserves the wholeness of what was there before. Yet at each moment in the evolution of the structure, from the additional, invisible structure which lies dormant (in the crevices of the structure), the transformations also have the ability to create something entirely new. Thus the process performs the seeming miracle that it respects what is there before, yet also manages to take the structure in a new direction, towards something which was *not* there before. And it does this not by arbitrary insertion of arbitrary new structure, but by pulling on latent aspects of the structure which are there already. Latent, they are there. But they are not yet visible or manifest.

The living process contains the procedure which makes this apparent miracle occur.

2 / THE HIERARCHY OF INDIVIDUAL AND ACCRETIVE PROCESSES

Before proceeding to elaborate this definition, we must recognize an important subtlety: Whether in a major metropolis, in a city, in a village, or in the countryside, generated living structures are made by the interaction of two kinds of process going on side by side:

(1) There are individual processes of design or construction, each one a locally complete, self-contained type of creative process in which a single center — one building, one shop, one room, one garden — of some scope is thought of, conceived, designed, and built, from start to finish. A local process of creation creates one complete center, large or small, from conception to completion. It is done in a controlled and continuous sequence, which happens in one (approximately) continuous time sequence. It does have a completion date.

(2) There is an accretive process which forms the larger structure, piece by piece. Centers — streets, buildings, shops, bridges, gardens — are added, or modified, and accumulated in such a way as to make larger centers — streets, neighborhoods, and so on. Accretive processes of creation are spread out in time and place, and are initiated independently by many different people. The acts of accretion gradually contribute to create a much larger whole, but this overall process generally has no finite beginning or end, and no completion date.

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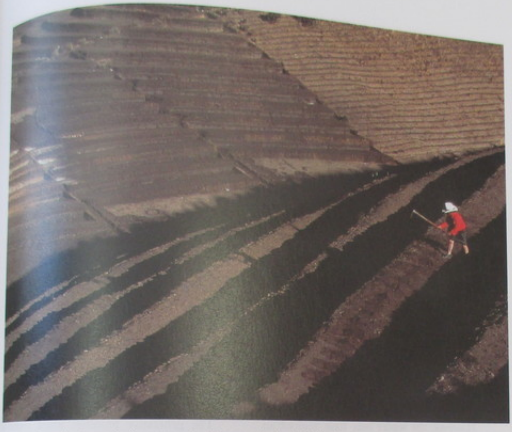


Guatemalan farmer forming and preparing his terraces; both an individual process, and an accretive process.

We may liken this overall scheme of things to the process by which a forest grows. There we also have accretion and local acts. On the one hand, there is a general large-scale process, largely random in sequence, in which many variegated individual acts of growth take place within the extensive (and sometimes tangled) existing structure of the forest. Second, there are thousands of instances of a more local process which are more controlled, each of which happens at a given site where there is a very well-ordered sequence which takes place as a single organism grows under the influence of its DNA, starting from a seed, and ending with a finished organism. In both the forest and the city, the process of accretion is made up of thousands of processes of local, individual growth, and in both cases it is capable of generating a successful, living result. Any definition of living process, must take both kinds of process into account.

All generative processes exist in these two forms. Here (above) is a photograph of of agricultural terraces formed by farmers in the mountains of Guatemala. We see a man working one of the terraces, and we see that his work, and the work of others, has terraced, or repaired the terracing of a whole hillside. Here we have both individual processes and an accretive process. The individual process — what this farmer is doing just now, with his pick — shapes the land, breaks the earth, loosens it, and shapes the slope to drain, be smooth, free of weeds, and ready for planting. And, in his mind, as he does it, there is also present the larger, accretive process in which his (and other people's) individual actions are fitted together to construct an emerging whole. The great pattern of terraces that was formed on the hillside was not formed by one man, but formed by the cooperative and intelligent adaptation of the individual processes to help form the whole.

An individual process that is part of an accretive process. You may ask why I show a medieval example rather than a 21st-century example. The reason is that in this example we see the masons carefully fitting their creative act into the whole around them. That work, in turn, makes larger wholes, as we see in the city of Acca (pages 206–7). Unfortunately, the same can only rarely be said of contemporary acts of building, which often exist in isolation, like cogs of a machine, making the modern city more an aggregation of these cogs, and less a multi-nucleated living whole.

However, the reader may have noticed an anomaly in the logic of the last paragraph. If one looks critically at the distinction between the two basic kinds of acts, accretive and local, one sees an unavoidable fuzziness. In a forest we can see, for example, that there is also a third kind of process in which a single organism, after its initial creation, is also *itself* continually being replenished and repaired. That repair and maintenance process is, once again, an accretive process in which certain new cells (or stems, or leaves, or roots, or twigs) are created within the larger existing whole in order to keep it alive. But this creative-accretive process is now happening within some *part* of an existing organism, not in the forest at large. It is a local version of the accretive process, happening internally within an individual organism.

The example reveals an important truth: every biological event that occurs in the forest is *both* an individual process of creation (at one level) and *also* part of a globally accretive process (with respect to some larger growing whole).

The generative processes which create a physical city have this feature, too. Every process is a process of creation at one level, and part of a larger process of accretion at another level. Something is built locally (room, building, doorway), and that something also helps to play a small part in the establishment and in the (much slower) creation and maintenance of a larger whole (neighborhood, garden, street).

This is the nature of all living process in the built environment. At every scale, every act of formation is both local and global, both creative/complete and accretive/incomplete.

Even a large building, though often built in what we view as a "single" process of design and construction, is itself made from a process-hierarchy of (let us say) 50,000 processes, each one both global and local. Each of the 50,000 processes is globally accretive (in adding to and helping some larger whole in the building) and locally creative (a complete package in its own right, for instance, designing and completing a room, or a wall-panel, or a step of a staircase).

In any living process at all, there is a hierarchy of these two kinds of processes going on. Even in the physically small example shown near the end of chapter 8 — the evolution of a painting by Matisse — the formation of the woman's individual locks of hair is both *part* of such a process, and is *itself* such a process. It creates individual centers, but these are parts of larger centers being formed in the woman's face.[1] And that work on that one painting, if we wish, may be seen as part of a much larger process through which the city of Paris is being formed from hundreds of thousands of processes. Bridges are formed; and within the bridge, girders are formed. Neighborhoods are formed, and within the neighborhood, buildings are formed. To form buildings, rooms and roofs are formed; rooms are furnished, and to furnish the rooms individual chairs and tables are made; these, once again, are formed by processes which make the centers — legs, top, casters, ornament — well or badly.

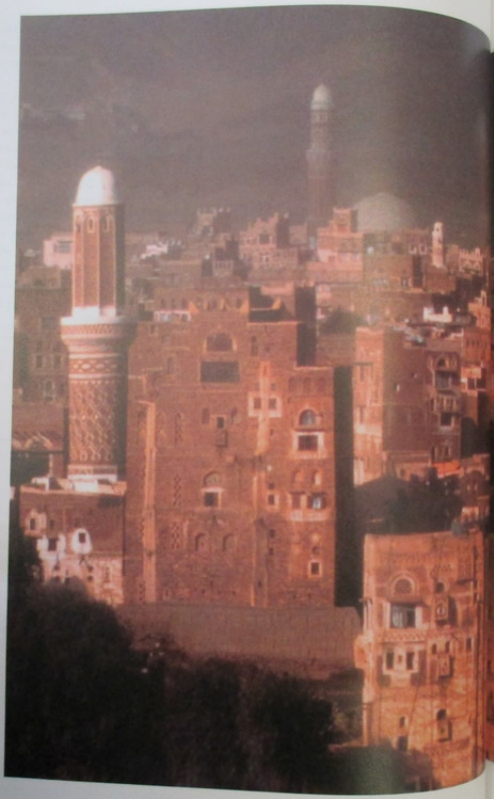
This hierarchy of center-formation, in one form or another, creates everything in the world. The only important question we must ask, if we are focusing on *living* process and on the capacity of a process to generate *living* structure, is whether these processes add up, whether there arises some coherent living order? That depends, in large part, on the extent to which the smaller processes contribute well to the formation of the larger wholes, whether each individual center is conceived, shaped, and built well according to its contribution to the invention and creation of the larger wholes in which it plays a part.

3 / THE SECRET

Here we come to the core of the secret. The fifteen structure-preserving transformations have the capacity to conserve and to create. They create, generate coherence in the large — and it is new coherence that they generate. Yet they are conservative and pull the future from the present.

Further, these fifteen transformations, though simple, guarantee the appearance of orderly, large and larger wholes with beautiful internal geometry. Instead of making aggregates of random structures, they propagate beauty with enormous force, both locally, and in the large.

This is the secret of all living process!

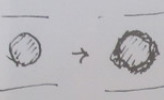


Acca, Yemen: created both by individual process, and accretive process.

4 / DIFFERENTIATION

To understand the way a living process helps us achieve living structure by differentiating space, let us consider, in detail, how space does actually get differentiated, and how a person may use the differentiating process to move steadily, again and again, from latent, half-formed structure to fully developed, coherent structure.

We may understand this human-based differentiation through the same example: the example of a CENTER being made more coherent, stronger, by the creation of a BOUNDARY. Suppose that at a certain stage in the development of a

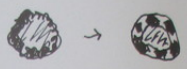


Differentiation of a center and its surroundings by the creation of a boundary

structure, there is a latent center somewhere. By that I mean that it is a center whose presence can be felt, but it is not yet very strong or coherent. We have the possibility then, of enhancing that center by making a BOUNDARY zone around it. We know (from Book 1, chapter 5) that the strength of the center will be increased if this boundary is large. We may therefore strengthen the boundary, and in doing so, the weak center that existed before will become stronger.

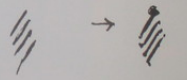
Now, once again, we know (from Book 1, chapter 5) that this boundary will be strengthened, if any latent centers within the boundary are themselves strengthened, and strengthened further if two systems of strong centers are created, which then form an ALTERNATING REPETITION.

We see in these cases how latent centers may be transformed by differentiation (through the use of the fifteen transformations) in such a way



Further differentiation of the boundary, by alternating repetition and positive space

that the system of centers as a whole becomes intensified or more alive. In similar fashion, others of the fifteen properties may be relevant. For example, the use of POSITIVE SPACE and ALTERNATING REPETITION, may take a particular ZONE or volume of space which forms a weak center, and may strengthen that center. Or comparably, the strengthening effect of a boundary, may be



Differentiation of a system of weak centers by the use of the positive-space and alternating-repetition transformations. The white space between the black lines, and the shape of the black lines themselves, have been modified by the transformations, so that the overall larger diamond visible in the configuration becomes stronger.

intensified by the use of GRADIENTS, which will increase its effect; or a second smaller boundary which forms a gradient, will also introduce LEVELS OF SCALE, once again, to strengthen the effect, and the growing impact on the originally weak, and only latent center.

Two things should be noticed about these transformations.

First, they are purely mathematical, that is, formal. They have their origin only in the nature of space itself, and do not arise as a result of "function." They are used, in all real cases

(buildings, biological systems, physical systems) in the service of function — but they are not functional in *origin*. They are pure transformations of space itself, through which the space becomes differentiated, and through which the life of the space is increased.

Second, as a result of the application of these transformations, the life of the whole is increased.

I do not mean to imply that these transformations can be applied blindly, in the hope of getting life to occur. They must always be *appropriate*. They must act in the service of function; they must be undertaken, always, with an eye to local adaptation, and so on. These matters are taken up in later chapters.

But the essential point is this. We do have a system of transformations which are, in principle, capable of nudging a system steadily towards living structure, and these transformations are precisely those transformations which govern the life of the centers themselves — and hence the wholeness (which *is* the system of centers), too.

5 / EMERGENCE OF BEAUTIFUL GEOMETRY

To drive the point home, I will give a real example, not only diagrammatic, where we see a beautiful thing emerging, by differentiation, from a sequence of transformations, and where it is clear that it is the transformations that have done the work.

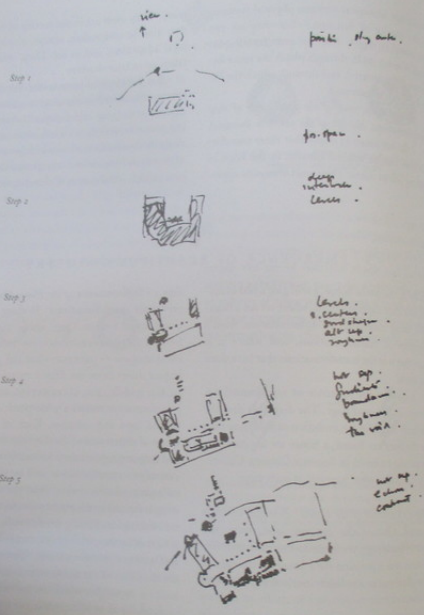
Consider the sequence of transformations, shown on the next page. The diagrams describe the early stages in the evolution of the house plan for the Sanders house, a house we are currently preparing to build in Sonoma County, California. Consider what happens at each step:

Step 1 : Location of the House. A single center is formed. Out of the context, land, view, and nearby buildings, the STRONG-CENTERS transformation sets a position for a house on the edge of the platform in the land, overlooking vineyards below.

Step 2 : Formation of the Courtyard. This single center is transformed, now, under the POSITIVE-SPACE, DEEP-INTERLOCK AND NOT-SEPARATENESS transformations. A deep center is formed, a courtyard which looks toward the view, is completed by the house, while the house takes three wings, to make the courtyard. These three transformations establish a connection with the land, reach out into the land, and enlarge it.

Step 3 : Differentiation of the House Wings. The previously undifferentiated U-shape is now transformed further. Once again, the primary force of the transformations come from practical considerations — patterns — but the geometric impact arises from the fifteen transformations. In the middle, the ALTERNATING-REPETITION transformation creates a wide porch of square-shaped bays and columns. Each of the three wings is differentiated further: the main room, and largest single center is formed by the LOCAL-SYMMETRY transformation and by the LEVELS-OF-SCALE transformation. And the right hand wing is formed by the BOUNDARY and GRADIENTS transformation. Finally, the entrance, to the left, is formed by the GOOD-SHAPE, DEEP-INTERLOCK, and ECHOES transformations. Throughout, we see the effect of the ROUGHNESS transformation, making rectangles which are as near perfectly rectangular as possible, while yet accommodating to the positive space and to the land, and the angles which they impose.

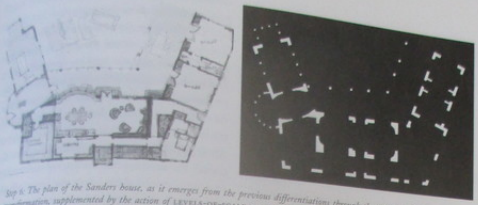
Step 4 : Differentiation of the House Interior and Expansion of the Garden. The central building is now further differentiated by transformations which create the core of the house: the organization of its living area and kitchen. This arises from intensive discussion about function and



Step-wise differentiation of the Sanders house

comfort with the family, expressed in the form of patterns: but the geometry is then produced by the action of the fifteen transformations once again. The organization comes from functional considerations — patterns — but the geometrical impact arises from the fifteen transformations.

Step 5 : Further Differentiation of Outlying Areas
The NOT-SEPARATENESS transformation now



Step 6: The plan of the Sanders house, as it emerges from the previous differentiations through the action of the BOUNDARY *transformation, supplemented by the action of* LEVELS-OF-SCALE, STRONG-CENTERS, LOCAL-SYMMETRIES *and* ROUGHNESS *transformations. Step 7: The right hand drawing shows the structural plan which emerged from this plan shortly afterwards.*

appears several times, to create outlying centers which differentiate the garden, but which above all create an indivisible relationships between the house and the surrounding land.

Step 6 : Detailed Differentiation of the Living Room. The BOUNDARY transformation is very active at the next stage, helping to form coherent space. It shapes the big bow window, the layer of rooms behind the kitchen, the passage and stair behind the fireplace part of the living room, and the overall definition of space and structure which begins firmly to shape the room. Similar effects are visible in the emergence of other rooms visible in the drawing. This action is supplemented by the action of LEVELS OF SCALE, STRONG CENTERS, LOCAL SYMMETRIES in the formation of the alcove window near the bottom of the stair. Throughout the ROUGHNESS transformation acts to make these very strong firmly shaped centers possible, while respecting the minor irregularities of plan. A plainly visible case appears, for example, in the small lobby to the kitchen inside the main entrance of the house. It has irregular shape to accommodate to external boundary considerations, while nevertheless preserving positive space, local symmetry, and strong centers in the interior of each part of its own space.

Step 7 : Emerging Structure. Next, this plan is transformed in such a way as to form a series of coherent structural bays. This is accomplished mainly by the LOCAL SYMMETRIES and LEVELS OF SCALE operators, through which we form individual coherent POSITIVE SPACE from structural elements like walls and columns. As we see, comparing the left and right drawings, this induces a fairly massive transformation in the whole.

6 / SUMMARY SO FAR

We see how the coherent geometry which makes the thing a unity, and which gives it beauty appears, step by step, as a result of differentiations caused and modified by the fifteen transformations. Throughout the process, these transformations essentially created the design.

Ideally, then, when things are going well, each center gradually gets shaped appropriately

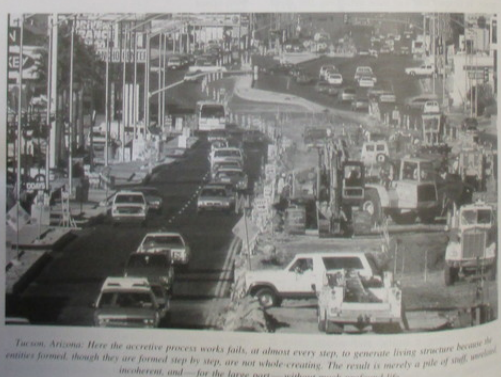
by successive differentiations, and is governed by the larger whole, which it embellishes and helps to shape, and from which it springs. When that happens, everything is going well, and living structure will emerge. This may happen either in the context of an individual building project unfolding, or it may happen in the context of accretion where the construction of an individual building helps to differentiate, and make coherent, the urban space around it.

In cases where the process is less successful, the individual actions that arise within a larger whole are not shaped according to the nature of the larger whole, do not help it or enhance its life. Rather, they are locally unruly fragments (like cancer cells) which do too little locally to sustain and improve the whole.

For reasons given in chapter 4, most 20th-century urban developments were of this latter kind. When I said, there, that contemporary design and planning and development are too often structure-destroying rather than structure-preserving, what I meant was that the fifteen differentiating transformations were largely missing from day-to-day processes.

On this page we see such an example from Tucson, Arizona, where the process of differentiation seems to have broken down altogether, and has been replaced by a very loose form of segregation in which the larger wholes are almost never taken care of or healed. In the late 20th century we became used to this. However (though it it has been uncommon for a few decades), the demand that each act of construction in a city should always *help* the larger wholes, and should play a helpful role, is not an overwhelmingly subtle demand. In a generated structure this happens most of the time. An architecture succeeds — and we shall succeed in building living worlds in our cities — when there is a generative process which will allow each part to be shaped correctly, according to its local position, *and in a way that guarantees it has a positive impact on the larger whole.*

This bland-seeming statement has far more teeth than we might at first imagine. If the city of



Tucson, Arizona: Here the accretive process works fails, at almost every step, to generate living structure because the entities formed, though they are formed step by step, are not whole-creating. The result is merely a pile of stuff, unrelated, incoherent, and — for the large part — without much profound life.

Tucson had a living process guiding development, the next acts that took place in the part of Tucson illustrated above would, without effort, include some constructive ways to repair what is there, improve the positive space, make it all more usable, not only for trucks, but for people, too.

If a city can do that one thing all the time, or nearly all the time, everything will gradually work out fairly well; and if we can work out rules of the game so that people all over the world — builders, bankers, lay people — can go forward, doing whatever they do in the world, repairing their surroundings, always accomplishing this one task, then the Earth's environment will steadily be healed. Cities and buildings can become coherent and harmonious, merely as a result of following this rule. From a social point of view, then, what matters are the generative processes, the specific rules of the game which people follow when creating centers. When architects design buildings, are we designing in such a way that the parts we create, large or small, contribute to the larger wholes and to the life of the larger whole? When a carpenter places a piece of wood, does the way he does it contribute to the life of the larger whole? When a city-planning official processes a permit, or modifies a permit, does the way he performs this act contribute to the life of the neighborhood?

The rules of the game — the way architects, builders, planners, painters, gardeners, and ordinary citizens play their roles and undertake their actions — that is what controls the form of the world. And the rules of the game needed are precisely those generative processes introduced in chapter 6. The question is, "Are the present rules of the game likely to help people generate a living structure in the larger whole?" It is this question that confronts us. Our aim, to generate a living world, need only be to tame and redefine the rules of the game, to make them work so that all of us together, as we go about our business, can create a living whole.

7 / THE FUNDAMENTAL PROCESS:

Let us now try to set forth a general model of differentiation. Drawing on the broad picture of local processes and accretive processes — we may see that every process of planning, or design, or construction, or repair — *if it is part of a living process* — will always have a certain general form. This will provide us with the tool we need for a general and powerful way of looking at architecture — indeed at the construction of the built world as a whole.

The idea that there might be a single class of processes at the core of all living processes in society — hence at the core of all building, engineering, and all construction of our world — may shock the modern mind. In the conventional 20th-century way of thinking about architecture we faced a great number of disparate kinds of activity; we had to pay attention to function, flow of people, engineering, building materials, color, traffic, climate, money, the wishes of the client. In normal professional work, all of these were assumed to be different *in kind*, and required different procedures. Somehow, as architects or engineers, we were supposed to combine these many disparate procedures to produce a successful whole.

I am proposing, instead, that in the course of all planning, building, conceiving, designing, landscaping, or making, at every stage we understand every process to be composed of repeated applications of the fundamental differentiating steps I have described. I believe all living processes are, in effect, combinations or combinations of combinations of this kind of differentiating step. A given living process may have a dozen steps, hence a dozen applications of the fundamental process, or it may have 500 steps, hence 500 applications — and the given building

project may still be in the process of being imagined on a computer or a drawing board, or may be under construction, or may have been developing for many years — but the situation is always essentially the same, and the essential nature of each step, each application, is always similar. The core of the differentiating steps lies in the way that centers emerge and evolve and interact.

At each stage in its evolution the process — when a living one — always starts from the wholeness as it currently exists at that moment. The work is complete in some respects, in some respects incomplete. At the next moment, we take a new step — introducing one new bit of structure (always composed of new, living, centers) into the whole. The new structure we introduce may be large, medium, or tiny; it may be physical or abstract; it may occur on the land itself or in a person's mind, or in the collective understanding of a group of people. But the point is that at every stage of every life-creating process, the new bit of structure which is injected to transform and further differentiate the previously existing wholeness, will always extend, enhance, intensify the structure of the previous wholeness by creating further, and stronger, living centers. I therefore regard the group of fifteen transformations which do this work as providing what we may regard as elements of a universal building block — or universal "next step" — for each step forward in all living processes. The structure-enhancing step, which again and again intensifies one center and creates "hooks" to other new centers, might even be called *the* fundamental process.

THE FUNDAMENTAL DIFFERENTIATING PROCESS

1. At any given moment in a process, we have a certain partially evolved state of a structure. This state is described by the wholeness: the system of centers, and their relative nesting and degrees of life.

2. We pay attention as profoundly as possible to this WHOLENESS *— its global, large-scale order, both actual and latent.*

3. We try to identify the sense in which this structure is weakest as a whole, weakest in its coherence as a whole, most deeply lacking in feeling.

4. We look for the latent centers in the whole. These are not those centers which are robust and exist strongly already; rather, they are centers which are dimly present in a weak form, but which seem to us to contribute to or cause the current absence of life in the whole.

5. We then choose one of these latent centers to work on. It may be a large center, or middle-sized, or small.

6. We use one or more of the fifteen structure-preserving transformations, singly or in combination, to differentiate and strengthen the structure in its wholeness.

7. As a result of the differentiation which occurs, new centers are born. The extent of the fifteen properties which accompany creation of new centers will also take place.

8. In particular we shall have increased the strength of certain larger centers; we shall also have increased the strength of parallel centers; and we shall also have increased the strength of smaller centers. As a whole, the structure will now, as a result of this differentiation, be stronger and have more coherence and definition as a living structure.

9. We test to make sure that this is actually so, and that the presumed increase of life has actually taken place.

10. We also test that what we have done is the simplest differentiation possible, to accomplish this goal in respect of the center that is under development.

11. When complete, we go back to the beginning of the cycle, and apply the same process again.

This process, though presented as atomic, is multiple: What appears like a basic unit of process, is itself actually a complex system of processes. At any given moment one center holds our focus. As we make it stronger, we have to strengthen (or create) half a dozen other centers and we try to do this simultaneously. That is a necessary part of making the one center we are working on. If our focus shifts, and we start paying focused attention to one of these other centers that is being worked on, we are then effectively ending one cycle of the fundamental process, and starting a new cycle, now focused on a different center.

In principle (not always in fact) every life-creating process repeats the fundamental process hundreds of times, iteratively, applying it again and again to the product of the previous application of the process. The process stops repeating when no further step can be taken that intensifies the life of the whole.

Such a process will always be structure-enhancing — by definition — because it keeps the wholeness intact, and extends it iteratively. Remember that wholeness in a given region of space is defined by the system of centers that exists there. Repeated use of the fundamental process keeps differentiating the space by enhancing some one or another of these centers (large or small) that is already latent (dimly present, but not yet fully emphasized) in the structure. It keeps on strengthening centers in such a way as to extend and preserve and enhance the whole.[2]

8 / THE CLASS OF LIVING PROCESSES

Using the fundamental process as an intellectual building block, we may reach the concept of a living process. I define a living process as any chain of differentiating steps, each of which carries out the center-intensifying process by means of the fifteen transformations, applying them, iteratively, to the whole. Such a process may serve to guide the design of a great building which is to be uniquely conceived, ordinary day-to-day building design, interior design, nature-conservation, engineering, heavy construction, land management, ecological transformation of a wilderness, or social transformation of a neighborhood.

In one form or another, versions of the fundamental process are used repeatedly in all living building processes. Most living processes are of one of three types:

1. A single use of the fundamental process.

2. A string of steps, each one an instance of the fundamental process, the series strung together one after the other, so that the process may be seen as the sequential creation of living centers.

3. A nested hierarchy of steps, each one an instance of the fundamental process, so that these steps are carried out not in a single precise order, but in a general broad order, each one then calling upon further steps, until the whole is finished.

In all these cases, it is repeated use of the fundamental process which forms the core. A living process may occur in a person's mind while conceiving the idea of a great building. A living process may happen in the cooperative work of a group of people making a park or a building together; it may happen in the actual fabrication or creation of a building element; it can happen in the peripheral processes which govern aspects of buildings, plans, and the environment. The evolution of a neighborhood, design of a major building, painting of a small miniature portrait, laying out and planting a park . . . all, if done in a living process, may follow this model. In all these

processes, at every step, the same cycle of structure-preserving events is repeated.

A living process always preserves a certain natural order, and happens in a certain natural sequence. Typically (though not always), we may say that the process moves from larger wholes to smaller ones, first allowing the largest ones to unfold from the context, then growing or filling in smaller ones within the context of the larger whole.

At other times, though, a process goes the other way, beginning with a small thing, which then grows larger, and extends, preserving or developing a larger wholeness. That is what happens when one particular plant grows in a forest. The forest does not first establish a larger plan for the forest as a whole. What happens is that each small process acts to contribute to a (not-yet perfectly defined) emerging larger whole, and keeps developing the wholeness in that way.

9 / PRACTICAL MANIFESTATIONS OF LIVING PROCESS

I emphasize that a living process, as I have described it, is an *idealized* scheme. In the real world of architecture, processes which are living ones do not necessarily resemble the scheme I have described. They are often more informal, and more ordinary.

A couple of examples will make the point. Suppose I am telling someone how to improve a corner of their garden. My advice would be something modest and practical: *Do one small good thing; then do another small good thing; then do another good thing.* Simple as this is, focusing on creation of one good thing at a time, is already likely to work; it will make the garden better. After a person has grasped that idea, I may then point out that sometimes, the good things that we do work even better if each small good thing also helps to achieve some slightly larger good thing. You not only plant a small lilac bush, but you plant it next to a sunny spot where you might like to sit on the grass, and in a way that *contributes* to this larger spot. Then a particularly lovely spot may be created in the garden. If we do *this* kind of thing every time we improve the garden, the process will make the garden better in a bigger sense, and in leaps and bounds. This point is, implicitly, a reference to the creation of larger centers — necessarily part of every living process. But I do not need to mention creation of centers explicitly to have a living process. The *idea* of creating centers is crucial. The *language* of centers does not have to be used to make it work.

The same point holds for larger and more public problems. We might formulate a public policy which gives advice about the location of freeways in the landscape. For example: *The position of a new freeway should be chosen to leave beautiful and harmonious land untouched. It must therefore thread its way through a landscape, using as far as possible only the most damaged available bits of land, both for the roadway itself and for the landscape on either side of it.* The effect of this policy on our Earth, if it were widely applied, would be extremely positive. But once again, though it is *implicitly* a living process, since it preserves and extends living centers where they exist, it does not explicitly use the language of centers to achieve it. And it does not need to. It encourages construction of new centers (in the surrounding land and in the freeway) in such a fashion as to increase, not reduce, the harmony of the larger structure of the land. That is what matters.

Society, everyday habit, and professional practice are all filled with rules, policies, generic processes, and homely bits of advice about process. So long as the *content* of these processes — not necessarily their verbal form — makes them living processes, they will help to create living structure in the world. We may

judge whether a given real process is living or not by paying attention to the process and asking if its various steps resemble, or do not resemble — in their *content* — the fundamental process. It is a living process when, in *content* — not necessarily in outward verbal form — it accomplishes, and approximates, the scheme I have described.

10 / THE NATURALNESS OF LIVING PROCESS

Living process may be understood well if it is understood to be the most *natural* process in a given circumstance. Suppose, for example, that you are going to lay out your own office for yourself. More or less, you know how to do it. So it does not make sense for me to tell you, shaking my finger at you: *You must use a living process.*

The idea of living process, is, in a sense, only a formal way of talking about your natural process. You already have certain natural instincts about where to sit, how to work, how much space in front, to the side, where to keep your books, and so on. In your own house you do these things naturally, as a matter of course. But the layout process used by big-time corporate furniture installers does not include, or even permit, the natural process I have just described. That is why it destroys life, rather than enhancing it. Part of our difficulty in modern society is that accepted formal processes often fail to include natural processes, and that is how they get things screwed up.[3]

Of course, there are many kinds of natural process. In one natural process you just do one thing after another, as you feel like it. It is natural in the sense that there is no imposed rhythm or order. The rhythm and order is whatever comes from within. But a more wisely achieved natural process may include deeper things, that are not obvious to the do-er. That is closer to Zen, which aims at being completely natural, but is also more deeply wise. If, for instance, you are placing a fence by a natural process, you may be nailing boards together as the spirit moves you. If I tell you that it is better when the space between the fence boards is more positively shaped — and you discover that the fence becomes more beautiful and gets more life when you do this — then you have a wiser process, which is still natural, but now embellished by a little more understanding. Here you have incorporated the POSITIVE-SPACE transformation, and so modify the process to make it more living. So, you learn something from the theory of living process, and incorporate it in your own natural process, making your own process slightly better.

A living process, with its inherent structure-preserving transformations, is always natural, similar to the best kind of natural process. It incorporates our most natural actions, but it goes deeper, and includes additional centers, which our naive natural process may not take into account. Thus, in laying out your office with a living process, you may pay more conscious attention to the work area next to the computer, make it bigger, create more comfort there, so that it becomes a living space in the room.

Whatever you are doing, whatever process you are following, the concept of a living process usually has the capacity to make it a little better, by making deeper, more profoundly and carefully structured living centers, replete with the fifteen properties — just helping you do a little better what you already do naturally.

11 / EXTREME GENERALITY OF THE CONCEPT OF LIVING PROCESS

What I have defined as living process is — I believe — the minimal, and necessary core of *any* process capable of creating life. In organic nature, some version of living process occurs in the formation of organisms, as I have suggested earlier. In the inorganic natural processes which create living structure in ocean waves, mountains, galaxies, some version of this cyclical structure-preserving process always occurs — as I have suggested in chapters 1 and 2.

And, of course, living processes are a necessary part of any successful process of designing and constructing well-adapted buildings and cities. This conclusion follows directly from the nature of wholeness itself, since centers *must* be created, and *must* meet the condition that all centers are helping other centers, if the structure generated is truly to have life.

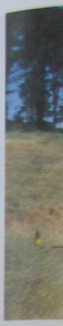
What is surprising is that all living processes can be subsumed under this single rubric.[4] If you examine the design and construction of the late 20th-century house shown in the appendix of this book, you will see an attempt to make such living process the basis of nearly all steps taken. If you go back to chapter 5, and look at the many successful 20th-century cases of living process in our modern world shown there, you will see that in those cases, too, it is most often the presence of structure-preserving transformations which makes them work. Whether it is in the development of Manhattan, in the planting of the daffodils in a garden in Sussex, in Matisse's drawing of a woman's face, or in the construction work on a community center in Indonesia — in all the examples the steps taken are, *in their essence*, of the same kind.[5] The steps are similar, regardless of scale. The growth of lower Manhattan deals with the initial conception of an entire area of a city that is two miles across; the example of the railroad yard in Minnesota is perhaps 700 yards long; another example deals with the planting of flowers in a garden perhaps 70 feet across; another governing the placing of a table is hardly more than 70 inches across.

12 / A PROCESS OF CREATING MEADOWS

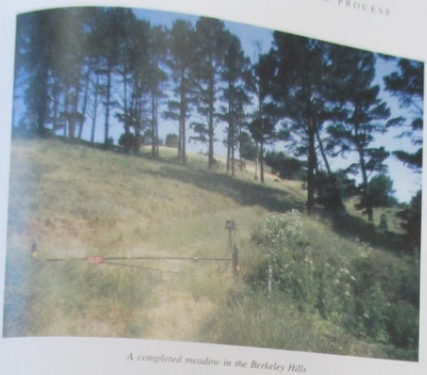
To end with, I now give a short but detailed and explicit example of one living process at work in the creation of landscape in the San Francisco Bay Area.

The following quoted description of the process refers to me, explicitly, since it was invented and described by my friend Bill McClung, while he was editing THE NATURE OF ORDER. I have left his words exactly as he wrote them, because I find the relaxed language, and his way of talking about the fundamental process in the context of meadows, extremely helpful. It gives real insight which adds to the way one may understand the process, and illustrates its both profound yet ordinary nature very well.

McClung has been engaged for several years in an effort to reconfigure the process of cutting fire-hazardous brush, in the fire-prone California hills on the outskirts of Berkeley and Oakland, in such a way as to make the places useful and beautiful: a significant living structure that is attached to these cities. He contemplates the creation of a 500-foot buffer zone, comprising thousands of acres, wherever wild lands come close to urban areas around the San Francisco Bay, and publishes a newsletter aimed at stimu-

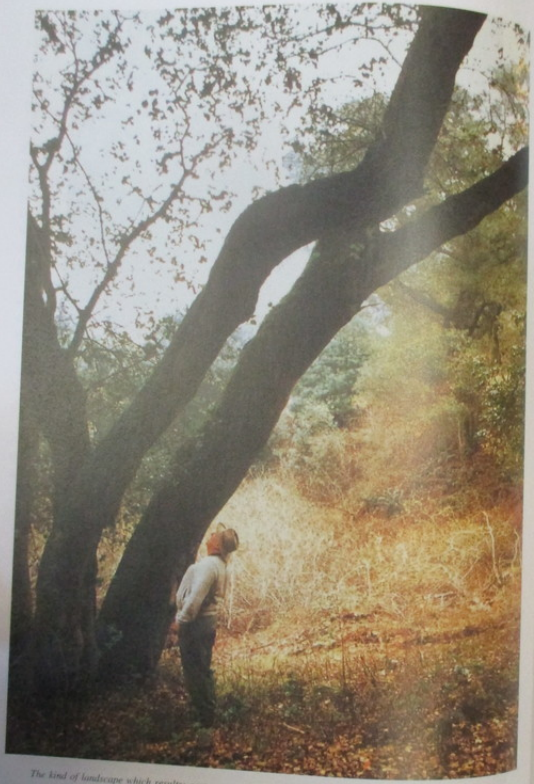


Studying a landscape in windbreaker is looking enhanc



A completed meadow in the Berkeley Hills

Shaping a landscape in the mist, deciding what minimal actions will do the most to give it life. The person in the yellow windbreaker is looking for the latent centers in the landscape, trying to identify the centers that should be encouraged, enhanced, and strengthened, and trying, at the same time, to decide what to cut away.



The kind of landscape which results: centers, spaces, and trees are made to stand out; the shape of meadows is lovingly crafted; space becomes more positive. All in all, it is a place where you want to be, because it now has more life. Rex Diederich, ex-fire captain of Berkeley, during his work on the formation of a new wilderness in the Berkeley hills, 1996.

Typical state of the l process b

Women cutting thistle

lating the creation
throughout the fire
buffer zone.

The following pa
from McClung's news

"Meadows [akin
mow] may sometime
think they usually are
mitigation work, we
and reducing vegetatio
excessive tree and bru
meadow is in how we
we do with what we h

"*The Fundamenta*
duce life in space, acc
exander, if we make th

Typical state of the landscape, before the center-making process begins: eucalyptus brush

Half way through cutting and clearing, the centers begin to emerge, but are not yet well-shaped or positive. After most of it is cleared, a meadow starts to form.

Women cutting thistle in Tilden Park meadow, 1996, starting to do the actual cutting and removing of brush, to make the centers, boundaries, and positive spaces come to life in the landscape.

lating the creation of beautiful meadows throughout the fire-hazardous areas of the buffer zone.

The following passage is reprinted verbatim from McClung's newsletter.[6]

"Meadows [akin to Old English mädwan to mow] may sometimes appear naturally, but I think they usually are constructed places. In fire mitigation work, we make meadows by cutting and reducing vegetation, from weeds to grass to excessive tree and brush growth. The art of the meadow is in how we apply reduction, and what we do with what we have removed.

"*The Fundamental Operation*. We can produce life in space, according to Christopher Alexander, if we make things following a natural, slow-unfolding process, which involves these steps: *(1) Observe and absorb the deep structure of the whole space.* The deep structure of a potential meadow is usually formed by the shape of the land, the major trees and brush clusters, natural edges, vistas, colors, smells, shadows, the way the sky is revealed and hidden, and important animal and plant life of the place. Such things Alexander call strong centers. *(2) Ask what we can do next to most intensify the life of what is before us, by strengthening the strong centers and wholeness already there. (3) Try to do it.* Life-generating work always involves strengthening existing strong centers, large or small, and in such a way as to make structure-preserving transformations. *(4) Evaluate the result and the new whole-*

Result of the application of the fundamental process: a completed meadow. This picture shows a harp concert in one of the meadows completed by Bill McClung.

ness. (5) Repeat the process step by step. (6) Stop when further improvements in the feeling of the whole cannot be made.

"In a one-acre meadow we might reduce and shape as much as five tons of plant and tree material, choosing what to cut and what to leave, reshaping the space, making it more alive if we are successful, while reducing fire danger by reorganizing fuels downward. The fuels near the ground decompose more rapidly and have less oxygen in a fire. The opening of good spaces where there was dense vegetation is how we make the meadow. The defining feature of the land form is better revealed when the grasses and weeds are cut, brush removed. An important vista is opened by removing dead tree debris. Insects and bugs thrive in the low debris piles, providing food for lizards, salamanders, birds and other animals. Well made, it will feel right. The feeling a place presents to us is a measure of its life. If the meadow feels safe and inviting, it probably is."

13 / NECESSARY FEATURES OF ALL LIVING PROCESS

The concept of living process, although it follows from a simple definition given at the start of this chapter, is complex and rich. At a stretch, it seems to me that it might possibly compare in intellectual breadth and depth to the concept of energy as it was introduced in the seventeenth century. When first introduced, energy (kinetic energy) appeared in the mechanics of Descartes and Newton, as $mv^2/2$. Gradually, during the following centuries, the concept evolved continuously, becoming more and more rich, more extended, and applying to an ever wider range of phenomena, until in the 20th century we saw the equation of mass and energy and the nearly uni-

venal format of energy underlying in one form or another nearly all the substance of the universe.

Perhaps the concept of living process has comparable potential to evolve its meaning. It is as intuitively accessible idea; it has enormous capacity to develop and expand. At this early stage, whatever is said, can hardly be more than a first approximation of an idea which must still be deepened and broadened in the next decades, as our understanding of it grows. We can, however, at least try to pin down some of the more important features which the concept has — in an early form. No matter how it is expressed, I believe future understanding of living process — if the concept survives in future generations — must have at least the following features:

1. A living process is a step-by-step adaptive process, which goes forward in small increments, with opportunity for feedback and correction at every increment (chapter 8).

2. It is always the whole which governs, in a living process. Even when only latent, whatever greater whole is latent is always the main focus of attention and the driving force which controls the shaping of the parts (chapter 9).

3. The entire living process — from beginning to end — will be governed and guided and moved forward by the formation of living centers in such a way that the centers help each other (chapter 10).

4. The steps of a living process always take place in a certain vitally important sequence, and the coherence of its results will be dependent to a large extent on the accuracy of this sequence which controls unfolding. (chapter 11).

5. Parts which are created during the process of differentiation must become locally unique; otherwise the process is not a living process. This means that all repetition is based on the uniqueness of the locally shaped parts, each adapted, by the process, to its situation within the whole (chapter 12).

6. The formation of centers (along with the sequence of their unfolding) is guided by generic patterns which play the role of genes (chapter 13).

7. Every living process is, throughout its length and breadth, congruent with feeling and governed by feeling (chapter 14).

8. In the case of buildings, the formation of the structure is guided geometrically by the emergence of an aperiodic grid which brings coherent geometric order to built form (chapter 15).

9. The entire living process is oriented by a form language that provides concrete methods of implementing adapted structure through simple combinatory rules (chapter 16).

10. The entire living process is oriented by the simplicity transformation, and is pruned, steadily, so that it moves towards formation of a beautiful simplicity (chapter 17).

In the next chapters I shall discuss these ten features of living process in detail. It is my hope that the reader can gain enough practical understanding from these discussions, to begin applying this kind of thinking to real cases of design and planning and construction. It is my hope, too, that a person can use these ideas to help shape his or her own procedures, and to approach gradually a more and more profound version of living process, that is rooted in these ideas. I am reasonably certain that, for any process to be a living one, these ten essential features, *at least*, must be present.

I would like the reader to consider my discussion of living process in the next ten chapters as applying to every conceivable process in society, and to every architecture-creating process, at any scale, in which the reader is herself/himself involved.

I cannot see a way of entering the 21st century — the century of biology — without some conception of living process. To create living structure in our world, profound sequences originating in the fundamental process, in some form, must be used again and again. The more we understand about creating life — in buildings, towns, pictures, artifacts — the more we will gradually come to realize that life comes

about in them when, and because, and only because, we are repeating the fifteen structure-preserving transformations again and again and again: And when we do, when we unfold the structure of the world successfully through differentiation, the results will always be the same, in some profound fashion, though infinitely various in their detail.

NOTES

1. See chapter 8, page 242–43.

2. If necessary, check back to the definitions of wholeness given in Book 1, chapter 3 and appendix 1.

3. The concept of naturalness has been very strongly emphasized and developed by Karl-Henrik Robert in the Swedish, and now world-wide, movement known as The Natural Step. See "Educating a Nation: The Natural Step," IN CONTEXT, Spring 1991.

4. I maintain that the definition of living process is completely general. During the last twenty years, I have tested versions of this process in hundreds of projects, at many different scales. Many are described in Book 3, A VISION OF A LIVING WORLD. I have taught this process as the core of design and planning and construction, in one form or another, to generations of my students. I have taught it to them in the context of engineering structures, where they have used it to make beautiful and efficient structures. I have taught it to them in the context of laying out neighborhoods, where they have used it to plan streets and houses, and guide the human process of planning. I have taught it to them on construction sites, where they have used it to shape, form, improve, give spirit to the physical process of construction and the details they build. I have taught it to landscape architecture students who have used it to shape and enliven land. I have taught it to ecologists who are now trying to use it to define the larger-scale ecological systems of a geographic region, especially visible in Stuart Cowan's work in the Pacific Northwest. I have taught it, in part, to my friend and editor Bill McClung, who has added it, injected it, into his already beautiful feeling for the process of making fire-safe meadows in the Berkeley hills. I have taught it, of course, to architects, all over the world, now laying out the form, circulation, shape, and character of very large buildings. I have taught it to city-planners laying out streets and neighborhoods in cities like San Francisco and Tel-Aviv, and in rural areas of Papua New Guinea: they include Yodan Rofe, Ken Costigan, David Week, and others. Aspects of what I have suggested here have played a role in the formulation of a new theory of the city by colleagues like Andres Duany, Peter Calthorpe, and Dan Solomon. They founded the Congress of New Urbanism welding such ideas into existing practice, and now practice them as they seek to establish pedestrian areas in cities.[6] I have taught it to engineers like Gary Black, who now practice it in the use of finite-element analysis, in a way based on the fundamental process, in the creation of new engineering structures. And I have taught it to planners who practice it in establishing the rules, governance, and urban design which contribute to this practice. I have even taught a version of it to my students in my painting classes, where many of them learned to make beautiful pictures.

All of these living processes are, in one fashion or another, made up from repeated application of the fundamental differentiating process. The fundamental process is the *one general* underlying step which is the building block of every process capable of generating life. We may do all of architecture, all construction, all farming, all forestry, and all bridge-building, all road building by following this simple fundamental operation thousands and thousands of times. This is the structure-preserving, differentiating step which is required to get life into the world.

5. For example, in lower Manhattan the process explicitly paid attention to the whole while parts were created. The picture the financiers and developers had of a close group of buildings, allowed the individual placement of the buildings to form the larger center which we now recognize as Wall Street. If they had not had the desire to place the buildings in a close-knit group, the buildings would not have formed this coherent center, and would instead have merely been isolated skyscrapers, as they are in Dallas or Phoenix today.

6. Reprinted from William McClung, "How to Make a Meadow Following Alexander—1," published in THE BUFFER ZONE, 2, (1998), page 3.

7. Note 7 for text on page 227. Discovery of the mechanism responsible for the appearance of the 250 cell types, is due to Kaufmann, see Stuart Kaufmann, AT HOME IN THE UNIVERSE (New York: Oxford University Press, 1995. Viking paperback edition, 1997), pp. 106–12.

APPENDIX / ON THE HUMAN EMBRYO

SOME PARALLELS BETWEEN REPETITION OF THE FUNDAMENTAL PROCESS AND MORPHOGENESIS IN EMBRYOS

We may gain appreciation of the character of living process in architecture by comparing it to the biological unfolding of a fertilized egg in an organism — the morphogenesis of an embryo. Every living process resembles, in general terms, the process which underlies the unfolding of an embryo.

To see the significance of the parallel, I make a few observations about morphogenesis. The process is remarkably simple in broad outline. It starts with a single cell. The first cell divides, and then divides again. All in all, in the case of a human embryo, there are some 50 cell divisions (happening all across the board about once every five days), creating an organism with about 2^{50} (10^{15}) cells; the fully developed human being. And within that organism containing 10^{15} cells, there are only about 250 cell types.[7] We know from this, that the rules of development must be simple. Some standard differentiating transformations (not unlike the transformations I have defined) must occur, be repeated 50 times, and so generate the complex, fully formed newborn human being. The simple transformations work because, being context sensitive, they take different forms in each context within the embryo, and thus produces appropriate and different results in each place where they are used.

The steps themselves are simple too. For instance, at an early stage, the ball of cells is spherical. At that stage, one particular spot gets marked, thus differentiating the sphere and forming an axis within the sphere. Later, that axis becomes the spinal column. The spot, now a mark at one end of the spinal axis, will later become further differentiated to form the head. At another stage, the ball of cells develops three layers that will later become the skeleton, the organs, and the skin.

So the process of differentiation is, in principle, simple. One can imagine that the transformations which occur at each stage must be quite straightforward, too. Yet later in the process it creates hands, feet, eyes, brain — deep complexity. So far (1998) the embryo's transformations have not been completely identified or well understood. Even in this era of supersophisticated computer simulations, the nature of these steps has so far eluded us. Of course it will be done soon. But it is interesting that something so simple, and so fundamental, has not yet been fully mapped or understood. Although the transformations are applied 10^{15} times, in the course of the transformations only about 250 different cell types arise. The ongoing transformations will, of course, generate these different cell types in response to different contexts. Again, it is remarkable that these transformations are so simple, and yet capable of creating such great complexity, architectural coherence, and beauty.

It is interesting too, that the body is replete with repetition. Structures *repeat*. We have perhaps 100 eyelashes, five fingers on each hand, hairs, toenails, muscles, bones — all repeating. Repetition — gigantic repetition — is the underpinning of the whole system, as it is of every structure in nature.

Yet this repetition is of an unusual type. When we think of repetition, we normally think of *repetition by addition*. I take some pennies out of my pocket, and lay them on the table, in a row. Repeating the same element, I get the repetition by addition. But the organism does not get repetition by addition. It gets it, most typically, by differentiation and division. A certain volume is filled with a wave structure, which then divides into five lines, and the wave crests then become fingers. The waves were created by filling a certain zone, dividing it. Most of the repetition in the organism comes from division, not from addition. This is a far more subtle type

of thing. The whole determines the parts. Parts are formed according to their position in the whole. Repeating units are formed by division of a structure into roughly equal parts, which then divide and differentiate further to get their form.

Consider, further, the actual transformations which occur in the embryo. At each cell-splitting that occurs, we may imagine a function which sets up the particular differentiations that occur in a particular zone of space. In some form, these transformations will obviously be hierarchical, each one taking place within some bounded part of the emerging body, and producing different results according to the local contexts where they occur. For instance, what happens next in the emerging head area is obviously different from what happens next in the emerging foot area. In this sense, what actually happens during the emergence of the fully developed body is vastly more than just fifty events. There are fifty time intervals in which such transformations occur. But in each time interval, there may be ten, or a hundred, or a thousand essentially different contexts or spatial zones, and the master process applies, then, to one thousand different versions of the transformation to the one thousand different loci, and has different effects according to the different contexts in those different zones. Thus we have not fifty, but many thousands of individually different transformations, happening during the nine months of morphogenesis, each one specific according to the context where it occurs, and each one then bringing into being new differentiations which ultimately create new structure, and create new contexts for further transformations of the same type, in the next round.

In architecture, too, all living processes are built in some form from what I have called "the fundamental process." They create new centers shaped according to the whole where they occur. Like the transformations which occur in the embryo, these creative processes are versions of a general transformation. But, like the master process of the embryo, these architectural transformations can be carried out by people in many different places, in the myriad different contexts of the built world. They may be applied again and again to different emerging structure in any part of the world. When we apply them successfully, we shall get coherent results, much as the general transformations in the embryo get consistent and coherent results in all their sphere of influence.