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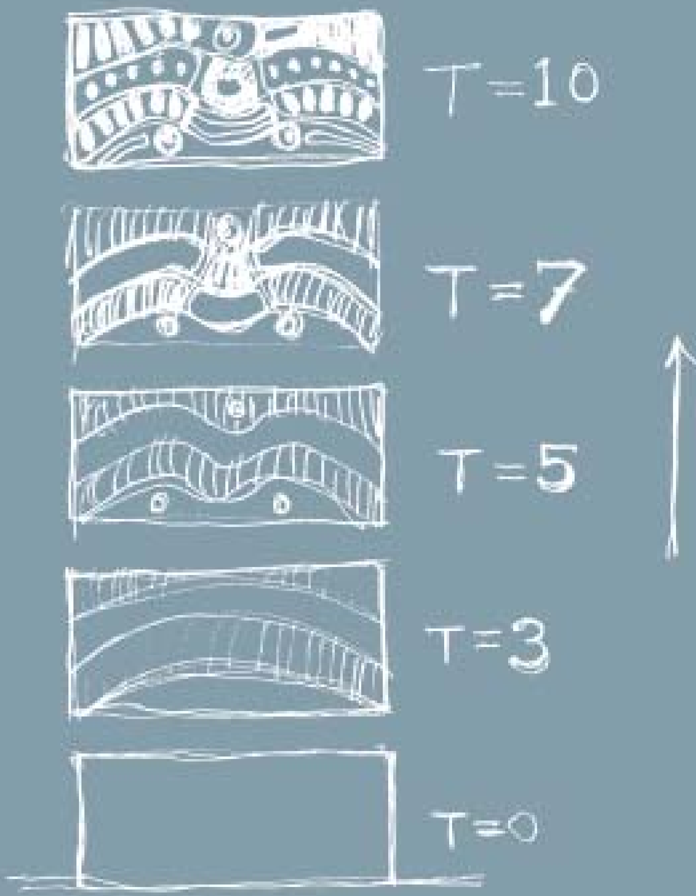


A THEORY OF ARCHITECTURE

PREFACE BY HIS ROYAL HIGHNESS THE PRINCE OF WALES

Chapter Seven

PAVEMENTS AS EMBODIMENTS OF MEANING FOR A FRACTAL MIND.

By Terry M. Mikiten, Nikos A. Salingaros, and Hing-Sing Yu

1. INTRODUCTION.

This Chapter puts forward a fractal theory of the human mind that explains one aspect of how we interact with our environment. The mind establishes a connection with the environment by processing information, an important process that drove the evolution of the brain. Some interesting analogies are developed here of how we store ideas and information within a fractal scheme. In particular, in this discussion we assert that floor patterns in buildings, and the pavements of sidewalks, streets, and plazas play a role in connecting human beings to surrounding structures, by acting as a vehicle for conveying meaning. Successful pavement design transfers meaning from our surroundings to our awareness. Directional patterning can lead the pedestrian. Such a connection, if done properly, can establish a positive psychological and physiological state. We argue that the success of patterned pavements is due to the fact that they connect hierarchically, which in turn triggers positive emotions.

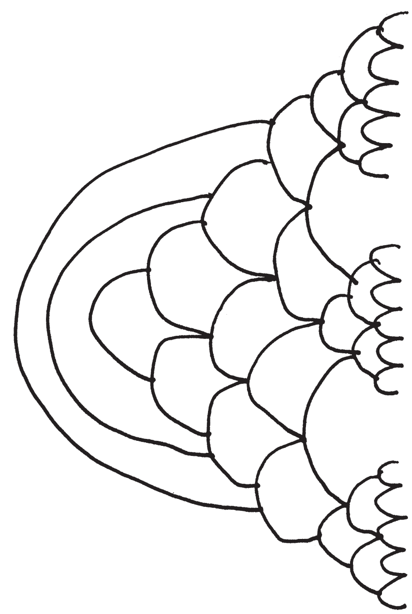
If we wish to preserve our intelligence in a more permanent form than electrical impulses in biological nerve tissue, we can transfer our thoughts to books; or engrave them on a physical medium such as stone. On a much more fundamental level than written language, however, we could impress (imprint) on open space a geometrical pattern that reflects analogous informational structures in the mind. A patterned pavement has information content and is physical and durable; it is therefore a sign of intelligence encoded in a structure that uses very little energy, hence is relatively permanent. Moreover, since a geometric design doesn't need spoken language to convey meaning, it is universal, i.e., it can be understood in some sense by any mind that can detect it. One may say that geometric design is a universal visual language.

Some of these ideas grow out of an earlier discussion on how human beings interact with their surroundings (Padrón & Salingaros, 2000). The perception of public space is linked with the design of its pavement, and human perception is a natural part of how the mind operates. The mind establishes connections automatically. This process occurs in any physical space, and it is either helped or hindered by design patterns and texture. The floor helps or hinders our perception of the surrounding space. We will build a case for a psychological link between an observer and an open space that depends in part on visual patterns. We claim that the environment links directly to our consciousness, which extends to embrace open spaces via patterns in the pavement. Finally, we provide some very broad guidelines of how pavements should be designed in order to achieve this linking.

2. FRACTALS AND HIERARCHICAL LINKING.

A fractal structure shows non-trivial geometrical substructure at every level of magnification (Lauwerier, 1991). Fractals define a scaling hierarchy that is complex at every level of magnification. The special case of "self-similar fractals" has the additional property that structure revealed at each level of magnification is related by scaling (Lauwerier, 1991). That is, the substructures when magnified by the appropriate factor are all similar to each other. Self-similar fractals are mathematically simple; since their structure is repeated at different magnifications to create the whole, they require only one basic algorithm (design) to generate. A basic design is repeated at different magnifications, and this links all the scales in a self-similar fractal together (see Figure 7.1).

Figure (7.1)
Fractal links different scales in a hierarchy.



Biological forms are always fractal (Weibel, 1994). Many are obviously self-similar, but organisms also include complex structures that are not. For example, the mammalian lung is a self-similar fractal in several of its larger levels (Weibel, 1994; West & Deering, 1995; West & Goldberger, 1987). There is a clear dendritic (tree-like) structure that optimizes — and is a consequence of — the subdivision of the airducts forming the lung (Figure 2.2). As one gets down to the smaller level of the alveoli, exact self-similarity is lost, because different complex substructures arise as the physical needs for gas exchange and blood circulation take over. The lung is a fractal all the way down to the molecular level according to the broader definition of "statistical self-similarity". In a "statistically self-similar fractal" the degree of structural complexity (though not the form) is similar at each scale, still linking the different levels of scale.

A fractal connects several different levels of scale. Whether established via similarity of form on each scale, or through some other common qualities such as texture or symmetries, the scale-connectivity property of fractals creates a hierarchical linking. Hierarchical linking in the environment attaches forms and textures to geometry at different levels of scale, and so to an observer. In such a system, it is very easy to go from the very small to the very large. It is impossible to link forms hierarchically if they are empty, since in that case the absence of substructure leaves too few subscales to link together.

A hierarchically-linked system can encode complexity in a simple manner. We can relate complexity to the length of an algorithm (i.e., a mathematical rule) required to generate a pattern or visual piece of information. If the algorithm is short, then the pattern is termed simple. For example, if one wishes to draw a fern leaf or cauliflower (normally considered complex structures) using a fractal algorithm, the algorithm is very short, because those designs embody hierarchical scaling. The algorithm draws all scales, down to the microscopic level. Fractal encoding is described by many authors (see Section 4 of Chapter 3; Lauwerier, 1991). We utilize this concept to propose that what appear to be complex processes in the human mind and its interactions with the environment could in fact be very simple in a fractal sense. Fractal processes and designs can provide the basis for connecting ideas, memories, architecture, and urban elements (Padrón & Salingaros, 2000).

3. THE CONCEPT OF MIND.

The brain is known to be a structured system of hierarchically-organized anatomic modules. These interacting modules communicate with one another. In turn, the modules contain within them other sub-modules that communicate among themselves (within the larger module). This pattern is repeated at several different levels of scale, culminating in what is a molecular and biochemical fractal of interacting and communicating systems (Alexander & Globus, 1996). Although it doesn't look tree-like, the functioning of the brain resembles the lung in having a linked hierarchy of scales.

In a similar way, we can conceive of the mind (our thoughts and feelings) as consisting of self-similar complexes of hierarchically-arranged modules all linked together in a way that can be continuously changing according to various stimuli and thoughts. The relationship of mind to brain can be characterized as a problem of figuring out in which way the mind (i.e., the processes of perception, consciousness, and understanding) and the brain (a physical complex of neurons) map onto each other.

In this conception of the mind, the brain can be regarded as a relatively isolated system that communicates with the world via nerve impulses generated by sensory receptors in the periphery. Our five senses provide the input, and are thus linked to all these images and memories. The main discourse among the different elements of the brain accomplishes a synthesis of the information coming in, resulting in the internal generation of what we call “conscious reality”. Drawing on the analogy of hierarchically-organized anatomic modules in the brain, we assume that the systems of organization that also characterize the mind are at least partially fractal in nature. That is, each contains a hierarchically-arranged system characterized by an algorithmic continuity between the successive functional levels of activity. Our mind appears to deal with hierarchies of thoughts rather than with single thoughts as isolated units.

Must the linking between successive levels of the hierarchy always be the same; i.e., does the mind represent a self-similar fractal? Not necessarily. It is possible to imagine a hierarchical system in which some clusters of levels may be connected according to one algorithm and others according to another algorithm. One of the most interesting aspects of the human brain is that it is capable of generating new hierarchical systems as needed. A synthesis of ideas can result in a new collection of ideas. In this setting, we have one hierarchical arrangement of concepts giving rise to another hierarchical arrangement of concepts. For example, a scientific discovery occurs when we notice a relationship between two or more phenomena: the result is a new idea.

Our essential thesis is that when a fractal system generates a new system, it has the same attributes and characteristics as the generator — especially hierarchical linking. Thus, mental associations that would appear at first to require enormous lengths of descriptive code (and consequently be termed complex) may in fact be handled by very short codes. If that is indeed the case, then the human mind could be using fractal encoding as a standard way of coding enormous chains of related thoughts into a single fractal entity. That fractal entity would then be easy to deal with as a unit. We draw the analogy to a computer program used for outlining text: one writes headings that enclose subheadings, which enclose notes, etc. All of these collapse into the outline. The evidence for this claim is revealed when we see how thoughts are naturally linked to each other internally. A design pattern may well be a representation of an architect's natural expression of these chains of thought in a tangible form.

4. MEMORY AND THE FRACTAL MIND.

Striking parallel properties exist in neuronal and thinking processes. The mind is synonymous with mental activity and is a subset of neuronal processes (Alexander & Globus, 1996). Since the brain consists of neurons for both involuntary and voluntary activities of the individual, the mind is also aware of both types of processes. Cognition depends on how well information is stored, retrieved, modified, and translated into commands. The memory process is central to neural function and is an example of the basic mapping that links the brain and the mind. Information that comes from memory helps to support perception and meaning.

The nervous system has a "massively parallel architecture" in the way this term is used in computer science. Different linked circuits on multiple scales of organization all working simultaneously are based on neurons (which are extremely numerous simple processors). Memory depends on the network formed among neurons. Artificial neural networks have been able to simulate primitive forms of memory function, thus proving that this is the way biological memory works (Rolls & Treves, 1998). Neuronal pathways linking regions of the cerebral cortex correlate with the construction of long-term memories (Rolls & Treves, 1998). It is evident in a diagrammatic representation of connections within the brain that there are layers of structures with projections from one to the other (Alexander & Globus, 1996). The presence of these prominent recurrent linkages has been correlated with the associative memory operated by neural networks (Rolls & Treves, 1998).

Associative memory is very important to architectural design. It can be responsible for powerful emotional experiences when we identify with what we already know, or which reminds us of something stored in our memory. In response to a small cue, which can be as trivial as a particular ornament, a color, or a fleeting odor, we selectively retrieve a specific set of linked memories quickly. A certain smell triggers recall of a past situation, and we remember a whole complex of memories linking emotions of the past moment with details of that event's physical environment, spaces, colors, sounds, etc. (see Figure 7.2). All of this information might have been dormant, i.e., much like a compressed file on a computer disk, and it is suddenly expanded as a result of a trigger. Evidently, the system architecture of our neuronal network is designed in favor of fast information retrieval from multiple locations of our stored memory.

In addition, there must be a flexible mechanism that allows new information to be added without losing old memories completely. The brain's multilayered structure has previously been suggested as providing a framework for associative memory (Marr, 1982). We suggest that a fractal-like neuronal system architecture provides a filter for selected memories to be stored in a stable layered configuration. Thus, associative memories that make us feel at ease would be manifested through this fractal mechanism.

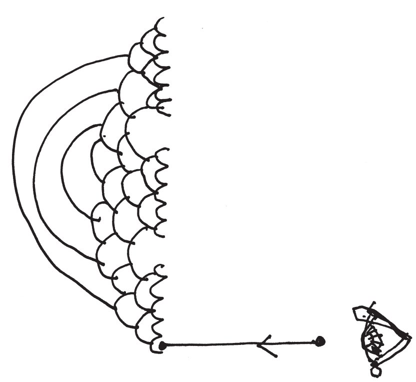


Figure (7.2)
Associative memory recalls a system from one detail.

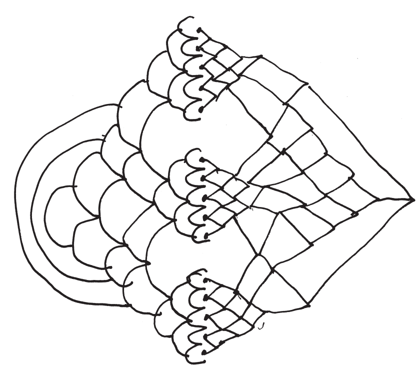
5. FRACTAL TUNING AND COMMUNICATION.

Fractal systems give rise to fractal-based communications signals. These, in turn, travel through fractally-organized channels. A simple illustration of this would be communications within a biological system. The entire system is fractal-based: the organs that generate the communication signals, the signals, and the receiving devices (the recipient organs) are all fractal in character. A key idea behind this is the concept that the body contains "receptor sites" which are, in effect, "tuned" to recognize certain chemical signals as opposed to others. For example, when the pituitary gland releases thyroid-stimulating hormone, the thyroid gland responds to this hormone but other organs of the body have no discernible response. We have hormones being generated by glands, the glands in turn impacting upon the organs at a distant site via the bloodstream, and finally arriving at the target organ where they manifest their actions in a biological way. All these require fine tuning of signal generation and reception at different levels, so as to provide a balanced control of all physiological processes in harmony with the nervous system (Yu, 1996).

Systems in the body are "tuned" to generically recognize different kinds of fractal hierarchies. We contend that the brain has special systems that are tuned in exactly this way. The brain's neural patterns are responsible for recognizing structured complex systems that have a hierarchical organization in which the levels in the hierarchy are defined in a systematic, algorithmic way. Such recognition has an emotive value for the person (or higher animal) in question. In general, when a system recognizes a structured entity in the environment, it attributes "meaning" to it. Organisms create communication signals that have a special structure, which is to say that they share a common language. Languages are characterized by collections of rules defining syntax and semantics. In a system of fractal-based communications, those rules are tantamount to the algorithmic connectivity among the hierarchies in the fractal structures used for communication.

Following an analogy with radio transmission, where tuning the receiver depends on matching a single frequency, fractal tuning represents a more sophisticated process that matches complex signals having a similar hierarchical structure. Brain mechanisms are especially receptive to such signals, and would screen other signals that have a different algorithmic structure — i.e., any signal that shows no hierarchical linking among its components. This represents a "filter", allowing us to connect selectively and preferentially to fractal forms (see Figures 7.3 and 7.4). It also explains instantaneous cognition as a kind of resonance between an external structure (i.e., the familiar forms and details of traditional architecture) and the internal structure of our cognitive system. Such a mechanism has already been suggested by Gibson (Gibson, 1979; Michaels & Carello, 1981) in his psychological model of "direct perception". The present theory of fractal encoding is thus consistent with Gibson's work.

Figure (7.3)
Fractal receptor recognizes another fractal structure.



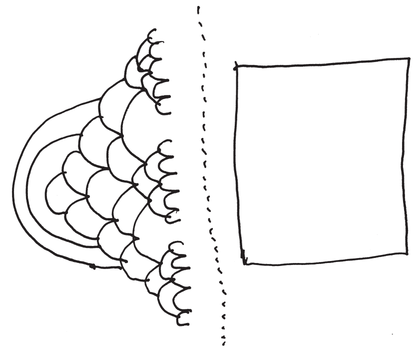


Figure (7.4)
There is no connection between a fractal and a non-fractal.

6. PROBLEMS OF MISCOMMUNICATION.

Evidence for structuredness in communications is seen in the use of metaphor as a tool for communicating among people. Metaphorical structures impact the way that people communicate complex ideas (Lakoff & Johnson, 1999). A metaphor is the use of words that trigger a complex system of connections and associations, generating new ideas and meaning in the process. We may interpret the effect of a metaphor as the transference of one hierarchical meaning system onto another, very different one.

In the model outlined here, which defines linked hierarchies as the central element in communication, a metaphor represents the act of completion of a partial structure of meaning, which is offered by way of explanation. We grasp the part we know, and then complete the rest in the most obvious manner (to us), which might not be the most obvious manner to someone else, however. Confronted with a complex concept, an individual might use only the easy component of the structure (consisting of a set of communicating elements) to make a point. Unfortunately, the listener in this dialogue then attaches to the entire construct, which was not explicitly given, whether or not this is appropriate in the particular setting. Thus, metaphors give the illusion of meaning and "truth" because they also give the illusion of completeness of structure. When communications channels utilize fractal structures, it is possible that a mixture of rules is being applied at different levels in the hierarchy. Such structures can give rise to ambiguity in communication.

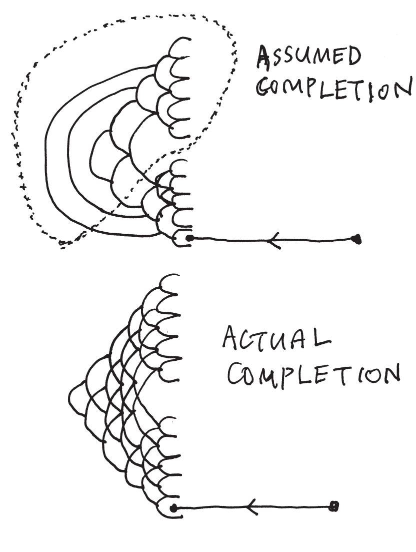


Figure (7.5)
Reconstruction may not be the intended fractal.

A frequent cause of miscommunication is the certainty of one party that what the other party said is completely understood. A piece of information provided by one individual triggers recall of a fractal construction in the other's mind (see Figure 7.5). Because different fractal encodings have common cross-over points, however, it frequently turns out that the completed fractal is not the one intended. This results in miscommunication. The problem lies in the completion process itself, which gives a feeling of satisfaction, hence the illusion that one has understood what was said. The emotion associated with the fractal encoding of a complete thought (complete in the sense of linking a hierarchy of different levels) could be the same thing as the feeling of understanding. This idea is consistent with the observation of a definite physiological (emotional) state correlated with a mental state such as "understanding" (Lakoff & Johnson, 1999). As thinking processes evolved from sensory and motor systems, the brain still uses those networks for higher functions such as thinking, so thinking is also "feeling".

A short-circuiting of fractal encoding (by crossing different hierarchies or meaning structures) is responsible for making us accept harmful ideas and notions as perfectly natural. This is deliberately practiced by those promoting such ideas, for example in advertising and political and religious indoctrination. The method consists of finding the possible cross-over points of a fractal string of knowledge and associations. A self-serving idea (which profits someone at the expense of others) is then attached to one of those cross-over points. From then on, the individuals whose brains carry this modified circuit will experience an emotional satisfaction that normally characterizes truth, even though they are being manipulated by a message. This is the basis for both the advertising industry, and of political and psychological indoctrination (see Chapter 10, *Darwinian Processes and Memes in Architecture: A Memetic Theory of Modernism*).

7. SHAPING THE BUILT ENVIRONMENT.

The built environment reflects structures in human thought, in that it is created by human minds. Thought works by establishing connections between concepts, creating conceptual structures and ideas. We assume that fractal structures in nature influenced the development of neuronal mechanisms in evolution that could encode and decode these structures automatically. If true, it is reasonable to suppose that the mind, which uses these mental mechanisms, seeks to shape its environment according to the same rules for structural connectivity that inherently make up cognition. Internal patterns of neural nets that form our sensory and thinking processes are organized in a way that reflects similar patterns of organization in the external universe.

People have a basic need to extend their consciousness to their environment, something that occurs effortlessly when surrounded by nature. We normally try to shape the artificial environment in a way that we can connect to it (or at least we did unselfconsciously throughout pre-industrial times). This explains the reason why we built cathedrals as examples of organized complexity: because we cannot connect to objects or environments that are either too random, or too simple. We instinctively use the ordered complexity of our own mind as a template to extend our consciousness outside our own body. Human consciousness is linked, through a hierarchy of structures on different scales, to what we build. Such visual connections extend the mind fractally to the physical environment.

Having put forward a theoretical model of how the mind might operate, we now apply the model to evaluate different visual structures within architecture and urban design. Passive input creates meaning in the brain, which then generates emotion. In principle, we have no control over input except movement; one can approach a source that generates positive emotions, and avoid a source of negative emotions. We can control the sources in the man-made environment through design if we choose to. Traditionally, architects built structures that generated an optimal emotional response, using their experience of what was the most beneficial input. Paradoxically, our intelligence allows us to override negative emotional cues, and to build structures that repel us.

8. PAVEMENTS AND HIERARCHY.

Architecture has in the past felt a need for pavements that are either patterned, or that embody figurative art. Our perception of space is founded on a connection with the ground via design. In creating an artificial built environment to house themselves and their activities, human beings have always been careful to connect with the ground visually. Methods that connect a pedestrian to the floor, whether inside a building or in an open space outside include pavements, tilings, textures, mosaics, etc. Kim Williams (1998) has undertaken a pioneering study of interior pavements. The detailed pavement in Medieval churches makes a major contribution to a user's experience of the architectural ensemble, independently of the structure itself. We are in complete agreement with Williams that pavements are central to mankind's architectural — and intellectual — development. Most twentieth-century pavements are plain and empty, having been built on the belief that there is no functional need for either representation or pattern in a pavement. We will argue the contrary: that pavements can serve a primary function of connecting observers to all visible surrounding structures. The connection becomes all the more necessary for larger spaces, so this effect is most dramatic in external pavements.

Everyday experience — which calls upon visual scales between 1 mm and 1 m contained in the human body — serves as the foundation for any fractal design hierarchy. If we are near enough, then visual and tactile information from a wall is responsible for the necessary connection, because the wall at eye level is closer to the eye than the floor is, and we can easily touch the wall. In a very large room or open space we connect visually and psychologically to an area surrounding our feet. This region defines the first fractal scales in a pavement design, and these external scales become linked to internal scales within our consciousness. Without a deliberate design around our feet, there is a chance that no connection will be experienced with the environment of a large space. Regardless of the smallest unit employed, whether it be a piece of mosaic, a brick, or a tile, contrast should be used to render the smallest scale unambiguously. Nevertheless, most urban plazas, and indeed, brick and stone walls of all types built in the twentieth century, deliberately disguise the smallest scale by repeating a single unit monotonously (e.g., so-called bonded brickwork, which creates a uniform surface), as opposed to defining patterns on different scales.

Spatial coherence requires internal definition on successively larger scales, going up to the size of the entire visual region. A patterned expanse needs to define several distinct scales to create hierarchical linking (see discussion in Chapter 4). Therefore, while a detailed pattern might connect to the user at the smallest scale, simply repeating the design indefinitely without using intermediate scales will fail to connect the user to the larger space (see Figure 7.6). Successful pavement designs contain similar but not identical regions. An urban space lacking such a hierarchical linking can never connect to surrounding buildings at a distance because the jump in scale is simply too large. For this connection to happen, the buildings must define an additional, largest scale in the *same* hierarchy. It is therefore necessary for the pavement texture, color, and design to harmonize with the surrounding structures. Similarity between the pavement and buildings relates the scales.

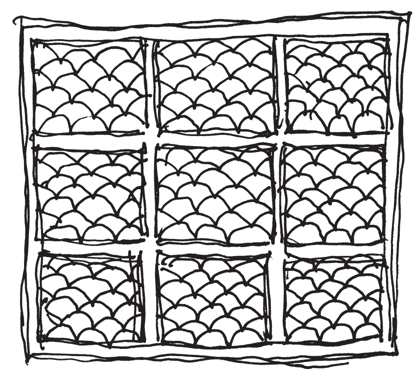


Figure (7.6)
A design should be used to define a higher scale.

9. THE IMPORTANCE OF MEANING STRUCTURES IN THE PAVED SURFACES OF URBAN SPACE.

The properties of urban space, and how patterned flooring helps to define it are discussed in (Salingaros, 1999b). Commenting on contemporary examples, I said:

"***Sidewalks, city streets, and street corners.*** An incredible opportunity to connect the pedestrian to the pavement has been missed all around the world, by using plain, featureless surfaces (even with expensive materials). The standard concrete sidewalk contains no visual information ... Even when brick is used for paving, perceivable patterns are usually avoided. Yet, patterns on the surface of pedestrian paths can make a great difference. Recall, for instance, all the wonderful mosaic and tiled pavements of the Roman world. Among notable later historical examples are the pavement of the Piazza San Marco, and the Portuguese architectural tradition of lively sidewalk designs. Some of the most famous modern patterned sidewalks are in Brazil, a former Portuguese colony." (Salingaros, 1999b: page 44).

The design of flooring, as in an open plaza, has to obey the same principles as other time-honored designs such as oriental carpets. Methods for connecting different scales are outlined in the model of complexity presented in Chapter 5 of this book. The basic mechanism for linking among units separated either by distance or by scale is similarity in texture, color, and form. Similarity works via translational, rotational, reflectional, and scaling symmetries in the plane (Washburn & Crowe, 1988). This is understood by artists and architects who seek to establish visual and emotional harmony. The coordination responsible for the visual coherence of the whole requires complex ordering, but not simplistic alignment. Symmetric arrangements on a plan do not connect elements across scales.

Great urban spaces were built before the twentieth century by following traditional design criteria. Discarding such techniques for connecting human beings to the built environment as developed over the previous several millennia, architects now design in a way that disconnects people from surrounding surfaces (Salingaros, 1999b). The focus is on formality and a particular visual style, which neglects more human needs. It is therefore a welcome surprise to see successful contemporary plazas built by the British artist and urban designer Tess Jaray (Williams, 2001). Jaray's pavements provide a satisfactory experience on a number of different scales. Her designs show a well-defined smallest scale; distinct yet connected designs on different scales; and careful harmonization with the surrounding buildings (Williams, 2001). One can see why her designs are so successful, using the fractal model for thinking and memory outlined in this Chapter.

From the informational point of view, an open plaza offers vastly decreased input from surrounding walls compared with a totally enclosed, roofed space. And yet, the greatest urban spaces give the strong impression of containing and embracing the user. It is therefore critical to connect to the ground via geometry, since it is with the floor that we can establish the strongest and most immediate connection in an open space. Thus, the most expressive pavements are to be found in traditional public open spaces around the world. When successful, pavements connect the pedestrian to the ground, and thereby permit the psychological sense of well-being that allows one to feel alive and move around. This is what determines the success of an open space independently of other factors such as exposure, surrounding façades, and density of cross-paths.

10. CONNECTION ESTABLISHES A PHYSIOLOGICAL STATE.

We postulate that the intensity of fractal connection corresponds directly to the degree that human beings intuitively feel a space or design to be meaningful or "alive". This model therefore identifies the visual connection of designs and structures with a viewer's emotional state. It is becoming increasingly clear from neurophysiological research that the human conceptual system and the possible forms of reasoning are very strongly shaped by the wiring of our brains (Lakoff & Johnson, 1999). Moreover, mental activity turns out to be emotionally engaged; i.e., it is likely that we actually *feel* our thoughts (Lakoff & Johnson, 1999).

Subconscious processes exist in our brains, which we believe encompass the fractal connections discussed above. This model of fractal encoding helps explain why we feel emotionally elated standing in a great historical plaza that is paved with some design which harmonizes with surrounding buildings (guidelines for achieving this harmony are given in Section 12, below). If all components work to connect and harmonize, we ourselves become an integral component of an enormous space because we link hierarchically with it. Just as we recall a hierarchy of associative memories from a single detail, we also connect to a large, complex space through a single detail. This represents one of the greatest possible architectural-aesthetic experiences for an observer.

The corollary is also of interest. Urban spaces that conform to the contemporary design canon (of visually hard and minimalist spaces) tend to be dead, because they fail to establish a positive emotional connection with the user. One can argue that this effect is not unintentional. A person feels ill-at-ease in such places, and consequently avoids them. If a space looks cold and austere because it lacks organized visual complexity, then we feel it as the absence of comfort and security. This is not simply a matter of choice; as proposed in this Chapter, non-fractal structures clash with our perceptive process. Not only is our environment thereby impoverished by a reduction of information, but the design rules that generate such environments deny and suppress fractal connections. A widely-embraced design culture ignores the need to create structures that elicit a sense that we are in a meaningful place, thereby severely narrowing the range of our emotional experience.

The environment is not separate from us, offering only objects and external sensations that we encounter: it is part of our being (Lakoff & Johnson, 1999). A balanced, healthy mental state requires an understanding of nature that is linked to our human emotions. The mind is much more than a computer; it is also able to process and engage emotional content. How are we to understand our sense of belonging to a larger whole? In this Chapter, we have discussed the experience of meaning from the environment, yet our explanation is very limited compared to what is described more accurately (more emotionally) in mystical and spiritual literature. Connecting to a larger, all-encompassing whole can lead to ecstatic participation, or a spiritual experience. Such a state has frequently been described as transcendence.

11. THE NATURE OF MEANING.

We wish to concentrate on the perception of meaning coming out of visual complexity in the environment. Visual information presented as a coherent image or coded pattern is cognitively accessible in a direct manner. There is a mapping function between structures in the world and structures in the mind. When the mapping is faithful to the hierarchical linking (i.e., it preserves the information and its interconnections rather than any overall shape), it creates an experience of meaning. Neural structures use information on connectivity to create meaning as an internal state: in our model, meaning is not *assigned* to external forms. The degree of conformal fit or coherence determines the strength of the sense of meaning and also the strength of the emotional experience. In its simplest aspect, meaning corresponds to either positive or negative emotion. When two or more meaningful structures are linked together in a meaningful way, we begin to build a system of beliefs.

If an image is incoherent, then the information it contains cannot be perceived easily as a whole. There is less meaning because, even though there may be considerable information there, the information is difficult to synthesize. This in turn generates a negative emotion. Viewers are more receptive to information that is presented in a pattern which is strongly connected to them. Information structured in this way is typically called “natural” or “intuitive”. It has been argued previously that intuition is actually a process involving structured reasoning (Mikiten, 1995). By contrast, a viewer will not be receptive to information that is presented via a visual pattern (or lack thereof) which fails to establish a strong connection with the viewer. We believe that environmental structures need to be fractal to satisfy the deeper connective processes within the human brain.

Our sense of understanding arises from the way we form conceptual structures in the mind. When a collection of ideas has coherence and a sense of relatedness among its elements, we perceive its structure. When we perceive the structure of thoughts and ideas as a coherent whole, we conclude that they are correct and that the construct is valid (Mikiten, 1995). We remember it as a guide for further thought. We also use it to guide our behavior. Ideas that are neatly linked and have a coherent structure are judged to be valid or “true”. The nature of intuition may be understood as the ability to match the structure of a present situation with the structures of problems that have been experienced before. Intuition represents the general ability to reach a conclusion on the basis of less explicit information than is ordinarily required to reach that conclusion (Mikiten, 1995).

12. CONCLUSION: SOME GUIDELINES FOR PAVEMENT DESIGNS.

Rules for creating a memorable open space can be abstracted from studying historical examples (Salingaros, 1999b). The lesson from the fractal encoding model is that there exists a fundamental similarity between complex structures in the environment and structures in the mind. Designing an open space can be successful if one follows one’s basic instinct towards ornament and detail, connecting and harmonizing different levels of design. In principle, therefore, there is really no need for rules if one is guided by one’s deepest feelings. The closer the match between the architect’s felt intuition about a space and the structure that is finally created as an expression of that intuition, the greater the meaning that space should have for the observer. In a sense, the built place becomes the vehicle for the mental structure of the architect to be manifested as a mental structure in the observer.

Nevertheless, some pointers are necessary because of the plethora of negative examples of flooring structures and urban spaces in existence. As discussed in the remaining five chapters of this book, architects’ intuitions about space have become corrupted by non-adaptive mental images (in the sense we cannot connect to them as humans), and so those intuitions can no longer be trusted. Even though instinct about pattern and surface is inborn, it can be replaced by a set of arbitrary preferences. Those people then desire an artificial version of reality: they have to be taught how to design in a manner that adapts to human sensibilities. We need to re-learn how to connect with our environment so that the process becomes automatic once again. Even though the best pavements depend on engineering principles, they have to balance and synthesize so many factors that the result should be considered a "work of art". A successful pavement will have the following characteristics, which satisfy hierarchical linking.

Table 7.1. Guidelines for Pavement Designs.

1. Human-scale design that connects immediately with a user.
2. The smallest units defined by contrast and symmetries.
3. A smallest design scale compatible with human dimensions.
4. A sequence of design scales reaching up to the full extent of the open space.
5. Intermediate levels of design that are distinct yet strongly linked via similarity.
6. Larger design scales formed from ordered combinations of elements on smaller scales.
7. Balance among all regions and scales: every element acts as a connector for the other elements.
8. Harmonization via patterns and colors at a distance, which links all scales with the surrounding buildings.

If these conditions are satisfied, then a user, on entering the environment, will experience a sense of meaningfulness as all of the scales in the view are seen as a unified whole. There is a fractal (i.e., hierarchical) connection to the entire space. The strength of each of the individual connections determines the coherence of the whole. In a poor design, the smallest elements are not symmetric, but appear to be amorphous or indistinct so that we cannot connect to them. The connection process starts from the smallest scales and proceeds through the larger scales up to the largest scale, which is defined by the surrounding structures. While our description of the connection process was sequential, the actual connection through perception is sudden. This experience is frequently dramatic, and creates a definite and sometimes intensely positive psychological and physiological state.

In conclusion, we have proposed a theory of pattern perception that can explain how patterns generate meaning in the environment. Although this theory is general, it was applied here to discuss pavements: i.e., floor patterns, and paving patterns for streets, sidewalks, and plazas. A strictly utilitarian approach to pavements requires no promise of destination or completion that attaches meaning to built forms and spaces. We believe that this impoverishes human physical and emotional experience. When the environment becomes more complex, the pavement should become the guarantee that the environment is planned to embody destinations and connections (see Figure 7.7). A pavement that is designed to have meaning will comply with the eight rules given above. Pavements as a definition of space represent the highest order of mapping between an architectural structure and a theme that the human mind can understand. Meaning in the pavement thus allows one to "know" the place without seeing all of it.

Figure (7.7)
The pavement design embodies meaning and destination.