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A THEORY OF ARCHITECTURE

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Chapter 1.

THE LAWS OF ARCHITECTURE FROM A PHYSICIST'S PERSPECTIVE

There are three laws of architectural order, which are obtained through analogy from basic physical principles. They apply to both natural and man-made structures. These laws may be used to create buildings that match the emotional comfort and beauty of the world's great historical buildings. The laws are consistent with architecture from all parts of the world: for example Classical, Byzantine, Gothic, Renaissance, Baroque, Islamic, Near Eastern, Far Eastern, and Art Nouveau architectures; but not with many of the architectural forms of the past seventy years. It seems that twentieth-century architecture contradicts all other architectures in actually preventing certain components of structural order. P 27

Chapter 2.

A SCIENTIFIC BASIS FOR CREATING ARCHITECTURAL FORMS

A scaling rule helps to achieve visual coherence by linking the small scale to the large scale. This work develops results of Christopher Alexander derived from theoretical physics and biology. I propose a scaling hierarchy and scaling rule based on natural objects having scale differentiations of a ratio of about 2.7 from the largest down to the very small. Buildings satisfying this scaling rule are subconsciously perceived as sharing essential qualities with natural and biological forms. As a consequence, they appear more comfortable psychologically. Scaling coherence is a feature of traditional and vernacular architectures, but is largely absent from contemporary architecture. P 45

Chapter 3.

HIERARCHICAL COOPERATION IN ARCHITECTURE: THE MATHEMATICAL NECESSITY FOR ORNAMENT

The case is made that architectural design needs to be organized hierarchically. A method and formula for doing so are derived based on biology and computer science. Fractal simplicity, in which there is self-similar scaling, replaces the outdated notion of rectangular simplicity. Architectural units on different scales are able to cooperate in an intrinsic manner to achieve an emergent property, which is not present in the individual components. The theory of hierarchical systems from Engineering Science explains how to relate different scales to each other. In buildings, the correlation between architectural scales determines whether a structure is perceived as coherent or incoherent, independently of its actual design, form, and composition. This Chapter presents a scientific proof of why organized detail (i.e. small-scale ornament) is essential to the overall coherence of architectural forms. P 63

Chapter 4.

THE SENSORY VALUE OF ORNAMENT

Ornament is a valuable component in any architecture of buildings and cities that aims to connect to human beings. The suppression of ornament, on the other hand, results in alien forms that generate physiological and psychological distress. Early twentieth-century architects proposed major stylistic changes — now universally adopted — without having a full understanding of how the human eye/brain system works. P 84

Chapter 5.

LIFE AND COMPLEXITY IN ARCHITECTURE FROM A THERMODYNAMIC ANALOGY

Using an analogy with thermodynamics, a simple mathematical model can be constructed following ideas of Christopher Alexander, which estimates certain intrinsic qualities of a building. This model predicts a building's emotional impact. The architectural temperature T is defined as the degree of detail, curvature, and color in architectural forms; whereas the architectural harmony H measures the degree of visual coherence and internal symmetry in the visual structure. The impression of how much "life" a building has is measured by the quantity $L = TH$, and the perceived complexity of a design is measured by the quantity $C = T\,(10 - H)$, where $10 - H$ corresponds to an architectural entropy (disorder). With the help of this model, new structures can be designed that have a dramatically increased feeling of life, yet do not copy existing buildings. P 105

Chapter 6.

ARCHITECTURE, PATTERNS, AND MATHEMATICS

This Chapter posits the importance of architectural patterns in every human being's intellectual development, examining how twentieth century architectural attitudes towards decoration and pattern have impoverished our experience of both mathematics and the built environment. P 129

Chapter 7.

PAVEMENTS AS EMBODIMENTS OF MEANING FOR A FRACTAL MIND

(WITH TERRY M. MIKITEN AND HING-SING YU)

This Chapter examines the role of pavement design as a vehicle for conveying meaning, taking as a point of departure how the mind establishes a connection with our environment. A theory is developed for how ideas and information may be stored within a fractal scheme. By putting forward a fractal theory of the human mind, we can explain some aspects of how we transfer meaning from our surroundings to our awareness. Interacting with our environment is an important theme seen during the evolution of the brain. P 144

Chapter 8.

MODULARITY AND THE NUMBER OF DESIGN CHOICES

(WITH DÉBORA M. TEJADA)

This Chapter analyzes one aspect of what is commonly understood as "modularity" in the architectural literature. There are arguments to be made in favor of modularity, but we argue against empty modularity, using mathematics to prove our point. Empty modules eliminate internal information, and their repetition eliminates information from the entire region that they cover. Modularity works in a positive sense only when there is substructure to organize. If we have a large quantity of structural information, then modular design can organize this information to prevent randomness and sensory overload. In that case, the module is not an empty module, but a rich, complex module containing a considerable amount of substructure. P 159

Chapter 9.

GEOMETRICAL FUNDAMENTALISM
(WITH MICHAEL W. MEHAFFY)

"Geometrical fundamentalism" aims to impose simple geometrical solids such as cubes, pyramids, and rectangular slabs on the built environment. This defines a characteristic of twentieth-century architecture and planning. The more complex connective geometry found in pre-twentieth-century architecture and in the architecture of traditional cultures is replaced. Geometrical fundamentalism may be in part responsible for the resentment the rest of the world feels against the industrialized western nations, because it replaces traditional buildings and cities with structures that are perceived as inhuman. A philosophy about geometrical shapes thus has an enormous socio-economic impact, by generating forces against globalization. The modernist movement promised a radical new utopian society based on a fundamentalist belief in pure abstractions. The extremely influential twentieth-century architect and urbanist Le Corbusier was entranced by the reductionist machine geometry of his time, and imposed it upon buildings and cities around the world. This misapplication of elementary abstractions constitutes a gross cognitive error, and fails to create satisfying human environments — the core purpose of architecture and the building arts. It parallels other totalitarian abstractions of the twentieth century, and this point will be discussed here. P 172

Chapter 10.

DARWINIAN PROCESSES AND MEMES IN ARCHITECTURE: A MEMETIC THEORY OF MODERNISM (WITH TERRY M. MIKITEN)

The process of design in architecture parallels generative processes in biology and the natural sciences. This Chapter examines how the ideas of Darwinian selection might apply to architecture. Design selects from among randomly-generated options in the mind of the architect. Multiple stages of selection generate a design that reflects the set of selection criteria used. The goal of traditional architecture is to adapt a design to human physical and psychological needs. At the same time, however, any particular style of architecture (adaptive or not) constitutes a group of visual memes that are copied for as long as that style remains in favor. Darwinian selection also explains why non-adaptive minimalist forms have been so successful at proliferating. The reason is because they act like simple biological entities such as viruses, which replicate much faster than do more complex life forms. Simple visual memes thus parasitize the ordered complexity of the built environment. P 195

Chapter 11.

TWO LANGUAGES FOR ARCHITECTURE

Design in architecture and urbanism is guided by two distinct complementary languages: a pattern language, and a form language. The pattern language contains rules for how human beings interact with built forms — a pattern language codifies practical solutions developed over millennia, which are appropriate to local customs, society, and climate. A form language, on the other hand, consists of geometrical rules for putting matter together. It is visual and tectonic, traditionally arising from available materials and their human uses rather than from images. Different form languages correspond to different architectural traditions, or styles. The problem is that not all form languages are adaptive to human sensibilities. Those that are not adaptive can never connect to a pattern language. Every adaptive design method combines a pattern language with a viable form language, otherwise it inevitably creates alien environments. P 220

Chapter 12.

ARCHITECTURAL MEMES IN A UNIVERSE OF INFORMATION

I describe here a symbiosis between ideas, images, texts, and biological forms. Human culture consists of created objects as information, which form an integral part of what we are — i.e., an essential extension of our biological bodies into our environment. This sensory, informational extension and mechanism for interaction defines a universe of information. With the advent of electronic communications, a relatively autonomous virtual world has been created. The space of information has proved a fertile breeding ground for the same informational entities — called "memes" — that formerly inhabited only human minds and artifacts. Architectural memes that took generations to diffuse through a restricted society can now spread around the world almost instantly, and will eventually alter its physical appearance. This Chapter aims to understand this process. P 242

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