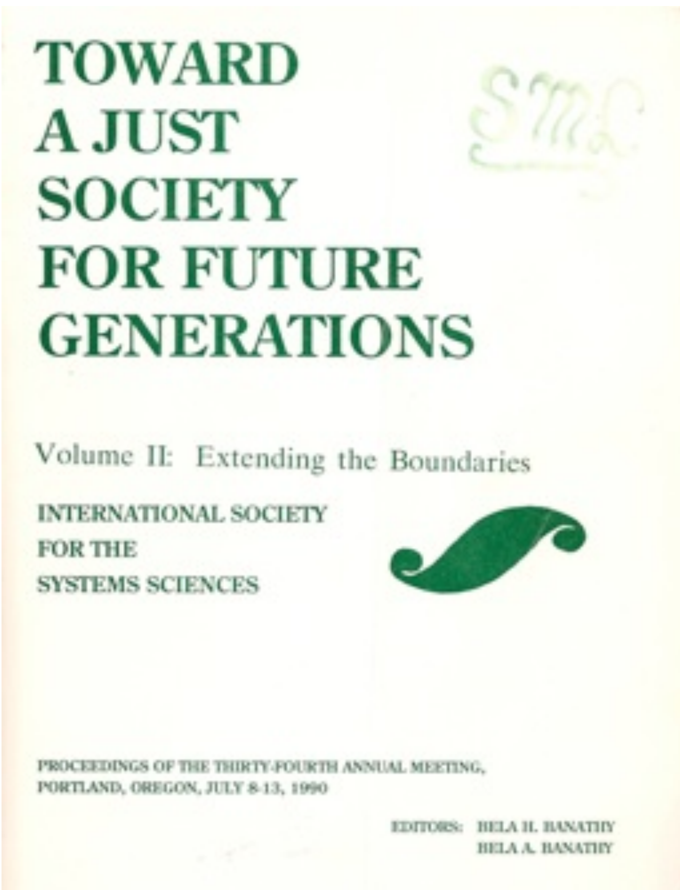
Primordial Structure



TOWARD
A JUST
SOCIETY
FOR FUTURE
GENERATIONS

Volume II: Extending the Boundaries

INTERNATIONAL SOCIETY
FOR THE
SYSTEMS SCIENCES

PROCEEDINGS OF THE THIRTY-FOURTH ANNUAL MEETING,
PORTLAND, OREGON, JULY 8-13, 1990

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This is an early article presented and published in 1990 at the 34th annual meeting of the International Society for the Systems Sciences , Portland. OR. July 8-13. 1990.

THE PRIMORDIAL STRUCTURE

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ABSTRACT

Physicists and biologists are systemisists and evolutionists. They seek to understand the mechanics of primordial structures by studying the mechanics of cluster formation of atoms and soap bubbles. The development of primordial atomic microclusters and primordial biologic substances obey the same physical laws. The evolution of the structural relationship of close-packed spheres has become the basis for the study of atomic structure and biologic structure. What evolves from close-packing spheres are the physically stable structures the tetrahedron, octahedron and icosahedron and their systems. Some of these are non-linear, dynamical, least-energy systems, best understood by using fractal constructions. Out of the primordial soup a biologic structure evolved that was self generating, hierarchical, low energy consuming, stable (even with flexible joints), omnidirectional and independent of gravity. The structural components are, for the most part, non-linear, non-hookean, and non-newtonian in their mechanical behavior. The endoskeletal tension-shell icosahedron has these attributes. This paper will explore the concept of the icosahedron as the primordial biologic structure, from viruses to vertebrates, including their systems and sub-systems.

INTRODUCTION

Most bioengineers are creationists. Their interest is the finished product. They use the analogies of modern day engineering principles in there quest to understand natural constructs. They view skeletal support systems as analogous to modern-day skyscrapers. In building a skyscraper the engineer envisionions the finished edifice, the design develops from the top down. What must happen is that by the input of energy and design the forces of nature and entropy are overwhelmed. Skyscrapers are immobile, earth oriented, gravity resisting, unidirectional structures. They are high energy consuming, with rigid joints and built of linear, hookean materials and utilize Newtonian mechanicanics with it's levers, beams and rigid joints creating torque and shear.

However, some architects and biologist have recognised that evolving natural structures use different design and construction concepts than does the skyscraper engineer. Biologic structures are selfgenerating and evolutionary. They must be structurally and functionally independent at each instant of their development. The design is from the bottom up. The joints, intracellular, intercellular or interstructure are flexible. Biologic structures are anentropic. They use the forces of nature to build rather than trying to overcome them. Unlike skyscrapers, they are omnidirectional, stable in any orientation to earth, mostly mobile, exist independent of gravity and low energy consuming. The structural components are, for the most part, non-linear, non-hookean, and non-newtonian in their mechanical behavior. The skyscraper may be an inappropriate analogy for biologic structures.

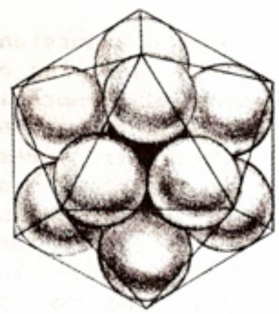
Physicists and biologists are evolutionists. They seek to understand the mechanics of the primordial structure by studying the mechanics of cluster formation of atoms and soap bubbles. The development of primordial atomic and biologic substances obey the same physical laws. The mechanical forces that shape clusters [2], DNA, proteins, subcellular structures, flora and fauna, vertebrates and invertebrates are constant and invariable. That which is true for the macro is true for the micro and vice versa. In evolution, mechanics and structure are integral, form follows function and each structure evolved from a previous construct. For every structure there is an homologous structure that preceded it. Homologous structures, the arm of a human, the wing of a bat, the leg of a horse, are structurally and mechanically related to some preceding form, as well as to each other. In both evolution and embryonic development each physical structure develops from a previously existing structure that rigidly obeys natures mechanical laws. At any moment in time a structure exists only if it can physically exist. Escher-like constructions that can only exist on paper or in the mind of a computer are intolerable to mother nature.

THEORY

Structure defines biology. From DNA, to drosophila, to diplodocus a biologic entity is dependent on its structure for its function. Out of the primordial soup a biologic structure evolved that was self generating, hierarchical, low energy consuming, stable (even with flexible joints), omnidirectional and independent of gravity.

There are only three naturally existing structures as only fully triangulated constructs are inherently stable [3]. They are the tetrahedron with four triangular sides, the octahedron with eight and the icosahedron with twenty triangular sides. Triangulated structures with flexable joints have only tension and compresion elements. There is no torque at the joints and if constructed hierarchically with triagles as the finite element in a fractile lattice [6] there are no levers and there is no shear within the structure. As a naturally existing structure all biologic constructions must be some combination or permutation of these structures. The icosahedron is the most efficient volume per unit of structural material. It is also the most efficient volume controlling device of nature and therefore the most suitable for biologic constructs.

Closely linked with structural evolution is the concept of close-packing of spheres. Architects [8], physicists [11][5], and biologists [9] recognize this concept as a fundamental element in the development of self generating structures. Close-pack four spheres as a cluster and the stable configuration is a tetrahedron. Eight spheres pack as an octahedron, and twelve spheres around a smaller thirteenth, or an empty space, generate an icosahedron [Fig. 1]. More spheres will only close pack as stable clusters when their outer shell is some frequency of an icosahedron, forty-two, ninety-two etc.. Any other configuration is



12 Sphere Icosahedron

unstable and cannot exist as a structure. To be consistent with the second law of thermodynamics nature would continually seek the lowest energy form, always tending toward the tetrahedral-icosahedral form. Icosahedra can be linked by mechanical bonding so that a chain of icosahedra may function as one icosahedron. This would allow for an infinite variety of shapes built from icosahedra as the finite element but still conforming to the laws of close-packing and of structure.

There is a variation of the icosahedron where the compression elements internalize as an endoskeleton [10]. Six compression struts separate the twelve vertices of the icosahedron with none of the struts passing through the center or touching one another [Fig. 2]. The compression elements "float" within a tension outer shell. These, too, can be linked through several mechanisms to form an infinite variety of forms with an internalized, floating, endoskeletal system held together by a continuous tension outer shell [Fig. 3]. Each sub-unit icosahedron can function as an independent icosahedron or as part of an ever increasing icosahedron in a hierarchical pattern. A tower built of stacked iccoasahedra could itself function as the ccompression elements or tension elements. Vertices, tension elements, or compression elements, may be shared so that icosahedra may nest within one another. The three dimensional tiling patterns that develop would be best formulated as fractals [7] [1]. The Mechanics of endoskeletal, tension-shell icosahedra are apparently unique. When loaded the whole structure shrinks or expands and so becomes more or less dense as a factor of the square of the radius. This produces a non-linear stress-strain curve. This type of curve is very common, if not a sine qua non, in biologic structures [4].

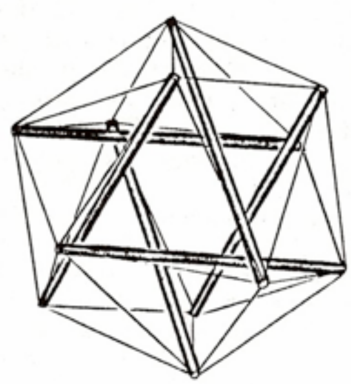


Fig. 2. Endoskeletal Icosahedron.

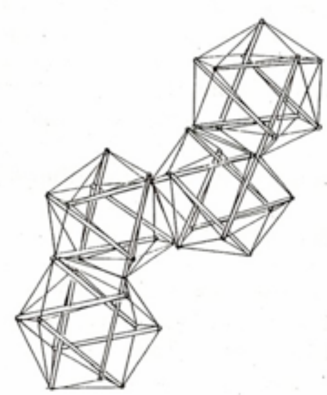


Fig. 3. Linked icosahedra.

DISCUSSION

Many biologic entities are already recognized, or are easily recognizable as conforming to this structural pattern. The proteins of viruses close-pack as icosahedra. The intracellular structure, clathrin, the cell wall of leukocytes, many amoebae, the marine organisms radiolaria and volvox, the compound eyes of insects, alveoli of lungs, fat cells, and puff balls of dandelions are all icosahedral structures. Amino acids, proteins such as DNA and similar structures must conform to these patterns as well.

With the icosahedron as the primordial structure and finite element we can build clusters of sub-cellular aggregates, cellular structures that in higher frequencies could hollow out blastomere or vesicle like, and complex organisms that can evolve phylogenetically and/or embryologically with exo or *endo* skeletons. This same structure would demonstrate hierarchical constructs that are least energy structures, stable with flexible hinges and have non-linear mechanical behavior. Soft bodied structures such as earthworms, frogs tongues and elephants trunks, would utilize the incompressible property of fluids as the compression resisting elements of the icosahedra. Internally vectored endoskeletal icosahedra would model the neck of a swan, the knee of an ostrich or cat, the tail of a monkey, or the musculoskeletal system of humans. These could be rigid at one instant of time, flexible the next, always maintaining its lowest energy state [Fig. 4].

As are other fractal constructions the icosahedral structures would be self-generating, self-organizing, self-similar and recursive non-linear dynamical systems, ideally suited for biologic modeling. Since it is the least energy system there would be no need for multiple systems to explain biologic evolution or structure.

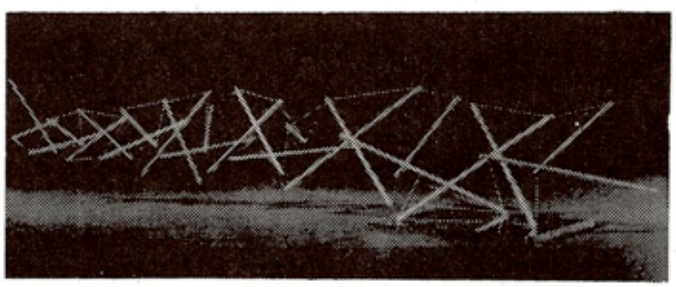


Fig. 4. Model for Easy K. (Snelson)

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