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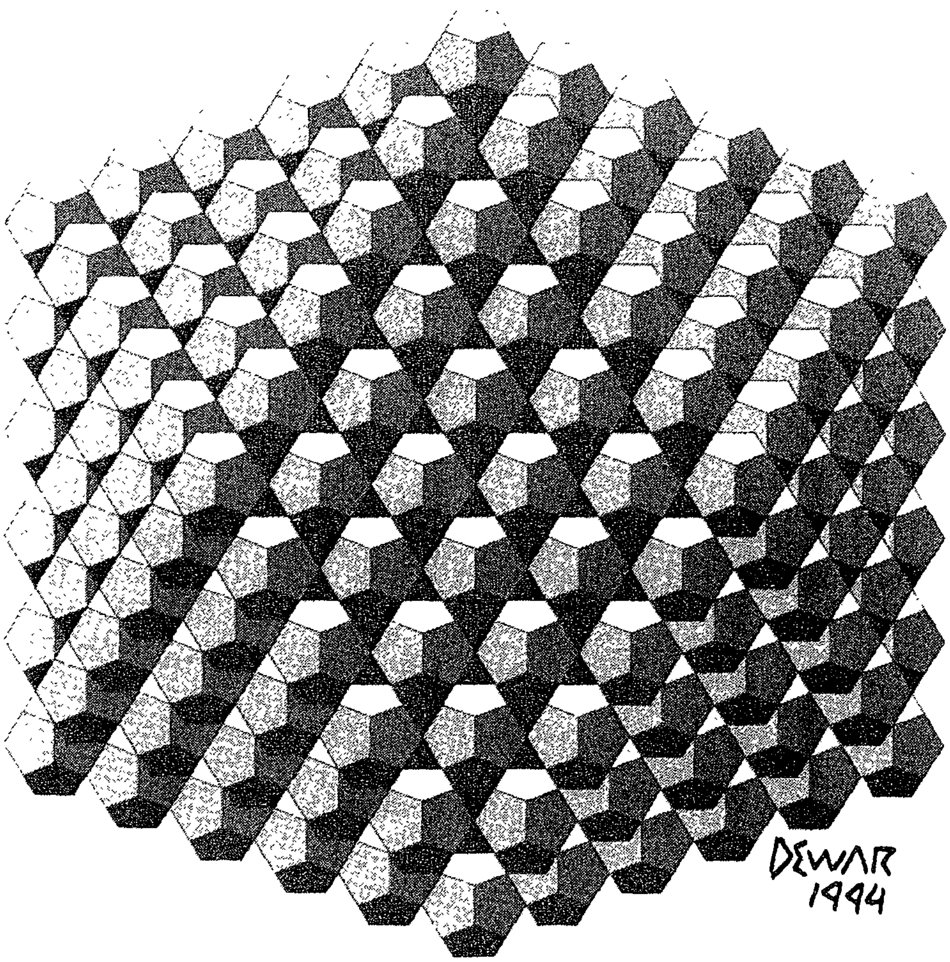

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ORDER STRUCTURES OF NATURAL SYSTEMS AND GENERALIZED GOLDEN SECTIONS

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The bifurcation of a unity into opposites with subsequent appearance of measure in the space of their interaction is one of the most important principles of the development and self-organization of natural systems. "The most wonderful and divine thing for a profound thinker to observe, says Plato, is the doubling of numerical values, characteristic of the nature, and vice versa, bifurcation, i.e. the relation which can be seen in all the types and kinds [of things]." (Epinomis, 990e).

In the process of evolution matter has split into substance and field and engendered gravitation and electromagnetism, strong and weak intranuclear interactions. The appearance of biological life in the form of flora and fauna, higher organisms with their sex dimorphism, at last, the binary opposition "society-nature" itself demonstrate the action of the mechanism of bifurcation of a unity as an integral attribute of the universe.

Every universum U is self-identical. This means that the most laconic form of the law of universum conservation will be:

(1) $dU = 0$, or $A + B = const$

where A and B are measurable opposites, members of a bifurcated unity.

In real systems chaos (disorganization) and order (organization) are related to each other. In the context of the given interpretation of the law of conservation relative informational entropy $H=A/const$ and redundancy $R=B/const$ are their measures. At the result the law of conservation will be as follows:

(2) $$H+R=1.$$

The relative entropy can be easily calculated if we know weight contributions $p_1, p_2, \ldots, p_n$ of all the n system's structural constituents:

$$H=-\frac{1}{\log n}\sum_{i=1}^{n} p_i \log p_i\,, \quad \sum_{i=1}^{n} p_i = 1.$$

The structure type (structure level) of a system as well as its functional regime (the rate of the processes of exchange) is determined by the distribution of its comprising components, i.e. by the vector $\{p_1, p_2, \ldots, p_n\}$, where p_i is the share of the i-th component. To each structure type corresponds the set of such a vectors, for which the value of entropy is invariant.

The structure types are marked and obey the regularity of order scales. That is why it is convenient to call them order structures.

The evolution of a natural system is accompanied by changing the rate of its self-destruction (the inner production of entropy $\frac{1}{H}\frac{dH}{dt}$), hence the rate of self-organization, reproduction and reconstruction of destroyed orders (the production of redundancy $\frac{1}{R}\frac{dR}{dt}$). This process acquires the character of quantized system's transition from one order structures to another implying a rapid change of rate of processes of exchange and other cycles of functional characteristics.

So commensurability, proportionality of the production of order (organization) and the production of chaos (disorganization) is natural for stationary states of unequiweight self-organizing systems:

(3) $$\frac{1}{R}\frac{dR}{dt} = k\frac{1}{H}\frac{dH}{dt}.$$

Hence $R = CH^k$. Vectors $\{H, R\}$ and $\{\frac{1}{H}\frac{dH}{dt}, \frac{1}{R}\frac{dR}{dt}\}$ defined in the square $[0,1]\times[0,1]$ are orthogonal:

$$H\cdot\frac{1}{H}\frac{dH}{dt} + R\cdot\frac{1}{R}\frac{dR}{dt} = 0.$$

Since the point $(1,1)$ belongs to every integral curve of equation (3), $C=1$. Taken together, (2) and (3) give "generator" of stationary values of relative entropy, some sequence of the generalized golden sections:

(4) $$H^k + H - 1 = 0, \quad k = 1, 2, 3, \ldots$$

To introduce zero into the coordinate system it is enough to assume that $k = S+1$ where $S = 0, 1, 2, \ldots$ The positive roots of equation (4) for the first 12 values of the exponent are shown in Table 1.

Table 1. Roots of equation (4).

S	H	R	S	H	R	S	H	R
0	0.5000	0.5000	4	0.7549	0.2451	8	0.8243	0.1757
1	0.6180	0.3820	5	0.7781	0.2219	9	0.8351	0.1649
2	0.6823	0.3177	6	0.7965	0.2035	10	0.8444	0.1556
3	0.7245	0.2755	7	0.8117	0.1883	11	0.8525	0.1475

It is quite natural to expect that points with contrary properties (i.e. anti-nodes) lie in the same domain (unit interval). They can be correlated with regimes of the strongest uncoordination in the growth of organization and in chaos when the former does not superimpose the latter, thus creating an extra load on the system. It is clear that these markers of the system's disharmony should be looked for in the maximal distance from the nodes of measure, binding them as "nodes of measurelessness" with the half-integer values of the parameter $k=(S+1)+1/2$: $3/2, 5/2, 7/2 \ldots$ They are engendered by the generator of anti-nodes, or distractors, of the integral characteristics H and R of the system as a whole (Table 2):

$$H^{S+3/2}+H-1=0. \quad (5)$$

Table 2. Roots of equation (5).

S	H	R	S	H	R	S	H	R
0	0.5698	0.4302	4	0.7672	0.2328	8	0.8299	0.1701
1	0.6540	0.3460	5	0.7878	0.2122	9	0.8399	0.1601
2	0.7053	0.2947	6	0.8045	0.1955	10	0.8486	0.1514
3	0.7408	0.2592	7	0.8182	0.1818	11	0.8563	0.1437

These points on the unit interval i.e. the "nodal line of measure" are centers of the zones of negative sinergism. The natural self-organizing system the entropy of which for quite a long time steadily adheres to one of these values (Table 2), is pathologic structurally and functionally. It evolutionizes in the ambivalent regime, quickly approaching disintegration and degeneration because its energy consumptions used for maintenance of its life activity are distinguished by their maximal losses. The peculiarities of its development, the increment of the substrate present a hybrid, "zigzag" line, composed of two separate sequences in the stochastic key. This reminds us the character of strange attractor. Strategies of behaviour of such systems, if they exist at all, usually do not possess an independent character but represent something eclectical.