

SECTION III: FRACTALS: PATTERNS IN NATURE

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Abstract

The discipline of General Systems (as I understand and practice it) assumes the existence of, and searches for, repeating patterns, cycles, or processes of natural phenomena, law, and/or organization, and "nested" or "self-similar" (fractal) hierarchies of structure throughout nature. Biology is especially full of examples, but repeating patterns are also found in all the physical sciences (the "Periodic Table of the Elements" is the classic atomic example). The cause of this pattern formation is thought to be the very narrow base of physical law (for example, conservation laws associated with the metric structure of spacetime), which heavily constrains, influences, and is reflected in the form of every higher natural system built upon it. (See also: [Sect VI: Information](#), and ["Sect VIII: Introduction to General Systems"](#))

Introduction

Working in the biological sciences at Cornell University for 20 years as a research technician for a world-class ecologist in a world-class academic/scientific environment, I quite naturally acquired, both by training and osmosis, a deep appreciation for natural organization, especially in biology, but also as revealed in science generally.

In 1980, my late father, Prof. John C. Gowan, invited me to participate in the annual meeting of a creativity institute in Buffalo, NY (the ["Creative Problem Solving Institute"](#) - "CPSI"), and join the

discussion group on General Systems. For the occasion I decided to try my hand at producing a "[Table of Natural Organization](#)", which I did as a hierarchy of 12 levels, 4 levels each in the atomic, biological, and astrophysical realms. The table has been with me in essentially its original form ever since, although it has been enlarged to include two parallel metaphysical levels of human thought, one intuitive and spiritual, the other rational and scientific. I have never been satisfied with my modeling of the metaphysical realm, and several versions have been tried, as for example the "[Sun Sign Model](#)", which attempts to address the entire range of human thought.

My father's investigations into the spiritual and psychological aspects of the metaphysical realm have been far more extensive and successful than my own, which is actually the major reason I have not been at pains to develop my own synthesis in this area, since I regard his as definitive. For similar reasons I don't expend much effort on electromagnetism, because that force is now so thoroughly understood (Feynman's quantum electrodynamics). (See: "[Trance, Art, Creativity: An Investigation of the Numinous Element and the Metaphysical Realm](#)", a book by Prof. J. C. Gowan Sr. available on his memorial website) (<http://www.johnagowan.org/TAC.zip>).

It was at the 1980 CPSI meeting (see above) that I first met Gus Jaccaci, who took an immediate liking to my table, and we have remained colleagues, friends, and collaborators ever since. Gus and George Land (the latter one of the luminary leaders of the Institute) had a General Systems dynamic of their own which happened to fit perfectly with the structural elements of my table, and a natural wedding of theory, structure, and dynamics ensued. Eventually (1986) the General Systems label was replaced by the fractal designation, but the two are practically interchangeable. I prefer the fractal characterization because it seems to more accurately reflect the nested, self-similar hierarchies of natural organization, and suggests a pathway (evolution), a dynamics (resonance), and a mathematics (fractal geometry), which might help explain and/or model these recurring patterns. Finally, there seems to be an emergent linkage between fractal geometry and "chaos" theory. For example, a

General Systems or fractal algorithm might be characterized as a "strange attractor" or "fractal basin" in chaos theory. (See also: the mathematical concept of "algorithmic compressibility" in John D. Barrow's book: "*New Theories of Everything*", Oxford Univ. Press, 2007, page 10.)

In 1986 Gus developed his "[Metamatrix® table](#)", a wholly abstract form derived from the fractal table, in which the same dynamic element runs both vertically and horizontally.

The fractal table has been published twice, first in Nov. 1989 in the "Training and Development Journal", and again in Sept. 1998 in the SSCC'98 symposium volume of the Durban South Africa "International Conference on Systems, Signals, Controls, Computers". In the symposium volume, the summary (section 6) of the series of fractal papers was published with the table. My copy of this symposium volume is in the Engineering Library, Carpenter Hall, of the Cornell University library system. Of course, the table and associated paper have also been published on the internet for as long as I have had my website (since Autumn, 1996).

The core "metric" or algorithm of the fractal pattern is 4x3, but is usually elaborated in complex systems to a [4th level \(4x4\) of emergent phenomena](#) and system expression or resolution. The 4x3 pattern is pervasive and fundamental throughout nature. It appears in all three General System models in these pages, as the central dynamic of the [4x4 grid](#) and [fractal table](#), as the 4 triangles of the "[hourglass](#)" or "Grail" diagrams, and again as the 4 triangular faces of the [tetrahedron models](#). There is no longer any doubt in my mind that the 4x3 pattern is the basic fractal algorithm, system iteration, or resonating pattern of the Cosmos - the fundamental "quantum unit" or structural element of natural organization. In the [tetrahedron models](#) it forms the "Word" of natural law or the "Tetragrammaton" that initiates Creation; in the [hourglass diagrams](#) it forms the "Grail", the relationship between the forces and particles of spacetime and matter; and in the nested hierarchies of the [fractal table](#) it elaborates all the material phenomena of the Cosmos.

The General System dynamic of Land and Jaccaci, derived originally by Land from biological data and published in his book "Grow or Die", consists of 4 parts, described as "Accretive, Replicative, Mutualistic, and Transformative" (Land's terms), or as "Gather, Repeat, Share, Transform" (Jaccaci's terms). It was Jaccaci who distinguished the "Transformative" stage as a separate 4th stage; in Land's model this 4th stage was joined with the third. My own structural hierarchy: "Unit, Pair, Group, Emergent New Unit" (or "Compound New Unit") neatly reflected the 4 operations of the Land-Jaccaci dynamic. Soon, perhaps in 1983 (?), Jaccaci realized that this dynamic ran vertically as well as horizontally in my 12 level table (which meant a 4th "Metaphysical" level had to be added to the original 3-part table). From this discovery Jaccaci later developed his abstract "Metamatrix"® table (1986).

Below is Jaccaci's description of the historical development of what we may call the "Land-Jaccaci-Gowan Table of Natural Organization":

"George Land (1973) has characterized the growth dynamic of this structural series in the sequential progressive terms of "Accretive, Replicative, and Mutualistic" behavior with which he defined the stages of what he called "Transformation Theory". Later he renamed his dynamic stages "Formative, Normative, and Integrative". In 1980 August Jaccaci added a distinct final stage of "Transformation" to the sequence of stages showing that the "Emergent Compound New Unit", [Gowan's] fourth stage in the structural series, was in fact the Transformation dynamic stage itself. Jaccaci then renamed the series of dynamics "Gather, Repeat, Share, and Transform". These dynamics of growth he then found to be isomorphic with and assigned them to [Gowan's] sequence of stages as: "Unit - (Gather (G)); Pair - (Repeat (R)); Group or Field - (Share (S)); and Compound new Unit - (Transform (T))."

"Once this matching of general systemic discoveries between

structure and dynamic was made by Jaccaci, he soon found [1983?] the "Organization in Nature Chart" progressing from four lines of order each in "Microphysical, Biological, and Macrophysical", had the same order of GRST running vertically throughout the whole chart, the "Microphysical" being the "Gathering" phase of the Universe story, the "Biological" being the "Repeat" phase, and the "Macrophysical" being the "Share" phase, with the invisible dynamic archetypes of emergent ordering being the "Transformative" phase [Gowan's "Metaphysical" level].

"With this fractal order running both horizontally and vertically throughout the organization chart, Jaccaci discovered what he called the "General Periodicity of Natural Order". He went on to apply this 16 stage matrix of natural order in a mapping he called the "Metamatrix"® [1986] to many varied stories and domains of growth and evolution showing both the descriptive and predictive nature of "General Periodicity".

Readers familiar with the theory of "Chaos" may recognize a familiar pattern in the model: beginning with a "linear" or simple input (cell 1), passing to a stage of bifurcation (cell 2), progressing to a stage of greater complexity including secondary bifurcations (cell 3), and finally a "chaotic" stage (cell 4) which predictably settles in the "fractal basin" of a 4x3 (or 4x4) "strange attractor" (the precise physical nature of the attractor, however, is unpredictable). Like a true fractal algorithm, the output of one level becomes the input of the next, the self-feeding iterations producing new self-similar expressions at ever-higher levels of information and system complexity. The model is scale-invariant, not only vertically with each row, but also with respect to the four major realms. (See: "*Chaos: Making a New Science*" by James Gleick, Viking Penguin Inc., 1987)

[The Fractal Universe](#)

The fractal "[Table of Natural Organization](#)" grew out of my attempt

to validate a personal suspicion that the pervasive 4x3 patterns in religion, mythology, and occult metaphysical systems of thought were simply intuitively recognized forms of a General Systems "operator", or fractal algorithm of the Cosmos. If true, the Unified Field Theory should also have this same form, corresponding to the same fractal algorithm, but in its rational mode. The Unified Field Theory and various metaphysical "World Systems", in this view, are all examples of the same cosmic ordering principle, fractal algorithm, or General Systems "metric", but one is seen with the intuitive mind, the other with the rational mind. If this viewpoint has any validity, then we should be able to find many *significant* examples of the operation of this fractal algorithm in nature.

Once I began looking for 4x3 systems in nature, I found so many examples I decided to arrange them in a table, itself constructed as a 4x3 matrix (later 4x4), in order to effectively tabulate the examples so their significance (or lack thereof) could be carefully accessed in a systematic fashion. The result is the large, 4-part "[Table of Natural Organization](#)", which I believe effectively demonstrates the existence of a 4x3 fractal order in Nature expressed structurally, dynamically, rationally, intuitively, physically and metaphysically.

Originally in three parts, the fractal table was expanded to a 4th, metaphysical level (sometime around 1987), largely due to the repeated requests of Gus. The 4 parts are: Microphysical, Biophysical, Astrophysical, and Metaphysical - the latter interpreted as wholly the abstract product of the human mind, in two modes, intuitive and rational. (Although conservation is a physical, natural phenomenon characteristic of energy, the "law of energy conservation" and the "1st Law of Thermodynamics" - are rational, "metaphysical" constructs of the human mind. The notion of the conservation - "salvation" - of the human soul, or of "Heaven" as a conservation domain of spirit, is similarly an intuitive metaphysical construct of our thought.)

Once I had discovered that the Cosmos did indeed have a fractal structure, I was as amazed and puzzled by its existence as anyone

else. 30 years later, I am still amazed and puzzled. However, lately it has occurred to me that this is by far the simplest and most economical way to build a Universe: the elaboration of a self-similar fractal structure - so similar in principle to "resonance" - is clearly the path of symmetry, "least energy", and least resistance. The fractal structure of Nature is essentially the "rolling thunder" of the primordial "Word" of natural law resonating through the eons in successive self-similar hierarchies of evolved and elaborated material phenomena.

The Fractal Structure of Nature **([4 Conservation Laws Connected in Triplets](#))**

The physical ground from which the 4x3 fractal algorithm or structural element originates and resonates is evidently the 4-dimensions of spacetime interacting (via the mediation of the asymmetric weak force) with light (free energy) to produce the three kinds of particles necessary to create matter: hadrons (the composite quark mass carriers), leptons (the elementary alternative charge carriers), and bosons (the field vectors or force carriers of the charges). We see the first expression of the fractal in the 3 families of four elementary particles - 3 quark pairs and 3 corresponding pairs of leptons. These resolve (decay) to the ground state baryon, the single nucleon of the hydrogen atom (the proton), itself a 4x3 structure - 3 quarks carrying four charges (color, flavor, electric, spin). Another 4x3 characterization of this fundamental material level is: 3 classes of particles (hadrons, leptons, bosons) with four forces of physics (electromagnetism, gravitation, strong, and weak). Antecedent to any material expression, we recognize a 4x3 structural dynamic of physical law and principle, as formulated in the ["Tetrahedron Model"](#).

The fusion of 4 hydrogen nuclei forms the "alpha particle" or the helium nucleus, 4 nucleons each of 3 quarks, a particle so stable it becomes the "brick" of the nucleosynthetic pathway. Next is formed carbon, 3 alpha particles each of 4 nucleons. Hence the carbon nucleus is a triple 4x3 resonance, beginning with the baryon (baryons are the class of hadrons composed of 3 quarks, such as the proton and

neutron (the "nucleons"). (Significantly, oxygen 16, the next alpha-particle step in the nucleosynthetic pathway beyond carbon 12, and of such importance for our life form, represents the 4x4 expression of the General Systemic pattern - 4 alpha-particles each of 4 nucleons.) From the carbon nucleus we move to the carbon electron shell and the organic chemistry of life. The electron shell of carbon is also a 4x3 resonance; 4 valence (bonding) electrons in the 3rd electron shell (1S2, 2S2, 2P2). Furthermore, the molecular bonding pattern of carbon is tetrahedral - 4 triangles (the crystal form of diamond). No other atom in the periodic table has anything like this combination of nuclear, electronic shell, and crystal 4x3 resonances - 5 in all. (Of consequence for the rapid evolution of Earth-life, water also has a tetrahedral molecular bonding pattern.) (See: [Newton, Darwin, and the Evolution of Life](#)".)

Beyond the tetrahedral bonds of molecular carbon, we find that DNA is itself a 4x3 chemical structure - 4 nucleic acids (adenine, guanine, thymine, cytosine) each composed of 3 molecular groups (sugar, phosphate, nitrogenous base). Finally, the genetic code is another 4x3 structure: the 4 nucleic acids code in triplets, producing the amino acids that comprise proteins. Hence we see how thoroughly the 4x3 cosmic fractal algorithm is embedded in biology. This is the clue to how the ancients could have intuited the 4x3 fractal structure of the Cosmos: they were intuiting the structure of their own genetic and physical constitutions. At higher levels of biological organization, we lose sight of the molecular thread, but the dynamic and gross structural elements of the 4x3 fractal remain evident - as discovered by Land, Jaccaci, and myself.

Each of the 4 major realms of the "Table of Natural Organization" can be characterized by a dominant 4x3 expression of the fractal: in the biological realm, this is obviously the molecular structure of DNA-RNA and its genetic code. In the microphysical or atomic realm, it is the 3 quarks and 4 charges of the atomic nucleus, plus the 4 quantum numbers of the electron shell (n, l, m, s) and the 3 components of atoms (electron, proton, neutron). At the astrophysical level, it is Kepler's 3 laws of planetary motion in 4 dimensional

spacetime, and the 4x3 force field of gravity - in Einstein's words - four 3rd order equations (the changing rate of gravitational acceleration in x, y, z, t). Maxwell's 4 equations of electromagnetism are another example in the long-range or spacetime forces (gravity and light). A major expression in the short-range or nuclear forces at the astrophysical level is found in the nucleosynthetic pathway, which depends upon the stability of the alpha particle or helium nucleus, the structural "brick" of element-building in stars. The 4x3 nuclear resonance of the nucleosynthetic pathway proceeds from helium to carbon, and upwards beyond oxygen in alpha-particle steps (with the consequence that elements with even atomic numbers are more common than elements with odd atomic numbers), but finally fails with chromium 48, which is highly radioactive, requiring 4 extra neutrons to achieve stability (chromium 52). The resonance settles at iron 56, one alpha particle beyond chromium 52, after which no more energy can be extracted from nuclear fusion. When the 4x3 resonance fails, so does the release of excess binding energy in nucleosynthesis. We should note there is a "miraculous" energetic resonance of the carbon nucleus, predicted by Fred Hoyle, which allows the formation of carbon from 3 alpha particles in the nucleosynthetic pathway of stars. Our hypothesis of a 4x3 cosmic fractal algorithm gives the same prediction.

Finally, at the metaphysical level of human thought, we find numerous examples from the intuitive "world systems" of religion, mythology, and occult traditions, including (in religion) the 4 sacred creatures which surround the throne of God (the Trinity); (in mythology) the 4 riders of the apocalypse and the 3 fates; (in the occult) the 4 elements and 3 qualities of astrology and the 4 trigrams of the I-Ching. In the rational mode we have the four forces of physics combined with 3 energy states in the Unified Field Theory (light, matter, charge - free energy, bound energy, and the symmetry debts of matter), the [Tetrahedron Model](#) of 4 conservation laws combined in triplets, the 4x3 [Higgs boson hierarchy](#) of the weak force, and numerous examples in the fractal hierarchy table previously cited. It is reflected in the body plan of humans and most terrestrial vertebrates - 3 major body divisions and functions

(cephalic - perception; thoracic, metabolic; pelvic, reproductive) x 4 limbs; and even in our calendar of 4 solar seasons x 3 lunar months.

The many striking correspondences between the classical astrological interpretation of the Sun Signs and the rational or "scientific" meaning assigned to those same matrix cells is stunning, for those who can walk in both realms - raising again the question of the power and extent of human intuition and the "ancient wisdom". (See: ["Physical Correlates of the Astrological Sun Signs"](#).)

Conclusion

In view of the demonstrated ["fractal organization of nature"](#), we can reasonably expect the Unified Field Theory to have a 4x3 core element, and probably a 4x4 expression as well: my original intuition regarding the probable correspondence between intuitive and rational cosmologies, systems, and representations seems justified.

The ["Tetrahedron Model"](#) is a set of 4 interacting conservation laws and fundamental principles which underlie and constrain the operation of the 4 forces. This set of conservation laws are truly metaphysical in that not only are they idealizations of the human mind, but they all have "spiritual" as well as physical interpretations and correspondences. We have already observed that the notion of "conservation" applies not only to energy but also to the "salvation" of souls and the spiritual conservation domain of "Heaven".

Likewise, the principle of "symmetry" is found not only in the aesthetic example of beauty, but in the ethical notion of fair play, the "Golden Rule" of social interaction, the equality of all souls before God, etc. In the notion of "causality" we also find the principle of "karma" or divine justice and retribution/reward, and personal responsibility for the consequences of our actions. In "entropy" we have a concept expressing the principle of eternal change, motion, evolution, and the gradual perfecting of a "fallen" or material universe.

It is a simple task to map the 4 conservation principles against the four forces in the "grid" or "matrix" format. (See: ["The Tetraforce"](#))

[Table](#)".) When we do this, however, we find this is essentially the same mapping and gives the same result as when we used the 4 energetic parameters: "free energy, bound energy, charge, force". This is apparently because we have reached the "bottom" of this line of generalization; there is no deeper abstraction characterizing this set of energetic parameters: energy and spirit are either equivalent or complementary. We have in both cases a mapping of "spiritual" or metaphysical parameters against the 4 physical forces, which is analogous to the astrological mapping of "Qualities" vs "Elements". We have essentially a matrix illustrating the impregnation of matter with energy, "spirit", or natural law, in either case a mating of the divine with the secular, the metaphysical with the physical; it is the energetic/spiritual component that "breaths fire into the equations" and sparks life from the dust of the Earth. And only such a mixture could suitably represent the Unified Field Theory, the fundamental note of the fractal, resonant hierarchy of our amazing and beautiful Cosmos.

Other phenomena of note suggested by inspection of the fractal hierarchy include the emergence of life from the replicating ability of the 4x3 structure of a molecule of RNA/DNA (See: ["Darwin, Newton, and the Origin and Abundance of Life in the Cosmos"](#).) Also, the notion that the biological function of humanity is to serve as the reproductive cells of Gaia, dispersing Earth-life into the galaxy. (See: ["The Information Pathway"](#).) The fractal hierarchy originates in the "rebound" from the electromagnetic ground state of the ["Higgs Cascade"](#). The purpose of the rebound is to return matter to its symmetric form as light, using the information conserved as charge to accomplish this goal (required by "Noether's Theorem" of symmetry conservation), as in the nucleosynthetic pathway of stars. *The charges of matter are the symmetry debts of light*, and charges act to repay those conserved obligations. But the fractal hierarchy also serves as the information pathway by which the cosmos creates life and acquires the ability to know itself. Through humanity the cosmos explores new modes of creativity, new domains of knowledge, new forms of beauty; the universe experiences itself and evolves through living forms. We are the Cosmos in its human form, become

self-aware.

Postscript: (added Dec., 2019)

(In the following, I assert the privilege of an old man who knows his prime is past, his time is short, and who wants to leave nothing of importance unsaid.)

The Language of God

Terence McKenna thought that the universe is composed of language (*True Hallucinations; The Archaic Revival* 1992-4). This is certainly true of our biological universe, insofar as we are willing to recognize DNA as the molecular language of life, heredity, and biochemical information. This connection between language and reality is presaged in the ancient biblical assertion that "in the beginning was the word" (John 1:1). DNA is the molecular language by which the biological realm and humanity are created, so we may consider DNA to be the divine/fractal language of a creative God. The language of God brings living beings into existence. When God says "tree" in the language of DNA, a living, actual tree comes into existence (through the usual natural channels). Our own human speech is but a pale reflection of this divine creative potency, but we do have a little that is uniquely our own (beyond our animal power of sexual reproduction): when we say "airplane" our civilization can actually bring an airplane into existence.

Machines, however, are not alive. The creation of life is the special province and miracle of God, although in this respect also, we are learning to participate and assist, through agriculture, plant and animal breeding (and finally through scientific understanding and genetic engineering) in the creation of living creatures, both diverse and new (but all within the DNA biochemical paradigm).

The divine speech of God has other powers, beyond and anterior to biology, simpler and more powerful, as when God says: "let there be light" (Genesis 1:3). The atoms, elements, stars, and the galaxies are likewise brought into being by some divine language we do not yet

fully understand. It appears that the "Periodic Table of the Elements" is constructed bit by bit from alpha particles (helium nuclei), and single protons and neutrons, within the centers of stars. These elements are subsequently dispersed throughout the universe by supernova explosions (the heaviest elements are evidently made during such events, or even during the collisions of massive, dense stars). Elementary particles are the letters, elements are the words, molecular combinations are the sentences that produce the chemistry (and ultimately the biochemistry) of the cosmos. All of it, from the beginning ([following Chardin](#)), is divine substance derived from the energy of light, protected by energy and charge conservation, the metric of spacetime (which provides gravitationally conjoined entropic conservation domains of space, history, causality, and information).

Life is in the atoms when they are created; life is not simply the consequence of some peculiar molecular combination capable of self-replication. Life is the divine energy of God inherently contained within and born with each atom. *Life is the grand miracle of, and the rationale for, our universe.* As Tolstoy concluded in his great novel "War and Peace": Life is God in the universe.

We are struggling to understand higher-level conservation languages, much of which is mathematical, trying to build a "[Unified Field Theory](#)" or "[Theory of Everything](#)" (which may include a "Multiverse"). The numinous nature and source of the Creative Energy itself is the ultimate "Mysterium Tremendum". To this mystery we can only bow and offer our reverence.

N.B. Although I have been using the word "God" in the traditional Christian sense, I have no specific idea what that word refers to. I use it to indicate the *primordial creative energy* that produced our universe (and perhaps our "multiverse"). This energy exists in every elementary particle (including light), and fills the "vacuum" of spacetime with virtual particle-pairs. It is responsible for all "natural law". But does it have a moral compass? Does it care about humanity? As Blake questioned in his immortal poem "Tiger": "Did

He who made the lamb make thee?" Since both tiger and lamb are part of the same DNA fractal creation, maybe it just doesn't matter - perhaps only the creative energy of the fractal itself matters, and whether it produces lambs or tigers is a non-issue. But from the perspective of the flourishing/flowering of the creative fractal energy itself, one would have to suppose that human creativity, both scientific and artistic, so long as it is "life affirming and enhancing" (i.e., advancing the growing/replicating/dispersing/evolving agenda of life), would find a helping harmonic resonance ("good vibrations") within the universal fractal energy and spirit that produced and sustains our universe.

There will always be some experiences (emotions like the merger of personal identity in love, or our awe before nature's majesty, grandeur, and beauty), which are beyond scientific understanding or rational description. That is why we have art, poetry, music, philosophy, and even religion, to help us process, embrace, and reproduce such feelings - emergent emotions arising from the surpassing complexity and resonant depth of humanity entangled in the cosmos.

The existence of a 4x3 fractal algorithm operating at every level in nature is one of the more astonishing discoveries in all of General Systems. The series of fractal papers linked below are not technically challenging and are generally self-explanatory; hence readers should have no trouble understanding them, and I will let them speak further for themselves.

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See also: Paul Davies, 1988: *The Cosmic Blueprint*. Simon and Schuster.

[See also: Terrence McKenna: *Archaic Revival*](#)

Related Papers:

["The Fractal Organization of Nature";](#)

["Nature's Fractal Pathway"](#)

["The Information Pathway"](#)

(See also: "[The Human Connection](#)"; "[Comments on the Metaphysical Realm, Rational Mode](#)"; the "[Information](#)" table)

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