



laetus in praesens

14 September 2020 | Draft

Fibonacci Spiral in 3D Framing Psychosocial Phyllotaxis

Articulation of global governance through the language of flowers?

- / -

Introduction

Self-similarity design patterns as exponential bullshit?

Global governance bullshit combining exponential growth and suboptimal distribution?

Lessons from nature on exponential growth and optimal distribution

Possibility of "psychosocial photosynthesis"?

Optimization of psychosocial "light capture"

Turn-taking as the psychosocial analogue of phyllotaxis?

Variety of suggestions for construction of the Fibonacci spiral in 3D

Experimental construction of the Fibonacci spiral in 3D

Expression and constraint as framed by Fibonacci spiral in 3D

From "on the square" through "in the box"

Spiralling transition comprehended through metaphor

Implication in multiple spirals -- spiral complementarity

Comprehensibility and appreciation of psychosocial phyllotaxis in governance

References

Introduction

There is extensive reference in plant biology to [phyllotaxis](#), namely the spiralling configuration of petals, pine cones and pineapples, for example. There is a seemingly unrelated preoccupation with [spiral dynamics](#) in a psychosocial sense, namely the evolutionary development of individuals, organizations, and societies.

The latter focus is only related by implication to the role of the spiral exemplified by the shell structure of the marine nautilus and the inspiration it has offered for psychosocial evolution, as first articulated by [Oliver Wendell Holmes](#). That particular inspiration has subsequently been recognized as a pattern for the [New Zealand Education curriculum](#) as well as framing the focus of the [Nautilus Institute for Security and Sustainability](#)

Distinct again are the extensive commentaries on the so-called [spiral of silence](#) through which opinions distinct from the mainstream are progressively constrained, leading to a sense of isolation, possibly extreme. In a period of pandemic lockdown, accompanied by deprecation of challenges to mainstream discourse, the spiral of silence could be understood as related to separate concern with the "[spiral of depression](#)" -- itself a characteristic feature of the pandemic.

More collectively relevant to the crisis of governance is recognition of the nature of a "[death spiral](#)", most obviously illustrated by the behaviour of ants in an [ant mill](#), effectively imprisoned by their instincts and lacking a coordinating force to guide them to safety, as argued by Ed Yong ([America Is Trapped in a Pandemic Spiral](#), *The Atlantic*, 9 September 2020). A poetic articulation of the condition was presented a century ago by W. B. Yeats:

Turning and turning in the widening gyre
The falcon cannot hear the falconer;
Things fall apart; the centre cannot hold;
Mere anarchy is loosed upon the world,
The blood-dimmed tide is loosed, and everywhere
The ceremony of innocence is drowned;
The best lack all conviction, while the worst
Are full of passionate intensity.
([Second Coming](#), 1919)

The "death spiral" theme is currently evoked with respect to human civilization by various authors (Geoff Dombicki, [This Guy Studies the 'Global Systems Death Spiral' That Might End Humanity](#), *VICE*, 15 November 2019; George Monbiot, [The Earth is in a death spiral](#),

The Guardian, 14 November 2018; Del Wolf Thiessen, *Psychopaths Rising: Unholy Links to Civilization and Destruction -- Our Evolved Death Spiral*, 2014; Newton Paulo Bueno, *A simple system dynamic model for the collapse of complex societies*, *Proceedings of the International System Dynamics Conference*, 2011)

Potentially offering insight, as complementary metaphors, are other forms of "death spiral":

- **death spiral in insurance**: namely a condition where the structure of insurance plans leads to premiums rapidly increasing as a result of changes in the covered population. It is the result of **adverse selection** in insurance policies in which lower risk policy holders choose to change policies or be uninsured. The result is that costs supposedly covered by insurance are pushed back onto the insured.
- **death spiral financing**: namely conditions when the holder of **convertible debt shorts** the issuer's common stock encouraging the debt holder to convert some of the convertible debt to common shares by which the debt holder's short position is then **covered**. The debt holder continues to sell short and cover with converted stock, which, along with selling by other shareholders alarmed by the falling price, continually weakens the share price, making the shares unattractive to new investors and possibly severely limiting the company's ability to obtain new financing if necessary. The **subprime mortgage crisis** of 2008 was characterized by the stocks of subprime lenders falling into a death spiral and dropping from the major exchanges in steady succession.
- **death spiral accounting**: namely the repeated elimination of products, in cost accounting and managerial accounting, resulting from spreading costs on the basis of volume instead of their root causes. It is also known as the **downward demand spiral**.
- **death spiral in aviation**: namely a type of dangerous spiral dive, otherwise termed a graveyard spiral, entered into accidentally by a pilot. They are most common at night or in poor weather conditions where no horizon exists to provide visual correction for misleading inner-ear cues.
- **fake news spiral**: could be recognized in the **woozle effect**, namely when frequent citation of previous publications that lack evidence misleads individuals, groups, and the public into thinking or believing there is evidence, and nonfacts become urban myths and factoids -- as has become evident in the misinformation pandemic associated with COVID-19.

Three variants of "**death spiral**" in **figure skating** are recognized: the backward-inside, forward-inside and forward-outside death spirals, originally named the Cosmic Spiral, Life Spiral and Love Spiral, respectively. A complementary process, as a form of "birth spiral", can be recognized in **stigmergy**, namely the indirect coordination and self-organization between agents or actions through the environment (L. Marsh and C. Onof, *Stigmergic epistemology, stigmergic cognition, Cognitive Systems Research*, 9, 2008, 1-2; Guy Theraulaz, *A Brief History of Stigmergy, Artificial Life*, 5, 1999, 2).

Collaborative open source projects and social movements are now studied as providing insights into the emergence of large-scale peer production and the growth of **gift economy**, as notably articulated in a proposal for **governance by stigmergy** by Heather Marsh (*Binding Chaos: mass collaboration on a global scale*, 2013; *The Creation of Me, Them and Us*, 2020). A spiral features prominently on the cover of the latter.

The question here is whether greater insight is to be obtained from representation of the **Fibonacci spiral** in 3D, as an approximation to the so-called **golden spiral**. Specifically how might this assist in reconciling distinctions of relevance to psychosocial development -- or its progressive constraint. Given the sense in which "flowering" is used metaphorically to describe the development of cultures, the further question is whether the metaphor can be articulated to a greater degree in the light of phyllotaxis -- and the culminating process of petal loss as precursor to fruit and seed (*Flowering of Civilization -- Deflowering of Culture: flow as a necessarily complex experiential dynamic*, 2014). The study of "stigmergic optimization" has notably recognized the role of the Fibonacci pattern (Abraham Ajith, et al, *Stigmergic Optimization*, 2006).

A potentially significant aspect of this exploration is the manner in which the Fibonacci pattern is related to the **golden ratio** -- esteemed for the aesthetic framing it offers, most notably in the proportions of architecture and design. In particular the focus here is on how this sense of proportion might be fruitfully extended to the design of psychosocial structures, most notably the architecture of knowledge, the design of organizations and the strategies of governance.

Are there limits yet to be appropriately recognized, as can be variously argued (Gyorgy Doczi, *The Power of Limits: proportional harmonies in nature, art, and architecture*, 1981; K. J. Niklas, *The role of phyllotactic pattern as a "developmental constraint" on the interception of light by leaf surfaces*, *Evolution*, 42, 1988; *Limits to Human Potential*, 1976).

Part of the difficulty lies in the sense in which both the Fibonacci sequence and the golden ratio proportion (in its various manifestations) are abstractions which are not immediately suggestive of how they can be interrelated -- usefully and comprehensibly. The experimental construction of the spiral in 3D may therefore be suggestive in this respect. The long tradition of "**saying it with flowers**" may imply significance as yet to be explored with respect to global governance.

Self-similarity design patterns as exponential bullshit?

Whilst there is a very extensive literature on the golden ratio and its relation to spirals governed by the Fibonacci pattern of numbers, there is also a notable set of commentaries on the role of the golden ratio in design as being simply a myth.

Bullshit? The critique includes the comments by George Markowsky (*Misconceptions about the Golden Ratio*, *College Mathematics Journal*, January 1992), Keith Devlin (*The Myth That Will Not Go Away*, *Devlin's Angle*, May 2007), and Mario Livio (*The Golden Ratio: The Story of PHI, the World's Most Astonishing Number*, 2002). For John Brownlee:

It's bullshit. The golden ratio's aesthetic bona fides are an urban legend, a myth, a design unicorn. Many designers don't use it, and if they do, they vastly discount its importance. There's also no science to really back it up. Those who believe the golden ratio is the hidden math behind beauty are falling for a 150-year-old scam (*The Golden Ratio: Design's Biggest Myth*, *Fast*

Critics note that the evidence for the [golden rectangle](#) as being especially pleasing is questionable -- with psychological studies showing a wide range of contrasting preferences, but with the ratio of the square root of two to one often being preferred over others. The idea that the golden ratio has any relationship to aesthetics at all is said to derive primarily from two people in the past, of which one was misquoted, and the other resorted to invention (according to Devlin).

As affirmed by Clement Falbo, over the past five centuries, a great deal of nonsense has been written about the golden ratio, its geometry, and the Fibonacci sequence (*The Golden Ratio: a contrary viewpoint*, *The College Mathematics Journal*, 36, 2005, 2). The author cites with approval the earlier comment of George Markovsky:

Generally, its mathematical properties are correctly stated, but much of what is presented about it in art, architecture, literature and esthetics is false or seriously misleading. Unfortunately, these statements about the golden ratio have achieved the status of common knowledge and are widely repeated. Even current high school geometry textbooks... make incorrect statements about the golden ratio. It would take a large book to document all the misinformation about the golden ratio, much of which is simply repetition of the same errors by different authors. (*Misconceptions about the golden ratio*. *The College Mathematics Journal*, 23, 1992, 1)

A more nuanced dismissal is offered by Dan Kalman and Robert Mena (*The Fibonacci Numbers: Exposed* *Mathematics Magazine*, 76, 2003, 3):

With such fabulous properties, it is no wonder that the Fibonacci numbers stand out as a kind of super sequence. But what if it is not such a special sequence after all? What if it is only a rather pedestrian sample from an entire race of super sequences? In this case, the home world is the planet of two term recurrences. As we shall show, its inhabitants are all just about as amazing as the Fibonacci sequence.

Citing Markovsky, a recent Royal Society report on Fibonacci numbers in sunflowers concludes that:

Given the extent to which Fibonacci patterns have attracted pseudo-scientific attention, this substantial replication of limited previous studies needs no apology (Jonathan Swinton, et al, *Novel Fibonacci and non-Fibonacci structure in the sunflower: results of a citizen science experiment*, *Royal Society Open Science*, 1 May 2016).

Clarification: As offered by Chris Budd (*Myths of Maths: the golden ratio*, *Plus Maths*, 23 February 2020) with respect to the classic construction in 2D:

There are two problems here. Firstly, the shape isn't a spiral. It is a sequence of circular arcs. As you go from one arc to another the curvature of the spiral jumps. It is most unlikely that in any natural phenomenon we would see such jumps. In fact, the shape is only an approximation to a true spiral. The form of spiral that it approximates is an example of a *logarithmic spiral*.

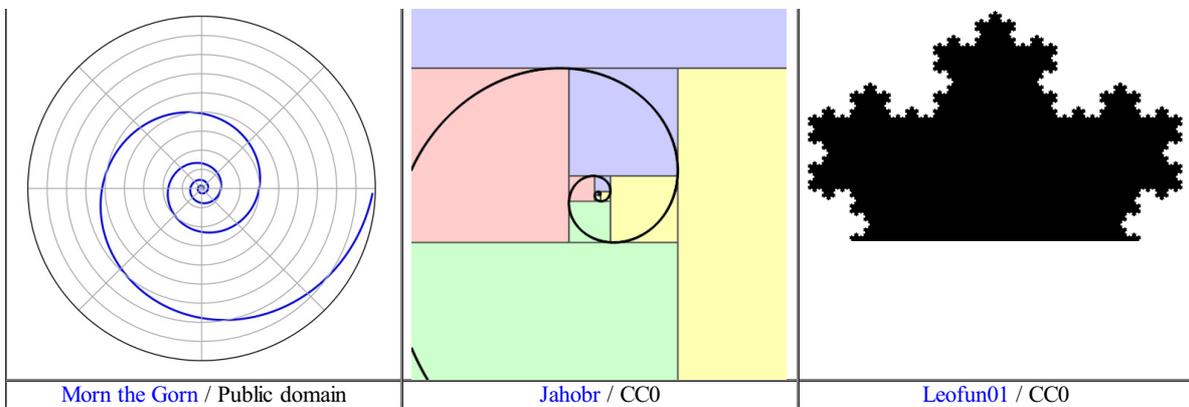
$$r = ae^{b\theta},$$

Such spirals are very common in nature, where e is the base of the natural logarithm. This means that if you rotate the spiral by any fixed angle then you get a spiral which is a rescaling of the original. The so-called *golden spiral* has the particular value of b where ϕ is the golden ratio (and angles are measured in radians).

$$b = \frac{\ln \phi}{(\pi/2)} = 0.3063489\dots$$

For Budd, there is no reason at all why this number is in any way special. The nautilus shell, frequently cited as an example as noted above, is a logarithmic spiral because the [self-similarity](#) property allows the shell to grow without changing shape. The values of b observed for the nautilus shell bear no relation to the value above, with the value of $b = 0.18$ seen most commonly in actual shells.

Logarithmic spiral	Golden spiral animation	Self-similarity illustrated by Koch snowflake



Exaggeration? Exactly what merits recognition as "bullshit" clearly calls for very careful reflection. Given the seeming absence of recognition of how the spiral of silence (or its reverse) might be governed by the the golden angle and the Fibonacci series, it is most ironical to note the manner in which the latter has been taken up as [Fibonacci retracements](#) in analysis of trading on the financial markets in the quest for profit, and the possibility of doubling it:

- Jasvind Singh: *The Golden Ratio in Trading* (PhillipCFD, 10 August 2017)
- Yuriy Batura: *Psychological Levels and Fibonacci Numbers* (Trading Strategies, 17 March 2019)
- Dan Blystone: *Strategies for Trading Fibonacci Retracements* (Investopedia, 11 May 2020)
- Emily Kotow: *The Magic of Fibonacci Retracement* (HedgeTrade, 19 September 2019).

Why does analogous thinking not feature in any form of [socially responsible investment](#) or in [ethical investment](#)?

If it is the golden ratio itself which should be specifically framed in this way, it raises the question as to whether any design criteria could be usefully framed in such terms, from one perspective or another. This invites further reflection on the role of contrasting perspectives regarding the golden ratio in their competitive quest for appreciative recognition -- and how the pattern of such perspectives might itself be more fruitfully understood.

Implications for unity of knowledge? The editors of *Evolution News* raise the question *Do We Live in a "Golden Ratio" Universe?* (2 December 2014). The question is framed in the light of an astonishing list of apparently unrelated phenomena that follow the golden ratio, as argued by Jan C.A. Boeyens and J. Francis Thackeray (*Number theory and the unity of science*, *South African Journal of Science*, 110, 2014, 11-12):

A convincing case for assuming a cosmic character of the Golden Ratio can be made based on the ubiquity of logarithmic spirals. Spectacular examples include the Whirlpool Galaxy (M51), ammonites, the shape of Nautilus shells, Hurricane Katrina and the distribution of planets, moons, asteroids and rings in the solar system.... The logarithmic spiral is firmly related to the Fibonacci series and the Golden Ratio of number theory. A familiar aspect of Fibonacci spirals is the way they feature in botanical phyllotaxis, the shape of kudu... horns and the curvature of elephant tusks. Less well known is the way in which the crystallographic structure of DNA, stress patterns in nanomaterials, the stability of atomic nuclides and the periodicity of atomic matter depend on the Golden Ratio. Apart from the Golden Ratio, a second common factor among this variety of structures is that they all represent spontaneous growth patterns. The argument that this amazing consilience ("self-similarity") arises from a response to a common environmental constraint, which can only be an intrinsic feature of curved space-time, is compelling.

This widely cited note was followed by that of [Michael Lieber](#) (*The Golden Ratio (1.62) as a dimensionless biological constant*, *South African Journal of Science*, 112, 2016, 9-10) noting his earlier comments in that regard. Such comments do not however include reference to potential psychosocial implications.

Global governance bullshit combining exponential growth and suboptimal distribution?

Given the argument above, it might be usefully asked whether the widely promulgated enthusiasm for the democratic organization of society could also be explored as a questionably cultivated myth -- as with the related notions of consensus and equality (*The Consensus Delusion: mysterious attractor undermining global civilization as currently imagined*, 2011; *Cultivating the Myth of Human Equality: ignoring complicity in the contradictions thereby engendered*, 2016).

Is there any sense in which the myth could be similarly said to derive primarily from "a few people" in the past, of which some may now be misquoted, and others may have "resorted to invention"? Is any aesthetic sense of appropriate proportionality, like the golden ratio, to be recognized as an urban legend -- a "design unicorn"? It is only too evident that many conceptions of governance do not derive from any such understanding of appropriate design. Or, if they do use it, they vastly discount its importance in practice.

Reference to "bullshit" may indeed be inappropriate, despite the number of well articulated arguments as to its relevance -- especially as exemplified by world leaders and within the institutions which frame their legitimacy (*Viable Global Governance through Bullfighting: challenge of transcendence*, 2009; *Zen of Facticity: Bull, Ox or Otherwise? Herding facts and their alternatives in a post-truth-era*, 2017).

Faced with exponential growth, inequality and suboptimal distribution, could the global leadership offered by the world's acclaimed

superpower at this time be usefully recognized as "light years" from design informed by mythical criteria inspired by aesthetic proportionality? Are the criteria of design primarily inspired by "anything goes", and "whatever works" -- of which anarchistic designs are but one extreme example in aesthetic terms?

The deliberate (or unconscious) cultivation of chaos in global governance is now a subject of commentary -- with the notable absence of any consideration of the aesthetic functions of design:

- Breno Bringel: *COVID-19 and the new global chaos* (*Open Democracy*, 25 June 2020)
- Emanuel Pastreich: *Governing the Earth: current political chaos demands a transformation of the United Nations* (*Global Research*, 2 September 2019)
- Anthony Burke and Rita Parker (Eds.): *Global Insecurity: futures of global chaos and governance* (Palgrave, 2017)
- Giovanni Arrighi and Beverly J. Silver: *Chaos and Governance in the Modern World System* (University of Minnesota Press, 1999)

Are the many concrete examples of urban planning an exemplification of abandonment of aesthetic principles in design -- perhaps ironically analogous to abandonment of the gold standard? Argued otherwise, **does the manner of configuration of parliamentary assemblies and organization charts constitute evidence of a commitment to design that ensures inequality and suboptimal distribution** -- whether in terms of communication possibilities or allocation of resources?

Such arguments highlight the curious contrast between the poorly articulated quest for a mythical Holy Grail of governance and the chaos currently associated with governance at the global level (*Ungovernability of Sustainable Global Democracy?* 2011; *Are the UN and the International Community both Brain Dead: given criteria recognizing that NATO is brain dead?* 2019). More curious is cultivation of the Holy Grail meme at the core of the capitalist quest for extreme profitability (*In Quest of Sustainability as Holy Grail of Global Governance*, 2011).

Change and adaptation: In a period in which much is made of the necessity for change in response to rapidly evolving conditions, of particular interest is the recognition that the property of self-similarity is indeed a factor in designing to facilitate such change (Stafford Beer, *Platform for Change*, 1978). If this is the case in nature, as is especially evident in some plant species, there is clearly merit in considering its possible role in psychosocial development.

Is it possible that any conventional deprecation of the golden ratio in design could be a case of "throwing the baby out with the bathwater"? Given the significant failure of science to alleviate, rather than exacerbate, the patterns of disagreement which now characterize global society and the discord between the "sciences", **it is appropriate to ask whether conventional science has the capacity to appreciate the aesthetic integration of which the golden ratio may be indicative** (*Knowledge Processes Neglected by Science: insights from the crisis of science and belief*, 2012).

Lessons from nature on exponential growth and optimal distribution

There is a curious contrast between the esteem for aesthetic patterns in nature based on spiral forms and the deprecation of the golden ratio as a mythical illusion. It is acknowledged that nature has engendered designs which effectively address the two-fold challenge of exponential growth and optimal distribution (David Bachman, *From the Golden Ratio to Fibonacci Phyllotaxis Spirals* 16 March 2018; I. Adler, et al, *A History of the Study of Phyllotaxis*, *Annals of Botany*, 80, 1997, 3).

For Takuya Okabe (*Biophysical optimality of the golden angle in phyllotaxis* *Scientific Reports*, 5, 2015, 15358):

Plant leaves are arranged around a stem axis in a regular pattern characterized by common fractions, a phenomenon known as phyllotaxis or phyllotaxy. As plants grow, these fractions often transition according to simple rules related to Fibonacci sequences. This mathematical regularity originates from leaf primordia at the shoot tip (shoot apical meristem), which successively arise at fixed intervals of a divergence angle, typically the golden angle of 137.5° . Algebraic and numerical interpretations have been proposed to explain the golden angle observed in phyllotaxis. However, it remains unknown whether phyllotaxis has adaptive value, even though two centuries have passed since the phenomenon was discovered. Here, I propose a new adaptive mechanism explaining the presence of the golden angle. This angle is the optimal solution to minimize the energy cost of phyllotaxis transition. This model accounts for not only the high precision of the golden angle but also the occurrences of other angles observed in nature. The model also effectively explains the observed diversity of rational and irrational numbers in phyllotaxis.

For Sören Strauss, et al (*Phyllotaxis: is the golden angle optimal for light capture?* *New Phytologist*, 225, 2019, 1):

Our simulations confirmed previous results by showing that the golden angle of 137.5° is indeed optimal for light capture and that morphological traits can influence the light capture curve. However, with a finer sampling of angles from 0° to 180° (resolution of 0.25°) our results also showed that there are many other divergence angles with comparable fitness based on light capture ability. Thus, the golden angle cannot really be seen as "the" global maximum in terms of LCE, but is rather one of many optimal angles....

Here, we have shown that many divergence angles are just as efficient for light capture; for example, the relatively common Lucas angle of 99.5° or the angle associated with the anomalous sequence of 151.14° For LCE, the most important characteristic of the divergence angle seems to be to simply avoid suboptimal regions, such as the minima around angles generated by low denominator fractions, such as 90° or 120° . Although this might explain why different plants have different divergence angles, the appearance of different angles on the same plant raises the question as to how any specific angle could be optimized in response to selective pressures. To answer this question, it is important to consider how phyllotactic patterns are

formed.

Online demonstrations of phyllotaxis in 2D are available showing how plants tend to arrange their stems and florets so that each successive one is at an angle of about 137.5° relative to the previous one (Stephen Wolfram, *Phyllotaxis Spirals*, Wolfram Demonstrations Project, 2011). The latter shows interactively what would happen if plants used other angles. Another interactive display extends the demonstration to 3D (Stephen Wolfram, *Phyllotaxis Spirals in 3D*, Wolfram Demonstrations Project, 2011).

Biomimicry with respect to processing of light? Mathematicians typically explore the possibility of generalization of any pattern. Questions relating to the pattern of Fibonacci numbers have thus been explored through the various [generalizations of Fibonacci numbers](#), and alternatives, including those of higher order, as indicated by *Wikipedia*:

<ul style="list-style-type: none">• Fibonacci integer sequences• Lucas sequences	<ul style="list-style-type: none">• Tribonacci numbers• Tetranacci numbers• Higher orders	<ul style="list-style-type: none">• N-generated Fibonacci sequence• Semi-Fibonacci sequence
---	---	--

Given the recognized biophysical optimization of the distribution of the organs of plants, most evident in the sunflower, it could then be asked what "generalization" this suggests in the light of [biomimetics](#). This is the emulation of the models, systems, and elements of nature for the purpose of solving complex human problems. It has proved especially significant in the development of aerodynamics, with all that flight has symbolized for humanity (*Engendering a Psychopter through Biomimicry and Technomimicry: insights from the process of helicopter development*, 2011).

There is therefore a case for recognizing that the distribution of plant organs according to a Fibonacci pattern for the reception of light and the distribution of seeds could indeed offer insights with respect to any psychosocial analogue -- especially the dissemination of memetic seeds. Of particular interest is any understanding of "light". This has long been valued as a metaphor for insight of various orders, from that of a creative idea to mystical illumination. The progressive learning experience could itself be considered from this perspective.

Possibility of "psychosocial photosynthesis"?

In the quest for analogues in the light of biomimetics, the spiralling according to the Fibonacci pattern -- as phyllotaxis -- could be understood as a quest for greater inspiration or illumination, as is of such importance to many. It is also a feature of the quest for creativity and innovation as a driving force in technological development.

Artificial photosynthesis: Of some relevance to this argument is the focus on artificial photosynthesis informed by biomimicry (*Biomimetic approaches to artificial photosynthesis: themed collection*, Royal Society of Chemistry). Advanced solar cells are one of many leaf-inspired biomimicry innovations widely explored to enhance artificial photosynthesis.

During photosynthesis in green plants, light energy is captured and used to convert water, carbon dioxide, and minerals into oxygen and energy-rich organic compounds. As has been described from that perspective:

... photosynthesis is the process of converting light energy into chemical energy. Specialized proteins in plant cells absorb particles of light which initiates the passing of electrons across a series of molecules. Subsequently, water is split by a protein complex into oxygen and hydrogen protons. The oxygen is released from the plant, while the electrons and hydrogen protons go on to help generate two compounds -- NADPH and ATP -- which are later used to power the reaction that transforms atmospheric carbon dioxide into sugars. The concept of photosynthesis, while fairly simple to grasp from a high level (i.e. light + water + carbon dioxide = sugars + oxygen), is actually quite complex, and there is still much to discover concerning it. (*Artificial Photosynthesis: a case of biomimicry*. *Awkward Botany*, 2 December 2015)

Photosynthesis as a metaphor: It is appropriate to note the extensive literature designed to guide comprehension of photosynthesis in an educational setting, even at the youngest age, including renderings into song (David Truss, *Photosynthesis and Learning: a learning metaphor*, 8 May 2010; *Photosynthesis song!*). Some references suggest **comprehension of photosynthesis through metaphor**; others offer analogies through which photosynthesis may be comprehended.

There seem to be **no indications of recognition of photosynthesis as a metaphor**. This is all the more surprising in that the process is fundamental to carbon fixation -- understood as an appropriate response to carbon emissions and the global warming crisis.

Surprising exceptions to this assertion with respect to photosynthesis as a metaphor are however to be found with regard to "spiritual photosynthesis":

- Andrew Jasko: *Spiritual Photosynthesis: how to see mystical light and shekinah glory* (*Lifeafterdogma*, 15 October 2019)
- Jerry Tutu: *Spiritual Photosynthesis: the dynamics of biblical meditation as the master key to total prosperity* (CreateSpace Independent Publishing Platform 2013)
- Edy Sutherland: *Spiritual Photosynthesis* (*Family Matters*, 19 March 2014)
- Vir Singh: *Photosynthesis: the core of spiritual karma* (*SpeakingTree*)
- Matt Shull: *Photosynthesis: turning light into truth* (*CampDecision*, 2015)
- Cheryl Petersen: *Spiritual Lessons from the Plant World* (*BeliefNet*)
- Erlend J. Brock: *The Correspondence of Photosynthesis* (*New Philosophy*, January-March 1986)
- *Spiritual Photosynthesis: Torah Color Theory* (*Gal Einai*, 2011)

Such exceptions are understandable, give the symbolic and spiritual significance traditionally associated with the Sun and its light.

The use of photosynthesis as a metaphor or as an analogy is somewhat complicated due to confusion regarding nomenclature, as has been usefully summarized (Georg Wohlfahr and Lianhong Gu, *The many meanings of gross photosynthesis and their implication for photosynthesis research from leaf to globe*, *Plant, Cell and Environment*. 38, 2015, pp. 2500–2507).

Psychosocial energy: The insights associated with the use of photosynthesis as a metaphor could be potentially recognized in terms of the energy crisis faced by global civilization. Without using it as a metaphor, the point is succinctly summarized by Regina Bailey (*The Photosynthesis Formula: Turning Sunlight into Energy*, *ThoughtCo*, 1 October 2018):

In photosynthesis, solar energy is converted to chemical energy. The chemical energy is stored in the form of glucose (sugar). Carbon dioxide, water, and sunlight are used to produce glucose, oxygen, and water. The chemical equation for this process is:
 $6\text{CO}_2 + 12\text{H}_2\text{O} + \text{light} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 + 6\text{H}_2\text{O}$

A major international response to the energy crisis is the [ITER nuclear fusion initiative](#) -- widely promoted as tapping the "energy of the sun" (Olivier Lucazeau, *Quest advances to recreate sun's energy on earth*, *Phys.org*, 28 July 2020; *Power from an artificial sun: Fusion reactor project aims to provide clean energy*, *France24*, 31 July 2020). The design principles of that project can be explored as a metaphor (*Enactivating a Cognitive Fusion Reactor: Imaginal Transformation of Energy Resourcing (ITER-8)*, 2006).

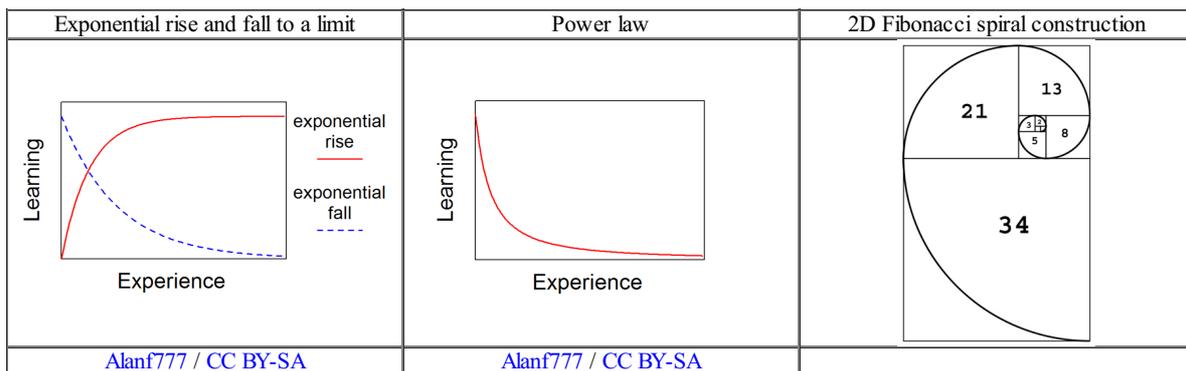
Creativity: A review of the various models in the literature for creative thinking is provided by Paul E. Plsek (*Models for the Creative Process*, *DirectedCreativity*, 1996). Common themes are extracted from these and presented in a composite model that integrates them. The author notes that such models are analogous to those used in business to guide strategic planning, quality improvement, problem solving, innovation, and other activities.

There is an obvious degree of irony to the manner in which light, and specifically the Sun, feature as metaphors in the creative process, whether for the individual or for the collective. This is most obvious in [solar symbols](#) and through use of the term "enlightenment", most evident with respect to the [Age of Enlightenment](#) -- heralded by emergence of a heliocentric worldview. The metaphor features in associated references to "revelation", whether as the "creative flash" of a new idea or in its more fundamental spiritual senses.

There is further irony in the importance of light in the reflection of Albert Einstein leading to his theory of relativity, as explored in detail by Douglas Hofstadter and Emmanuel Sander (*Surfaces and Essences: analogy as the fuel and fire of thinking*, 2013).

Learning curve: It is therefore intriguing to note the resemblance of diagrammatic representations of the [learning curve](#) to the construction of an approximation to the Fibonacci spiral (below right). A learning curve is a graphical representation of the relationship between [proficiency](#) at a task and the amount of [experience](#) accumulated -- typically in the case of an individual, but clearly applicable to any collectivity. As shown below, proficiency (measured on the vertical axis) usually increases with increased experience (the horizontal axis), that is to say, the more a task is performed, the better the performance. Learning curves may refer to a specific task or a body of knowledge.

Understood as an exponential rise, the increase in skill or retention of information may increase rapidly to its maximum rate during the initial attempts, and then gradually levelling out, meaning that the skill of a person (or a collectivity) does not improve much with each later repetition, with less new knowledge then gained over time.



Expressed as a [power law](#), the experiential rise is similar in appearance to an [exponential decay](#) function, and is almost always used for a decreasing performance metric, such as cost. Representation of such decay is of potential relevance both to personal experience in the aging process and to processes of civilizational collapse (*Societal Learning and the Erosion of Collective Memory: a critique of the Club of Rome Report: No Limits to Learning*, 1980; *Limits to Human Potential*, 1976).

Experiential learning -- "in the curve": Beyond the capacity to produce indicative representations, lies the nature of the experience of learning and why this accords with a sense of a learning curve -- even a "steep learning curve". It could otherwise be assumed that learning could be represented as a straight line from one corner of a square to its opposite. The reality is sensed otherwise -- as a curve -- governed by the complex process of acquisition of both proficiency and experience (or their loss, as experienced in the aging process). Physically the obvious requirement is for an "access ramp" of appropriate curvature and slope.

Any such sense bears comparison with the widespread concern with "being in the loop" and more particularly with its embodiment, as suggested by the insights of Douglas Hofstadter (*I Am a Strange Loop*, 2007). This followed his widely cited earlier study (*Gödel, Escher, Bach: an Eternal Golden Braid*, 1979). The relevance of these insights to biomimicry is further reinforced by his subsequent

study in collaboration with Emmanuel Sander (*Surfaces and Essences: analogy as the fuel and fire of thinking*, 2013).

The argument can be taken further, using the Fibonacci construction diagram with its complex of nested squares. Arguably there is a sense, offered during the course of running around a circular track, in which there is a shift in understanding and perspective after completing a portion of the learning process. This may be experienced as the reality of there being more learning to follow -- whether of a different nature or offering a particular perspective on the first phase. The changing size of the contiguous squares offers the implication that this may be sensed as a constraint or an intensification on the one hand, or a dilution or broadening of perspective on the other.

Each quarter curve could be understood as leading to a change of phase -- possibly to be understood as passing through a form of glass window, a rite of passage, or involving "shock learning" (as originally promoted by the Club of Rome). Each such transition is consistent with understandings of rebirth (*Varieties of Rebirth: distinguishing ways of being "born again"*, 2004). The coronavirus pandemic could be explored in that light.

More intriguing in the Fibonacci construction diagram is the manner in which the spiralling curve completes a cycle -- whether involving contraction or expansion. The associated sense of completion has been articulated in poetic form

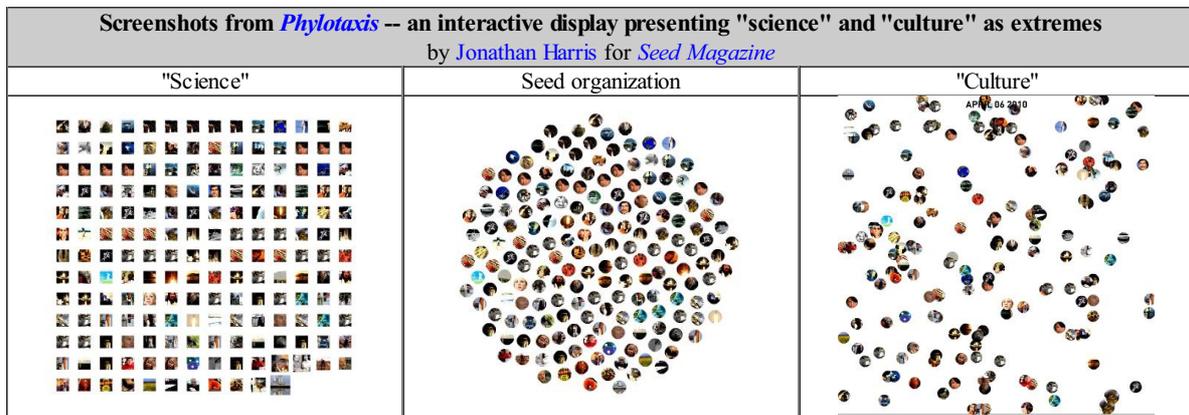
We shall not cease from exploration,
and the end of all our exploring
will be to arrive where we started
and know the place for the first time. T. S. Eliot

Such return to beginnings may indeed be a case of "all the wiser", tragically constrained through exposure to reality, or with insight enhanced in some manner. With its proportions governed by the golden ratio, the diagram is indicative of the recognition of a sense of proportion -- of putting things in proportion. It could also serve to represent the process of **enantiodromia**, defined by **Carl Jung** as:

...the emergence of the unconscious opposite in the course of time. This characteristic phenomenon practically always occurs when an extreme, one-sided tendency dominates conscious life; in time an equally powerful counterposition is built up which first inhibits the conscious performance and subsequently breaks through the conscious control.

Given the reference to Jung, also of relevance is the fourfold organization of the Fibonacci construction diagram in the light of the distinctive psychosocial significance potentially associated with each quarter. The insight has been variously articulated otherwise (Mark Vernon, *The Four-fold Imagination* [of William Blake], *Aeon*; Spyros Bofylatos and Thomas Spyrou, *A Four Layer of Abstraction Communication Framework Supporting Design Dialogue*, European Academy of Design, 2015).

Optimization of psychosocial "light capture"



So framed, as in nature, this offers the possibility of highlighting the strange dynamics between those in quest of insight and anxious to assert the particular value of their discoveries in what may become a highly competitive environment. As is only too evident, whether in the ideological or religious domains, those imbued with insight readily claim its unique nature and qualify other claims as secondary -- if not dangerous. The claim to have "grasped it" merits careful reflection (*Beyond Harassment of Reality and Grasping Future Possibilities: learnings from sexual harassment as a metaphor*, 1996).

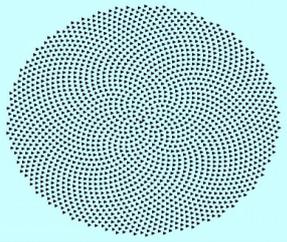
Civilization could be said to have demonstrated total and complete inability to address this challenge. A degree of exception to this assertion is to be found in the case of innovation embodied in patents. This claim to property is obviously also evident in the case of land and claims to mineral exploitation rights. However any generalization as "intellectual property" extends primarily to artistic works and writing -- copyright -- but is highly problematic in the case of "cultural property", as is evident in the case of that of indigenous cultures.

There is the intriguing possibility of an analogy between photosynthesis in plants and the manifestation in psychosocial reality of intellectual products -- intellectual property. The necessity of light for photosynthesis is obvious, just as is creative inspiration -- if not revelation -- for intellectual products. Whilst the processes of photosynthesis are reasonably well understood (although questionably replicable), those of creativity and innovation remain relatively mysterious. Phyllotaxis according to the Fibonacci pattern enables that in plants. **Yet to be clarified is the optimal distribution of psychosocial elements to best enable creativity and learning** -- especially

as it relates to collective learning of relevance to governance

It is from that perspective that the current organization of parliamentary and other assemblies can be usefully challenged -- especially with any visual comparison with exemplars of optimal distribution in nature, as discussed separately with the following images (*Global Governance Communication*, 2010; *Towards an Appropriate Architecture of Global Conference Communication*, 2010). The challenge of "insight capture" in such contexts then merits comparison with "light capture" by plants (*Technical facilitation of insight capture and processing*, 2019).

Organization of insight processing appropriate to global governance?	
European Parliament (Strasbourg)	United Nations General Assembly (New York)
	

Pattern of representative global insight organization and dissemination -- possible alternative appropriately inspired by the Golden Mean?	
	
Sunflower showing organization of seeds (<i>Flower Patterns and Fibonacci Numbers</i> , Mathematics and Knots, U.C.N.W., Bangor, 1996 - 2002; S. Douady et Y. Couder, <i>La physique des spirales végétales</i> , La Recherche, janvier 1993)	<i>Fibonacci Numbers and Nature: Why is the Golden section the "best" arrangement?</i> 2009 by Ron Knott Schematic layout of a sunflower from an Excel spreadsheet with a slider to alter the turns-per-seed on an interactive chart to show to enable recognition of the best distribution of 2000 seeds on a seedhead.

Fibonacci global map? Of potential value in the quest for meaningful global governance is the equidistant distribution of points on a sphere in the light of the Fibonacci pattern -- and any implication of phyllotaxis:

- Benjamin Keinert, et al: *Spherical Fibonacci Mapping*, *ACM Transactions on Graphics*, 34, 2015, 6, Article 193
- Rihard Swinbank, et al: *Fibonacci Grids: a novel approach to global modelling*, *Quarterly Journal of the Royal Meteorological Society*, 132, 2006).
- Mikhail Lyubich, et al: *The Fibonacci Unimodal Map* (*Journal of the American Mathematical Society*, 6, 1993, 2)
- Jean-Francois Sadoc, et al: *Phyllotaxis on surfaces of constant Gaussian curvature* (*Journal of Physics A Mathematical and Theoretical*, 46, 2013, 29)

The set of hexagrams of the *I Ching* can be understood as indicative of distinctive conditions of governance and change, and the associated psychodynamic tensions, as discussed separately (*Designing Global Self-governance for the Future: patterns of dynamic integration of the netherworld*, 2010; *Harmonics of "globalization": a universal constant?*, 2010). As reproduced there, the spherical distribution of those conditions by József Drasny (*The Image of the Cosmos in the I Ching: the Yi-globe* (2007) could merit reconsideration in this light.

As variously explored, with COVID-19 now constituting a major threat to global civilization, there is a strange irony to the probability that the protein spikes on the virus, as so widely depicted, are distributed around its spherical form according to a Fibonacci pattern (*Reimagining Coronavirus in 3D as a Metaphor of Global Society in Distress*, 2020; *Spike-endowed Global Civilization as COVID-19*, 2020; *Cognitive Engagement with Spike Dynamics of a Polyhedral Coronavirus*, 2020).

Patent organization: Of potential relevance to this argument is the **triple helix model of innovation**, inspired as it is by the structure of DNA -- and subsequently extended into quadruple helix and quintuple helix models. The associated spirals are discussed below.

Unrelated to the triple helix model as such, studies of innovation patterns as represented by patents include that of Inga Ivanova and Loet Leydesdorff:

Using time series of US patents per million inhabitants, knowledge-generating cycles can be distinguished. These cycles partly coincide with Kondratieff long waves. The changes in the slopes between them indicate discontinuities in the knowledge-generating paradigms. The knowledge-generating paradigms can be modeled in terms of interacting dimensions (for example, in university-industry-government relations) that set limits to the maximal efficiency of innovation systems. The maximum values of the parameters in the model are of the same order as the regression coefficients of the empirical waves. The mechanism of the

increase in the dimensionality is specified as self-organization which leads to the breaking of existing relations into the more diversified structure of a fractal-like network. This breaking can be modeled in analogy to 2D and 3D (Koch) snowflakes. The boost of knowledge generation leads to newly emerging technologies that can be expected to be more diversified and show shorter life cycles than before. **Time spans of the knowledge-generating cycles can also be analyzed in terms of Fibonacci numbers.** This perspective allows for forecasting expected dates of future possible paradigm changes. In terms of policy implications, this suggests a shift in focus from the manufacturing technologies to developing new organizational technologies and formats of human interactions (*Knowledge-generating Efficiency in Innovation Systems: the relation between structural and temporal effects*, arxiv, February 2015) [emphasis added]

The authors produced an earlier study on: *The Efficiency of Triple-Helix Relations in Innovation Systems: measuring the connection between a country's net income and its knowledge base*, SSRN Electronic Journal, January 2015). Subsequently Inga Ivanova produced a study specifically focused on the Fibonacci pattern (*The Dynamics of Financial Markets: Fibonacci numbers, Elliott waves, and solitons*, December 2019).

A provocative question then arises from this nexus of preoccupations. **Is the exponential production of knowledge -- in terms of patents and intellectual property, its organization, and the distribution of the embodied insight -- appropriate to a civilization in crisis?** Typically most insight of any value is subject to copyright, security classification, or paywalls -- irrespective of how vital it might be to any remedial response.

This is evident in the competitive production of some 320 vaccines in response to COVID-19 -- primarily evoked by the profits to be made. Provocatively it might be asked whether preoccupation with self-organization, from the perspective of stigmergy, addresses this process through the production of copyrighted papers.

Understood as a process of "psychosocial photosynthesis", absolute priority is consequently given to the reification and commodification of creativity and insight, as variously criticised (Dustin Kidd, *Commodification and Creativity: a review of Tyler Cowen's Creative Destruction*, *The Hedgehog Review*, Summer 2003; Jeremy Gilbert, *Against the Commodification of Everything: anti-consumerist cultural studies in the age of ecological crisis*, *Cultural Studies*, 22, 2008, 5).

New thinking: The desperate appeals for "new thinking" in times of crisis occur in a context of highly competitive focus on patent registration as being indicative of "innovation". This merits recognition within the underlying context clarified with many case studies by [Thierry Gaudin](#) (*L'écoute des silences: les institutions contre l'innovation*, 1978). The author's reference to silence merits consideration in the light of the literature on the spiral of silence and the role of such silence (Alain Corbin, *History of Silence: de la Renaissance à nos jours*, 2018).

With respect to expectation of social innovation, the argument is presented most succinctly by Stafford Beer as a form of *Le Chatelier's Principle*:

Reformers, critics of institutions, consultants in innovation, people in sort who "want to get something done", often fail to see this point. They cannot understand why their strictures, advice or demands do not result in effective change. They expect either to achieve a measure of success in their own terms or to be flung off the premises. But an ultrastable system (like a social institution)... has no need to react in either of these ways. It specialises in equilibrational readjustment which is to the observer a secret form of change requiring no actual alteration in the macro-systemic characteristics that he is trying to do something about (*The Cybernetic Cytoblast: management itself*. Chairman's Address to the International Cybernetics Congress, September 1969)

There is a case for adapting insights from the extensive studies of competitive light capture by plants, as reviewed by Marina Semchenko, et al:

Competition for light is size-asymmetric due to the unidirectional nature of sunlight. Slightly faster growth and larger body size confers a disproportionate advantage to a competing plant by simultaneously increasing its own light capture and its shading of smaller competitors... As a result, above-ground competition can lead to the competitive exclusion of smaller or slower-growing individuals and play a decisive role in community structuring (*Positive effect of shade on plant growth: amelioration of stress or active regulation of growth rate?* *Journal of Ecology*, 100, 2011, 2)

With respect to innovation in science, the challenge has been expressed otherwise by [Max Planck](#):

A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it.

Organization of insightful knowledge? It is curious to note the relatively simplistic approaches to the actual organization of insight, as evident in the various classifications of subjects in information systems. This raises the question as to whether the vast resources of mathematics, with its complex insights into relationships, are organized in the most fruitful manner to enable their comprehension and application, as argued separately (*Is the House of Mathematics in Order? Are there vital insights from its design*, 2000).

Potentially valuable in this respect is the efforts expended to organize the chemical elements, evident in the many alternative representations of the [periodic table of chemical elements](#). Analogous forms of periodicity may yet be discovered in the organization of knowledge, as separately argued (*Towards a Periodic Table of Ways of Knowing -- in the light of metaphors of mathematics*, 2009). A

similar argument might be made in the light of the [standard model of particle organization](#) (*Beyond the Standard Model of Universal Awareness: Being Not Even Wrong?* 2010), especially given the explorations of physics in that regard (*Physics beyond the Standard Model*, Wikipedia).

In the study of phyllotaxis, consideration is given to time periodic models (*The Mathematics of Phyllotaxis*). Is there any basis for a pattern of phyllotaxis in the organization and comprehension of knowledge? This might be suggested by detection of Fibonacci numbers in the periodic table, as variously explored:

- Okan Gurel and Demet Gurel: *Observed Fibonacci Sequences in the Periodic Table* (*Biophysical Journal*, 102, 2012, 3)
- Hugo Ryan Currie and Geoffrey Michael Currie: *An Investigation of the Application of the Golden Ratio and Fibonacci Sequence Associated with the Chart of Nuclides* (*Open Science Journal*, 5, 2020, 2)
- *Do atoms follow the patterns of the Fibonacci sequence, Pi, the Golden Ratio, or any other mathematical trends?* Quora, 2015)

Of the thousands of noted periodic tables in the *INTERNET Database of Periodic Tables*, some 68 take spiral form, potentially reflective of such organization (for example, Imran Ali, et al, *Advanced spiral periodic classification of the elements*, *Chemistry International*, 3, 2017, 3). A "spiral periodic table-mandala based on the pattern of phyllotaxis" has been provisionally presented by [Dmitry Weise](#) (*Archetypes of Periodic Law*).

Organization of antenna, metaphorical and otherwise: Attention to the detection and reception of insight in any environment may well be described using "antenna" as a metaphor, although little is then said about how these may be organized or deployed. The organization of petals and leaves on plants could well be described as functioning in some manner as antenna.

From a general systems perspective, it is therefore of interest to explore how the extremely well developed mathematics of radio antenna design is comparable with phyllotaxis in plants. One study which explores a degree of similarity is that of Italo Mario Fabbri (*The Spiral Solenoids and the Leaf Antenna in Phyllotaxis Differential Geometry*, University of Milan, 2018), using the common metaphorical reference to a "leaf coil" in conjunction with a sense of phyllotaxis:

The fundamental spiral coil named leaf coil is obtained by joining together the so called forward and backward spiral coils which define the new concept of the differential geometry of phyllotaxis. The other spiral coils are composed of symmetrically rotated leaf coils, combined together in such a way to eliminate the transverse magnetic components along the longitudinal z axis

Reference to "phyllotactic" arrangement is a feature of discussion of antenna design (Jean-Christophe Angevain, et al, *Phyllotactic arrangements of reflector mesh facets to decrease grating lobes*, *9th European Conference on Antennas and Propagation*, 2015). A related possibility is the subject of a patent (Aidan Rhys Dwyer, et al, *Photovoltaic array utilizing phyllotactic architecture*, US20120260967A1, 2012).

Turn-taking as the psychosocial analogue of phyllotaxis?

Reference to collective assemblies clearly raises the question of optimal communication in governance and in the associated decision-making. [Turn-taking](#) is a type of organization in conversation and discourse where participants speak one at a time in alternating turns. In practice it involves processes for constructing contributions, responding to previous comments, and transitioning to a different speaker, using a variety of linguistic and non-linguistic cues. Turn-taking may come to be highlighted to a greater degree in online meetings (such as Zoom).

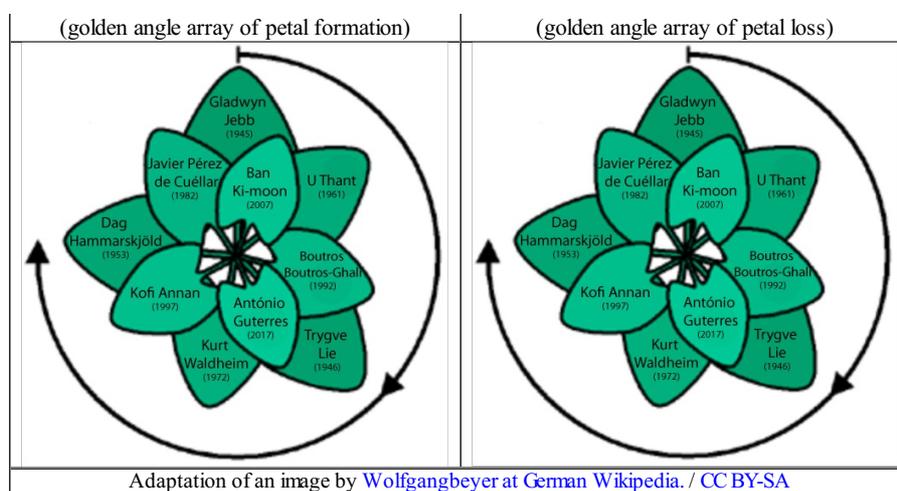
A related process is notably evident in location of events, in [board rotation and succession](#), and especially director rotation as a characteristic of corporate governance (Will Kenton, *Director Rotation*, *Investopedia*, 21 August 2019). In the form of [job rotation](#), employees may be assigned to different jobs throughout their employment -- most obviously in the case of security personnel. Especially intriguing is the complex pattern of [turn-taking in the use of facilities](#) in the [Holy Sepulchre](#) in Jerusalem by competing religious denominations. There is seemingly little consideration of its implications for any potential pattern between the Abrahamic religions sustaining the crisis in the Middle East. The so-called [immovable ladder](#), and its linearity, offers a remarkable metaphor of the constraints on any capacity for transcendence potentially requiring curvature (as suggested by requirements for an "access ramp"). Turn-taking has however taken a remarkable form in [time-sharing](#) arrangements.

As noted in the extensive review of turn-taking in *Wikipedia*, while the structure is generally universal, namely overlapping talk is generally avoided and silence between turns is minimized, turn-taking conventions nevertheless vary by culture and community (Tanya Stivers, et al, *Universals and cultural variation in turn-taking in conversation*, *Proceedings of the National Academy of Sciences*, 106, 2009, 26). Conventions vary in many ways, such as how turns are distributed, how transitions are signaled, or how long is the average gap between turns.

Given the current global inadequacy of "dialogue", there is arguably a case for exploring the relevance of structures analogous to phyllotaxis in ordering patterns of intervention -- given tendencies to dominance. Such exploration would be consistent with the preoccupations of [conversation analysis](#), [dialogical analysis](#) and [discourse analysis](#).

With respect to such an analogy, there is an ironic contrast to the organization of the sunflower, as shown above. **In the case of turn-taking, the emphasis is on the organization of time rather than space** -- in addition to any understanding of the dissemination of memes.

Turn-taking illustrated by speculative configuration of Secretaries-General of the United Nations	
"Flowering" of the United Nations?	"Deflowering" of the United Nations?



More particularly however, there is a sense in which each participant can be readily perceived as a "bearer of light" -- although potentially with some being caricatured by others in terms of solar metaphors. Explored otherwise it is a case of taking turns to be recognized by one's peers -- to "be in the light" and thus to be "re-cognized" by others. This is variously implied to be fundamental to the democratic process and to notions of fairness. As such, sharing, fairness and taking turns now feature in early childhood education.

Studies of some relevance to such exploration include:

- John Heritage: *Conversation Analysis and Institutional Talk: analyzing distinctive turn-taking systems* (Proceedings of the 6th International Congress of the International Association for Dialog Analysis, 1998)
- John Bolender: *Hints of Beauty in Social Cognition: broken symmetries in mental dynamics* (New Ideas in Psychology, 26, 2008, 1)
- Rick Dale, et al: *The Self-Organization of Human Interaction* (Psychology of Learning and Motivation, 59, 2013)
- Jenni Ingram, et al: *Turn-taking in the Mathematics Classroom* (University of Oxford, 2014)
- Fritsch, Matthias: *Taking Turns: Democracy to Come and Intergenerational Justice* (Derrida Today, 4, 2011, 2). s
- Nigel G. Ward: *Ten Prosodic Patterns of Turn-Taking in Japanese Conversation* (University of Texas)
- Sandy Donovan: *When Is It My Turn?: A Book about Fairness* (LernerClassroom, 2014)

The patterns of turn-taking over time can be explored through metaphors of alternation as a means of facilitating comprehension of the dynamics of the process (*Metaphors of Alternation: an exploration of their significance for development policy-making*, 1984).

Further clues are potentially offered by music and song, especially when involving improvisation of participants in a group, as discussed separately (*Improvisation in Multivocal Poetic Discourse: Basque lauburu and bertsolaritza as catalysts of global significance*, 2016; *Multivocal Poetic Discourse Emphasizing Improvisation: clarification of possibilities for the future*, 2012). The role of the golden ratio is notably evoked in commentary on the music of Bartók (Roy Howat, *Bartók, Lendvai and the Principles of Proportional Analysis*, *Music Analysis*, 2, 1983, 1)

With the implied focus on information, the analogy could be understood in terms of energy in its more fundamental sense. Using the case of the declining Roman Empire, this was the focus of the study by Thomas Homer-Dixon (*The Upside of Down: catastrophe, creativity, and the renewal of civilization*, 2006). Of potential relevance to this argument, he has followed this by a study of hope (*Commanding Hope: the power we have to renew a world in peril*, 2020). As a form of inspiration, hope-related psychosocial processes could also merit consideration in the light of photosynthesis.

Variety of suggestions for construction of the Fibonacci spiral in 3D

The geometric construction of an approximation to the Fibonacci spiral in 2D is widely referenced. It could be readily assumed that the principles of such construction could be extended to 3D -- if not to higher dimensions. Criticism of that approach was however noted above.

It is therefore appropriate to note the very extensive literature survey and commentary by M. Nagy, S. R. Cowell and V. Beiu (*Survey of Cubic Fibonacci Identities: when cuboids carry weight*. arxiv, 18 February 2019; *Survey of Cubic Fibonacci Identities: when cuboids carry weight*. arxiv, 18 February 2019). This was initially presented to the 7th International Conference on Computers Communications and Control, (2018) under a slightly different title (*Are 3D Fibonacci spirals for real?: From science to arts and back to science*, 2018):

This paper is aiming to start an investigation on possible extensions of the classical Fibonacci spiral (2D) to three dimensions (3D). Our goal is to understand if and how 3D spirals, which are called or linked to Fibonacci, are in fact supported mathematically. Our inspiration here has been the 2D Padovan spiral for which a 3D extension is known. The classical 2D Fibonacci spiral is generated on a particular tiling of the 2D space with squares which follow a well-known Fibonacci identity. In this paper we shall analyze quite a few 3D spirals. **The main conclusion is that the search for a 3D Fibonacci spiral is left wanting, as none of the 3D spirals we were able to find is backed by a Fibonacci identity describing a recurrent tiling of the 3D space** (similar to the recurrent tiling in 2D). Still, this paper has set the stage for the construction of 3D Fibonacci spirals by showing that for distinguishing different tilings of the 3D space a thorough understanding of homogenous Fibonacci cubic identities is compulsory. *[emphasis added]*

Given that conclusion, questions can be usefully asked about the many references to "spiral" of psychosocial relevance, most notably those of spiral dynamics and the spiral of silence. In the former case, for which there are many images available on the web, are typically structured with indicative colours,(about which there is much controversy). In the latter case very little structuring is indicated, the implication being only that it takes the form of a vortex.

There are of course many different spirals with which psychosocial development might presumably be associated. The Nagy survey notes that that there may be many variants of the Fibonacci spiral itself. Some 30 spirals that have been defined mathematically are listed by *Wikipedia (List of Spirals)*. Of interest, for example, is the argument for the relevance of a 3D spiral in cardiac studies (Davide Piccini, et al, *Spiral Phyllotaxis: the natural way to construct a 3D radial trajectory in MRI, Magnetic Resonance in Medicine*, 66, 2011, 4):

The pattern known as "spiral phyllotaxis" is an eye-catching arrangement, consisting of two sets of spirals forming a lattice. This pattern can be identified in a great number of plants and flowers, where the visible spirals going clockwise and counter-clockwise are typically associated with two successive elements of the Fibonacci sequence. In these cases, the angle between successive leaves is always close to the golden angle. Extensive studies on spiral phyllotaxis and its mathematical properties have been reported in many scientific fields within natural sciences..., theoretical sciences..., and also engineering applications....

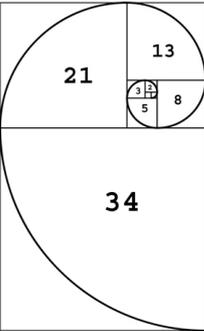
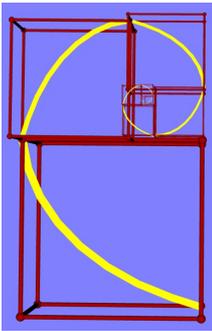
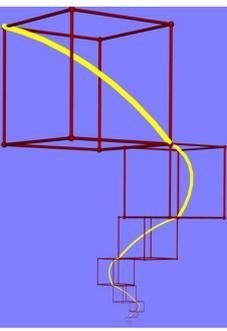
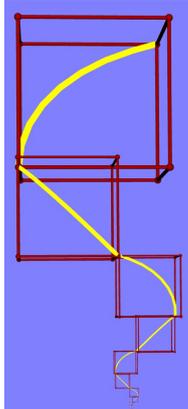
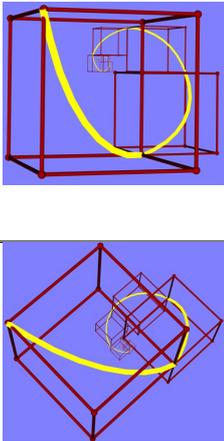
The argument here assumes that the role of the Fibonacci spiral in nature suggests an especially fundamental role which is likely to be of relatively greater relevance to psychosocial development than other spirals. The memorability of any spiral pattern may be all the greater if it is reminiscent of spirals in nature. It is therefore appropriate to assume that the metaphoric use of spiral in spiral dynamics and the spiral of silence could be usefully articulated through the Fibonacci spiral -- justifying further exploration of its representation in 3D.

Experimental construction of the Fibonacci spiral in 3D

Given the widely referenced geometric construction of an approximation to the Fibonacci spiral in 2D, the following exercise assumes that the principles of such construction could be extended to 3D in some way. This is consistent with the cuboid approaches noted above by Nagy (2019) and with the consideration of R. L. Ollerton (*Fibonacci cubes, International Journal of Mathematical Education in Science and Technology*, 37, 2006, 6).

Seemingly in contrast with those approaches, the concern here is to highlight the actual formation of the spiral in 3D such that it is consistent with the metaphoric and/or intuitive references to spiral in "spiral dynamics" and the "spiral of silence".

The preliminary result is as indicated below.

2D Fibonacci spiral construction	Screenshots of 3D construction of approximations to Fibonacci spiral (variously rotated)			
	Comparable view to 2D	Alternative views		
				

Several issues were encountered in generalizing from the 2D square construction to the 3D cube in X3D:

- the quarter circle curve in 2D, centered on the opposite vertex of a square, cannot be readily replicated in 3D on the opposite vertex of a cube,
- the approach taken was to use less than a quarter-circle. Since the centering on the opposite vertex did not give a satisfactory termination of the curve at the corners of a cube, the centre of the curve was displaced from the vertex along one axis. Presumably a better result could be achieved by displacing the centre along two or three axes.
- an initial incorrect assumption regarding the relative sizes of the successive cubes was revised with guidance from Sergey Bederov of Cortona 3D who also recommended use of a helix for the curve or coordinate interpolation. Both possibilities were considered but abandoned in favour of a segment of a circle (constructed as a torus) as a comparison with the approximation offered by the 2D construction.
- the result was somewhat successful, but it does not give a smooth curve from some perspectives -- although it is reasonably smooth from others as a preliminary exercise

- the model in X3D allows for adjustment of several parameters. The possibility of scaling each extruded curve along its length to enable smoother connections between cubes was considered but not implemented.

The preliminary result is nevertheless a useful demonstration of a failed approximation which is of value to framing further discussion and experiment -- notably with improvements to the geometry of the curve segment within each cube. Arguably it is potentially of greater relevance than some of the solutions based on distinctive mathematical hypotheses as reported by Nagy (2019) for which several interesting images are presented (necessarily subject to copyright). Although limited to 2D, of potential relevance to any such exercise is discussion of the use of modelling software (Dan Mackinnon, *Phyllotaxis Spirals*, *Mathrecreation*, 5 September 2008; H. Dogan-Dunlap and J. R. Jordan. *Modeling Spiral Growth in a GSP Environment*, *MAA*, 8, 2008).

In the light of the earlier argument, the form of a "learning curve" could be especially appropriate (rather than those considered) -- with the possibility of attributing significance to a "third factor", in addition to proficiency and experience (Jonathan Wai, *What Goes Into The Development Of Greatness? Psych Learning Curve*, 18 March 2019). A possible candidate is some combination of commitment and dedication.

Expression and constraint as framed by Fibonacci spiral in 3D

The stacked sequence of cubes framing the spiral indicated above suggests several interpretations of the pattern, according to implications of orientation of the stack:

	Evolution "upwards" "flowering"	Devolution "downwards" "deflowering"
larger cubes "at bottom" smaller "at top"	contraction to smaller (compactification) implication of oneness	expansion to larger ever greater confusion
larger cubes "at top" smaller "at bottom"	expansion to larger identification with universe	contraction to smaller ever greater isolation / depression

The four modalities in the table crudely distinguish what might be better described in terms of an intensification of awareness (with heightened implication) from a diffusion of awareness (with heightened identification with otherness to a universal degree).

The spiral of silence, understood as downward to extreme isolation, can indeed be understood as corresponding to a spiral of depression. However any such isolation can also be understood as a form of internal intensification, as recognized from the perspective of mysticism -- suggesting that the spiral might be from larger to smaller radius, with the smaller cubes "at the top". The sense of constraint and isolation can be understood as potentially conflated as in any mystical notion of the "dark night of the soul", and a requisite endarkenment (*Enlightening Endarkenment: selected web resources on the challenge to comprehension*, 2005).

Corresponding to the Age of Enlightenment cited above, it might then be asked whether current crises are a precursor of an "Age of Endarkenment", as variously envisaged (David Colquhoun, *The Age of Endarkenment*, *The Guardian*, 15 August 2007; Gerald Weissmann, *Galileo's Gout: science in an Age of Endarkenment*, 2007; Nick Cater and Brendan O'Neill, *The Age of Endarkenment*, Centre for Independent Studies, 2014). The latter argues:

In terms of the downward spiral, or the rise of the Endarkenment... the disappearance of the scientific method, the disappearance of that willingness to challenge authority is one of the key problems... What we are seeing in terms of the rise of the Endarkenment is a real diminishing of the values of the Enlightenment, belief in reason, belief in scientific method, belief in freedom -- all those things are being wound back. As a consequence of that, we are also seeing the downgrading of economic growth and economics and of exploiting Nature.

For spiral dynamics, the spiral is typically depicted as "upward" from the smaller to the larger. This recognizes a progressive expansiveness of awareness and expression -- a "flowering" of civilization and consciousness, even an identification with flow in all its forms.

Without considering issues of phyllotaxis (discussed below), the "flowering" metaphor offers the challenging recognition of the process through which the "petals" are lost. This is a completion of the cycle as framed by that metaphor -- whatever the interpretation of "deflowering". Japanese culture celebrates the loss of petals in terms of the impermanence of *mono no aware*. The metaphor also suggests the possibility of fruit and seed of which the flower may be the requisite precursor. This is a challenging interpretation with respect to any deflowering of civilization.

Also relevant is the sense in which expansion of the spiral through a devolutionary process is one in which awareness is diffused incoherently -- as is exemplified and implied by the confusion of misinformation and fake news in modern society.

From "on the square" through "in the box"

On the square: Given the widely documented role of Freemasonry in relation to governance (irrespective of the suspicions of conspiracy theorists), it is intriguing how the key symbolism of that world view specifically emphasizes the [square and the compasses](#), often embedded within a circle. Considerable emphasis is placed on the implications of the phrase being "[on the square](#)" -- a phrase variously adopted outside that context with an indication of morality.

The process of construction of an approximation to the Fibonacci spiral in 2D could be understood as exemplifying use of the symbolic instruments of Freemasonry. However the distinction meriting exploration is between such design and construction, understood as

explaining subtle insight, and the experiential **embodiment** of that insight.

The former is a matter of description, whereas the latter has cognitive implications. As description, the emphasis is on "isness" -- even reification, or a reflection of subtlety into a form of cognitive "flatland". A **Flat Earth** perspective is variously deprecated as the epitome of misunderstanding, although a variety of arguments can be presented in support of Flat Earth theory. *Wikipedia* notes, for example, that despite the scientific fact of Earth's sphericity, pseudoscientific flat Earth conspiracy theories are espoused by **modern flat Earth societies** and, increasingly, by unaffiliated individuals using social media. Unusually, *Wikipedia* includes a page on *Why Wikipedia cannot claim the Earth is not flat*.

On the other hand, *Scientific American* includes an argument by **Davide Castelvecchi** (*What Do You Mean, The Universe Is Flat?*, Part I, 25 July 2011; *Part II*, 31 July 2011). This frames the conceptual dilemma through the following seemingly inconsistent statements which are associated with scientific theories:

- The universe is three-dimensional.
- The universe is four-dimensional -- three for space, one for time.
- The universe has nine, or ten or eleven dimensions
- Matter curves spacetime.
- The universe is flat.
- The universe is infinite.
- The universe is 84 billion light-years wide.
- The universe is a bubble, or an onion.
- Or a hall of mirrors, shaped like soccer ball.
- Or a shape out of Dante's Divine Comedy

As discussed by Davide Castelvecchi, a key issue is the meaning to be associated with "exist" and "existence". How does a person exist in a flattened condition? This is a matter explored from fictional mathematical perspectives (**Edwin Abbott Abbott**, *Flatland: a romance of many dimensions*, 1884; **Ian Stewart**, *Flatterland*, 2001; **Dionys Burger**, *Sphereland: a fantasy about curved spaces and an expanding universe*, 1965; **A. K. Dewdney**, *The Planiverse*, 1984).

Many of the cognitive challenges are evident in the follow-up to *Alice in Wonderland* (1865) in which the Looking-glass world is set out like a giant chess board (Lewis Carroll, *Through the Looking-Glass, and What Alice Found There*, 1871). The characters represent chess pieces; Alice starts out as a pawn, and the action in the story emulates the moves of a real chess game.

Given the challenge framed by "getting into orbit" around the globe, how does a person achieve the psychological equivalent? Discussion of existence is notably reframed by the suggestion from physics that reality calls for explanation in terms of quantum mechanics, with implications for international relations as ably argued by **Alexander Wendt** (*Quantum Mind and Social Science: unifying physical and social ontology*, 2015). The cognitive flatland, into which people are increasingly **dumbed down**, might then be understood as a form of frozen reality -- a kind of cognitive **standing wave**.

Such a perspective frames globality in a totally radical manner, as explored separately (*Encountering Otherness as a Waveform -- in the light of a wave theory of being*, 2013; *Being a Waveform of Potential as an Experiential Choice: emergent dynamic qualities of identity and integrity*, 2013). From a "toroidal perspective", it might then be provocatively asked whether a "global life" worth living? (*Imagining Toroidal Life as a Sustainable Alternative: from globalization to toroidization or back to flatland?* 2019).

In the box: Use of the square metaphor, with its only too evident boundaries, offers one understanding of being trapped. The 3D analogue of a cube offers one sense of perspective on life "on the square" -- experienced as flatland. However the cube as a metaphor also offers the sense of being "boxed in", with a corresponding sense of claustrophobia. Both square and cube frame the aspiration to freedom, however that is to be understood in terms of escape or flight. The challenge is partially recognized through widespread reference to the requirement for **"out-of-the-box thinking"**.

The cognitive argument can be taken further by reference to the **knight's move in chess** -- and the *keima* in the Japanese equivalent to chess (*shogi*), or the *ma* in the Chinese equivalents of *xiangqi* and *janggi*. In each case a move passes through two squares in one direction across the board, followed by a shift to an orthogonal square. The move implies a degree of shift out of the plane of the square, offering a degree of overview. Ironically the sense in which this implies valuable "oversight" (as implemented in institutions) is curiously undermined by the alternative interpretation of negligence (regrettably evident in official capacities).

The movement of the knight has long been associated with creativity and strategic surprise (*Knight's move thinking: appreciated or deprecated*, 2012). Curiously, but most appropriate to this argument, "knight's move thinking" is defined by the medical profession as a **thought disorder** denoting a lack of connection between ideas, namely a loosening of associations.

Considered to be similar to derailment of thought, it is characterized by odd, tangential associations between ideas that lead to disruptions in the smooth continuity of speech. The association between ideas is interpreted to be illogical, notably wandering between various trains of thought. The Knight's move is then a metaphor for the unexpected, and illogical, connections between ideas. The illogicality of the loosening of associations, which is found in schizophrenia, is contrasted with the flight of ideas which characterises hypomania. "Knight's move thinking" therefore features in the early diagnosis of schizophrenia.

The knight is however part of the emblem for the **US Psyops** as a traditional symbol of **"special operations"** -- signifying the ability to influence all types of warfare. It featured as the name of a German military operation (*Operation Rösselsprung*) to kill or capture Josip Broz Tito at Drvar during World War II. With respect to business strategy, Richard Pech and Greg Stamboulidis make the point that:

Utilizing a chess metaphor, they each deployed a knight's-move strategy, leaping forward and sideways in a manner that has caught, and continues to catch their linear-thinking competitors by surprise. (*How strategies of deception facilitate business growth*, *Journal of Business Strategy*, 31, 2010, 6)

In a discussion of the current disruptive dynamics of global governance, termed "monkeying" for the purpose, a case was made for *Reframing "monkeying" in terms of Knight's move patterns* (2011). Both the creative and problematic implications of the argument are developed and illustrated separately (*Swastika as Dynamic Pattern Underlying Psychosocial Power Processes: implicate order of Knight's move game-playing sustaining creativity, exploitation and impunity*, 2012).

It is however the ancient Chinese game of *Go Weiqi*, otherwise known as Encirclement Chess, is suggestive of further clues to be derived from the geometry of the construction of the 2D Fibonacci spiral approximation. The successive squares in that construction, distinctively proportioned according to the golden ratio, embody an encircling process consistent with a 3-step pattern like that of the knight's move. Whether understood as achieving a kill (capturing some form of otherness), or achieving an insight ("capturing light"), it is the successful engagement with otherness (even closing a deal) which is highlighted.

The subtlety of the encircling process of go, in contrast to that of chess, is usefully highlighted by the analysis of the Vietnam War by *Scott Boorman* (*The Protracted Game: a wei-ch'i interpretation of Maoist revolutionary strategy*, 1971). Of relevance is the study by Li Ma (*Xiangqi vs Chess: the cultural differences reflected in Chinese and Western games*, *Open Journal of Social Science*, 9 March 2020).

Given the contrast between the 2D square and the 3D cube, the argument can be taken further in the light of the variants of *three-dimensional chess*. In that case any encircling engagement is understood in terms of:

- a rook moves through the six *faces* of a cube in any rank, file, or column.
- a bishop moves through the twelve *edges* of a cube.
- a knight makes a *leap* in 3D, comparable to one step as a rook followed by one step as a bishop, thereby enabling it to control 24 different cells from the centre of the game board.

Spiralling transition comprehended through metaphor

Highlighting the knight's move helps to make another point by recognizing that it is just one metaphor held to be indicative of the nature of a creative process. As such it is readily perceived as alienating, even mechanical by some, despite its conventionally acknowledged advantage in giving a degree of focus to strategic thinking.

The transition, whether out of the constraints of the square, or out of the box -- together with its spiralling nature -- is necessarily better framed by a set of complementary metaphors or images, each with their strengths and weaknesses (*Complementary Metaphors of Discourse: towards transformative conferencing and dialogue*, 1984).

A similar argument has been made with respect to the strategic response to the pandemic (*Alternating between Complementary Images of Coronavirus: requisite variety to enable viable strategic engagement*, 2020). The point can however be made more provocatively (*Complementary Bullfighting Metaphors of Global Governance: challenge of asymmetric engagement*, 2009). Given that none of the metaphor fully encompasses the truth of the matter, **it is appropriate to ask how disparate the metaphors need to be in such a set to constitute a requisite variety** -- in a cybernetic sense, with its strategic implications (*Global Coherence by Interrelating Disparate Strategic Patterns Dynamically*, 2019).

The metaphors might include the following, although any such set itself invites creative reframing:

1. *flight-related metaphors*, especially the sense of "taking off", "uplift" and "getting into orbit" (as cited in relation to careers and projects) -- exemplified by the contrast made between the symbolism of an eagle and that of a grounded turkey (*Counteracting Extremes Enabling Normal Flying: insights for global governance from birds on the wing and the dodo*, 2015; *Coordination of Wing Deployment and Folding in Politics: bird flight and landing as complementary metaphors of global strategic coherence*, 2018)
2. *staircase metaphors*, most notably those of spiralling (and counter-spiralling) forms, imaginatively comparable to the double helix, or more complex forms, as noted above (*Climbing Elven Stairways: DNA as a macroscopic metaphor of polarized psychodynamics*, 2007; *Walking Elven Pathways Enactivating the Pattern that Connects*, 2006)
3. *musical metaphors*, most obviously understood as an array of choirs or voices, as imagined in some religious perspectives of heaven, as poetically rendered by *Dante Alighieri* in the *Divine Comedy* -- describing a journey through *Hell (Inferno)*, *Purgatory (Purgatorio)*, and *Paradise (Paradiso)*. Of some relevance is the importance attached to the *Trisagion*, sung in perpetuity by the 12 *Song-Uttering Choirs of angels*.
4. *stages of self-reference*, with each stage challenging or questioning the articulation of the previous stage and providing a form of template for a subsequent stage
5. *mythical tales*, perhaps most notably embodied in the Persian poem of the *Conference of the Birds* in quest of the *Simurgh* as the potential ruler of their disparate natures. When the group of birds finally reach the dwelling place of the Simurgh, all they find is a lake in which they see their own reflection mirrored. The cognitive implications of such mirroring can be explored from a strategic perspective (*Stepping into, or through, the Mirror: embodying alternative scenario patterns*, 2008). The latter noted issues arising from cognitive "glass ceilings" and avoidance of self-reflexivity. The insights to be derived from mirroring can be presented in a more challenging manner (*Looking in the Mirror -- at Josef Fritzl ? Global conditions on reflection*, 2009).
6. *progressive approximation to closure* through a sequence of increasingly subtle agreements -- perhaps exemplified by protracted negotiation, deal-making, and *Getting to Yes: negotiating agreement without giving in* (1981)

7. **game-playing "levels"** are an ever increasing preoccupation in game-playing of all kinds, but most notably in online [video gaming](#) (requiring [level design](#)), preceded by their role in military and corporate [scenario gaming](#). As noted above, these may offer a sense of "rebirth" (*Varieties of Rebirth: distinguishing ways of being "born again"*, 2004). The 2D construction of the Fibonacci spiral lends itself to the distinction of games of increasing cognitive challenge, as discussed separately (*Tao of Engagement -- Weaponised Interactions and Beyond: Fibonacci's magic carpet of games to be played for sustainable global governance*, 2010). This invites other possibilities in a 3D context.
8. **knight's move**, as indicated above, notably with respect to three-dimensional chess, or its speculative higher dimensional variants
9. **lauburu**, as the 4-fold [Basque symbol](#) is a geometrical variant of the Swastika symbol offering other insights into the pattern of the knight's move. Especially intriguing is the manner in which this can be understood through an animation in 3D extending to 24 "voices" (*24-fold Pattern Implied by Dynamics of the Lauburu in 3D: visualization of the interplay of sets of voices in discourse*, 2016)
10. **cycles** are readily recognized as closely related to understandings of the cyclic repetition of the spiral form (*List of cycles*, *Wikipedia*). Of particular relevance is how the cyclic process is embodied cognitively and strategically, as argued separately (*Encycling Problematic Wickedness for Potential Humanity*, 2014). As indicated in the discussion of "encirclement chess", particular strategic importance is associated with [encirclement](#) in the interplay between opposing forces.
11. **whip dynamics** offer a surprising contrast to other metaphors, as exemplified by the sound made by a [stockwhip](#) through [whipcracking](#) in the process of herding livestock. The sound is produced when a section of the whip moves faster than the [speed of sound](#) creating a small [sonic boom](#). The metaphor is of particular interest in relation to social change given that the [Nautilus Institute for Security and Sustainability](#) reframed its understanding of the nautilus spiral form to encompass whip dynamics. With the challenge of the pandemic to the world population so recently reframed in terms of "[herd immunity](#)", it might be asked whether it is COVID-19 which could be understood as whipcracking by a metaphorical stockwhip -- or whether any global crisis is of that nature. Arguably this may be the preferred metaphor for leaders with a dictatorial bias.
12. **patterns of N-foldness**, through which society indicates preferences for various forms of order and the complexity calling for comprehension. This is exemplified by 30, as with the set of articles in the *Universal Declaration of Human Rights*. It is appropriate to note that the 30-edged icosahedron used for mapping that set is central to the cybernetic argument of Stafford Beer (*Beyond Dispute: the invention of team synteegrity*, 1994). Given that role, it is appropriate to note that the dihedral angle at 138.19 is a surprisingly close approximation to the golden angle of 137.5 -- with the icosahedron being unique among the Platonic solids in possessing a dihedral angle greater than 120. Curiously the "si" of Simurgh is indicative of the thirty-fold set of species represented in the *Conference of the Birds*, each reflective of an inhibiting human weakness -- with the potential irony of its occurrence in the title of the Papal Encyclical in response to climate change (*Laudato si'*, 2015). The latter features prominently in a recent study for the Club of Rome, as separately reviewed (*Exhortation to We the Peoples from the Club of Rome Review of "Come On! -- Capitalism, Short-termism, Population and the Destruction of the Planet"*, 2018).

Consistent with the last metaphor, a 12-fold set of disparate metaphors is presented above. This helps to focus the question of how many metaphors are required to render the strategic challenge comprehensible and under what circumstances -- in the light of the as yet unexplained preferences in practice for N-fold sets of particular scope (*Checklist of 12-fold Principles, Plans, Symbols and Concepts*, 2011; *Eliciting a 12-fold Pattern of Generic Operational Insights: Recognition of memory constraints on collective strategic comprehension*, 2011). Other preferences include a 20-fold pattern (*Requisite 20-fold Articulation of Operative Insights? Checklist of web resources on 20 strategies, rules, methods and insights*, 2018).

In constructing an approximation to the Fibonacci spiral in 3D (in the exercise above), the curve was framed by a stack of 12 cubes. One representation of the levels of spiral dynamics distinguishes 12 such levels by 12 colours -- indicative of a progression of insight and an implication of higher degrees of integrity. As suggested above with respect to distinctive "voices", these can of course be understood in mythical terms as the requisite number of distinctive "angelic" voices -- or even as [Stations of the Cross](#), variously distinguished in Christianity as numbering up to 14.

As with the tuning systems of music, it is however characteristic of the dynamic that there are strong differences of opinion on the number of levels and colours preferred in interpretations of psychosocial spirals -- most obviously between an 8-fold pattern and a 12-fold pattern (Frank Visser, *A More Adequate Spectrum of Colors: a comparison of color terminology in Integral Theory, Spiral Dynamics and Chakra-Psychology*, *Integral World*).

As implied by the conclusion of the *Conference of the Birds*, part of the challenge with any such set is to reframe any elitist sense of a progression "upwards" or "inwards" which has the effect of engendering alternative perspectives "left behind" or otherwise "remaindered" (*Reintegration of a Remaindered World: cognitive recycling of objects of systemic neglect*, 2011). As noted above by citing the poem of T. S. Eliot, it is a case of arriving "where we started" -- in order to "know the place for the first time".

The set of metaphors could then be reframed to ensure that any spiralling transition recovers or revisits the point of departure -- as featured in myths of [eternal return](#). In geometric terms, use can be made of helicoidal spirals (*Psychosocial Learnings from the Spiral Form of Hurricanes: implications of the triple helix and the 3-fold triskelion as "cognitive cyclones"?* 2017; *Framing Cyclic Revolutionary Emergence of Opposing Symbols of Identity: biomimetic embedding of N-tuple helices in spherical polyhedra*, 2017; *Visualization in 3D of Dynamics of Toroidal Helical Coils*, 2016).

Challenge of "growth": In the case of plants, phyllotaxis is intimately related to growth. Any presentation of the Fibonacci spiral, as an indication of growth through some form of "psychosocial phyllotaxis", calls for some kind of reconciliation between exponential -- if not unending -- growth. The problematic nature of such understanding is only too evident in criticism of unconstrained economic growth and the commitment to its future enhancement.

Of interest with respect to the spiral form depicted in 3D is the implication that this might more fruitfully be understood as intensive rather than extensive. This would be consistent with insights regarding its higher dimensionality as explored by physicists in terms of compactification, or the understanding of [implication in contrast to explication](#), as articulated by [David Bohm](#) (*Wholeness and the Implicate Order*, 1980).

Implication in multiple spirals – spiral complementarity

Helical models of innovation: As noted above, the [triple helix model of innovation](#) has been inspired by the structure of DNA. Studies have already noted the organizing role of the golden ratio in the cross-section of the helical pattern of DNA. Current enthusiasm for the triple helix model derives from its intertwining of the roles of academia, government and business in the innovation process.

Given the constraints on innovation highlighted above with respect to competitive patent production, it might be expected that some consideration would be given to some analogue to phyllotaxis governed by a Fibonacci pattern. Whilst this does not yet seem to be the case, it is noteworthy that the [Triple Helix Chapter](#) of the University of Chicago enabled publication of a study which highlights the Fibonacci pattern (Beamlak Lefebo, *Order in Chaos: mathematical models of social animal interactions*, *The Spectrum*, October 2018).

The triple helix model has now been extended to [quadruple and quintuple innovation helix frameworks](#). The main constituent element of the helical system is knowledge, which, through a circulation between societal subsystems, changes to innovation and know-how in a knowledge society and for the knowledge economy. The quintuple helix visualizes the collective interaction and exchange of this knowledge in a state by means of five helical subsystems: education, economy, natural environment, media-culture-based public, and the political system.

Pineapple model of governance? A contrasting approach to configuration in governance is currently a focus of the so-called [doughnut model](#) (Kate Raworth, *Doughnut Economics: Seven Ways to Think Like a 21st-Century Economist*, 2017), as discussed separately ([Relevance of doughnut model to a pandemic?](#) 2020).

The doughnut-like area is defined by combining the much-debated set of 9 "planetary boundaries" (*Planetary Boundaries: exploring the safe operating space for humanity*, 2009) with a new set of 11 social boundaries, based on the 11 dimensions of human deprivation that emerged from the issues raised by governments in their Rio+20 submissions, as separately discussed ([Recognizing the Psychosocial Boundaries of Remedial Action: constraints on ensuring a safe operating space for humanity](#), 2009; [Exploring the Hidden Mysteries of Oxfam's Doughnut: recognizing the systemic negligence of an Earth Summit](#), 2012).

As discussed separately, the relatively simple geometry of a doughnut can be contrasted with a "pineapple model" -- as the basis for communicable insight into future "global" organization ([Pineapple model of global governance?](#) 2020). Whilst many may indeed be inspired by the doughnut, many more are likely to be familiar with a [pineapple](#). As succinctly stated by artist David D'Ostilio:

Pineapples are mathematical objects that occur in nature. Their growth is dictated by the fibonacci sequence in multiple ways. Fibonacci numbers dictate the number of spirals that appear on the skin of the fruit. There are 8 spirals in one direction, 13 spirals in the opposite direction, and 21 spirals vertically. Each of these numbers appear chronologically in the fibonacci sequence. This pattern of growth determines the iconic diamond pattern found on the pineapple ([Sacred Growth, Fruiting Column: Fibonacci Pineapple](#), 2015).

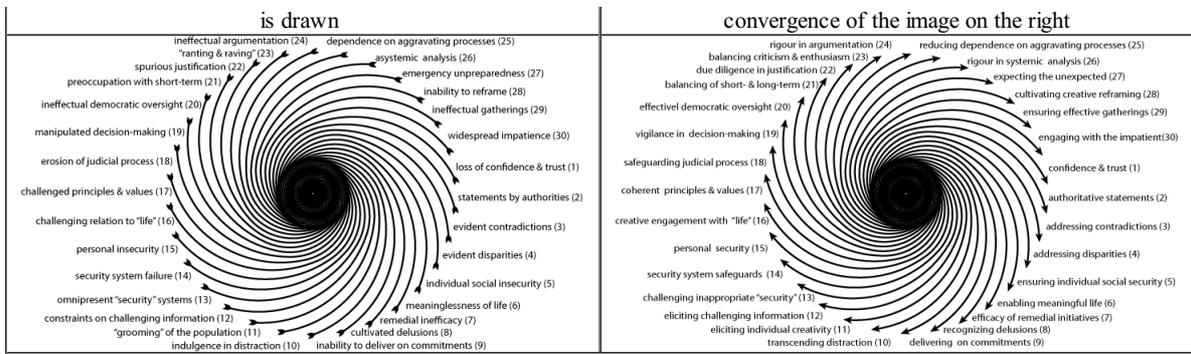
Intriguingly the pineapple embodies a degree of complexity consistent with the argument above and its animations. Curiously the pineapple potentially offers a very fruitful 3D articulation of the Triple Helix model -- one seemingly as yet to be explored.

With respect to phyllotactic organization, there are various more extensive comments of potential relevance to the future elaboration of any pineapple model of governance (Philip Ondedonk, *Pineapples and Fibonacci Numbers*, *The Fibonacci Quarterly*, 1970; Judithlynnne Carson, *Fibonacci Numbers and Pineapple Phyllotaxy*, *The Two-Year College Mathematics Journal*, 9, 1978, 3; John McCullagh, *Fibonacci Numbers in Pineapples*, *Newry Journal*, 30 November, 2007) with the latter offering very clear illustrations of the helical patterns. Especially relevant to psychosocial organization is the "work in progress" of [Vlado Dimovski](#) and Miha Uhan (*Management from a Natural Perspective: discovering the meaning of Fibonacci numbers for management*, University of Ljubljana).

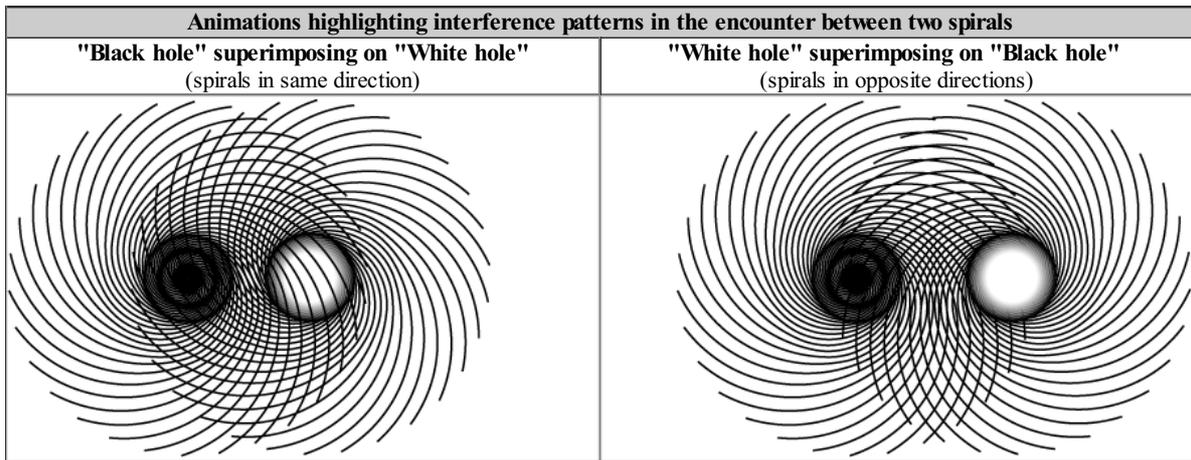
The insights relating the Fibonacci patterning of natural order to that of the pineapple, and to the implications for governance, are primarily allusive, if not particularly elusive. A valuable clue is however offered by the various procedures for the geometrical transformation of polyhedra. These notably include truncation, stellation, dualization, compounding, and zonohedrification. Giving rise to [zonohedra](#), the latter is of particular relevance to any formal modelling of the pineapple, as variously presented by George W. Hart (*Zonohedrification*, *The Mathematica Journal*, 7, 1999, 3; *Zonohedrification*). Such possibilities are discussed separately ([Formalizing a pineapple model of governance through zonagons and zonohedrification?](#) 2020).

Interweaving enabling and disabling trends: Such trends can be usefully represented in spiral form, as discussed separately and reproduced below ([Interweaving "cyclones" and "anti-cyclones" in a global system](#), 2012)

Representation of mutual reinforcement of systems of global trends	
System of 30 disabling global trends engendering together a hurricane-like vortex into which society	System of 30 enabling global trends engendering together an escape from the problematic



Of obvious interest is any representation of the interference of such trends in a psychosocial system, as indicated below.



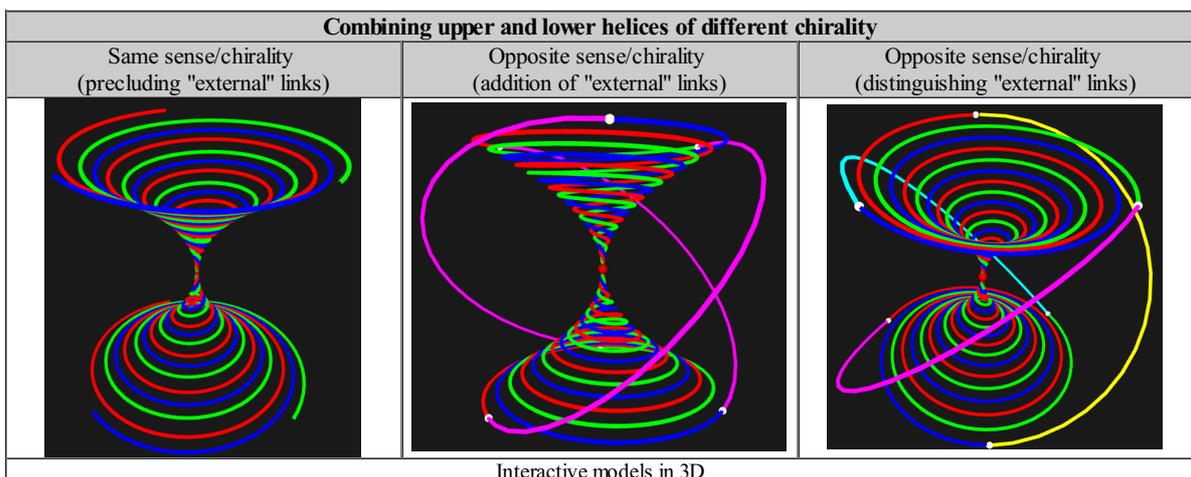
Multi-spiral orientation and directionality: The alternative interpretations of spirals in the light of their orientation and directionality suggest that some attention should be given to more complex configurations.

Not only is it possible for progression of awareness to be associated with travel "upward" in an expanding spiral, it may also be associated with travel "downward" in a contracting spiral. Similarly progression of awareness may be associated with travel "downward" in an expanding spiral, as well as being associated with travel "upward" in a contracting spiral.

How, and under what circumstances, such displacement of perspective is to be recognized remains to be determined. Such complementarity suggests the need to explore the integration of such seemingly contrasting trends -- epitomised by the distinction between "enlightenment" and "endarkenment", as discussed separately (*Designing Global Self-governance for the Future: patterns of dynamic integration of the netherworld*, 2010). This endeavours to relate the Fibonacci spiral to the Euler spiral (spiro, clothoid or Cornu spiral), namely a double spiral, widely used as transition curves in railroad/highway engineering for connecting and transiting the geometry between a tangent and a circular curve.

The question is relevant to the various references to the circulation of the light (*Circulation of the Light: essential metaphor of global sustainability?* 2010). However, rather than "what circulates" in some cyclic sense, the question might be better formulated as "what spirals" -- namely a "spiralling of the light".

Interweaving complementary spirals in 3D: Possibilities of visualizing such interweaving are discussed separately, as illustrated below (*Psychosocial Learnings from the Spiral Form of Hurricanes: implications of the triple helix and the 3-fold triskelion as "cognitive cyclones"?* 2007).



The representations above can be developed further, as discussed and illustrated separately (*Framing Cyclic Revolutionary Emergence of Opposing Symbols of Identity: biomimetic embedding of N-tuple helices in spherical polyhedra*, 2017):

- [Embedding the triple helix in a spherical octahedron](#)
- [Embedding the quadruple helix in a spherical cube](#)
- [Embedding the quintuple helix in a spherical dodecahedron and a Pentagramma Mirificum](#)
- [Embedding six-fold, eight-fold and ten-fold helices in appropriately encircled polyhedra](#)
- [Embedding twelve-fold, eleven-fold, nine-fold and seven-fold helices in appropriately encircled polyhedra](#)

Comprehensibility and appreciation of psychosocial phyllotaxis in governance

The future may see as extraordinary the lack of attention to the comprehensibility and appreciation of the patterns through which society is purportedly governed. The many socio-economic and political models, especially those enhanced by mathematical insights into complexity, could be said to be totally indifferent to their comprehensibility and attraction. This is all the more remarkable in that it is a primary preoccupation of flowers and other features of plants -- for reasons intimately related to their own survival.

Flowers are indeed widely appreciated for the aesthetic elegance of their abilities in this regard -- to the point of featuring in displays at receptions hosted by the governors, and by symbolic gifts to leadership. They also feature in the commemoration of the tragedies resulting from the failures of governance (Ann Elias, *War and the Visual Language of Flowers*, *War, Literature and the Arts*, 20, 2008, 1-2). They may well feature in the executive offices of institutions -- potentially consistent with the principles of *ikebana* and their fundamental relationship to *bushido*.

There is a long tradition of "saying it with flowers", as articulated through the [language of flowers](#) (or floriography), namely communication through the use and arrangement of flowers. In Japanese, as *hanakotoba*, that language is used to communicate directly to the recipient or viewer without needing the use of words. There is a charming irony to the possibility that **more appropriate forms of governance may be rendered comprehensible through floral forms**.

The opportunity can be explored speculatively (*Aesthetics of Governance in the Year 2490*, 1990). It can be framed in terms of music and song as being more widely appreciated than the current preferences in governance for text (*A Singable Earth Charter, EU Constitution or Global Ethic?* 2006). The question in the light of the argument above is whether the geometrical abstractions so fundamental to phyllotaxis can borrow from the evolutionary experience of nature in order to enhance the appreciation and efficacy of governance -- and the "flowering of civilization". The design insights remarkably offered in this respect by [Keith Critchlow](#) are especially relevant (*The Hidden Geometry of Flowers: living rhythms, form and number*, 2011).

Critchlow notes with respect to *Photosynthesis: what exactly is it?*:

Photosynthesis is surely as fine a metaphor for 'the bringing down of light' as any within our human comprehension. That we take this miracle for granted is a reflection of the attitude that pervades the modern world, and that encourages us to take life itself for granted, and in doing so we lose all reverence and respect for it. This constant flow of light into lower workable forms of energy is essential to life... from subtlety to grossness, we find that light is, both metaphorically and factually, the most subtle and the finest, and that it is essentially the source of all 'thingness' in the material domain when defined as energy... Thus, if we may be permitted, light is inspiration itself. (p. 373)

With respect to *Phyllotaxis or the display of leaves on their parent stem*, Critchlow notes:

Leaves display a remarkable number of choices as to how they orient themselves. Naturally the primary motivation is to receive as much light as possible yet to avoid interfering with the light needs of the neighbouring leaves. (p. 377)

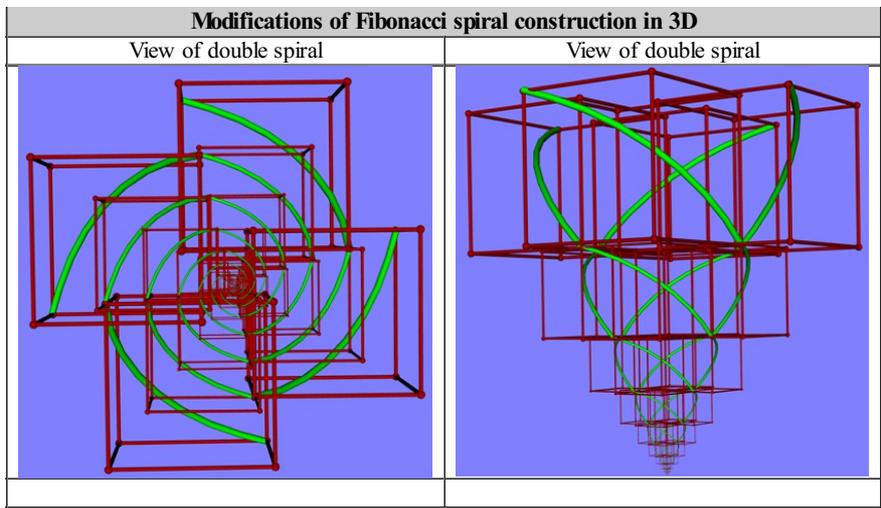
The argument is otherwise developed by [Jozef Keulartz](#) (*Using Metaphors in Restoring Nature*, *Nature and Culture*, 2, 2007, 1). The challenge is the "translation" of such insights into the language of psychodynamics and governance. From a [general systems](#) perspective, a valuable provocation would be the transformation of Critchlow's magnum opus (by simple "cut and paste") into any of the following:

- *The Hidden Geometry of Governance: living rhythms, form and number*
- *The Hidden Geometry of Organizations: living rhythms, form and number*
- *The Hidden Geometry of Projects: living rhythms, form and number*

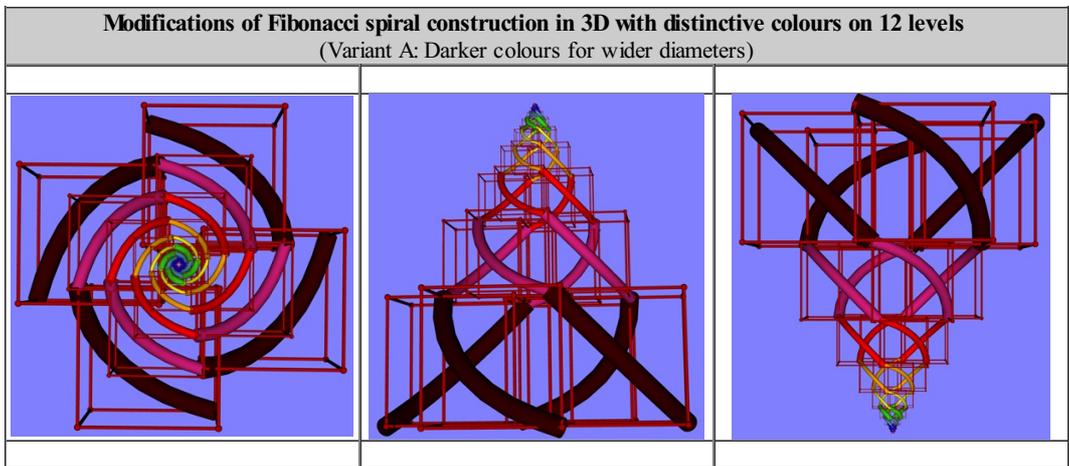
The experimental construction above of a 3D approximation to the Fibonacci spiral and the golden spiral could be used as a framework to articulate the various allusive references to spiral as it may be of relevance to psychosocial dynamics -- and their possible spiritual interpretations. It is however intriguing to note that the effort to do so meaningfully is subject to technical and other constraints -- analogous to the challenge of rendering any abstract model comprehensible. Again there is the question of how flowers render themselves attractive when institutions are so singularly inadequate in this respect.

Various modifications of the model 3D model above can be explored below -- lending themselves to contrasting interpretations. Reflection of the single spiral into a double spiral form invites questions as to the nature of the complementarity of the two spirals. They could be distinctively coloured, with one framing a rising flow and the other a falling flow.

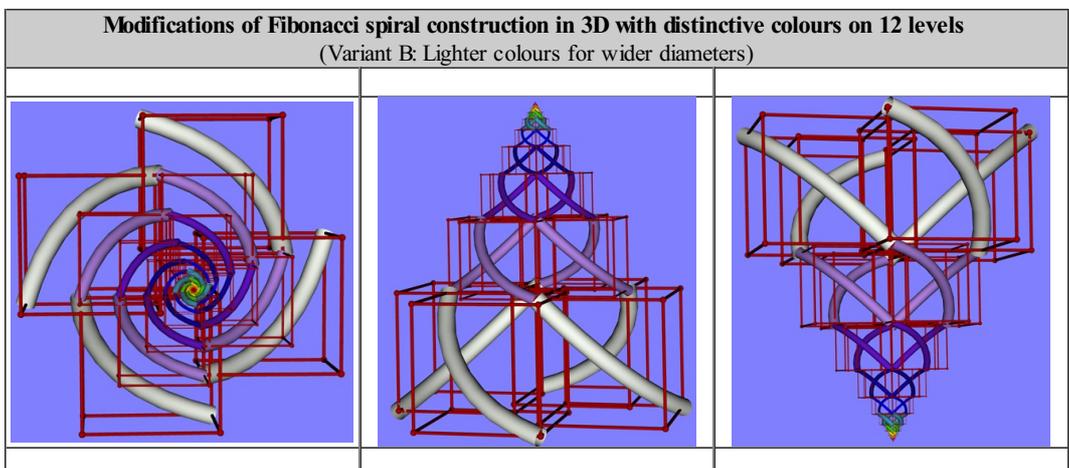
As noted above, segments of the spiral could be scaled to smooth the connections at the junction points. Optionally the framing cubes could be rendered transparent to different degrees at different stages -- or simply removed.



Of potential interest is the number of "levels", "phases" or "stages" to the spiral construction and how these are distinguished by colour (if not by transparency). Reference was made above to the careful comparison between contrasting conventions in the light of different models of psychosocial development (Frank Visser, *A More Adequate Spectrum of Colors: a comparison of color terminology in Integral Theory, Spiral Dynamics and Chakra-Psychology, Integral World*). In the following modifications use was made of the compromise revision proposed by the author for 12 distinctively coloured stages. It is however appropriate to note that the representation of the colours in the models may not correspond to the recommendations for technical reasons (requiring further attention).



In the variant above it is assumed that the lighter colours are associated with the most compact turns of the spiral. When these are presented at the "top" of the spiral, this lends itself to the interpretation of progress from the darker turns at the "bottom" -- according to one common understanding of progress. When reversed, the lighter turns could be interpreted as corresponding to a compactification and intensification of awareness. Such differences can be explored from a wider perspective (*Unquestioned Bias in Governance from Direction of Reading? Political implications of reading from left-to-right, right-to-left, or top-down*, 2016).



In the variant above it is assumed that the lighter colours are associated with the widest turns of the spiral. When these are presented at the "top" of the spiral, this lends itself to the interpretation of progress from the darker turns at the "bottom" -- according to one common

understanding of progress. When reversed, this lends itself to the interpretation of progress from the constraints of the more limited darker turns at the "bottom".

In the light of the introductory comments, the variants and their possible interpretations are a challenge to understanding any "spiral of depression", the "death spiral" of civilization, or the "spiral of silence" (*Civilization as a Global Configuration of Silences: recognizing silence of a higher order*, 2013).

[The argument is developed further in terms of the value of *zome* configuration of virtual meetings (*From Zoom Organization to Zome Configuration and Dynamics Integrating the doughnut, helix and pineapple models towards global strategic coherence*, 2020)]

References

J. Adam. Mathematics in Nature: modeling patterns in the natural world. Princeton University Press, 2006

Irving Adler. Solving the Riddle of Phyllotaxis: why the Fibonacci Numbers and the Golden Ratio occur in plants. World Scientific, 2012 [[commentary](#)]

Abraham Ajith, Grosan Crina and Ramos Vitorino (Eds.). Stigmergic Optimization. Springer, 2006 [[contents](#)]

Silvano Arieti. Creativity: the magical synthesis. Basic Books, 1976

Karen Armstrong The Spiral Staircase: my climb out of darkness. Random House, 2005

Don Edward Beck and Christopher C. Cowan. Spiral Dynamics: mastering values, leadership and change. Wiley–Blackwell, 1996

Don Edward Beck, Teddy Hebo Larsen, et al. Spiral Dynamics in Action: humanity's master code. Wiley, 2018

Stafford Beer:

- Platform for Change. Wiley, 1978
- Beyond Dispute: the invention of team synteegrity. Wiley, 1994

David Bohm. Wholeness and the Implicate Order. Routledge, 1980

Scott Boorman. The Protracted Game: a wei-ch'i interpretation of Maoist revolutionary strategy. Oxford University Press, 1971

Sayfan G. Borghini. Stigmergy in the Design of Social Environments. *The European Physical Journal Special Topics*, 2016 [[abstract](#)]

David Bowles. Flower, Song, Dance: Aztec and Mayan Poetry. Lamar University Press, 2013 [[commentary](#)]

Nick Cater and Brendan O'Neill. The Age of Endarkenment. Centre for Independent Studies, 2014, Occasional paper 137 [[text](#)]

Alain Corbin. History of Silence: de la Renaissance à nos jours. Polity, 2018

Keith Critchlow:

- The Hidden Geometry of Flowers: living rhythms, form and number. Floris Books, 2011
- The Mystery of Flowers: the sacred geometry of plants. *Resurgence*, 272, May/June 2012
- The Golden Meaning: An Introduction. Kairos Publications, 2014

Michael Docherty, et al. General Theory of Stigmergy: modelling stigma semantics. *Cognitive Systems Research*, 2014 [[abstract](#)]

Gyorgy Doczi. The Power of Limits: proportional harmonies in nature, art, and architecture. Random House, 1981

Margery J. Doyle and Leslie Marsh. Stigmergy in the Human Domain. *Cognitive Systems Research*, 2013

Manfred Eigen and Ruthild Winkler. Laws of the Game: how the principles of nature govern chance. Random House, 1981

Thierry Gaudin. L'écoute des silences: les institutions contre l'innovation. Union générale d'Éditions, 1978 [[contents](#)]

B. Ghiselin (Ed.). The Creative Process. University of California Press, 1952

Matila Ghyka. The Geometry of Art and Life. Dover Publications, 1977

Jay Hambidge. The Elements of Dynamic Symmetry. Dover, 1967

Francis Heylighen:

- Stigmergy as a Universal Coordination Mechanism: definition and components. *Cognitive Systems Research*, 2015 [[abstract](#)]
- Stigmergy as a generic mechanism for coordination: definition, varieties and aspects. 2011 [[abstract](#)]

Douglas Hofstadter:

- I Am a Strange Loop. Basic Books, 2007 [[summary](#)]
- Gödel, Escher, Bach: an Eternal Golden Braid. Basic Books, 1979 [[summary](#)]

Douglas Hofstadter and Emmanuel Sander. Surfaces and Essences: analogy as the fuel and fire of thinking. Basic Books, 2013

Thomas Homer-Dixon:

- Commanding Hope: the power we have to renew a world in peril. Knopf, 2020.

- The Upside of Down: catastrophe, creativity, and the renewal of civilization. Knopf, 2006
- The Ingenuity Gap. Knopf, 2000.

Arthur Koestler. The Act of Creation. Hutchinson, 1964 [[summary](#)]

Heather Marsh:

- Binding Chaos: mass collaboration on a global scale. CreateSpace Independent Publishing Platform, 2013
- The Creation of Me, Them and Us. CreateSpace Independent Publishing Platform, 2020

Leslie Marsh and Christian Onof. Stigmergic epistemology, stigmergic cognition. *Cognitive Systems Research* 2008 [[abstract](#)]

Leslie Marsh and Margery J. Doyle. Stigmergy 3.0: from ants to economies. *Cognitive Systems Research*, 2013 [[abstract](#)]

G. H. Mitchison. Phyllotaxis and the Fibonacci series. *Science*, 196, 1977.

Scott Olsen. The Golden Section: nature's greatest secret. Bloomsbury, 2006

Michael S. Schneider. A Beginner's Guide to Constructing the Universe: mathematical archetypes of nature, art, and science. HarperPerennial, 1995

Ian Stewart. Flatterland. Perseus, 2001

D'Arcy Wentworth Thompson. On Growth and Form. Cambridge University Press, 1917

Marie-Louise Von Franz. Number and Time: reflections leading toward a unification of depth psychology and physics. Northwestern University Press, 1974

R. W. Weisberg. Creativity: Beyond the Myth of Genius. W. H. Freeman, 1993.



This work is licensed under a [Creative Commons Attribution-NonCommercial 4.0 International License](#).

For further updates on this site, [subscribe here](#)