



laetus in praesens

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Psychosocial Learnings from the Spiral Form of Hurricanes

Implications of the triple helix and the 3-fold triskelion as "cognitive cyclones"?

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Posted on the occasion of the first detection of gravity waves consequent on the coalescence of spiralling black holes -- and the award of the Nobel Prize to physicists associated with that discovery

(see further development in: *Framing Cyclic Revolutionary Emergence of Opposing Symbols of Identity: Eppur si muove -- Biomimetic embedding of N-tuple helices in spherical polyhedra*, 2017)

Introduction

The potential value at this time of transforming traditional 2D symbols into 3D can be fruitfully explored (*Cognitive Implications in 3D of Triadic Symbols Valued in 2D: representations of the triskelion in virtual reality and implications for quantum consciousness*, 2017).

Composed as it is of three interweaving [Archimedean spirals](#), the [triskelion](#) (triskele) could well be recognized as topologically equivalent to a triple helix. That argument noted the widespread interest in the [Triple Helix model](#) and the pattern of international conferences of the [Triple Helix Association](#) since 1996. These seek to promote all aspects of the interaction between academy-industry-government in fostering research, innovation, economic competitiveness and growth.

As described by the Triple Helix Research Group of Stanford University, the Triple Helix thesis is that the potential for innovation and economic development in a knowledge society lies in a more prominent role for the university and in the hybridisation of elements from university, industry and government to generate new institutional and social formats for the production, transfer and application of knowledge. (*The Triple Helix Concept; publications*). The approach is being extended to a Quadruple Helix on the understanding that sustainable development of a knowledge economy requires coevolution with the knowledge society. A further extension has been proposed to a Quintuple Helix model seen to be of relevance to the challenge of global warming.

In highlighting the importance of triadic thinking, the earlier paper implied a degree of topological equivalence between the triskelion and the triple helix as a consequence of transformation in 3D. Various forms of the triskelion pattern have been valued as of fundamental significance over millennia. However there appears to be little recognition of the psychosocial implications of any triple helix, other than as a particular form of innovation remarkably distinct from that associated with [social revolutions](#) and [paradigm shifts](#) -- perhaps readily described as "cognitive cyclones". It is in this sense that a degree of equivalence can be recognized with the spiral form of powerful hurricanes -- understood in cognitive terms as inexorable "[winds of change](#)".

Such an association can be recognized in the light of the disruptive impact of the recent succession of hurricanes ([Harvey](#), [Irma](#), [Maria](#)) which have called into question the assumptions of human dominance over nature in the face of climate change. As a "wind of change" in his own right, these have inspired reference by commentators to President Trump as "Hurricane Trump" (*Hurricane Trump*, *The New York Times*, 23 September 2017; *Dealing With Hurricane Trump*, *Politico Magazine*, 4 September 2017; *Hurricane Trump makes landfall in Manhattan*, *The Japan Times*, 20 September 2017; *Hurricane Trump and America's Road to Nowhere: how did we get here?* *Salon*, 2 September 2017; *The Destruction Left By Hurricane Trump*, *OurFuture.org*, 29 August 2017 *The Daily 202: Is Hurricane Trump a Category One, a Category Five or something in between?* *The Washington Post*, 11 October 2016).

Much is known about the structure and dynamics of [hurricanes](#). Much is also known about the [helical structure of DNA](#) and of [spirals](#) in general. The question is how such insight might be related to the intuited significance of the triadic triskelion and how it might be employed to enrich the very particular institutional preoccupations promoted under the banner of the Triple Helix model and its extensions. The relevance of the latter to the radical nature of current global challenges would seem to be somewhat questionable -- despite the claimed potential.

Whilst the symbolic significance of the triskelion is elusive (however enduring), the current institutional concern with the Triple Helix (whatever its potential) does not seem to reflect the complexity and fundamental role of DNA -- whether double-stranded or triple-stranded. Neither would seem to be offering the power so obviously evident in hurricanes. The psychosocial difficulties are evident in the manner in which widespread [binary thinking](#) undermines all too readily most current efforts towards fruitful triadic thinking -- especially in a surreal context characterized by fake news of every kind. The verbal exchanges between Donald Trump and [Kim Jong-un](#) regarding North Korea are but one dramatic example, with those between [Alt-Right](#) and [Alt-Left](#) in the USA offering another. Both risk engendering violence.

In the language of cybernetics and control systems, is this a case for recognizing the need for [requisite complexity](#) appropriate to global governance challenged by a variety of "cognitive vortices"? These call into question the rational modalities of the linear thinking on which viable uptake of innovative models is unfortunately so dependent.

Achieving perspective on a vortex through triadic framing

Vortices: Society is variously characterized by vortices into which attention is drawn -- if not "sucked", as into a whirlpool. Such vortices are evident in the preoccupations of different schools of thought, belief systems, and movements of opinion. Their operation has been rendered evident by recognition of the problematic roles of "[spin](#)", [viral marketing](#), and "[fake news](#)" in absorbing attention.

The possibility of being drawn into such a vortex is a feature of the interest by the social sciences in [gravity models](#). It is through this understanding of catchment areas that marketing locates consumer facilities (shopping malls, entertainment complexes, etc). These usefully give focus to a desired outcome of the process, namely a profitable sale or pleasurable experience, or some form of conversion through a "cognitive wormhole" offering access to another "universe" in metaphorical terms (Hayo Siemsen, *Conceptual Adaptation: Bridging Spatial and Temporal Relations by Cognitive Wormholes*, 2009; William H. Warren, et al, *Wormholes in Virtual Space: from cognitive maps to cognitive graphs*, *Cognition*, 166, 2017). More extension use is variously made of the phrase "psychological wormholes". Current competition between such vortices can be explored in terms of the attention economy, as separately discussed (*Investing Attention Essential to Viable Growth*, 2014).

People are typically faced with the challenging experience of navigating between such attractors -- without necessarily being sucked in. Those associated with attractors are under ever increasing pressure to offer ever greater power to their particular vortex through what is offered by entering it.

Triadic framing of a vortex: In contrast with the well-recognized dynamics of any binary framing, the simplest framing of a vortex is by a triad. As minimal vortices, there is a case for recognizing the cognitive dynamics associated with the many triads which have variously been considered fundamental. As noted in the previous paper, although seemingly of limited value in reframing conflictual relationships in practice, these include analytical models offering explanatory capacity:

- **Dialectical method:** Recognized in terms of "[thesis](#), [antithesis](#), [synthesis](#)" as originated by [Georg Hegel](#), this ideal has proven to be of limited relevance to psycho-social domains in which "synthesis" is desperately required in practice.
- **Semiotic triangle of meaning** of [Charles Ogden](#),
- **Oedipus complex** as articulated in the triangulation of [Jacques Lacan](#),
- **Phenomenological epoché** of [Francisco Varela](#)
- **Beck's cognitive triad** of negative thought present in depression
- **MacDonald triad** of sociopathic infantile traits for anti-social personality disorder
- Classification of **triadic signs** by [Charles Peirce](#) into universal **trichotomies** as building blocks in an inference process:
 - by what stands as the sign
 - *qualisign* (also called a *tone*) a quality
 - *sinsign* (also called *token*) an individual fact
 - *legisign* (also called *type*) a rule, a habit;
 - by how the sign stands for its object
 - *icon*: by its own quality, such that it resembles the object, regardless of factual connection and of interpretive rule of reference
 - *index*: by factual connection to its object, regardless of resemblance and of interpretive rule of reference
 - *symbol*: by rule or habit of interpreted reference to its object, regardless of resemblance and of factual connection
 - by how the sign stands for its object to its interpretant
 - *rheme* (also called *seme*, such as a term) as regards quality or possibility, as if the sign were a qualisign, though it can be qualisign, sinsign, or legisign
 - *dicisign* (also called *pheme*, such as a proposition) as regards fact, as if the sign were an index, though it can be index or symbol
 - *argument* (also called *delome*) as regards rule or habit.
- **Social threefolding**, namely the sociological theory, first proposed by [Rudolf Steiner](#), suggesting the progressive independence of society's economic, political and cultural institutions -- currently promoted by the [Global Network for Social Threefolding](#).

Such patterns are evident more generally in:

- Three-fold patterns of divinity: Seemingly, whatever the religion, any fundamental trinity (or [triple deity](#)) is claimed to be comprehended by the priesthoods as explicated definitively in learned texts. Ultimately the relationship is typically held to be a "mystery" beyond ordinary comprehension, as with the [Christian Trinity](#). However any such acknowledgement of subtlety has seemingly not informed the challenges of those religions in engaging with others.
- Abrahamic religions: There is clearly little comprehension of the relationship between the three primary [Abrahamic religions](#) of any relevance to reframing fruitfully the conflicts they reinforce and in which they have engaged over centuries. These are clearly fundamental to global dynamics at this time. Islam considers any trinitarian relationship to be blasphemous. The monotheism of Judaism excludes the possibility of any trinity.
- Eternal triangle: On a personal level, experience of the "[eternal triangle](#)", which is such a challenge to the binary ideal of family life, remains beyond fruitful comprehension by those involved and affected. It is typically a source of great existential suffering and tragedy.
- Information security: Core principles of [information security](#) -- confidentiality, integrity and availability -- otherwise known as the [CIA triad](#).

Dynamics of desperation and depression? Arguably the naming of such triads has not yet contributed sufficiently to recognition of the cognitive and experiential dynamics which they are claimed to frame. It is perhaps the greatest of ironies that the increasingly preoccupying phenomenon of individual [psychological depression](#) is recognized with the same term as that of the [meteorological depression](#) associated with hurricane formation on a global scale. Each could potentially offer insights into the other, especially with respect to depression experienced by populations globally in the face of current crises (*Implication of Personal Despair in Planetary Despair: avoiding entrapment in hopeful anticipation*, 2010).

As argued there, much is increasingly made of the worldwide incidence of depression, otherwise known as clinical depression. This is recognized as characterized by an all-encompassing low mood accompanied by low self-esteem, disturbed sleep or appetite, poor concentration, and loss of interest or pleasure in normally enjoyable activities. At its worst, depression can lead to suicide, a tragic fatality associated with the loss of about 850,000 lives every year, according to the [description](#) of the World Health Organisation.

This disorder is distinguished from [mood depression](#), namely a state of low mood and aversion to activity, involving experience of feelings of sadness, helplessness and hopelessness. In the USA, for example, in a year between 13-14 million people experience a depressive disorder [see [depression statistics](#)]. Depression is the leading cause of disability and the 4th leading contributor to the global burden of disease (DALYs) in 2000. By the year 2020, depression is projected to reach 2nd place of the ranking of DALYs calculated for all ages, both sexes. Depression is already the 2nd cause of DALYs in the age category 15-44 years for both sexes combined.

Arguably "despair" is a characteristic of both the clinical and mood varieties of depression. Reference is readily made to the experience of being "in a spin" or to the "spin cycle" of depression or other desperate conditions (*Avoid the S.P.I.N. Cycle of ADHD; Bipolar Disorder: surviving the spin cycle; The Spin Cycle: recovering, relapsing, recovering*).

It can be readily argued that "Hurricane Trump" was engendered by the collective despair of many Americans (*Trump won places drowning in despair -- can he save them? WTOP*, 21 August 2017; *The Opioid Election: how Trump won regions of despair, The Fix*, 30 April 2017; *A Pennsylvania Town in Decline and Despair Looks to Donald Trump, The New York Times*, 9 November 2016; *Trump is Attuned to Zeitgeist of Darkness and Despair, Daily Kos*, 20 January 2017). The mystery of how this came about is another matter, as queried by [James Fallows](#):

Yet Donald Trump has won. How could his message of despair and anger about the American prospect, and disrespect for the norms that made us great, have prevailed in a nation that still believes in itself at the local level? How can Americans have remained so confident and practical-minded in their daily civic dealings, and so suspicious, fearful, and tribally resentful about the nation as a whole? (*Despair and Hope in Trump's America, The Atlantic*, January/February 2017)

Such despair by the desperate has since been curiously matched to an unusual degree by that experienced in the USA in reaction to the election of Donald Trump (*Americans who voted against Trump are feeling unprecedented dread and despair, Los Angeles Times*, 21 December 2016; *Despair and introspection on U.S. coasts after Trump win, Reuters*, 9 November 2016; March 30, 2017; *Enough of Russia! There's an Epidemic of Despair in the US, Counterpunch*, 30 March 2017; *Why The Left Will Never Stop Despairing Over Trump, The Federalist*, 1 February 2017).

Global perspective on the system of cognitive vortices: The challenging cognitive nature of such "cyclonic dynamics" can be rendered more explicit through a triangular pattern basic to the mathematical argument of [q-analysis](#), as developed by Ron Atkin (*Multidimensional Man; can man live in 3-dimensional space?*, 1981). As separately summarized (*Comprehension: Social organization determined by incommunicability of insights*), Atkin illustrates the challenge of comprehension in relation to experience "within" the geometry of a triangle -- especially with regard to the perspective necessary to comprehend the geometry of the triangle as a whole -- namely the trinity.

Daily depiction by the media of meteorological conditions offer insight into the dynamics of cyclones and anti-cyclones -- and their relationship. These are presented through graphics of ever-increasing sophistication. Similar indications are widely available for [thermohaline circulation](#) across or around the globe ([Great Ocean Conveyor Belt](#); [Gulf Stream](#)).

There is no such approach to the complex system of vortices with which people and governments have to deal -- most notably with respect to cycles and movements of opinion.

A case for such a perspective can be variously made (*Enabling Governance through the Dynamics of Nature: exemplified by cognitive implication of vortices and helicoidal flow*, 2010; *Weather Metaphors as Whether Metaphors: transcending solar illusion via a Galilean-*

[style cognitive revolution?](#) 2015).

Especially intriguing with respect to the oceans as conveyors, is metaphorical use of "conveyor belt" in the light of the common experience of people conveyors in enclosed public spaces. However the experience of such conveyors obscures important dynamic characteristics fundamental to the viability of such technology. These features may be understood as a vital enrichment of the metaphor to preclude dangerous simplifications in the dynamics of situations where the metaphor is typically applied. (*Potential Misuse of the Conveyor Metaphor: recognition of the circular dynamic essential to its appropriate operation*, 2007).

The latter argument cites a widely referenced key chapter on "The Conveyor Belt" by Ken Wilber (*Integral Spirituality: a startling new role for religion in the modern and postmodern world*, 2006). This focuses on the role of the traditional religions as a sacred "conveyor belt" to move people through all the stages of psychospiritual development -- a developmental conveyor belt. Wilber sees it as "quite possibly, the single greatest problem facing the world... fixing this problem, if there is a fix, would provide a startling new role for religion in the modern and postmodern world" (12 June 2006).

In developing this argument, a comparison is made between the application of the metaphor to spiritual development, to market operation, to linear time, and to an understanding of the operation of ocean conveyors -- most notably the Gulf Stream. In all these cases the impoverishment of the metaphor, as currently used, fails to reinforce an understanding of a vital circular dynamic (with its necessary transformative "twists"). These may be essential to more insightful strategic responses to situations, such as the drug trade or population dynamics, where the metaphor may typically be used as a simplistic explanatory device -- reinforcing articulation of simplistic strategies.

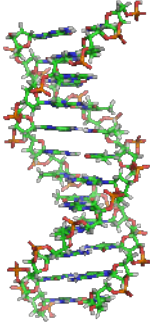

Contrasting the implications of "triple helix" -- cognitive and otherwise

Contrasting usage: The term "triple helix" is used in a range of contexts in the literature, seemingly with little clarity on how these are fruitfully related, conflated or unfortunately confused:

- **Triple-stranded DNA:** There is a distinctive literature on the triple helix as a relatively uncommon molecular structure. The point is notably made that in the early quest for understanding of the structure of "DNA", a triple-stranded DNA model was proposed by Linus Pauling.
- **Biomimicry inspired primarily by double-stranded DNA:** Given the fundamental role played by DNA in genetics and the engendering of life forms, in terms of [biomimetics](#) its form lends itself to consideration in terms of innovation -- as the theme of the Triple Helix model (Janine M. Benyus, *Biomimicry: Innovation Inspired by Nature*, 2002; Yoseph Bar-Cohenon, *Biomimetics: Nature-Based Innovation*, 2011). This extends to speculation on the relevance of the pattern for psychosocial dynamics (*DNA Supercoiling as a Pattern for Understanding Psycho-social Twistedness*, 2004; *Climbing Elven Stairways: DNA as a macroscopic metaphor of polarized psychodynamics*, 2007).

The double-stranded form would seem to have inspired reference to the implications of a triple helix form (Richard Lewontin, *The Triple Helix: gene, organism, and environment*, 2001; Michael Wheeler and Andy Clark, *Culture, Embodiment and Genes: unravelling the triple helix, Philosophical Transactions of the Royal Society*, 2008). the latter suggests that self-created environmental structures and reliance on culturally-transmitted information have selected for cognitive modules for continual bootstrapping and increases in computational complexity. Triple helix models of mind recognize the role of genetic biases in sculpting key developmental trajectories, and the resulting space both for strong forms of genetically specified cognitive modularity and for weaker forms of emergent modularity resulting from trajectories marked by multiple bouts of culturally scaffolded experience and the self- selection of environments.

This framing notably extends to innovation understood in evolutionary terms (Loet Leydesdorff, *The Triple Helix: an evolutionary model of innovations. Research Policy*, 29, 2000). The latter reinforces the biological inspiration through the use of the triple-stranded animation as the logo for a webpage providing access to an extensive set of [related papers](#).

| Double helix | Triple helix |
|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
|  |  |
| Source: <i>Wikipedia</i> : Richard Wheeler (Zephyris) 2006 | Source: webpage on triple helix of Loet Leydesdorff |

- **Model of innovation engendered by an institutional triplicity:** There is a remarkable range of research and other initiatives under the banner of the Triple Helix model (Marina Ranga and Henry Etzkowitz, *Triple Helix Systems: an analytical framework*

for innovation policy and practice in the knowledge society, *Industry and Higher Education*, 27, 2013; [International Triple Helix Institute](#)). This a provocation in terms of what it does not appear to address (as noted below).

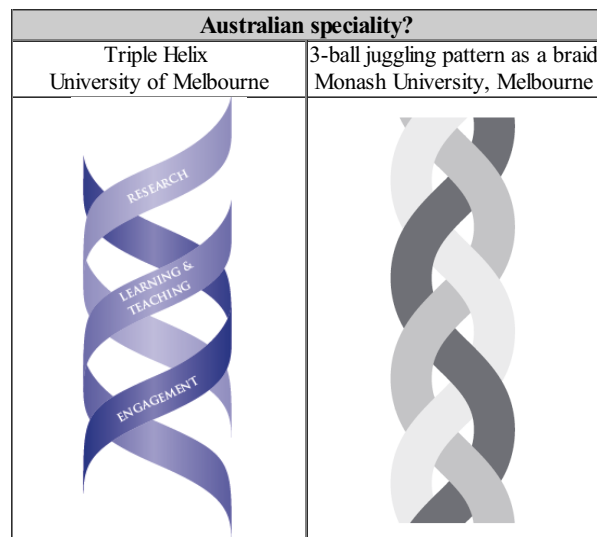
- **Model of learning as an extension of institutional innovation:** It would seem that the institutional model has inspired exploration of a "triple helix" approach in domains such as learning, especially in the light of the cognitive implications of innovation (Eva Rydberg Fähræus, *A Triple Helix of Learning Processes: how to cultivate learning, communication and collaboration among distance-education learners*. Stockholm University, 2003).

At the University of Melbourne, the Triple Helix of research, learning and teaching and engagement. is the core organising principle of its strategy, and an enduring commitment, as illustrated below left, and described by its Vice-Chancellor (Glyn Davis, *Growing Esteem: a discussion paper*, University of Melbourne, 2014). As indicated therein, however, the challenge of "integrating" the labelled strands remains a challenge.

To make this model a success, we will need to integrate further the three strands of the Triple Helix so that research, learning and teaching, and engagement powerfully reinforce each other....

The University has employed considerable resources to pursue each of the strands of the Triple Helix. Yet the real power of the Triple Helix -- its integration -- remains only partially realised. Having pursued the individual goals of each strand, the University can now bind together all the strands of the Triple Helix through engagement....

How does the University achieve its aims to deliver greater impact through research, offer an outstanding student experience in a digital world, and better integrate the strands of the Triple Helix? The answer lies not just in the goals we set for the institution, but in how we support our people, organise infrastructure, and align resources.



- **Juggling patterns as braids:** As indicated by [Burkard Polster](#) (*The Mathematics of Juggling*, Monash University), the diagram above-right shows what the trajectories of juggling the basic 3-ball pattern look like (viewed from above). The three trajectories form the most basic braid. Braids are recognized as important mathematical objects. It has been shown that every braid can be juggled in that sense (Burkard Polster, *The Mathematics of Juggling*, 2003). The implications have been further discussed separately (*Potential cognitive implications of toroidal helical movement*, 2016; *Category juggling reframed through visualization dynamics*, 2016).
- **Sociophysics:** An effort was made to reconcile understandings of sociology and physics through a triadic framework by [Paris Arnopoulos](#) (*Sociophysics: Cosmos and Chaos in Nature and Culture*, 1993). As a consequence of the emergence of interest in the Triple Helix concept, Arnopoulos articulated the correspondence with that framework on the occasion of the Third Triple Helix International Conference (*Braiding the Triadic Codex and Triple Helix: the sociophysics of nature-culture-nurture and academy-industry-polity*, 2000). This provides a greater degree of articulation between the three strands than is seemingly available from other sources.
- **Management approaches extending to considerations of spirituality and culture:** Although the institutional model has that particular focus, the approach has been extended by drawing on both cultural and spiritual dimensions, notably as argued by [Constantin Bratianu](#) (*The Triple Helix of the Organizational Knowledge. Management Dynamics in the Knowledge Economy*, 2013):

The new perspective is based on the metaphor that organizational knowledge is a field rather than a stock, or stocks and flows. It is a complex metaphor using the thermodynamics principles. The organizational knowledge is composed of three different fields: cognitive knowledge, emotional knowledge and spiritual knowledge. These fields are nonuniform,

nonhomogeneous and they interact in a dynamic way. Cognitive field contains knowledge about what is, emotional field contains knowledge about how we feel, and the spiritual field contains knowledge about people's aspirations and life values....

Cognitive knowledge, emotional knowledge and spiritual knowledge are the three components of the fundamental triple helix of the organizational knowledge, and they are in a continuous interaction and transformation.

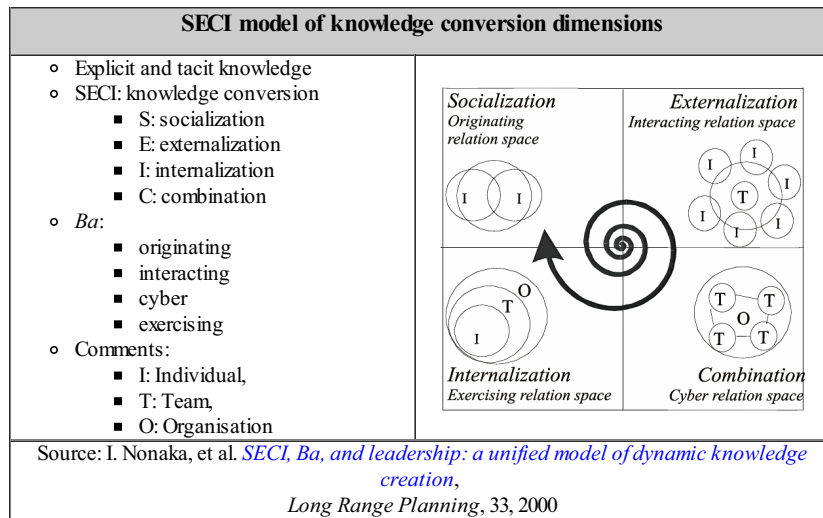
It is intriguing to note the manner in which a subtle insight from the culture of innovation in Japanese management has been associated with an enrichment of the Triple Helix model. This is explained by Balázs Lengyel in the following terms:

One of the most known knowledge creation models - **SECI** - by **Ikujiro Nonaka** is based on the continuous interaction between personal and organizational tacit and explicit knowledge (Nonaka et al, 2000). The most extraordinary element of Nonaka's model is the concept of '*Ba*' that provides the different contexts for the knowledge creation processes.... *Ba* -- providing the physical and virtual presence -- is necessary for the knowledge transfer and knowledge creation.

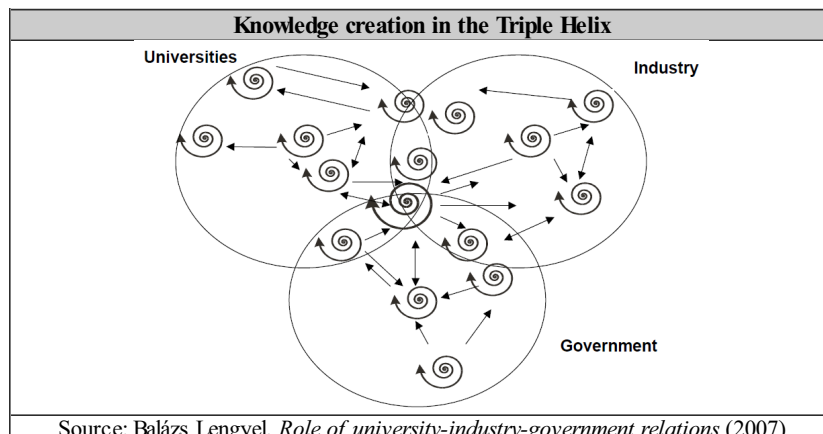
For Lengyel, given its crucial importance, this is translated as "Relation Space", understood as including physical, social, cultural and historical contexts.

While tacit knowledge needs proximity and simultaneity, explicit knowledge can be transferred to big distance and long future. It is very important in the knowledge creation, especially in the externalisation and socialisation that the actors could develop such a common place and time where knowledge can be shared with the overlap of personal contexts. Relation space collects all the knowledge elements to a common place and time that these elements cannot be understood without. (*Role of university-industry-government relations: knowledge transfer and Triple Helix mechanisms in Budapest*. Budapest University of Technology and Economics, 2007)

Of particular interest with respect to the spiral pattern explored in this argument is the presentation by Lengyel of the following schematic.



The pattern above is reminiscent of the **All Quadrants All Levels** (AQAL) schema of Ken Wilber's **integral theory**. Lengyel makes further use of the spiral form in his own argument, as follows.



- **Self-referential complexity:** It would however appear that, as observers, physicists are inherently averse to exploring the implications of any form of "self-reference" in the quest for a Theory of Everything. This contrasts with concerns articulated from a cybernetic perspective in considering means of control of complex systems, and potentially those of significance to global governance (Maurice Yolles, *Knowledge Cybernetics: a new metaphor for social collectives*, *Journal of Organisational Transformation and Social Change*, 3, 2006, 1). From that perspective, **feedback processes** of first, second, third and possibly higher order are envisaged, engaging any observer to an ever higher degree, as discussed with respect to *Cybernetics of cybernetics: complex adaptive systems?* (*Consciously Self-reflexive Global Initiatives*, 2007).
- **Traditional symbolic implications:** These are recognized in terms of the enduring significance associated with the various forms of the triple spiral (Glenys Livingstone, *Celebrating the Triple Spiral: a PaGaian cosmology*, *PaGaian Cosmology*, 2007)

Analyses of Triple Helix literature: The extensive literature on the Triple Helix model of innovation has evoked analyses which clarify its limitations:

- **Case study:** A case study of the Triple Helix approach by Lukas Hohmann notes:

Triple Helix constellations in the nanotechnological industry and in the context of different forms of security in society show that these structures are a useful instrument to generate intelligent solutions on certain societal problems. With regard to Smart Governance, Triple Helices are able to increase the intelligence of democratic structures and parts of their processes. In contrast, they lack influence on metarules. The capitalisation of knowledge is an influencing factor, which prevents a more general implementation of Triple-Helices. (*To what Extent Is the Triple Helix Model of Etzkowitz and Leydesdorff of Use for the Implementation of Smart Governance: an analysis referring on implemented Triple Helix constellations*).

- **Semantic network:** Another analysis of interest focuses on the relevance to a particular sector (Jang Hyun Kim, *A Hyperlink and Semantic Network Analysis of the Triple Helix (University-Government-Industry): the interorganizational communication structure of nanotechnology*, *Journal of Computer-Mediated Communication*, 17, 2012, 2).
- **Scientometrics:** (Loet Leydesdorff and Martin Meyer, *The Scientometrics of a Triple Helix of University-Industry-Government Relations*, *Scientometrics*, 70, 2007, 2)

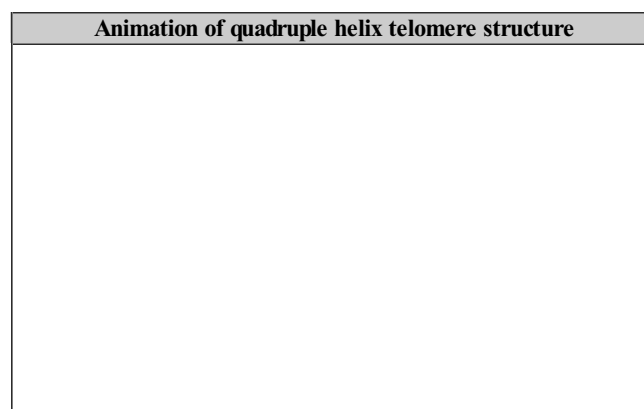
Systemic closure: fourth helix -- and beyond?

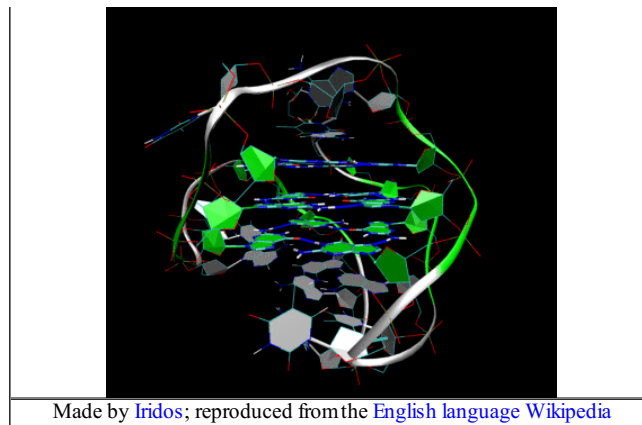
Seemingly casual extension of the Triple Helix model to a "quadruple helix" is potentially indicative of the degree of divorce from any biomimetic implications of DNA (Simona Cavallini, et. *Using the Quadruple Helix Approach to Accelerate the Transfer of Research and Innovation Results to Regional Growth*, Committee of the Regions of the European Union, 2016; Sara Paulina De Oliveira Monteiro and Elias G. Carayannis (Eds), *The Quadruple Innovation Helix Nexus -- a Smart Growth Model: quantitative empirical validation and operationalization for OECD Countries*, 2017; Loet Leydesdorff and Henry Etzkowitz, *Can 'the public' be considered as a fourth helix in university-industry-government relations? Report on the Fourth Triple Helix Conference, 2002*, *Science and Public Policy*, 30, 2003)

That said, of potential relevance is the following clarification:

"The Fourth Helix" is a reference to the DNA structure of **telomeres**. Telomeres are the ends of our chromosomes, made up of many repeats of the DNA sequence TTAGGG. Bound with proteins, telomeric DNA assumes a complex conformation which protects the chromosomal DNA from degradation. An often-used analogy compares telomeres to the plastic bits at the ends of a shoelace which keep the fabric from unraveling.... The four-helix structure formed at the end of our telomeres is called a "**G-quadruplex**". (*What does the "Fourth Helix" Mean?* *The Fourth Helix*, 25 October 2013)

If the Triple Helix is inspired to any degree by DNA, the "ends" of the helix would seem to call for a form of systemic closure to prevent the helix from degrading and "unravelling". **Little is said in the literature about where the Triple Helix, as frequently depicted, is "going to" or "coming from"**. The role of the 4-fold telomeres as "ends" in the case of DNA do indeed point to the necessary integration of what could then be explored as a Quadruple Helix. **Systemic closure would seem to be necessary whether the focus is on institutional or cognitive organization.**





Understood in terms of the requisite dimensionality for global coherence and its comprehension, especially in the light of the cybernetic argument for higher orders of feedback processes, there is then a case for exploring a "quintuple helix" pattern, as discussed separately (*Concordian Mandala as a Symbolic Nexus: insights from dynamics of a pentagonal configuration of nonagons in 3D*, 2016; *Visualization in 3D of Dynamics of Toroidal Helical Coils: in quest of optimum designs for a Concordian Mandala*, 2016).

Loet Leydesdorff argues, for example, that:

Integration among the functions of wealth creation, knowledge production, and normative control takes place at the interfaces in organizations, while exchanges on the market, scholarly communication in knowledge production, and political discourse tend to differentiate globally. The neo-institutional and the neo-evolutionary versions of the Triple Helix model enable us to capture this tension reflexively. Empirical studies inform us whether more than three helices are needed for the explanation. The Triple Helix indicator can be extended algorithmically, for example, with local-global as a fourth dimension or, more generally, to an N-tuple of helices. (*The Triple Helix, Quadruple Helix, ..., and an N-Tuple of Helices: explanatory models for analyzing the knowledge-based economy?* *Journal of the Knowledge Economy*, 3, 2012, 1, pp. 25-35)

In proposing a framework for a trans-disciplinary analysis of sustainable development and social ecology, a key question has been raised by [Elias Carayannis](#) and D. F. Campbell (*Triple Helix, Quadruple Helix and Quintuple Helix and how do knowledge, innovation and the environment relate to each other?* *International Journal of Social Ecology and Sustainable Development*, 1, 2010, 1, pp. 41-69).

The possibility has been developed in subsequent papers ([Elias G. Carayannis, et al., *The Quadruple/Quintuple Innovation Helixes and Smart Specialisation Strategies for Sustainable and Inclusive Growth in Europe and Beyond*, *Journal of the Knowledge Economy*, 2014](#); [Elias G. Carayannis, et al., *The Quintuple Helix innovation model: global warming as a challenge and driver for innovation*, *Journal of Innovation and Entrepreneurship*, 2012](#)). The authors summarize the case for this development as:

However, in one line of interpretation it could be argued that the Triple Helix places the emphasis on knowledge production and innovation in the economy so it is compatible with the *knowledge economy*. The Quadruple Helix already encourages the perspective of the *knowledge society*, and of *knowledge democracy* for knowledge production and innovation. In a Quadruple Helix understanding, the sustainable development of a knowledge economy requires a coevolution with the knowledge society.

The Quintuple Helix stresses the necessary *socioecological transition* of society and economy in the twenty-first century; therefore, the Quintuple Helix is ecologically sensitive. Within the framework of the Quintuple Helix innovation model, the natural environments of society and the economy also should be seen as drivers for knowledge production and innovation, therefore defining opportunities for the knowledge economy. The European Commission in 2009 identified the socioecological transition as a major challenge for the future roadmap of development. *The Quintuple Helix supports here the formation of a win-win situation between ecology, knowledge and innovation, creating synergies between economy, society, and democracy*. Global warming represents an area of ecological concern, to which the Quintuple Helix innovation model can be applied with greater potential.

Relevance of any helical model to global governance?

Biomimicry? Labelling the strands of the Triple Helix with generalities would seem to preclude specific interpretations. Naming the strands with specificities similarly precludes the challenge of comprehending their more fundamental implications.

Any "mechanical" multiplication of the number of strands is a warning that there is a major challenge to the comprehension of complexity in relation to governance which needs to be factored in (*Comprehension of Numbers Challenging Global Civilization: number games people play for survival*, 2014). Such multiplication also signals the possibility that what is implied in the strands of the Triple Helix may be more fundamental systemically, functionally and cognitively than the significance implied by the conventional labels attributed to them.

There would seem to be a sense in which such models seek to imply a pattern of innovation inspired through biomimicry by helical DNA -- so vital to biological life and its apparent simplicity -- but without taking any account of the complexities of that structure, as required by genetics and the inspiration they have offered for memetics and its psychosocial implications. As an exercise in biomimicry, the relevance of the Triple Helix model to psychosocial life could be considered to be at an early stage corresponding in historical terms to

those of the struggle to determine the nature of molecular DNA.

It could be argued that it is the 3-fold nature of "institutional technology" that is the pattern inspiring the Triple Helix, rather than multi-stranded DNA. In either case the challenge for a knowledge society is to enable global governance to "get off the ground" and "fly". It is in this sense that the cognitive insights from helicopter development are of interest (*Engendering a Psychopter through Biomimicry and Technomimicry*, 2011). However, with the focus on innovative knowledge creation, any helical model must necessarily engage with memes and memetics, whether or not the approach is inspired by genetics, as discussed separately (*Epimemetics, biomimetics, epimemetics and biomemetics*, 2010).

Requisite complexity? Specifically the Triple Helix model would appear to avoid the many cognitive challenges of triadic thinking implied by the examples above, despite the detailed approach to institutional arrangements. Thus whilst it is able to address the academy-industry-government triad, or variants such as learning-communication-collaboration, it has little to say about such fundamental issues for governance as the conflictual relations within the Abrahamic triad of Christianity-Islam-Judaism -- tragically extended to Buddhism in the case of the current [Rohingya persecution](#). Curiously it could be said that academia, business and government may well have more fundamental connections with one or other Abrahamic religion than they do amongst themselves -- as indicated in the case of government by "Christian Democrat" parties, in business by the Islamic Chamber of Commerce and Industry, and in academia by the Hebrew University of Jerusalem. How does a [state religion](#) affect understanding of the Triple Helix model? Christianity is the favoured faith in 28 of the 40 countries with a preferred religion.

These religions exemplify the manner in which the highest human values are distinctively embodied by institutions and behaviours to the point at which each is completely unable to "see" and appreciate the fundamental nature of the truth that is recognized by the other -- then declared to be fundamentally wrong, or worse. Whatever form it takes, the violence engendered in consequence is then held to be "inexplicable" (*Global Incomprehension of Increasing Violence: matching incapacity to question the reason why*, 2016). Of potential relevance to this pattern, the constraint on "seeing" is a primary characteristic of the paradoxical movement of [information in relation to black holes](#) in the cosmos (*Nobody Knows Where A Black Hole's Information Goes*, *Forbes*, 24 January 2017).

Arguably, as framed, such helical models are more suggestive of the simplicity of a multi-stranded rope -- essentially safe, rational, comprehensible and uncontroversial. The implication, as with the famous declaration by Margaret Thatcher, is that [There Is No Alternative](#) (TINA). It is questionable whether such a pattern is adequate to a global environment engendering cyclones disruptive of conventional modes of governance. That the Triple Helix, as with so many models in circulation, is typically presented "flat" in 2D (and published statically in journals and slides), is an unfortunate reinforcement of a "cognitive flatland" in which dynamics and higher dimensional considerations are at best implicit (*Irresponsible Dependence on a Flat Earth Mentality -- in response to global governance challenges*, 2008).

Irrespective of any more fruitful alternative, there is the remarkable systemic role played by corruption -- as it might need to be considered in relation to the adequacy of the Triple Helix model (Christiane Gebhardt, *The transfer of corruptive routines from old industrial regions to innovation clusters: a blind spot in innovation studies*, *Triple Helix*, 4, 2017, 3). Given the focus of that model on innovation, there is great irony to the widely recognized ingenuity associated with corruption, currently exemplified by the activities of hackers and the systemic challenge they constitute in an information society. Any such reversal of norms governing innovation suggests that a helical representation may need to be specially configured (as explored below) -- possibly suggested by the existence of forms of DNA of different chirality.

With respect to any wider uptake of the Triple Helix model of relevance to global governance, the possibility of factors remaining to be more effectively addressed is discussed separately (*Recognizing the Psychosocial Boundaries of Remedial Action: constraints on ensuring a safe operating space for humanity*, 2009).

Global governance? Of particular interest is the potential relevance of the Triple Helix model to the challenges to any institutional reform of the United Nations. The relevance will presumably become apparent through the process of the [Global Challenges Prize for a New Shape Remodelling Global Cooperation](#) (2017). This is eliciting numerous proposals for reform to the decision-making processes of the UN. It has been instigated by [László Szombatfalvy](#), founder and chairman of the [Global Challenges Foundation](#), created in 2012 with the aim of deepening understanding of the greatest risks to humanity -- and catalyzing ideas around how these global risks can be minimized or eliminated, as discussed separately (*Global Challenge of the Global Challenge : In-quest of a decision-making framework appropriate to a world in crisis ?* 2016).

Given the unprecedented escalation of tensions between the US and North Korea at the time of writing, it is appropriate to ask how any helical model might contribute to any reframing of that process -- especially given the ironic sense in which cyclone formation is itself a process of "escalation". The dangerous failure to take account of other dimensions and processes is highlighted from an historical perspective by Michael Brabazon (*Trump misreads North Korea's sacred dynasty at his peril*, *The Guardian*, 23 September 2017). This notes the poorly understood relevance of *juche* to the spiritual foundations of the Korean world view -- and the implications for psychosocial coherence there.

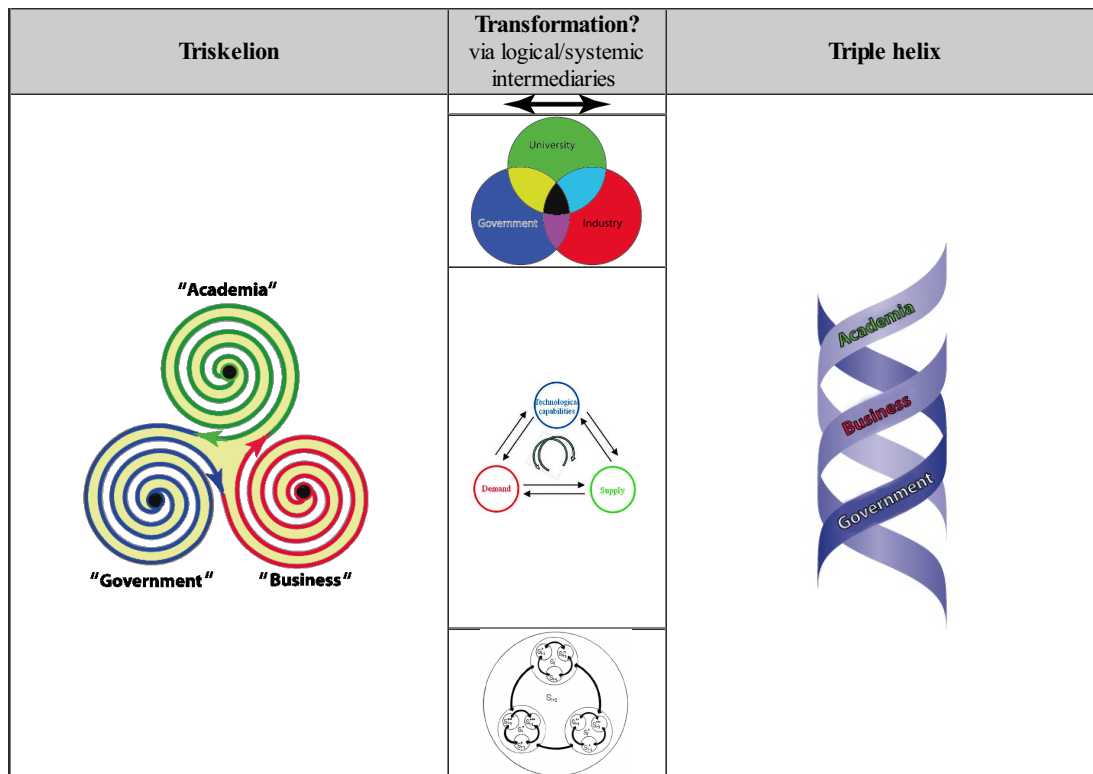
Reconciling triskelion and triple helix: a topological transformation with psychosocial implications?

Topological equivalence and its cognitive implications: The argument above has emphasized the challenge to comprehension associated with helical models, exemplified by the Triple Helix. Double-stranded DNA is itself a challenge as the lengthy process of its discovery and structural determination illustrated. It has also been argued that the combination of complexity, simplicity and symmetry of the triskelion have in some way contributed to enduring appreciation of its significance over millennia. The point was also made that, as commonly depicted, the Triple Helix model is systemically incomplete -- through lack of attention to its "ends". The lack of closure

implies an "openness" to the environment which can be interpreted as both an indication of vulnerability and an inadequate degree of coherence.

It is in this sense that reference is made to the enduring symbolic significance of the triskelion as implying an intuitive understanding by which the Triple Helix model could be informed. Arguably the triskelion offers the most compact depiction in 2D of a complete psychosocial system in that it is without systemic "loose ends" -- understood as extra-systemic sources and sinks.

The issue is how to expand the triskelion as a 2D "projection" through a fruitful "conjunction" into 3D -- compatible with the form of a triple helix. The complementary nature of "conjunction" is discussed separately with respect to NATO in terms of *Explanation as interplay of projection and "conjunction"?* and *Surrogates of "conjunction" as an unrecognized cognitive process? (Envisaging NATO Otherwise -- in 3D and 4D? Potentially hidden faces of global strategy highlighted through polyhedra, 2017).*



The animation on the left above offers a useful indication of how the distinct modalities "inform" each other -- and potentially to a more fundamental degree rather than superficially. The [introductory paper](#) offers a link to a [video](#) of suggestive movement of small spheres around the triskelion pathway. The "cognitive wormholes" are in each case usefully indicated by a "black hole" (whose metaphorical implications are discussed at greater length in that introductory paper). The lack of linkage between the strands in the image on the right is significant in itself as indicative of a challenge of effective integration -- as with the lack of indication of the systemic implication of the upper and lower "loose" ends of that image.

The central panels above show various schematics through which the logical and systemic relations of the Triple Helix model are clarified. The uppermost highlights the pattern in terms of a classical [Venn diagram](#); together with that beneath it, these derive from Loet Leydesdorff and Inga Ivanova (*'Open Innovation' and 'Triple Helix' Models of Innovation: can synergy in innovation systems be measured?* *SSRN Electronic Journal*, January 2016) referring to earlier sources (Etzkowitz and Leydesdorff 2000, p. 111; Petersen et al., 2016, p. 667). The lowest panel derives from Loet Leydesdorff (*The Mutual Information of University-Industry-Government Relations: an indicator of the Triple Helix dynamics*. *Scientometrics*, 58, 2009, 2) sourced from a schematic depiction of a complex system by J. A. Goguen and Francisco Varela (*Systems and distinctions: Duality and complementarity*, *International Journal of General Systems*, 5, 1979).

With respect to the argument here, the Venn diagram is especially useful in highlighting the central integrative focus -- however it may be provocatively associated with a black hole or a cognitive wormhole. The Triple Helix literature only associates it with trilateral networks and hybrid organizations. In terms of the central mystery of any cognitive triad, it also invites reflection in terms of what Jacques Lacan termed *objet petit a* insisting that it should remain untranslated -- *'hus acquiring, as it were, the status of an algebraic sign'*, associating it with the Greek term *agalma*. Understood as a precious object hidden inside a relatively worthless box, it is the object of desire sought in the other, possibly never to be attained. Subsequently he understood it as placed at the centre of a [Borromean knot](#) as the locus of intersection of three orders: real, symbolic and imaginary (pointers helpfully indicated by [Cadell Last](#)).

Transformation phases: The intriguing question is then how to demonstrate the degree of topological equivalence between the form of the triskelion and that of the triple helix. This requires a succession of transformations which may themselves be of cognitive significance. The image on the left (above) usefully suggests the proportion of the preoccupations of academia, business and government for their own respective modalities in each case -- in comparison with the relatively limited preoccupation with the connectivity between them.

One approach, perhaps the clearest, is through the following animation as prepared by Sergey Bedorov of Cortona3D.

Screen shots of phases in animation of transformation from triskelion to triple helix (and back)

Animation kindly prepared by Sergey Bedorov of [Cortona3D](#). Interactive versions: [VRML/WRL format](#); [X3D format](#). Video ([mp4](#))

Technical comment: The VRML version was tested only in Cortona3D Viewer and will probably fail in other viewers because it uses some non-standard nodes. The X3D version has been tested only in H3DViewer and may only work incorrectly in other viewers (partly because a workaround was used for a H3DViewer bug, and partly because other X3D viewers are even more buggy).

This approach invites exploration of the potential implications of an extended variant, as indicated by the following -- in which two versions of the triskelion are interwoven and unravelled, as a means of indicating closure of the triple helix. This contrasts with the "incompletion" of the version above. The animation could be further developed to imply various understandings of mirroring and inversion.

Screen shots of phases in animation of transformation from double triskelion to triple helix (and back)

Animation kindly prepared by Sergey Bedorov of [Cortona3D](#). Interactive versions: [VRML/WRL format](#); [X3D format](#). Video ([mp4](#))

Another approach to exploration of the topological equivalent is indicated in the following. The first set of images below shows the steps in distinguishing the 3-fold double spirals, separating the 2 single spirals associated with each of the 3 lobes of the triskelion. This gives rise to 6 spirals, of which one set is inverted or reversed with respect to the other, as shown in the right-most panels.

3-fold spirals

| 3-fold double spirals (triskelion) | 3-fold spirals (distinguished) | 3-fold spirals (white "displaced") | 3-fold spirals (lower reversed) |
|------------------------------------|--------------------------------|------------------------------------|---------------------------------|
| | | | |
| | | | |

Paradoxical junction? The assumption was made, correctly or otherwise, that in terms of its psychosocial implications the final helix would consist of an "upper" and "lower" portion -- linked by what is effectively a "cognitive wormhole". This is consistent with the pattern associated with growth spirals and cyclones. The complementarity between the two halves can be understood as necessary for functional completeness -- what "goes into" a spiral sink must "come out" somehow and somewhere. Given the [earlier argument](#) in relation to the pattern of gravitational waves and black holes (for which there are many accessible images on the web), it is especially interesting to note the following depictions.

Schematic illustrations of black holes in relation to gravitational waves

| Spiral dance of black holes | Two gravitational waves |
|-----------------------------|-------------------------|
| | |

Source: [LIGO/T Caltech](#). [Pyle](#); also [video](#) of

artist's animation showing merger of two black holes and gravitational waves rippling outward during the event (another video).

Source: Shutterstock_375622714.jpg

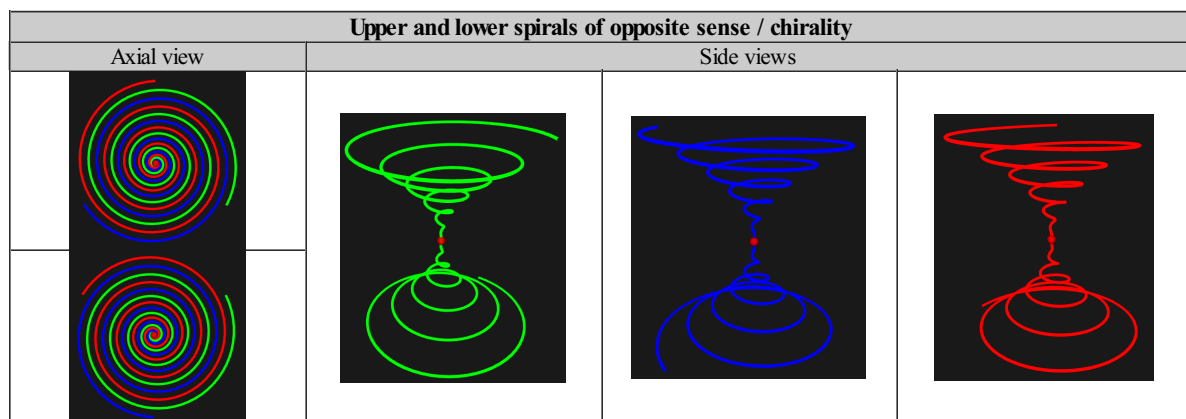
GW170814: *A Three-Detector Observation of Gravitational Waves from a Binary Black Hole Coalescence*, (LIGO Scientific Collaboration and Virgo Collaboration, 14 August 2017)

The concern was then the nature of the inversion between the "upper" and "lower" halves and how the 6 individual spirals could then be appropriately combined. Linked by a "cognitive wormhole", it was assumed that this would imply a radical reversal or inversion, as separately argued (*Transformation of worldview from "inside-outside" to "outside-inside"*, 2013; *Alternation of worldview between "inside-outside" and "outside-inside"*, 2013; *Paradoxical cycling between "inside-outside" and "outside-inside"*, 2013).

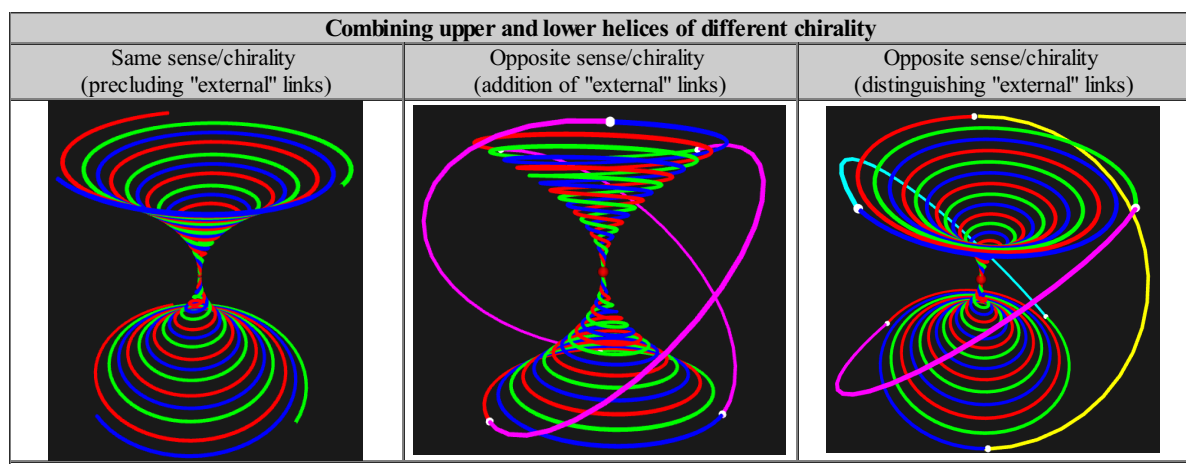
The relevance of such a paradoxical perspective is highlighted by the phrase "down the rabbit hole", widely publicized in video form (*What the Bleep Do We Know!?* 2004). Arguably any quest for radical innovation is all about seeing things "otherwise". As rendered in the 3D form below, at the nexus of two helical cones, the junction point recalls the cross-over function of the *corpus callosum* linking the two hemispheres of the human brain -- inviting reflection on the function of any psychosocial analogue (*Corpus Callosum of the Global Brain? Locating the integrative function within the world wide web*, 2014; *Engendering Viable Global Futures through Hemispheric Integration: a radical challenge to individual imagination*, 2014).

Arguably it is some such framework which of requisite complexity to frame the "incomprehensibility" of the violent relationships between world views, exemplified by the case of the Abrahamic religions. The mystery of their respective insights might be more appropriately recognized in terms of *holes*, understood otherwise (*Is the World View of a Holy Father Necessarily Full of Holes? Mysterious theological black holes engendering global crises*, 2014; Roberto Casati and Achille C. Varzi, *Holes and Other Superficialities*, 1994). From that perspective, it is a profound irony that the encounter between world views should be such a matter of "gravity", variously engendering waves in global society -- and extreme forms of turbulence.

Transformation from 2D to 3D: One assumption was therefore that the set of 3 flat spirals (upper or lower) can simply slide together in 2D to create 2 multi-coloured spirals with a common centre, as indicated in the left-most panels below. Whilst this process can be readily represented in a 3D visualization in which objects can pass "through" each other, there is value in considering the more complex process in which 2D spirals are extended into 3D (into the plane, as shown in the other panels below) and then slid together without cutting through each other.



Chirality: The left-most panel below is indicative of an attempt at using multi-coloured spirals of the same directionality, namely without any reversal through the "cognitive wormhole" (irregularities in the spirals can also be seen). Given the concern with the functional connections required for the 6 "loose ends", the more coherent pattern resulted from using a distinct reversal changing the directionality/chirality of the two sets of spirals (and remedying the spiral irregularities). As shown in the middle panel below, this enabled the smooth introduction of 3 outer connectors between upper and lower halves (coloured mauve). These can be understood as corresponding to the 3 inner connectors in the original triskelion (as mentioned above). These connectors are distinctively coloured in the right-most panel as an indication of different psychosocial functions.



Possible further complexification of the 3D visualization includes allowing small spheres to move along the helical pathways. One variant of this was presented in the previous paper where red, blue and green spheres moved from the separate lobes of the triskelion along its continuous pathway -- without colliding (see [video](#)). The structure could be enhanced in this way, since the pathway is also continuous - even through the "cognitive wormhole".

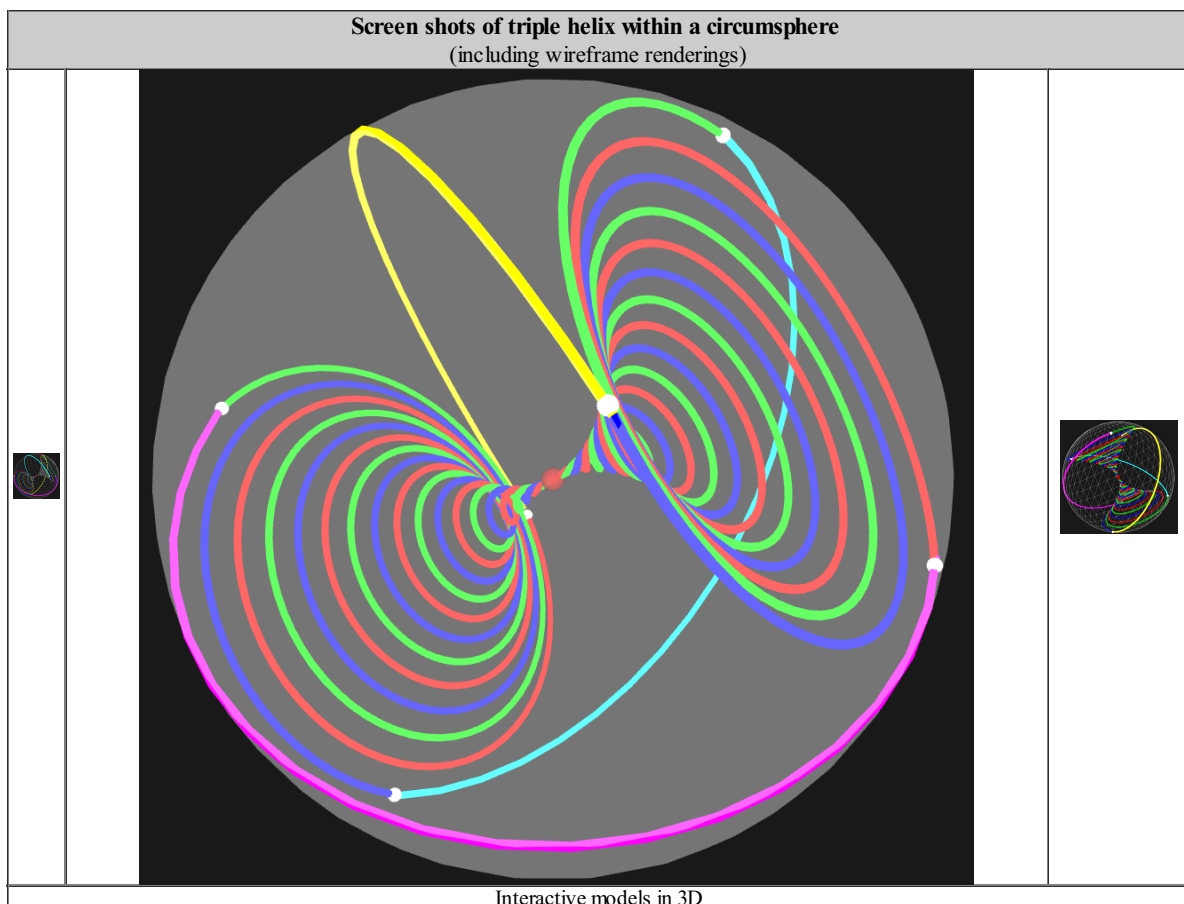
Technical comment

The original intention was to present the phases of the transformation as a single animation in 3D. For that reason the first step involved construction of the triskelion in an X3D format using X3D-Edit. For lack of time and skill, this was finally limited to the construction of a single 2-spiral lobe in X3D from which an image was made. The image was manipulated in Adobe Illustrator and Photoshop to provide the triskelion as shown on the left (with obvious imperfections). The other images in the first set of panels were derived from this.

Of interest in that process was juxtaposing the 3 lobes of the triskelion with 3 appropriate linking curves which otherwise would be better described mathematically (see [Parametric equations and specifications of a triskelion \(triple spiral\)](#)). It is those "inner" links which are reflected in the distinctively coloured "outer" links between the upper and lower portions of the final helix (above right). Those linking curves could have been similarly coloured in the original triskelion image.

Use of X3D was made for the extension of the 2D spirals into 3D in order to constitute the helix with its upper and lower parts -- as well as insertion of the connecting curves (which could be more appropriately defined mathematically, as in the original triskelion). It is of course the case that the number of spiral "whorls" could be increased, as with the "height" of the final helix -- as parameters offered in any more complex interactive visualization. This would however have constrained the clarity of the representation in the panels above.

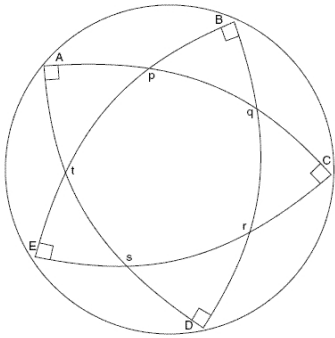
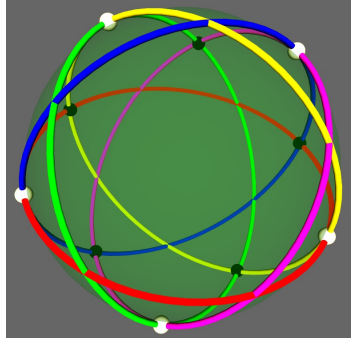
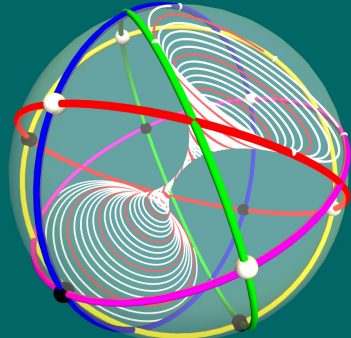
Circumsphere and globality? The geometry of the above figure suggests the addition of a circumsphere to emphasize the relation to an understanding of the global coherence of the triple helix (as indicated below). With the radius chosen, of interest is that the external links between the two halves of each helix are then half-portions of **great circles** around that sphere. Each helix then "starts" at junction points with a great circle -- marked by the small white spheres. Less evident is whether it is imperfections in the construction of the model which ensure that those great circles (if complete) would not currently intersect at right angles -- or whether better construction would ensure that they intersect at some other particular angle.



Quintuple helix and Pentagramma Mirificum? Whether or not the **three great circles** would indeed intersect otherwise in a more precise construction, of further interest is the potential implications in the case of a quintuple helix. As indicated below, an intersection of the associated **five great circles** at right angles would then merit consideration in the light of the **Pentagramma Mirificum**, defined by that property. This has been fundamental to the mathematics of global navigation through **spherical trigonometry** and its formulation via Napier's Rules (Glen Van Brummelen, *Heavenly Mathematics: the forgotten art of spherical trigonometry*, 2013). Their status as merely mnemonic has been contested (Joel Silverberg, *Napier's Rules of Circular Parts*, Canadian Society for the History and Philosophy of

Mathematics, 2008). Those taught to children are misleadingly simplistic by comparison (*The Five Great Circles of Earth*, YouTube, 2017). The question is how any such circles might serve with respect to the challenges framed by the [Global Sensemaking](#) network.

As argued separately and by analogy (with other images and animations), the Pentagramma Mirificum may offer insights of relevance to global governance (*Global Psychosocial Implication in the Pentagramma Mirificum: clues from spherical geometry to "getting around" and circumnavigating imaginatively*, 2015). Is there a set of "Napier's Rules" to be articulated for governance, whether of mnemonic significance or otherwise?

| Possible "reconciliation" of geometry of Pentagramma Mirificum with Quintuple helix | | |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|
| Non-regular spherical polygon (as originally sketched by John Napier , 1550-1617) | Complementary variants of pentagram on opposite sides of a circumsphere (white variant in front, vertical; black variant, inverted, seen through sphere) | Indicative embedding of quintuple helix (10 helical "ends" tangential to great circles of of Pentagramma Mirificum) |
|  |  |  |
| <p>Images on right and in centre prepared as interactive 3D models (centre image: WRL format, X3D format; right image: WRL format; X3D format) best viewed in wireframe renderings Guidance was helpfully provided by Sergey Bederov of Cortona3D</p> | | |

In the right-hand image above, the embedding of the quintuple helix could require more precise construction of the model to determine whether (and exactly how) the "ends" of the helices are tangential to the two variants of the pentagram, or merge with them. As indicated, one variant has the right-angle intersections of the great circles marked by larger white spheres, the other by larger black spheres. The centre image shows a view from "above" (helices omitted), that on the right shows a view "down". The embedding of the helices therefore shares a common axis with that of the pentagrams. The right-angle intersections are then associated with "side" views. The possible tangents are thus associated with portions of the great circles without right-angle intersections. For the sake of clarity, the distinctive colour coding of the triple helix model has been replaced by white (with the exception of a single red helix for indicative purposes). The colours have been used for the great circles.

Although symmetrical to a degree, through mirroring of the "upper" and "lower" pentagrams, that structure is not spherically symmetrical. The helical pattern (similarly mirrored) is associated with the 2 larger "holes" in that framework by which the 2 pentagrams are framed. Presentation of a quintuple helix has the advantage of offering a means of suggestively holding the distinctions between different orders of cybernetic feedback -- to the extent that self-reference calls for fourth and fifth order self-reference (as mentioned above). Such considerations are of potential relevance to cybernetic understanding of a [viable system model](#) (VSM) and its multiple recursions. In ascending the recursions of the viable system the context of each autonomous 5-4-3-2 [metasystem](#) enlarges and acquires more variety.

Further exploration of five-fold patterning is recognized with regard to [spherical tessellation](#) through the manner in which five (of the six) great circles of the [icosidodecahedron](#) enclose regular pentagons and equilateral triangles (Italo J. Dejter, *Great Circle Challenge and Odd Graphs*). By contrast, and of relevance to any association of polyhedra with helical interweaving, the tetrahedron offers six great circles and the octahedron three (Edward S. Popko, *Divided Spheres: geodesics and the orderly subdivision of the sphere*, 2012).

Suggestive representation of dynamics of a "cognitive wormhole" associated with a quintuple helix

Whether in the form of a triple helix or a quintuple helix, the framework offers a reminder that any approach to governance or innovation can be understood both in axial and in spiral terms -- as a strategic decision or as a developmental process. These recall the distinction between the "sword" of the executive and any contextual "chalice", as with "incubators" for innovation notably promoted as [technopoles](#) by the EU. As symbols the distinction has been explored by [Riane Eisler](#) (*The Chalice and The Blade: our history, our future*, 1987) as offering a new conceptual framework for studying social systems that pays particular attention to how a society constructs the roles and relations between the female and male halves of humanity.

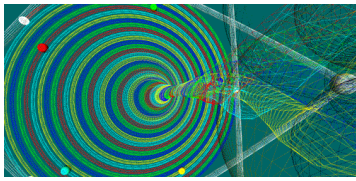
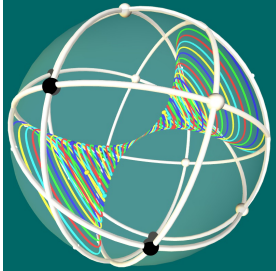
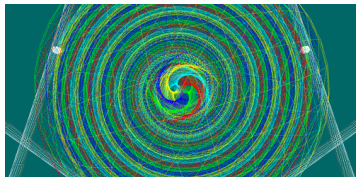
Given the chalice-like form of the framework, the challenge of achieving this can be compared with the legendary quest for the "Holy Grail" (*In-forming the Chalice as an Integrative Cognitive Dynamic: sustaining the Holy Grail of global governance*, 2011). The cognitive dimension can be explored in the light of a [catastrophe theory](#) approach to innovation and governance (*Interrelating Cognitive Catastrophes in a Grail-chalice Proto-model: implications of WH-questions for self-reflexivity and dialogue*, 2006). It is in this sense that the framework above can be variously used and amended to explore and illustrate different "stories".

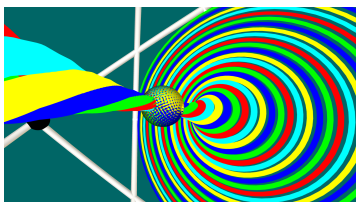

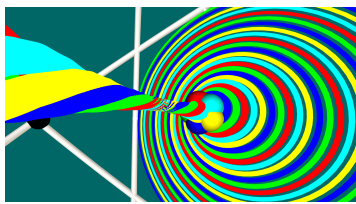
The helical pattern can, for example, be rotated relative to the pentagram framework. Appropriate to this argument, as an exemplar of innovation, of further potential interest are any implications from such rotation in the light of the seminal insights of [Nikola Tesla](#) into the rotation of a magnetic field (*Reimagining Tesla's Creativity through Technomimicry: psychosocial empowerment by imagining charged*

[conditions otherwise](#), 2014). The two portions of the helical pattern can be rotated at different rates (as in the videos below), or in different directions relative to one another. The design could be enhanced in a number of ways.

| Rotation of Quintuple Helix relative to double Pentagramma Mirificum | | |
|-------------------------------------------------------------------------------------------------------|-----------------------------------------------|--------------------------------------------------|
| fast | medium | slow |
| 10 rotations per second (mp4) | 1 rotation per second (mp4) | 0.2 rotations per second (mp4) |
| Animations produced with X3D Edit in the WRL and X3D models accessible above (but variously modified) | | |

Rather than rotate the set of helices as shown there, small spheres can be set to move from the outmost end down the spiral and through the "wormhole" -- or allowed to emerge from it. In this modification the five helices are distinctively coloured and the pentagram framework is presented in a single colour. Spheres of corresponding colour move down(or up) the pathways provided by those helices. Of particular interest in the interactive mode is the curious ability then offered to inspect the conflation and fusion of the distinctive spheres as they enter or leave the wormhole at the origin point of the framework. This is best seen in a wireframe rendering. It can be understood as indicative of the dynamics of distinctive cognitive modalities as is typical of interdisciplinarity. Each helix is then suggestive of a distinctive thematic or cognitive stream of discourse.

| Views of cognitive wormhole for coloured spheres moving along corresponding quintuple helix pathways | | |
|------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Wireframe view of wormhole (animation) | Quintuple helix in pentagram framework | Wireframe view from wormhole (animation) |
|  |  |  |
| Video version (mp4) | | Video version (mp4) |

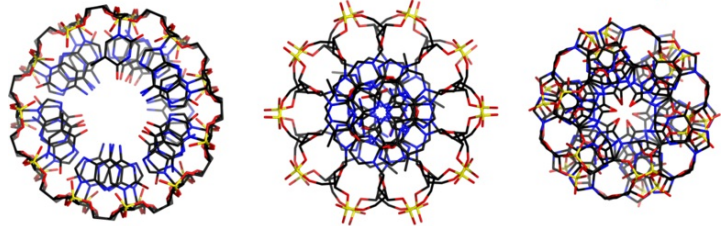
| Sphere fusion at wormhole | View from wormhole of approaching spheres | Partial sphere fusion prior to wormhole |
|------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
|  |  |  |
| Animated versions created with X3D-Edit. Interactive versions: X3D format ; WRL format | | |

The images and animations above derive from a single interactive model showing the 5 spheres in movement into and out of the wormhole. The model offers a number of viewpoints, most notably views **of the wormhole** and views **from the wormhole**, in addition to views from each end of the quintuple helix -- of spheres spiralling into and out of the wormhole. The design choice regarding direction of movement of spheres, into and out of the wormhole, has been made for illustrative purposes only. Clearly various alternative design choices could have been made.

Attribution of significance: considering meaningful pattern mapping

The argument above drew attention to the need to render more explicit the extent and nature of the bonding between the helical strands -- again in the light of their vital function in double- and triple-stranded DNA. Expressed otherwise, the issue is whether the helical structure offers a useful means of holding and integrating functional distinctions -- a pattern which can be meaningfully mapped, as has been the case with the [Human Genome Project](#).

An indication of the [most common DNA forms in terms of geometry](#) is presented below -- as seen through looking along the axis of the helix. The literature does not seem to indicate any focus on analogous patterns of bonding in the Triple Helix model.

| End view of A-, B-, and Z-DNA conformations. |
|----------------------------------------------------------------------------------------------------------------|
|  |
| Reproduced as a detail of an image in Wikipedia (where side views of the helix are also given) |

Memetic code and morphogenesis: Such patterns suggest a relation to the literature reflecting speculatively on the possibility of a "memetic code" as discussed separately (*Identifying 20 "amino acids" of a memetic code potentially vital to psychosocial life?* 2015) . Clearly this is a step beyond the current considerations of the Triple Helix model -- and is potentially indicative of the restrictive focus of that model in relation to innovation, if innovation is in any way to be considered analogous to [morphogenesis](#).

In psychosocial terms the latter has been a particular focus of [René Thom](#) (*Structural Stability and Morphogenesis*, 1972), as variously discussed separately (*Enabling morphogenesis and transformation through catastrophic questioning*, 2013; *Morphogenesis of globalization: enabling topological transformation*, 2010). Of particular interest to that approach is the relation between those preoccupations and [catastrophe theory](#) -- especially given the disruptive power of "cognitive cyclones". Envisaged as it has been to enable innovation of relevance to the future, has the Triple Helix model been "future proofed" and "hurricane proofed"?

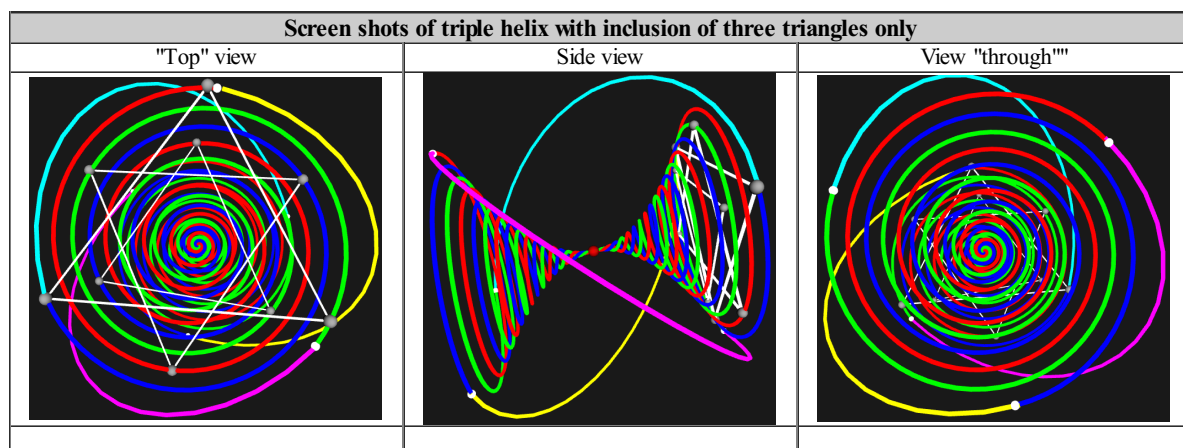
Whilst a "memetic code" remains elusive, if not questionable, there is considerable investment in patterns through which knowledge might be organized -- if only to facilitate the processes of search engine. Typically these avoid concern with the comprehensibility of such patterns and the coherence they supposedly imply.

It is in this sense that traditional preoccupation with coding systems in order to preserve collective memory merits attention, as extensively documented by [Lynne Kelly](#) (*The Memory Code: the Secrets of Stonehenge, Easter Island and other Ancient Monuments*, 2017; *This ancient mnemonic technique builds a palace of memory*, *Aeon*, 2017). Perhaps appropriately, any view along the axis of a helix (as above) recalls the preoccupation with circlets of beads (*Designing Cultural Rosaries and Meaning Malas to Sustain Associations within the Pattern that Connects*, 2000; *Engaging with Globality through Cognitive Circlets*, 2009).

The challenge is that such circlets are widely held to be meaningful -- whereas the Triple Helix is currently only meaningful to the very few, much challenged in communicating its potential to a wider audience (expected to subscribe to the framing it offers). A more provocative contrast could be made in the light of the strange significance associated with so-called "[loving cups](#)" ("pass cups", tygs) when 3-handled for ceremonial purposes, as is often the case across cultures and down the centuries. The 3 top-to-bottom links associated with the helical structure above render it reminiscent of that form.

The strange cognitive inversion implied by the contrast between rational articulation of academic and strategic models and the forms valued for their significance suggests that any "cognitive wormhole" is somehow irrationally fundamental to the creativity associated with radical innovation. This is evident to varying degrees in studies of creativity ([Arthur Koestler](#), *The Act of Creation*, 1964; [Daniel Dervin](#), *Creativity and Culture: a psychoanalytic study of the creative process in the arts, sciences, and culture*, 1990)

Triadic bonding between helical strands? Such indications frame the possibility of "populating" experimentally the triple helix in some comprehensible manner -- the issue being to ensure a triadic bonding between the three strands as variously indicative of stages and processes of interaction between academia, business and government, or the cognitive functions of which they are the institutional manifestation. An obvious approach is to link the strands with a set of triangles as being suggestive of a particular understanding of such psychosocial bonding.

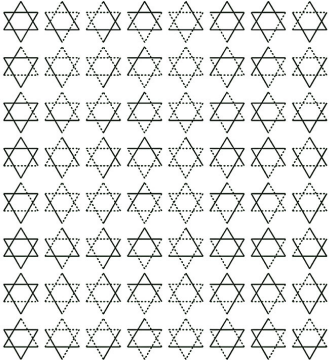
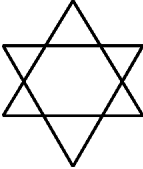


Clearly many more triadic bonds could be added in this way. How they are positioned precisely calls for (mathematical) attention to the relative position of the three strands so bonded. Multiple triangles viewed down the helix would bear some resemblance to the views above of DNA.

The triangles are especially indicative of the nature of triadic thinking, as cited above. The question then becomes how distinct significance might be attributed to any particular triangle linking the three strands. With respect to decision-making, the argument can be taken further by considering (if only speculatively) the relationship between the superposition of triangles (as perceived) and a particular relationship between the [Star of David](#) and the *I Ching* (*Mapping of I Ching hexagram coding onto Star of David*, 2008). Although resembling the Star of David in the simplest case, multiple inclusion of triangles between the helical strands would result in triads being variously oriented to one another, forming a more complex pattern.

As illustrated by the animation below, this has the advantage of highlighting a dynamic aspect to the triadic bond. It is appropriate to recall that the 64 different [hexagrams](#) distinguishing particular decision-making conditions within the *I Ching* are composed of an upper and a lower triad (of which there are 8 types). Speculative references to a complementary relationship between the *I Ching* and DNA patterns are noted separately (*Archetypal Otherness -- "DNA vs. I Ching"*, 2007). As with the triskelion, the point to be emphasized is the enduring significance widely attached to the *I Ching* over millennia. Appropriate to this argument, the relevance of the *I Ching* pattern is

a feature of the recent study by Steven Rosen, (*Quantum Gravity and Taoist Cosmology: exploring the ancient origins of phenomenological string theory*, *Progress in Biophysics and Molecular Biology*, 2017)

| Representation of <i>I Ching</i> hexagram codes mapped onto the Star of David (framed, for mnemonic purposes, by implications for innovation) | | | |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|----------------------------------|
| 64 <i>I Ching</i> hexagrams configured as double triangles (as in animation on the right) | Animation suggestive of the dynamics of triadic bonding -- up and down the helix | | |
|  | | Consensus (about innovation) | |
| | Comprehension (of innovation) |  | Coherence (of innovation) |
| | Confidence (in innovation) | | Communication (of innovation) |
| | | Complexity (of innovation) | |
| <p>[tentative: of interest is the convention regarding allocation of trigram lines to triangle positions and whether alternative allocations are anyway of significance in their own right</p> | | | |

Some possible sense of the distinctive decisions is indicated separately (*Transformation Metaphors derived experimentally from the Chinese Book of Changes (I Ching) -- for sustainable dialogue, vision, conferencing, policy, network, community and lifestyle*, 1997). Framing the animation (tentatively) by implications for innovation offers the suggestion that particular conditions may only apply in certain circumstances.

Helical supercoiling: To the extent that the Triple Helix model is inspired by the helical structure of DNA, it is curious to note the seeming absence of any reference to the significance of **DNA supercoiling** which is of such importance in a number of biological processes. This refers to the over- or under-winding of a DNA strand, and is an expression of the strain on that strand. Technically the "twist" is the number of helical turns in the DNA, whilst supercoiling is defined in terms of the "writhe", namely the number of times the double helix crosses over on itself. Extra helical twists are positive and lead to positive supercoiling, while subtractive twisting causes negative supercoiling.

Such insight into patterns fundamental to biological mutation should encourage insight into their implications for innovation in wider society. The potential relevance has been argued separately (*DNA Supercoiling as a Pattern for Understanding Psycho-social Twistedness*, 2004). The argument has been developed further in the experimental visualization of helical coils (*Visualization in 3D of Dynamics of Toroidal Helical Coils: in quest of optimum designs for a Concordian Mandala*, 2016).

Any use of "supercoiling" in relation to mutation and innovation is a reminder of the possible inappropriateness of assuming that this can best be comprehended in 3D, especially if significant innovation might be better understood as being of higher dimensionality. Termed **compactification**, physics makes a case for **higher dimensions** being "wrapped" up on themselves, or "curled" up on **Calabi-Yau spaces**, or on **orbifolds**. Such thinking has been recognized as relevant to the cognitive organization of the transformation processes in music (*In Quest of a Dynamic Pattern of Transformations*, 2012; Carol L. Krumhansl, *The Geometry of Musical Structure: a brief introduction and history*, *Computers in Entertainment*, 2005). Especially relevant to this argument is the work of **Dmitri Tymoczko** (*The Geometry of Musical Chords*, *Science*, 2007) who notes:



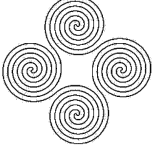
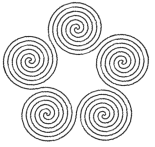
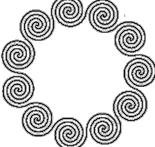




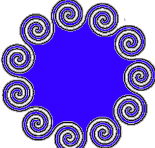
A musical chord can be represented as a point in a geometrical space called an orbifold. Line segments represent mappings from the notes of one chord to those of another. Composers in a wide range of styles have exploited the non-Euclidean geometry of these spaces, typically by utilizing short line segments between structurally similar chords. Such line segments exist only when chords are nearly symmetrical under translation, reflection, or permutation. Paradigmatically consonant and dissonant chords possess different near-symmetries, and suggest different musical uses.

Given the cognitive intimacy of musical comprehension and appreciation, associating the higher cybernetic orders of self-referential feedback (noted above) with the cognitive implications of 3D helices might be usefully explored in terms of such dimensional compactification and supercoiling.

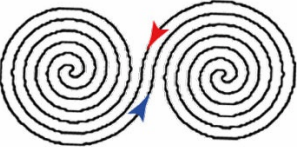
So framed, the external links between the "upper" and "lower" ends of the 3D helix depicted above, combined with the hexagram

patterning of the Star of David, suggest further possibilities as indicated by representation of the latter in 3D (*Framing Global Transformation through the Polyhedral Merkabah: neglected implicit cognitive cycles in viable complex systems*, 2017).

Quadruple helix / Quadskelions -- Quintuple helix / Quinskelions? As indicated with respect to the parametric renderings of the triskelion, the possibility of "polyskelions" can be readily envisaged (J. Jacquelin, *Parametric equations and specifications of a triskelion (triple spiral)*, *Mathematics Stack Exchange*, 30 January 2014). As adapted from the images there, these would take the following form. The coloured variants are included to emphasize the manner in which each could be understood as "engaging" with the environment and informed by it -- with the triskelion as the first in the sequence to suggest an "interior" and to function as a form of container.

| Comparative renderings of "polyskelions" | | | | |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Biskelion | Triskelion | Quadskelion | Quinskelion | Hendecaskelion |
|  |  |  |  |  |
|  |  |  |  |  |
| Adapted from depictions by J. Jacquelin (<i>Parametric equations and specifications of a triskelion (triple spiral)</i> , <i>Mathematics Stack Exchange</i> , 30 January 2014). | | | | |

The above panels offer a reminder that both the "skelions" and any helices can be of distinctive **chirality**, with whatever that may imply, as explored in another context (*Unquestioned Bias in Governance from Direction of Reading? Political implications of reading from left-to-right, right-to-left, or top-down*, 2016). Given that DNA can take both right and left-handed forms, is the Triple Helix model understood to be based on a right-handed or left-handed spiral -- and what would any such difference imply?

| Engaging with otherness: binary, ternary, quaternary and quinary relationships ? (experimental animation) | |
|--------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | <p>Arrows are associated with the double spirals to indicate the nature of their systemic linkage with neighbouring spirals. The directions of the arrows alternate as an indication of input and output of information.</p> <p>In "emitting" the coloured arrows, the spirals are assumed to be associated with the same colours in all the images (as used above: left=blue, right=red, upper/lower=green, except in the 4- and 5-fold cases),</p> |
|  | <p>The binary condition, typical of conflictual situations, is shown as transformed through an emergent third perspective (the triskelion), whether mediating (above), or engendering (reversed, as with an engendered child).</p> <p>Of particular interest is the manner in which systemic continuity is established paradoxically through the centres of each spiral (as "cognitive wormholes"). If any central whorls are occluded in some way, this would suggest an inauthentic relationship, even a systemically pathological condition.</p> <p>The animation would need to be further extended to take appropriate account of chirality.</p> |

The quadskelion could be considered relevant to the four-fold articulation of Nonaka (indicated above) as well as to possibilities of a Quadruple Helix model. Similarly the quinskelion form could be of relevance to proposals for a Quintuple Helix model. Of particular

interest in that respect is the significance associated with the 5-fold star in iconography, notably of both Islam and the USA, and the challenge implied by the 6-fold, as discussed separately (*Middle East Peace Potential through Dynamics in Spherical Geometry: engendering connectivity from incommensurable 5-fold and 6-fold conceptual frameworks*, 2012). The manner in which 5-fold and 6-fold stars link the helical strands of particular models is especially suggestive -- perhaps to be understood in terms of the operation of an electrical [commutator](#) and [rotary transformers](#).

There is a curious parallel with respect to health and healing between the pentagonal *Wu Xing* pattern, as a fundamental Chinese concept, and the Pythagorean symbol of the *Hygiea* (*Beyond dispute in 5-dimensional space: Pentagramma Mirificum?* 2015). That there is a degree of sensitivity to such pentagonal symbols is evident from the concern which can be aroused in the media by their inversion and association with questionable rituals. The hendecaskelion anticipates a rendering of a dodecaskelion with all the potential strategic implications currently associated with the 12-fold (*Checklist of 12-fold Principles, Plans, Symbols and Concepts: web resources*, 2011; *Topological Clues to a Memorable 12-fold Systemic Pattern*, 2011).

The presentation of spirals in the above argument has been limited to a particular number of "whorls", irrespective of whether the helix was triple or more complex. Any sense of the number of whorls appropriate to the meaning to be carried recalls the many considerations of "levels" in integrative processes, each level implying a higher integrative order -- however that is to be understood by different belief systems and schools of thought, as may be variously discussed (*Engaging with Insight of a Higher Order: reconciling complexity and simplicity through memorable metaphor*, 2014; *Engaging with Questions of Higher Order: cognitive vigilance required for higher degrees of twistedness*, 2004; *9-fold Higher Order Patterning of Tao Te Ching Insights: possibilities in the mathematics of magic squares, cubes and hypercubes*, 2003). In experiential terms, "whorl" can be explored through the framework of [spiral dynamics](#) (Don Edward Beck and Christopher Cowan, *Spiral Dynamics: mastering values, leadership and change*, 1996; Don Edward Beck, et al, *Spiral Dynamics in Action: humanity's master code*, 2018).

From global weather patterns to global whether patterns?

The various patterns presented above, in 2D or with their implications for 3D, are necessarily ideal abstractions variously susceptible to comprehension -- possibly through a degree of intuition. Suggestive comparisons with black holes may evoke another form of intuition to the extent they recall the experience of depression or being cogitively "in a spin". Reference to cyclones and hurricanes are suggestive of another kind of credibility to the extent these may have psychosocial analogues.

Weather mapping: It is therefore curious, as noted above, that there is widespread familiarity with global **weather patterns** as regularly presented by the media -- with real-time animations accessible on the web (*Earth: a global map of wind, weather, and ocean conditions*). It is all the more curious in that "win", "weather" and "sea" are all a source of metaphor to describe familiar psychosocial conditions and dynamics. Yet there is seemingly little effort to provide a comprehensible map of the "**whether patterns**" relevant to global decision-making. A case for doing so has been made separately (*Weather Metaphors as Whether Metaphors: transcending solar illusion via a Galilean-style cognitive revolution?* 2015). Common "cyclones" could then be recognized as the variously emergent issues of governance: employment, housing, food, environment, security, justice, etc. -- however these might be fruitfully related to responsible global agencies (industry, academia, government, civil society, religions, etc).

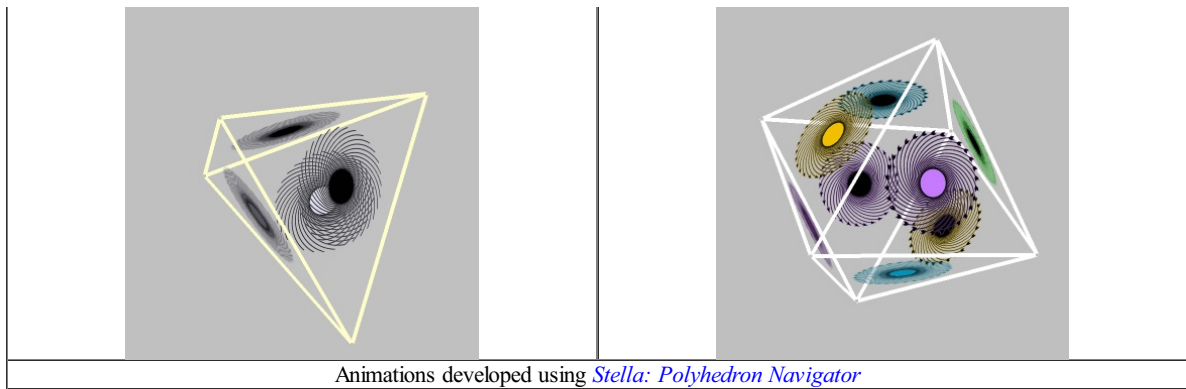
With respect to [cyclones](#) on the surface of a planetary globe, these are recognized as rotating counterclockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere; [anticyclones](#) rotate in the opposite direction in each case. This is due to a [coriolis force](#). Chirality is also recognized in the case of black holes. It is far from clear what analogues to such effects merit consideration in psychosocial systems. In psychophysical perception, misperception of body orientation due to the Coriolis effect (also referred to as the [Coriolis illusion](#)) can induce nausea and is a concern for pilots, for whom it can cause extreme disorientation. This suggests possible relevance to the challenge of global governance.

The helical representations -- whether symbolic or inspired by biomimicry -- could be understood otherwise by associating them to some degree with a global form, as an Earth analogue of global civilization understood in psychosocial terms. As is obvious from the presentation of global weather patterns, cyclones feature variously on the surface of the globe. Rather than emphasizing the relationships between them "superficially" as "skelions", triskelions, or otherwise) or "longitudinally" as with helices (triple, or otherwise), such idealization could be associated with approximations to a sphere -- as variously offered by the spherically symmetrical polyhedra. The degree of abstraction is then deliberately reduced for mnemonic purposes.

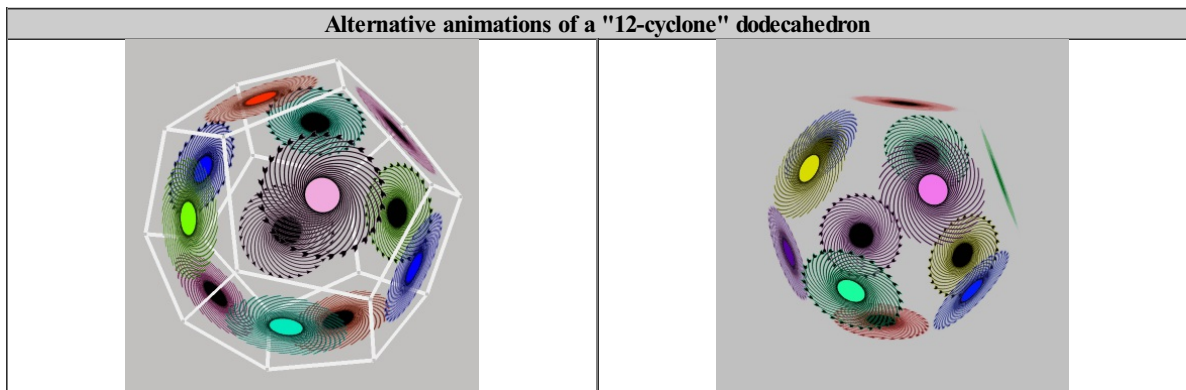
Polyhedral arrangement: Examples are provided by the following, based on various choices on how many issue/agency "cyclones" are to be distinguished. These derive from *Arranging the flowers to engender an ecosystem?* (2014), an exercise in representing the "cyclones" as "flowers", given the challenge of flow to comprehension (*Flowering of Civilization -- Deflowering of Culture: flow as a necessarily complex experiential dynamic*, 2014).

Following the argument above with regard to polyhedral holding patterns of different complexity, some indicators are offered by extending into three dimensions what might be considered the "2-flower" (biskelion) pattern of the Tao symbol, as illustrated by the following images and animations.

| Schematic animation of a "4-cyclone" tetrahedron | Schematic of animation an "8-cyclone" octahedron |
|--------------------------------------------------|--------------------------------------------------|
| | |



Of interest in this mnemonic approach is the representation of the compatibility between the flowers in the "ecosystem" constituted by the choice of polyhedron. This could be indicated by how the directionality of the arrows (clockwise/anti-clockwise, inward/onward) meshes with the neighbouring flowers (or "clashes" with them). A more complex example is offered by the "12-flower" case of the dodecahedron as indicated below.



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