



laetus in praesens

Alternative view of segmented documents via Kairos

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Comparable Modalities of Aesthetics, Logic and Dialogue In the light of correspondences between their polyhedral representation

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Introduction

Various elements of the following argument originally featured in a discussion of *Living with the enemy as an aesthetic challenge?* (2021), in the light of the strategic shift by a number of governments from "elimination of COVID-19" to one of "learning to live with the virus". Framed as the principle enemy of humanity at this time, the shift is subtly related to other arguments with regard to the need for an enemy as a sustaining focus for viable governance as currently conceived.

As indicated earlier, when framed as a conventional threat, an enemy typically evokes the kinds of strategic response favoured from a security perspective and cultivated with military metaphors (*Enhancing Sustainable Development Strategies through Avoidance of Military Metaphors*, 1998). Terrorism and Afghanistan have been witness to the questionable outcome.

The aesthetic modality is typically ignored (other than in parades) or presented through horrific images to evoke a military response. Given such unfruitful outcomes, it is appropriate to ask whether aesthetics offers more integrative possibilities, as previously argued (*Aesthetics of Governance in the Year 2490*, 1990; *A Singable Earth Charter, EU Constitution or Global Ethic?* 2006).

The curious possibilities of poetry have been argued with respect to Afghanistan, for example (*Poetic Engagement with Afghanistan, Caucasus and Iran an unexplored strategic opportunity?* 2009; *Strategic Jousting through Poetic Wrestling: aesthetic reframing of the clash of civilizations*, 2009). In any exploration of living with the enemy, a more general case can be made (*Poetry-making and Policy-making: arranging a marriage between Beauty and the Beast*, 1993). With respect to the new challenge of negotiating with the Taliban, this may be of particular relevance -- seemingly as yet to be explored.

A major difficulty in any unconventional exploration of the wider significance of "aesthetics" follows from the characteristics of so-called **silos** and **mentalities**. Typically those with greatest insights into music, for example, are alienated by the perspective of mathematicians on the matter -- who may well have little interest in the aesthetics of music. Both may question the relevance of logicians, for whom aesthetics as such may be close to meaningless. Given the hypersimplicity of strategic decision-making in this period -- with its dependence on binary thinking -- any possible relevance of aesthetics to governance and more fruitful processes of dialogue are readily held to be inherently remote. As might be expected, those offering mediating skills in dialogue attach little significance to aesthetics, maths or logic.

Curiously however, great value is attached to iconic poetry, song and music on the occasion of some forms of summitry -- purportedly exemplifying the values central to their decision-making. The choral role of Beethoven's *Ode to Joy* in the *Anthem of Europe* is an obvious example -- although its cognitive relevance to those exposed to it would seem to be completely and utterly ignored, as speculatively argued (*Reversing the Anthem of Europe to Signal Distress*, 2016)

Arguable there is good reason for impatience in this context, given the crisis of governance. Rather than the old advice of "following the money", the

bias in the following argument is to "follow the numbers" as an organizing principle -- especially given the extent that they are potentially meaningful across disparate and otherwise incommensurable domains. A striking example is offered by the unexplained preference for 12-fold strategies (*Checklist of 12-fold Principles, Plans, Symbols and Concepts: web resources*, 2011).

In that light it can be asked whether there are particular psychosocial and cognitive constraints on the preference for sets of numbers, as is variously explored by some disciplines (*Comprehension of Numbers Challenging Global Civilization*, 2014; *Representation, Comprehension and Communication of Sets: the Role of Number*, 1978; *Patterns of N-foldness: comparison of integrated multi-set concept schemes as forms of presentation*, 1980).

The following speculative argument explores some implications for the relation between disciplines and practitioners -- ensconced in their respective ivory towers -- and the potential relevance for governance which is typically irrelevant to them. The dismissal of such preferences as a coincidence may well be as dangerously simplistic as their deprecations of the aspersions of numerology. The point has been argued with respect to the UN's Sustainable Development Goals (*Systemic Coherence of the UN's 17 SDGs as a Global Dream: Rather than merely an arbitrary outcome of political horse-trading*, 2021). Given the role of religion as a powerful influence on governance, the point can be argued otherwise (*Mathematical Theology: Future Science of Confidence in Belief -- self-reflexive global reframing to enable faith-based governance*, 2011).

In "following the numbers", the biased focus in what follows is on the tendencies in a very wide range of disciplines to recognize patterns in terms of 14-foldness. Given that many of these relate to governance of a kind, the question is how the articulation of such a pattern may be rendered comprehensible and memorable -- if only in valuable mnemonic terms, as argued separately (*Time for Provocative Mnemonic Aids to Systemic Connectivity?* 2018). The latter exercise notably focused on an issue of current relevance to governance in practice, namely the possibility of reconciling the "headless hearts" to the "heartless heads". This is strikingly highlighted in what follows by the remarkable disconnect between the **logical connectives** (so vital to the algorithms of global modelling and the detection of misinformation) and the subtleties of natural language -- so readily ignored in dangerously simplistic decision-making.

The possibility of connectivity of a subtler order, consistent with the 14-fold pattern explored here, is the aesthetic role of the world-renowned **sonnet** form of 14-lines. This is most notably celebrated in the work of William Shakespeare and the poet **Petrarch** as instigator of Renaissance humanism. **In contrast with most other 14-fold patterns, that form is especially remarkable in that it makes aesthetic use of logical connectives to interrelate the details articulated in the succession of lines.** This suggests implications for the comprehensibility and memorability of complex strategic initiatives, whether the UN's SDGs, engagement with the pandemic, or with the challenge of climate change.

Of interest in this respect, is the use of artificial intelligence to generate sonnets (Jey Han Lau, et al, *Deep-speare: A joint neural model of poetic language, meter and rhyme. Proceedings of the 56th Annual Meeting of the Association for Computational Linguistics (Long Papers)*, 2018), summarized by the authors as *This AI Poet Mastered Rhythm, Rhyme, and Natural Language to write like Shakespeare, IEEE Spectrum*, 30 April 2020). This initiative is indicative of the potential for transforming alienating texts of treaties and climate pacts into memorable form, as previously suggested with respect to the **sonification** of vaporware and **global hot air emissions**.

Pattern of 14-foldness as an implicit organizing principle for governance?

The case for the following search of web resources follows from two similar investigations undertaken previously (*Checklist of 12-fold Principles, Plans, Symbols and Concepts: web resources*, 2011; *Requisite 20-fold Articulation of Operative Insights? Checklist of web resources on 20 strategies, rules, methods and insights*, 2018).

Web searches were undertaken to determine the extent to which a 14-fold pattern was used to organize information of relevance to any form of governance. Typically the search key, using Google or Bing, was for "14 X", where X could be any of the following: points, pillars, phases, stages, steps, commandments, principles, articles, stages, rules, guidelines, or steps. A few other sources were used, notably *Wikipedia* and *Listverse*. The results have been roughly clustered below by theme (rather than by X).

A key question is how the individual results are to be interpreted, and which could be provisionally set aside as not immediately helpful to the later commentary (to follow). Possible interpretations include:

1. use of 14 is simply arbitrary and similar results would be available for similar themes using 12, 13, 15 or 16, for example
2. use of 14 as a propaganda slogan, as with its value to white-supremacists (*Fourteen Words*)
3. use of 14 as derived from traditional symbolism, possibly as some form of imitation of its use in mythology
4. use of 14 as a consequence of preoccupation with numerology, ciphers and **gematria**, possibly following from the previous point
5. use of 14 as primarily imitative of use of that number in related literature on a theme
6. use of 14 as derived from 2x7, given the greater attention that has been given to use of that number
7. use of 14 as implying in some manner a sense of closure, namely the completion of a set -- typically in the absence of explanation of how it constitutes completion (in contrast with lesser or greater numbers)
8. use of 14 as follows from well-studied sets of constraints, typically informed by mathematics

The primary interest is in (7) and (8), with some sense of how insights into closure may have informed traditional thinking, namely (3). As a number greater than those which it follows (7 to 13), a key question is how any closure of the set is comprehended, since the ability to recall with ease any of the elements of a set between 7 and 13 decreases progressively.

Under what conditions does 14 "work" -- or is believed to do so -- and why? This question can obviously be asked of the set of 16+1 Sustainable Development Goals (as noted above), and of the results of the similar exercise with regard to sets of 20 indicated above.

Through clustering the sets roughly by theme (despite a degree of overlap), this clearly focuses the question as to how a set of 14 may be held to be especially relevant to the particular domain. The results are presented separately as an annex, because of the length of the checklist (*Pattern of 14-foldness as an Implicit Organizing Principle for Governance? Web resources*, 2021). The 170 sets there are roughly clustered as follows (with some commentary):

- Management
- Entrepreneurship / Organization
- Leadership
- Policy / Governance
- Sustainability / Environment
- Ethics / Justice
- Religion / Spirituality / Symbolism
- Health
- Knowledge / Data / IT
- Education / Communication
- Design
- Rules
- Miscellaneous:

Intuitive pattern recognition and its formal articulation?

With respect to pattern recognition, this exercise is supported to some degree by the arguments of [Jeremy Lent](#) (*The Patterning Instinct: a cultural history of man's search for meaning*, 2017) as critically reviewed separately (*Patterning Intuition with the Fifth Discipline*, 2019).

As indicated above, the intention of the whole checklist of disparate indications is to focus on **the possibility of a subtle or intuitive recognition of a particular form of integrative coherence which is given a variety of expressions -- in the absence of a "language" through which to express such subtlety**. It is in this sense that the comprehension and expression of such a 14-fold pattern may be more meaningful through music or poetry (as discussed below).

However, when a 14-fold pattern is expressed, through music or otherwise, there is the possibility that the constraint defining the completion and closure of the pattern (namely not 13, not 15), is indicated by intuitive recognition of what lends itself to a degree of clarification in mathematics, topology, logic and cybernetics. Some potential indications are offered by:

- **14 possible Bravais lattices filling three-dimensional space**, as discussed below, in relation to crystallography and polyhedral. The 14 Bravais lattices are grouped into seven lattice systems: triclinic, monoclinic, orthorhombic, tetragonal, rhombohedral, hexagonal, and cubic. (*Why are there only 7 types of unit cells and 14 types of Bravais lattices?* [Chemistry Stack Exchange](#))
- **14 non-trivial binary connectives in logic**, namely the 16 binary Boolean connectives, minus the "tautology" and the "contradiction" connectives. As determined by the psychologist [Shea Zellweger](#), these may be embedded into a 3D rhombic dodecahedron (which he called a "logical garnet"); a similar structure of 6 logical hexagons had been proposed by [Paul-Aimé Sauriol](#) (*Remarques sur la Théorie de l'hexagone logique de Blanché*, *Dialogue*, 7, 1968; *La structure tétrahexaédrique du système complet des propositions catégoriques*, *Dialogue*, 15, 1976) as discussed below and separately (*Neglected recognition of logical patterns -- especially of opposition*, 2017).
- **14 electrons for f-sublevel completion**: the maximum number of electrons that can fit in the f-sublevel of an atom, as clarified below by presentations of the periodic table of chemical elements (*How many electrons can occupy the f orbitals at each energy level?* 2018)
- **14 sides to bubbles in a foam**, as noted by a specialist in the architecture of biological cells, [Donald Ingber](#): He argues elsewhere that there are fundamental design principles that govern the structure of any foam in 3D: the bubbles, on average, have 14 sides. This is well accepted and confirmed experimentally although the focus of current research (*Weaire-Phelan Structure*, *DesignCoding*). Yet, as noted by Ingber, some bubbles have 13 sides, others 15, other 12, etc.; the shape of any particular bubble is impossible to determine. Nevertheless, on average, they always come out to 14. Thus, one can deduce fundamental design principles that are certain in an 'uncertain' world. (*Interview with Donald E. Ingber*, *Culture Machine*, *InterZone*, July 2002)
- **14 process elements** identified from a cybernetic perspective as constituting a comprehensive performative epistemology for the **viable system model** (VSM) process (David Lowe, Angela Espinosa and Mike Yearworth, *Constitutive Rules for Guiding the Use of the Viable System Model: reflections on practice*, *European Journal of Operational Research*, 287, 2020, 3). As noted by the authors, and of relevance to the disparate nature of the checklist above, **these are held to be representative of the range of VSM practice but not an exact reproduction of the coverage in each of the sources analysed, keeping with the requirement to capture process elements that would be generative of variability of practice rather than prescriptive of it**.
- 14 Feynman diagrams, namely pictorial representations of the mathematical expressions describing the behaviour and interaction of subatomic particles. 14 such diagrams constitute a class of primitive diagrams representative in quantum mechanics of scalar **meson-nucleon scattering**.

A number of these disparate clues -- variously informed by mathematics -- are tentatively interrelated in the following exploration. This includes reference to the conclusion of the explorations of [Christopher Alexander](#) (*A Pattern Language*, 1977; *The Nature of Order: an essay on the art of building and the nature of the universe*, 2003-4), most notably with respect to harmony, as discussed separately (*Harmony-Comprehension and Wholeness-Engendering: eliciting psychosocial transformational principles from design*, 2010).

Also noted as of potential interest, but not considered, are

- **the 14-factor solution of a factor analysis** to construct a scale measuring the unidimensional facets underlying the term **perfectionism** (Agnes Mariann Stairs, *Examining the Construct of Perfectionism: a factor-analytic study*, University of Kentucky, 2009).
- **14-factor government securities yield curve**: namely providing an understanding of the dynamics of **yield curves** as critical input to the risk management calculations of central banks, bank regulators, major banks, insurance firms, fund managers, pension funds, and endowments around the world (Donald van Deventer, *A 14-Factor Heath, Jarrow and Morton Model for the United Kingdom Government Securities Yield Curve, January 1979 to January 2017*, *Nasdaq*, 10 July 2017). In contrast with a degree of dependence on single factor explanations, the study considers 14 potential explanatory factors: the idiosyncratic portion of the movements in quarterly forward rates that mature in 14 periods between 6 months and 25 years, extending the 10 factors indicated in the Bank for International Settlements market risk guidelines; all 14 factors are statistically significant across the yield curve for United Kingdom Government Securities
- **14 distinct sets of real numbers**: namely those that can be generated through taking a set of **real numbers** and applying the **closure** and **complement** operations to it in any possible sequence.

The separate checklist of 14-fold patterns clearly highlights the question as to the nature of the 14 "whats" that may be expressed in a 14-fold pattern. **It might be expected that the language used in each domain reduces or distorts any more general meaning in some way -- in the absence of any adequately comprehensible or communicable meta-language**. Why indeed were some major traditional temples designed with 14 pillars (as noted above)?

The point to be stressed is that any meta-language of relevance to current strategic crisis of governance is potentially a major challenge to comprehension, and if partially understood may be variously interpreted and applied in ways that are usefully clarified by Lowe et al.

It is in this sense that a curious study by the historian of philosophy [W. T. Jones](#) is helpful in framing the discussion (*The Romantic Syndrome: toward a new methodology in cultural anthropology and the history of ideas*, 1961). As discussed separately, the author distinguishes 7 axes of bias linking 14 extremes which could be understood as encompassing the disparate variety above (*Axes of Bias in Inter-Cultural Dialogue*, 1993; *Sustainable Development: a system of 14 complementary concepts*, 1994).

Given the concern with comprehension, the argument which follows focuses first on a musical articulation of 14-foldness -- an alternative modality offering a framework to which the other formal possibilities noted above may be potentially related. One clue may lie in the pairing of the 14 as 2×7 , given the greater comprehension of 7-foldness ([George A. Miller](#), *The Magical Number Seven, Plus or Minus Two: some limits on our capacity for processing information*, *Psychological Review*. 63, 1956, 2).

Bach's Fourteen Canons -- musically complete (30 minus 16)?

A provocative point of departure is the significance attributed to the canons of Johann Sebastian Bach (*Fourteen Canons on the first eight fundamental notes of the aria* and their relation to the *Goldberg Variations*). There are numerous recordings of these, although far less evident is how they may then be understood to enable "living with the enemy" -- and why their value has not been explored from this perspective, especially as being potentially indicative of the forms fundamental to the architecture of any New Renaissance.

Comparison can be made with the 14 *Enigma Variations* composed by [Edward Elgar](#), whose "enigma" continues to invite speculation ([Robert W. Padgett](#), *Elgar's Enigma Theme Unmasked*, 2012). Thus for [Stephen Johnson](#) (*What are... variations in music?* *BBC Music Magazine*, 9 June 2016) :

In Elgar's *Enigma* the process is mostly what you might call 'melodic' variation. The original theme is audibly present in each one of the 14 variations, however much Elgar may decorate it, extend it here or contract it there. The effect is like a series of portraits of the same person, but in different costumes and settings, engaged in different kinds of activity. In the Bach however, it is not so much the tune as the bass-line -- along with harmonies built upon it -- that remains constant. However long or short the variations, each one is clearly based on the same harmonic template, the proportions more or less the same -- let's call this 'harmonic' variations.

Whilst Elgar was obsessed with cryptography, it is intriguing that Bach attached such considerable importance to patterns of numbers, as discussed by [Milton Mermikides](#) (*Maestro of more than music*, *Aeon*, 10 September 2021). This notes his preoccupation with the number 14 -- extensively "encoded" in his music -- a matter variously debated in terms of number symbolism (or deprecated as numerology). Of further interest is the fact that the *Goldberg Variations* consist of the aria of 14 together with a set of 30 variations. Less evident is the extent to which these constitute complete sets, and how they relate to one another -- potentially precluding additional variations, as might be evident from a mathematical perspective. ([Tom Huizenga](#), *Bach's Enduring Enigma: an introduction to the 'Goldberg Variations'*, *NPR*, 19 March 2012).

The *Goldberg Variations* have a complex and unconventional structure: the variations build on the bass line of the aria rather than its melody, and musical canons are interpolated according to a grand plan. There are 9 canons within the 30 variations; every third variation is a canon. These variations move in order from canon at unison to canon at the ninth. The first eight are in pairs (unison and octave, second and seventh, third and sixth, fourth and fifth). The ninth canon stands on its own due to compositional dissimilarities. The final variation, instead of being the expected canon at the tenth, is a *quodlibet*. It has been suggested that the inspiration for Bach from an aria with 64 variations by [Handel](#) in 1733.

Setting aside the cryptography of Elgar, and focusing primarily on Bach, the question raised by the 14 canons is whether they exemplify in some way the 14 "process elements" distinguished by [Lowe et al](#) (2020). Did Bach have an intuitive appreciation of what now constitutes a "viable system" from a cybernetic perspective? [Ironically it is perhaps appropriate to note that the instigator of VSM theory, [Stafford Beer](#), named his dogs Bach]. Do the 14 canons offer a musical interpretation of those process elements -- allowing for the abstractions of the meta-language from which both languages might be said to emerge?

Counterpoint -- a musical instance of opposition?

Counterpoint -- and the enemy: This exploration is framed by the need for greater understanding at this time for a more highly developed understanding of "living with the enemy". This can be usefully explored through [counterpoint](#). In the case of Elgar's *Enigma Variations*, it has been argued that the theme is a counterpoint on some well-known melody which is never heard. The much admired music of Bach (*The Well-Tempered Clavier*, 1722) is recognized as exemplifying the art of counterpoint.

As clarified by *Wikipedia* (which offers a sound file of an example from Bach):

In music, counterpoint is the relationship between two or more musical lines (or voices) which are harmonically interdependent yet independent in rhythm and melodic contour. It has been most commonly identified in the European classical tradition, strongly developing during the Renaissance and in much of the common practice period, especially in the Baroque... Counterpoint focuses on melodic interaction -- only secondarily on the harmonies produced by that interaction.

Counterpoint has been given a mathematical foundation. The entry cites [John Rahn](#) to the effect that:

It is hard to write a beautiful song. It is harder to write several individually beautiful songs that, when sung simultaneously, sound as a more beautiful polyphonic whole. The internal structures that create each of the voices separately must contribute to the emergent structure of the polyphony, which in turn must reinforce and comment on the structures of the individual voices. The way that is accomplished in detail is ... 'counterpoint'. (*Music Inside Out: Going Too Far in Musical Essays*, 2000).

Counterpoint species: Counterpoint continues to be taught through a set of five "species", elaborated in its original form by [Johann Joseph Fux](#) (*Gradus ad Parnassum*, 1725):

- Note against note;
- Two notes against one;
- Four notes against one;
- Notes offset against each other (as [suspensions](#));
- All the first four species together, as "florid" counterpoint.

In all species, the following rules govern the combination of the parts:

- The counterpoint must begin and end on a perfect [consonance](#).
- [Contrary motion](#) should dominate.
- Perfect consonances must be approached by oblique or
- The interval of a tenth should not be exceeded between two adjacent parts unless by necessity.
- Build from the bass, upward.

- contrary motion.
- Imperfect consonances may be approached by any type of motion.

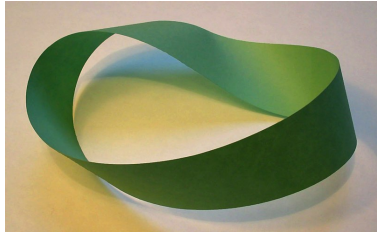

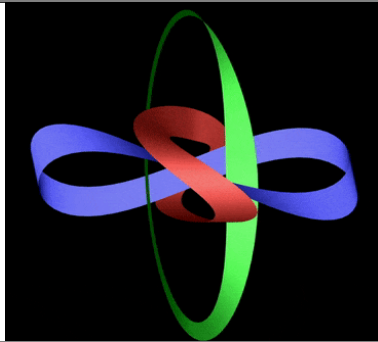
Strategic counterpoint? As discussed with respect to *Structuring Mnemonic Encoding of Development Plans and Ethical Charters using Musical Leitmotifs* (2001), Jacques Attali has argued for recognition of the anticipatory power of the organization of music with respect to social organization, notably that of Bach (*Noise: the political economy of music*, 1977). Of special interest is the controversy this book aroused (see web reviews). He himself became the first president of the European Bank for Reconstruction and Development. He has since written *Demain, qui gouvernera le monde?* (2011), the subject of a separate critique (*Tomorrow, Who Will Govern the World?* 2011).

With respect to the strategy of universal vaccination, any understanding of transcendent harmony offered by counterpoint is clearly severely inhibited as a result of the systematic suppression of any counterpoint in discourse. It could be said that the strategic need to reframe any form of disagreement as misinformation, if not disinformation, bears a strange resemblance to the constraints imposed on acceptable sacred music by religious authorities to the exclusion of the so-called *diabolus in musica* (*Why is the Augmented 4th the "chord of evil" that was banned in Renaissance church music?*, *The Guardian*; *Musicae Sacrae: Encyclical of Pope Pius XII on Sacred Music*, 25 December 1955).

Of some relevance to this argument, counterpoint features in the study by Douglas Hofstadter (*Gödel, Escher, Bach: an Eternal Golden Braid*, 1979). In that respect it has been speculatively argued that the elusive "integration" variously sought may of necessity be dynamic rather than static -- and as such "fugitive" (*Fugitive Integration*, 1982; *Some Clues to Social Harmony from Music*, 1993).

Musical clue to engaging with "the other side" through the Möbius strip: Whilst potentially pleasing to the eye, the animations above engage only one of the senses in the quest for a more fruitfully integrative "perspective". The argument can be developed through recognition of the limitations of the un-reconcilable two-sidedness evident in the rotating board presented above -- an embodiment of "us" and "them", and the threat to either of the "dark side".

Extension of the geometry of a two-sided board into a strip, with the addition of a twist, suggests paradoxical cognitive possibilities to which reference is occasionally made. This is the primary feature of the **Möbius strip**: the strip has only one side (as shown below left). This invites commentary on alternative ways of engaging with any other (*Psychosocial Work Cycle: beyond the plane of Möbius*, 2007; *Psychosocial Energy from Polarization within a Cyclic Pattern of Enantiodromia*, 2007). It suggests a means of "unknotting" strategic dilemmas, as these may be related to Borromean rings, as suggested below right (*Engaging globally with knots and riddles -- Gordian and otherwise*, 2018).

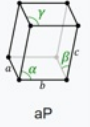
Möbius strip as suggestive of cognitive challenge		
Conventional image	Animation of the "use" and "them" illusion	Borromean ring configuration (with Red surrounds blue; Blue surrounds green; Green surrounds red)
		
David Benbennick, CC BY-SA 3.0, via Wikimedia Commons		Video (mp4); Virtual reality (x3d; wrl)

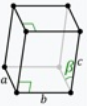

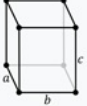

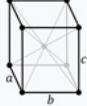
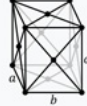
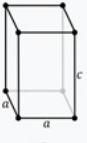
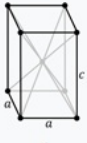
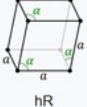
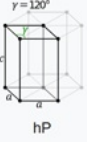
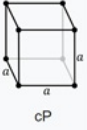
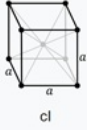
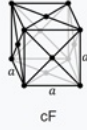
The above images are far from exhausting the clues suggestive of possibilities of engaging with otherness -- remarkably clarified through the implication of the Möbius strip in the music of Bach, as discussed and illustrated musically by Tony Phillips (*Bach and the musical Möbius strip*, *Plus Magazine*, 2016; based on work with Eric Altschuler, published in *Musical Times* in 2015). The commentary is consistent with the arguments of Douglas Hofstadter, as mentioned above.

Phillips' argument turns on the possibility of imprinting a musical score on "one side" of a Möbius strip, with the challenging implied question -- since the strip only has one side -- of how the score then relates musically to the "other side".

Comprehension of 14-foldness through Bravais lattices -- and precious stones?

As mentioned above, fundamental to understanding in crystallography is the role of the 14 **Bravais lattices** in exhausting the possibilities of filling three-dimensional space. They are grouped into seven lattice systems: triclinic, monoclinic, orthorhombic, tetragonal, rhombohedral, hexagonal, and cubic. (*Why are there only 7 types of unit cells and 14 types of Bravais lattices?* *Chemistry Stack Exchange*).

(Lattice system) Crystal family	14 Bravais lattices					Space groups	**** Point symmetry
	Point group (Schönflies notation)	Primitive (P)	Base-centered (S)	Body-centered (I)	Face-centered (F)		
(a) Triclinic montebrasite, amazonite, perthite, rhodonite, kyanite, axinite, sunstone, moonstone	C_1					2	enantiomorphic polar
(m) Monoclinic gypsum, brazilianite, azurite,						13	

titanite, chrysocolla, jade, spodumene		C_{2h}							
(o) Orthorhombic tanzanite, chrysoberyl, olivine, andalusite, topaz, cordierite		D_{2h}					59		
(t) Tetragonal zircon, scapolite		D_{4h}					68		
(h) Hexagonal beryl, benitoite, sugilite, apatite, taaffeite	Rhombohedral	D_{3d}					7		
	Hexagonal	D_{6h}					18		
(c) Cubic diamond, garnet, spinel, pericals		O_h					36		
Adapted from Wikipedia									

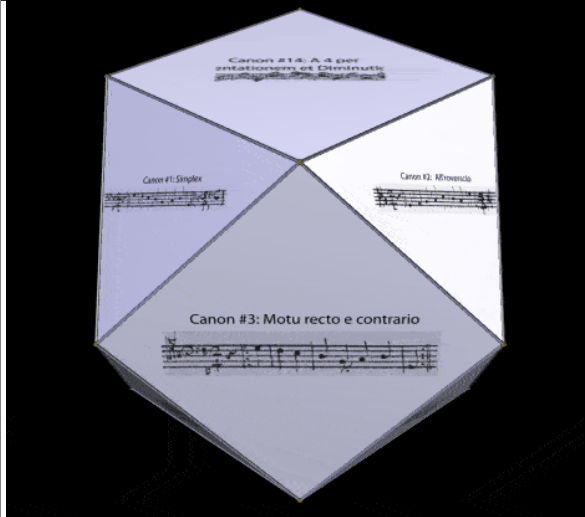

Arguably the familiarity with crystals should then be supportive of comprehension of patterns of 14-foldness, avoiding the abstruse mathematics through which such lattices are defined by specialists. Again it could be asked whether, in distinguishing 14-fold sets, there is an intuitive appreciation of the order framed otherwise by such lattices.

The widespread appreciation of precious stones, and the manner in which they are associated with the highest human values, is suggestive of some such possibility (*Patterning Archetypal Templates of Emergent Order: implications of diamond faceting for enlightening dialogue*, 2002; *Summary of Gemstone Faceting and Crystals*, 2002).

Cognitive implication in polyhedra: the 14-sided cuboctahedron and its dual,

As polyhedra, such patterns were central to the structural interest of Buckminster Fuller, most obviously his focus on the cuboctahedron of 14 faces and its much-studied vector equilibrium ("jitterbug") transformations into other polyhedra characterized by 30 features (H. F. Verheyen, *The complete set of Jitterbug transformers and the analysis of their motion*, *Computers and Mathematics with Applications*, 17, 1989, 1-3; *Vector Equilibrium and its Transformation Pathways*, 1980).

The wider appreciation of such transformations through music is suggested by mapping the 14 canons onto the faces of a cuboctahedron, and noting the manner in which it unfolds. Of relevance to the above argument, Fuller's preoccupation with the management of global resources (notably in the light of the image of *Spaceship Earth*) was informed by geometric insights derived from the cuboctahedron (*Operating Manual for Spaceship Earth*, 1968). However, despite the intention implied by the title of his 2-volume magnum opus (*Synergetics: Explorations in the Geometry of Thinking*, 1975), this has not translated into cognitive facilitation of "living with the enemy" in the New Renaissance (*Geometry of Thinking for Sustainable Global Governance: cognitive implication of synergetics*, 2009).

Integrative implications of music and geometry	
Bach's 14 canons on a cuboctahedron	Unfolding a cuboctahedron with canon mappings
	
Generated using Stella Polyhedron Navigator	

A possible bridge is to be found in the cybernetic insights of [Stafford Beer](#) into [viable systems](#) and [syntegration](#), especially the role of 30-foldness in the icosahedron (*Beyond Dispute: The Invention of Team Syntegrity*, 1994; Tara Carpenter Estrada and Brittany Nixon May, *Building Bridges With Bach: syntegration of music and visual art, General Music Today*, 12 March 2019). The mystery of any cognitive core operations is: **why 30, why 20, why 14?** Why do such numbers "work", as tentatively explored separately (*Requirement for emirps and enantiodromia in navigating songlines; Requisite variety of "voices" for psychosocial wholth: 6, 8, 12, 20, 30?*; *Toneship design to enable noonautics by the voices of civilization?* 2015).

Given the role of an [orbifold](#) in ordering musics ([Dmitri Tymoczko](#), *The Geometry of Musical Chords, Science*, July 2007), it is intriguing that orbifolds have a recognized role with respect to what can be termed the "moonshine" connectivity of such subtle correspondences (Michael P. Tuite, *Monstrous Moonshine from Orbifolds*, 1992). Curiously the "theory of variations" is also a fundamental theme of mathematics -- although how this might inform the musical insight, or that of the psychosocial life of a New Renaissance, remains to be highlighted.

Oppositional logic and its geometry – 16 minus 2 connectives?

Oppositional logic: A related approach to "living with the enemy", offers possible clues to the collective insight of Bach's 14 canons, namely through the geometry of oppositional logic (*Oppositional Logic as Comprehensible Key to Sustainable Democracy: configuring patterns of anti-otherness*, 2018; *Neglected recognition of logical patterns -- especially of opposition*, 2017). The relevance of some such approach is evident from current preoccupation with fake news and misinformation, which has triggered extensive investment in use of artificial intelligence to filter out such information from data accessible to the public.

However, the manner in which questionable information continues to be generated suggests that -- as with the coronavirus -- it may indeed be necessary to "live with the enemy" (as an instance of "untruth") rather than desperately to pursue a strategy of its elimination. The point is all the more relevant in that "misinformation" may be variously interpreted from different perspectives, some of which may be appreciated as a characteristic of humour and entertainment (*Comparability of "Vaxxing Saves" with "Jesus Saves" as Misinformation? Problematic challenge of global discernment*, 2021). Use of algorithms to filter information is then itself questionable, if an AI is expected to engage credibly with humans in discourse consistent with the [Turing test](#).

Truth tables: Arguably if there is one characteristic of psychosocial reality which is a fundamental challenge to governance it is that of "opposition" and the framework within which it can be appropriately and coherently integrated. The argument for doing so is that the relevant academic literature is particularly focused on the **geometrical representation of opposition** as otherwise articulated in [truth tables](#) through the set of 16 Boolean [logical connectives](#). Fundamental to understanding of opposition is that perceived between "true" and "false", as clarified by so-called [binary truth functions](#).

The formal recognition from a logical perspective of 16 logical connectives is fundamental to the organization of [logic gates](#) in computers -- the device whereby information and misinformation are purportedly to be distinguished at this time, and whereby results are obtained from advanced computer searches (*Know about Basic Logic Gates with Truth Tables, Elprocus*).

Truth table for all 16 binary logical operators (adapted from Wikipedia ; clustered in pairs)								
	Operation name	Brief explanation	Venn (red=true)	Logic gate	True (1) False (0)		Operator	
15	Tautology	a formula or assertion that is true in every possible interpretation; redundancies of propositional logic			1111	TTTT		(P OR NOT P)
0	Contradiction	when a proposition conflicts either with itself or established fact; often used as a tool to detect disingenuous beliefs and bias.			0000	FFFF		
14	Logical disjunction	meaning either refines or corresponds to that of natural language expressions such as "or". P, but Q			0111	FTTT	OR	P OR Q (P AND Q)
1	Logical NOR	joint denial, namely a truth-functional operator which produces a result that is the negation of logical "or".			1000	TFFF	NOR	P NOR Q NOT (P NOR Q)
13	Converse implication	the truth of the converse is generally independent from that of the original statement			1011	TFTT*		(Q IMPLY P)
2	Converse nonimplication	the negation of converse implication (equivalently, the negation of the converse of implication).			0100	FTFF		NOT (Q IMPLY P)
12	Projection function				0011	FFTT		(P)
3	Negation	interpreted intuitively as being true when another proposition is false, and false when the other is true			1100	TTFE		NOT (P)

11	Material implication	assumed as a model of correct conditional reasoning within mathematics; serving as the basis for commands in many programming languages. Due to the paradoxes of material implication and related problems, material implication is not generally considered a viable analysis of conditional sentences in natural language. If P then Q; Either P or Q			1101	TTFT		(P OR Q*)
4	Material nonimplication	the material nonimplication from P to Q is true only if P is true and Q is false.			0010	FFTF		NOT (P OR Q*)
10	Projection function	the function from elements to equivalence classes is a surjection, and every surjection corresponds to an equivalence relation under which two elements are equivalent when they have the same image			0101	FTFT		(Q)

5	Negation				1010	TFTF		NOT (Q)
9	Logical biconditional	the only case where a logical biconditional is different from a material conditional is the case where the hypothesis is false but the conclusion is true. In this case, the result is true for the conditional, but false for the biconditional.			1001	TFFT	XNOR	P XNOR Q (P IF Q)
6	Exclusive disjunction	exclusive or; true if and only if its arguments differ (one is true, the other is false)			0110	FTTF	XOR	P XOR Q P IFF Q (P IF NOT Q)
8	Logical conjunction	true if and only if <i>all</i> of its operands are true.			0001	FFFT	AND	P AND Q (Q IMPLY P)
7	Logical NAND	alternative denial; the negation of the conjunction operation, expressed in ordinary language as "not both".			1110	TTTF	NAND	P NAND Q NOT (P IMPLY Q)
The Venn diagrams used above and below, are the work of Tilman Piesk , and reproduced from Wikipedia , where they are considered to be in the public domain								

From 16 to 14 connectives -- precluding a logical meta-perspective?

It is remarkable with respect to this argument to discover that the set of 16 formally defined connectives is variously reduced, most notably to 14, in the light of arguments indicating that this or that set of connectives is unnecessary in practice -- as being trivial or redundant. Arguments for reduction of the 16 include:

- **contradiction**, noted above as when a proposition conflicts either with itself or established fact. Used as a tool to detect disingenuous beliefs and bias, it raises the question as to whether the set of 14 connectives avoid engagement with the reality of much discourse characterized by contradiction -- of which opposing parties tend to accuse each other. (Nancy Fraser, *Democracy's Crisis: on the political contradictions of financialized capitalism*, Weatherhead Center for International Affairs, 33, 2018, 1; John Brenkman, *The Cultural Contradictions of Democracy: political thought since September*, 2007; Mao Zedong, *On Contradiction*, 1937)

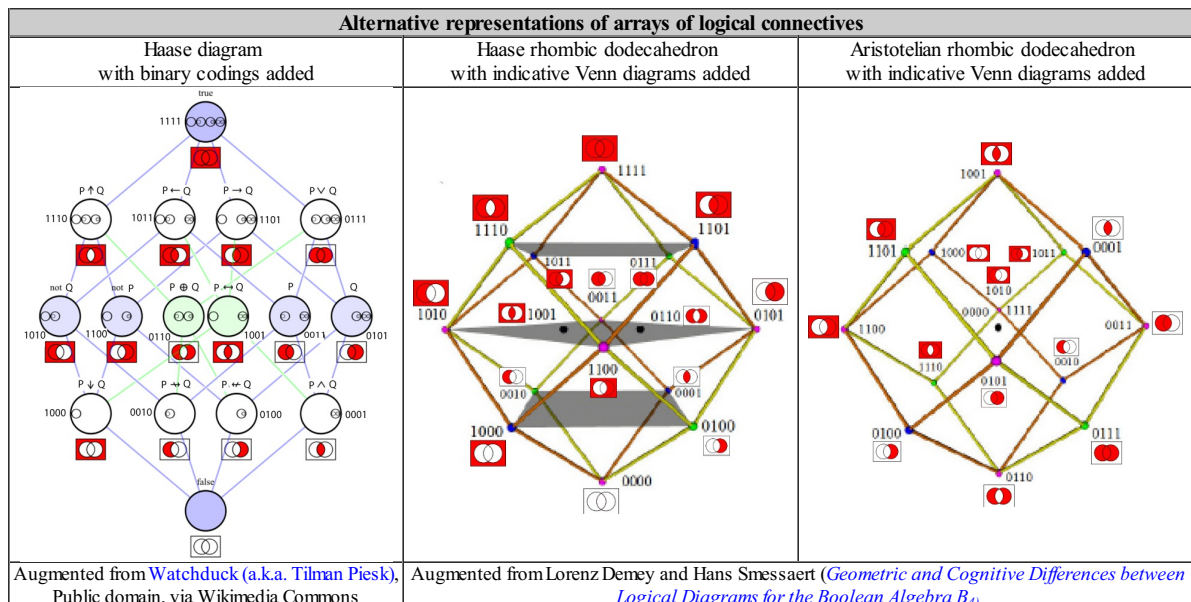
With everything held to be false (white in the Venn schematics above and below), as inherent in a meta-perspective this could then be indicative of a critical recognition of imperfection and inconsistency -- evoking questioning and creativity. It recalls the Sanskrit expression *Neti Neti* (not this, not that).

- **tautology**, noted above as when an assertion is true in every possible interpretation and is therefore redundant.

With everything held to be true (white in the Venn schematics above and below), as inherent in a meta-perspective this could then be indicative of a form of totally uncritical complicity in celebration of the obvious -- avoiding any tendency to question or challenge. It recalls a Sufi insight -- the "perfection of what is". This is consistent with the widespread allusion that "everything is connected to everything", possibly as a reflection, envisaged as *Indra's Net*., explored mathematically as *Indra's Necklace* (David Mumford, et al. *Indra's Pearls: the vision of Felix Klein*, 2002)

Logical connectives necessarily preclude such considerations which necessarily call for careful discussion in a mode of meta-discourse. There the contrasting perspectives necessarily complement each other in paradoxical ways, expressed metaphorically and allusively as the relation between *yang* and *yin*. The pattern of logical connectives can then be recognized as constituting a form of "cognitive incarceration" as discussed below. Provocatively however, **for mnemonic purposes of political and policy relevance, the use of P versus Q in distinguishing the 14 logical connectives might then be usefully be understood as indicative of "privilege / priority" versus "questionable / quashing"**. This interpretation is explored further below.

The reduction is most clearly presented in the following in which the precluded connectivity is effectively associated with a fourth dimension, in contrast with the 3-dimensional articulation of the other connectives. The extra dimension is depicted in the literature using a tesseract or hypercube as indicated separately ****

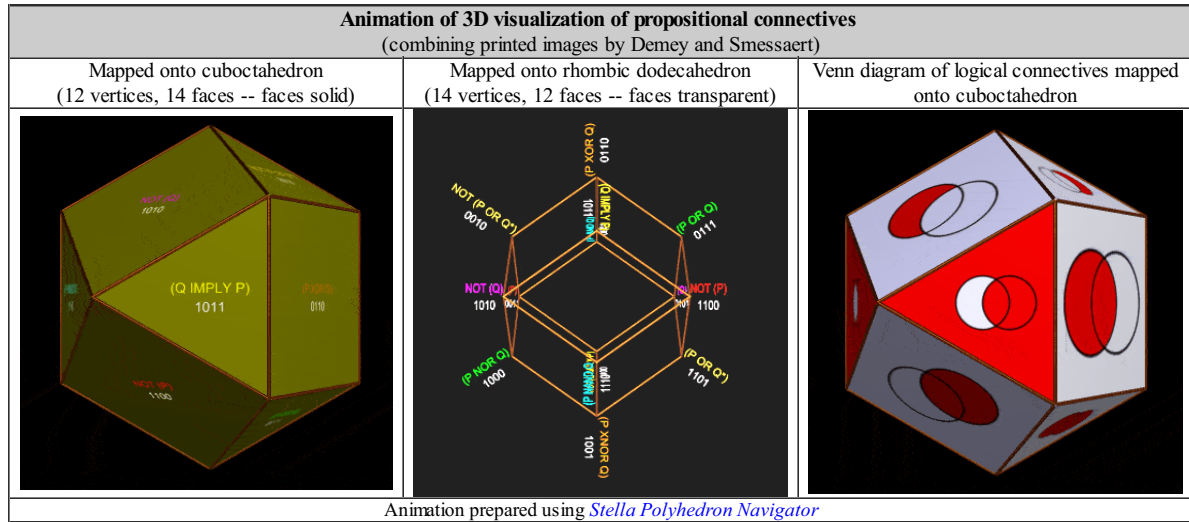


Mapping onto the rhombic dodecahedron of 14 vertices: Of particular relevance, beyond the Aristotelian [square of opposition](#) is its relationship to the rhombic dodecahedron featuring in [Hasse diagrams](#). The explorations of [logical geometry](#) and [Aristotelian diagrams](#) have been most recently summarized in comprehensive papers by Lorenz Demey and Hans Smessaert developing the idea that Aristotelian diagrams can be fruitfully studied as geometrical entities. :

- [Logical and Geometrical Distance in Polyhedral Aristotelian Diagrams in Knowledge Representation](#) (*Symmetry*, 9, 2017)
- [The Relationship between Aristotelian and Hasse Diagrams](#) (2014)
- [Geometric and Cognitive Differences between Logical Diagrams for the Boolean Algebra \$B_4\$](#)
- [On the 3D Visualisation of Logical Relations](#) (*Logica Universalis*, 3, 2009, 2)

In particular the studies focus on four polyhedral Aristotelian diagrams for the Boolean algebra B_4 , viz. the [rhombic dodecahedron](#), the [tetrakis hexahedron](#) [dual of the [truncated octahedron](#)] the tetraicosahedron and the nested tetrahedron -- variously involving discussion of the [hypercube](#). The rhombic dodecahedron is especially favoured as a pattern in the study of Boolean logical connectivity

The cuboctahedron has particular characteristics with respect to transformation between polyhedral forms that have been highlighted by Buckminster Fuller, notably proving fundamental to enabling him to design geodesic domes. Of particular significance is enabling the transformation between 2,3,4 symmetry and 2,3,5 of the Platonic polyhedra.



Further reduction? The argument for reduction even leads to a conclusion that 5 connectives would be adequate, and even one of those is superfluous. Further argument can reduce the connectives to two -- and even to one, understood as the [Sheffer Stroke](#) (Chad Vance, [Choosing Logical Connectives](#); Mike Estela, [Truth Tables of Five Common Logical Connectives or Operators](#)). The argument for five is to achieve a "balance between efficiency and parsimony" -- as may be convenient under certain circumstances, or a matter of personal preference.

For G. Cherlin ([The Binary Logical Connectives](#), 2005):

In English as far as I am aware, we use the following: *and, or, nor implies, if, unless, and tantamount* (in the form "is tantamount to") and we get two more using *not* as binary connective, and two more, on certain occasions, via "the former" and "the latter". In addition, not saying anything can possibly be construed as one more. On the other hand, the identically false connective does not seem to be easily expressible. The phrase "yes and no" comes to mind, however. On a relatively generous assessment we achieve twelve of the sixteen. We seem to be missing the negations of implications and equivalence, and the ability to manufacture a completely false expression efficiently. The question has arisen as to whether all possible connectives are expressed succinctly in at least one natural language.

Clearly a major difficulty at the present time, in the predominant ("mainstream") discourse, is the assumption of the adequacy of a simple, but radical, distinction between "true" and "false" -- ignoring the possibility of "shades of grey". This ignores 4-fold modalities, characteristic of some Eastern discourse, namely between: A, not-A, A and not-A, neither A nor not-A (Kinhide Mushakoji, [Global Issues and Interparadigmatic Dialogue; essays on multipolar politics](#). 1988). These distinctions notably feature in Buddhist logic and philosophy recognized to be full of contradictions. Now modern logic is learning why that might be a good thing Graham Priest, [Beyond True and False, Aeon](#); R. Lance Factor, [What Is the "Logic" in Buddhist Logic? Philosophy East and West](#), 33, 1983, 2). Debate on these matters continues (Mauricio Osorio and Claudia Zepeda, [Three New Genuine Five-valued Logics Intended to Model Non-trivial Concepts, Electronic Notes in Theoretical Computer Science](#), 354, December 2020).

The confusion is all the greater as a consequence of alternative terminology for the 16 distinctions, including distinctive notations. Greater clarity is evident from the binary notation with which the 16 can be associated, as presented in a separate discussion ([Governance beyond the logical focus on true vs false?](#) 2019). Also confusing is the tendency of papers to avoid offering examples of what each of the 16 distinctions implies in terms of natural language.

Given the inspiration offered to Gottfried Leibniz by the Chinese Shao Yung circle of hexagrams in promoting the binary coding system (of which only a 4-position portion is used by logicians), it is appropriate to ask how the 16 logical connectives are now perceived in Chinese (Yi (Esther) Su, [The Acquisition of Logical Connectives in Child Mandarin, Language Acquisition](#), 21, 2014, 2; Stephen Crain and Peng Zhou, [Acquisition of Logical Connectives and Focus, Encyclopedia of Chinese Language and Linguistics](#), 2015; Ch'un-Yen Lai, [Logic and Chinese Grammar: a study of Chinese logical connectives](#), 1979).

Noteworthy, for example, is the remark by Michael Nyland that *the standard translations of some particles that function as logical connectives often do not work well when translating texts from classical Chinese into English* ([A Note on the Logical Connectives in the Huainanzi](#), 2014). One study reports on 20 "logical connectives" (Xiaoying Li, [Comparison and analysis of logical connectives usage by english learners from the perspective of quantitative, BioTechnology](#), 10, 2014, 3).

Dangerous loss of connectivity in global modelling and misinformation detection by algorithm?

The set of logical connectives can be understood as a form of pattern language potentially offering a remarkable degree of coherence. Given their role in formal logic and in the design of computer logic gates, their inadequacies in practice merit particular attention in the light of ever higher dependency on them in global modelling and the detection of misinformation (*Misleading Modelling of Global Crises: unquestioned bias in authoritative representations of reality by science?* 2021).

Mismatch with natural language: As noted by Rowan Patricia Garnier however:

Operators called 'logical connectives' convey in a precise way the logical relationships between truth functional propositions and hence determine what can be inferred from them. Mathematical reasoning therefore relies heavily on their use. Whilst the operators are free of ambiguity, this is not so for the linguistic items (called 'linguistic connectives') by which they are codified. In English, at least, **there is a widely reported mismatch between the logical concepts and the 'meanings' of the linguistic connectives with which they are frequently identified.** (*Understanding Logical Connectives: a comparative study of language influence*, University of London Institute of Education, 1992) [*emphasis added*]

Ironically there is a peculiar communication disconnect between the representation in truth tables of the 16 logical connectives and their relation to the natural language of any dialogue which an algorithm may be purportedly designed to process -- most notably with respect to the detection of "misinformation" or "fake news" at the present time. A degree of clarification is however variously offered by the following:

- *Truth Tables and Analyzing Arguments: Examples (Lumen: mathematics for the liberal arts)*
- E. Hadjiconstantinou and G Mitra: *Transformation of Propositional Calculus Statements into Integer and Mixed Integer Programs: an approach towards automatic reformulation* (U.S. Army European Research Office, 1991)
- Mohd Zakree Ahmad Nazri, Hana Yamein Ishak and Rossilawati Sulaiman: *Decision Support System* (Open University Malaysia, CBSS4103, 2010)
- Richard Bornat: *Proof and Disproof in Formal Logic: an introduction for programmers* (Oxford University Press, 2005)
- James Trafford: *Meaning in Dialogue: an interactive approach to logic and reasoning* (Springer, 2016)
- Maarten van Wijk: *Logical Connectives in Natural Language -- a cultural-evolutionary approach* (2006)
- Rowan Patricia Garnier: *Understanding Logical Connectives: a comparative study of language influence* (1992)
- *Selection of Logical Connectives, Philosophy Stack Exchange*

However it is far from clear that all 16 logical operations formally described are readily and comprehensibly exemplified in natural language. It is unclear whether any effort is made to educate people in the use of the range of such connectives in discourse -- in contrast to the investment in emphasizing the simple binary distinction between true and false. This is most obvious in the focus on binary games (*Destabilizing Multipolar Society through Binary Decision-making: alternatives to "2-stroke democracy" suggested by 4-sided ball games*, 2016).

With respect to the disconnect, the *Wikipedia* entry notes:

The standard logical connectives of classical logic have rough equivalents in the grammars of natural languages. In English, as in many languages, such expressions are typically grammatical conjunctions. However, they can also take the form of complementizers, verb suffixes, and particles... The meanings of natural language connectives are not precisely identical to their nearest equivalents in classical logic. In particular, disjunction can receive an exclusive interpretation in many languages. Some researchers have taken this fact as evidence that natural language semantics is nonclassical. However, others maintain classical semantics by positing pragmatic accounts of exclusivity which create the illusion of nonclassicality. In such accounts, exclusivity is typically treated as a scalar implicature... Related puzzles involving disjunction include free choice inferences, Hurford's Constraint, and the contribution of disjunction in alternative questions.

Other apparent discrepancies between natural language and classical logic include the paradoxes of material implication, donkey anaphora and the problem of counterfactual conditionals.

As specifically noted with respect to material conditional implication, this is used in all the basic systems of classical logic as well as some nonclassical logics. It is assumed as a model of correct conditional reasoning within mathematics and serves as the basis for commands in many programming languages. However, many logics replace material implication with other operators such as the strict conditional and the variably strict conditional. Due to the paradoxes of material implication and related problems, material implication is not generally considered a viable analysis of conditional sentences in natural language.

Questionable comprehension of logical connectives: Even as indicated by the terms distinguishing such connectives, it is clear that the distinctions made can only be meaningful to the very few rather than to the many purportedly constrained by their use. It is for example questionable what proportion of decision-makers could recognize and recall the pattern of all 16 or make conscious use of them. Given the potential importance of such a pattern language for discourse, it remains questionable what education is provided in their use. It is striking to note how few are the attempt to illustrate the distinctions with simple examples, as offered by Maarten van Wijk (*English language lexicalisations of all 16 connectives*, 2006)

Relevant studies include:

- Francesca Jones *Understanding the Frequency and Use of Logical Connectives in Science Texts: implications for students and teachers* Twenty-Fourth Annual Meeting Society for the Scientific Study of Reading, 2017
- Zorana Vasiljevic *Assessing Learners' Comprehension of Logical Connectives in L2 Texts Theory and Practice in Language Studies*, 3, 2013, 1)
- Diego X Román, et al *Linguistic Cohesion in Middle-School Texts: a comparison of logical connectives usage in science and social studies textbooks*, *Electronic Journal for Research in Science and Mathematics Education*, 20, 2016, 6)

For the latter:

Learning from textbooks is challenging because students must understand novel concepts while also comprehending the language used to convey those concepts. In the domain of science, one posited reason for the perceived difficulty in the reading comprehension of science texts is the low frequency of logical connectives (words that signal relationships between sentences and ideas)... Our findings from a large corpus of 12 science and 12 social studies textbooks showed that science texts contained a higher rate of logical connectives than social studies texts....

The rate of logical connectives usage increased over grade levels in science but not in social studies.... with science texts favoring inferential connectives (e.g., furthermore) and social studies texts favoring contrastive connectives (e.g., however).

Five most inferential logical connectives compared to percent of all inferential logical connectives					
Science			Social science		
Top 5	n	%	Top 5	n	%
So	665	45%	Then	621	54%
Then	327	22%	So	291	25%
When you	176	12%	Because of	131	11%
As a result	125	9%	Therefore	70	67%
Therefore	113	8%	Thus	43	4%

*** politics, climate change, pandemic.

For David J. Lobina:

Remarkably, only two/three of the possible 16 binary connectives of logic have been lexicalised in the world's languages: AND, (inclusive) OR, and, in some accounts, the joint denial NOR (Horn, 2012). However, connectives such as material implication or alternative denial seem easily entertainable in a mental logic-like system, and this raises the question of whether the language faculty allows any of the unlexicalised connectives at the interface between narrow syntax and the thought systems (*The Universe of the Logical Connectives in Language*, IEICE Technical Committee Submission System)

For Maarten van Wijk *Logical Connectives in Natural Language: a cultural-evolutionary approach* Universiteit Leiden, 2006)

This thesis attempts to explain the particular selection of the 16 logically possible truth-functional connectives that is found in human language. Only a few of these connectives, such as (AND) and (OR) are expressed using single-morpheme lexicalisations in natural language. Others, such as (NAND) and (IFF) are expressed compositionally, by combining words for other connectives or adding extra phrases specific to language. Various kinds of explanations have been put forward for this observation.

Post-truth tables? Whilst the focus of logical connectives is on "truth", there are challenges to any simplistic interpretation of its nature (Dominique Raynaud, *Truth in the Post-Truth Era*, 2019). It might be asked whether there is need to frame a "post-truth" table (*Towards articulation of a "post-truth table"?* 2016), especially in the light of the challenge of [quantum logic gates](#) necessary in quantum computing.

The relevance of such oppositional logic to issues of governance seems to be primarily explored by [Fabien Schang](#) (*A Formal Semantics of International Relations; A General Semantics for Logics of Affirmation and Negation*, *Journal of Applied Logics*, 2021; *An Arithmetization of Logical Oppositions; Logic in Opposition*, *Studia Humana*, 2013; *Depicting Negation in Diagrammatic Logic: legacy and prospects; International Disagreements*, 2014; *Agreeing about Disagreement; Two Visual Logics: diagrams vs graphs*).

The question is whether Bach's canons can be usefully distinguished by an interpretation of the binary coding in the above animations -- as an aesthetic complement offering a sense of connectivity and coherence otherwise.. Do Bach's canons, and the *Goldberg Variations*, offer clues to what can otherwise only be expressed formally through alienating abstractions? Is Bach equally alienating to many -- step down

Constraint of the 7-fold on comprehension of more complex patterns?

The introduction to this argument noted the importance attached to the much-cited study of [George Miller](#) (*The Magical Number Seven, Plus or Minus Two: some limits on our capacity for processing information*, *Psychological Review*, 1956) -- and to the subsequent research on human [working memory capacity](#).

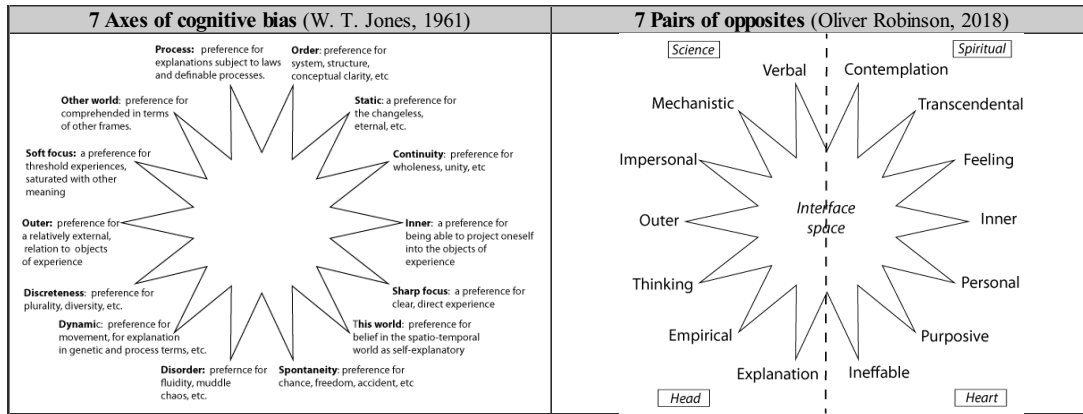
As discussed separately, any such constraint is clearly of particular relevance to comprehension of the many 20-fold cognitive toolkits cited in the earlier exercise (noted above) -- whether of principles, strategies, rights, or values (*Constraint of the 7-fold on comprehension of the 20-fold*, 2018). Presumably it is both a constraint on comprehension of the *10 Commandments*, or of the 30 rights in the *Universal Declaration of Human Rights* -- "as a whole". In the latter case, it might be asked why the set of rights is effectively beyond human "working memory capacity" -- without any consideration of the matter.

More generally it could be asked, if there is a 7-fold constraint on use of a cognitive toolkit of requisite variety, **how is it appropriate to address the challenge of enabling people and society to "get their act together"** -- and to keep it together in the light of any aspirations to sustainability?.

What is seemingly required is a way of relating the 7-fold to the 14-fold, the 20-fold, and the 30-fold. One of the polyhedral configurations above offers an approach to this. The cuboctahedron of 14 faces (above right) has 7 axes of symmetry through those opposing faces. As noted above, it also offers a much-studied path of transformation between the Platonic polyhedra through the so-called jitterbug process explored through [synergetics](#) by Buckminster Fuller (*Synergetics: explorations in the geometry of thinking*, 1975/1979). Unfortunately, as discussed separately, Fuller does not interpret the promise of that title with respect to the cognitive issues explored here (*Geometry of Thinking for Sustainable Global Governance: cognitive implication of synergetics*, 2009).

Of relevance to that quest are the distinctions noted in the diagrams below indicative of a degree of equivalence or correspondence. The axes of bias derive (below left) from the philosophical work of W. T. Jones (*The Romantic Syndrome: toward a new method in cultural anthropology and the history of ideas*, 1961) as summarized separately (*Axes of Bias in Inter-Cultural Dialogue*, 1993). With respect to any 14-fold pattern, the distinction of 7 axes of bias can be understood as interrelating 14 extremes. These could be understood as encompassing the disparate variety in the checklist above -- and indicative of relevance to a viable system of *governance* (*Sustainable Development: a system of 14 complementary concepts*, 1994).

The image on the right is a slightly redrawn version of that of [Oliver C. Robinson](#) (*Paths Between Head and Heart: exploring the harmonies of science and spirituality*, 2018), as summarized by the author (*Palintonos Harmonia: the alchemy of opposites*, *Paradigm Explorer*, 2018, 2). That theme is inspired by the insight of Heraclitus and others into "taut harmony" (or "counter-stretched harmony"), as extensively reviewed by [Bernd Seidensticker](#) (*Palintonos Harmonia, Hypomnemata*, 72, 1982) .



Configuration of 7-fold axes in 3D: Given the emphasis on comprehension and the need for imaginative communication, an earlier exercise framed the challenge as one of developing a cognitive "stargate" -- using the above as examples in 2D (*Complementary features of "stargate" design and functionality?* 2018).

The approach here is to imagine that the "elements" framing the stargate are of a degree of subtlety consistent with what might be attributed to the mysterious dimensions of deities or values -- imbued with a degree of paradox, possibly to be understood as a form of riddle as with the formulation and function of Zen koans. Clearly it would be presumptuously foolish to endeavour to describe such elements in a new modelling exercise, hence the case for exploring insights into "meta-modelling" (*In quest of a "meta-model": engaging in a meta-modelling process?* 2010; *Models: M-theory as indicative of meta-modelling potential?* 2015; *Criteria for an Adequate Meta-model: preliminary list*, 1971).

It could readily be argued that preferred values are a reflection of cognitive biases -- disguised by the manner in which the latter are named and described. In that sense any checklist of cognitive biases could be understood as implying a checklist of values, with the advantage that the mutual exclusivity of particular biases would be an indication of the mutual exclusivity of particular values.

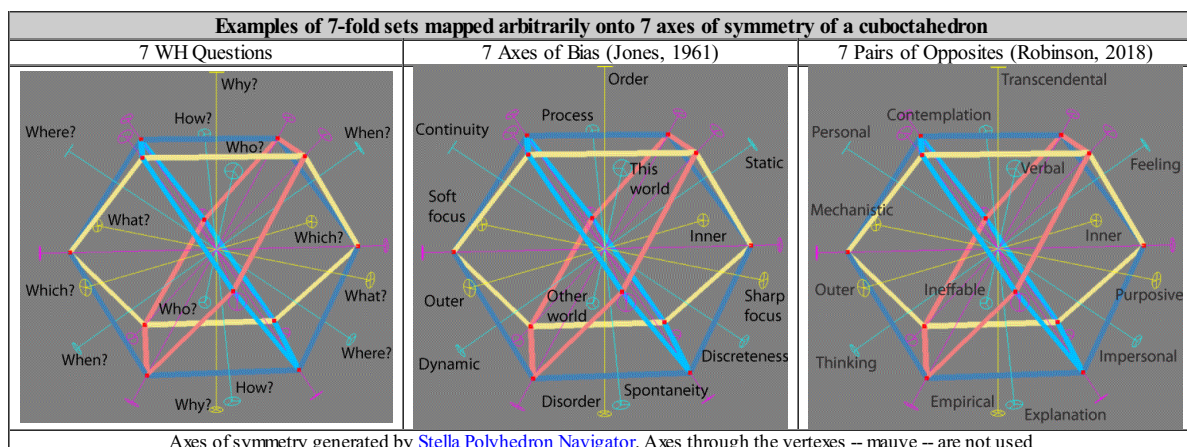
Do such axes of "bias" imply fundamental axes of values? With the emphasis on axes in both articulations, this suggests that an imagined "stargate" is as likely to be of higher dimensionality than is seemingly implied by those images. The "portal" is somehow to be understood as through a centre of corresponding dimensionality. Switching to a 3D depiction of values (following the argument above), the 7 axes in each case can be readily associated with semi-regular polyhedra with 14 vertices or 14 faces. Robinson's "interface space" is then at the centre of that form.

Most valuable in this respect is the **rhombic dodecahedron** (14 vertices of 2 type; 12 faces of 1 type) and its dual the **cubeoctahedron** (14 faces of 2 types; 12 vertices of 1 type), as discussed separately (*Neglected recognition of logical patterns -- especially of opposition*, 2017; *Oppositional Logic as Comprehensible Key to Sustainable Democracy: configuring patterns of anti-otherness*, 2018).

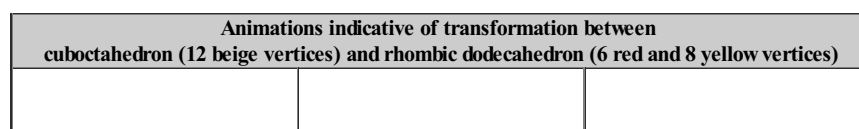
With respect to the above argument, the rhombic dodecahedron (12 faces, 14 vertices) is of interest as the dual of the cubeoctahedron. Rather than mapping any 7-fold pattern of dilemmas onto the cubeoctahedron, it could then be more appropriately mapped onto a rhombic dodecahedron where the 7 axes through 14 faces (as above) are now presented as 14 vertices through which 7 axes pass (as shown below). The form is used to distinguish different extremes of the 7 WH-questions -- contrasting the local here-and-now for the individual with the global challenges of collective strategy. The elusive compromise is then associated with the neologism **glocal** -- essentially dynamic. It is understood as the simultaneous occurrence of both universalizing and particularizing tendencies in contemporary social, political, and economic systems. In the animation below it is usefully indicated by the central sphere -- as a **nexus of dynamic reconciliation of dilemmas**.

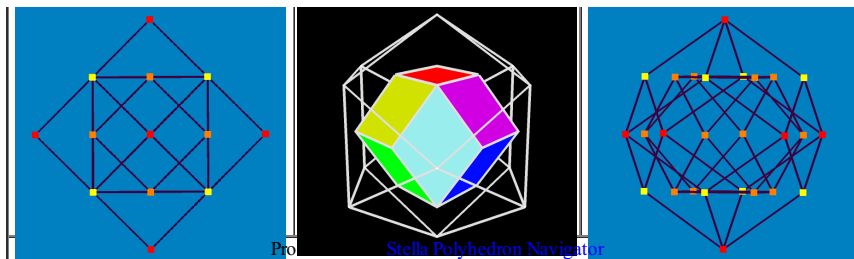
Those axes can be used as a means of mapping various 7-fold sets for purposes of comparison. It is a means of giving an ordered focus to the confusion of decision-making and choice, whether in the momentary here-and-now for the individual, or on a larger scale for elaboration of global strategy. The examples mapped arbitrarily onto those axes below derive from:

the classical set of 7 WH-questions, as discussed separately (*Conformality of 7 WH-questions to 7 Elementary Catastrophes: an exploration of potential psychosocial implications*, 2006; *Interrelating Cognitive Catastrophes in a Grail-chalice Proto-model: implications of WH-questions for self-reflexivity and dialogue*, 2006)



Axes of symmetry generated by [Stella Polyhedron Navigator](#). Axes through the vertices -- mauve -- are not used





Reality "bubbles" -- forming a psychosocial "foam"?

Psychosocial bubbles? There is a curious sense in which the reduced selection of 14 connectives could be associated with increasing reference to "bubble psychology", especially the [filter bubbles](#) engendered by search algorithms ([Eli Pariser](#), *The Filter Bubble: what the internet is hiding from you*, 2011; Richard J. Vann, *Toward a Theory of Bubble Psychology: current approaches and a consumer-level explanation*. 13 October 2014; David Dreman, *Bubble Psychology*, *Forbes*, 3 August 1999).

The relation between individual bubbles and foams -- metaphorically understood -- is a primary feature of the magnum opus of [Peter Sloterdijk](#) and Wieland Hoban (*Bubbles: Spheres (Microspherology)*. Semiotext(e), 2011; *Globes: Spheres (Macrospherology)*. Semiotext(e), 2014; *Foams: Spheres (Plural Spherology)*. Semiotext(e), 2016), as discussed separately ([Requisite philosophical reframing of bubbles, globes and foams?](#) 2017).

Anticipating the physical insights from the argument, *Foams: Plural Spherology* (2016) is most succinctly described in the following publisher summary:

"So the One Orb has imploded -- now the foams are alive". *Foams* completes the Spheres trilogy: his 2,500-page "grand narrative" retelling of the history of humanity, as related through the anthropological concept of the "Sphere." For Sloterdijk, life is a matter of form and, in life, sphere formation and thought are two different labels for the same thing. The trilogy also offers his corrective answer to Martin Heidegger's *Being and Time*, reformulating it into a lengthy meditation on *Being and Space* -- a shifting of the question of who we are to a more fundamental question of where we are. In this final volume, Sloterdijk's "plural spherology" moves from the historical perspective on humanity of the preceding two volumes to a philosophical theory of our contemporary era, offering a view of life through a multifocal lens. If *Bubbles* was Sloterdijk's phenomenology of intimacy, and *Globes* his phenomenology of globalization, *Foams* could be described as his phenomenology of spatial plurality: how the bubbles that we form in our duality bind together to form what sociological tradition calls "society". *Foams* is an exploration of capsules, islands, and hothouses that leads to the discovery of the foam city. The Spheres trilogy ultimately presents a theology without a God -- a spatial theology that requires no God, whose death therefore need not be of concern. As with the two preceding volumes, *Foams* can be read on its own or in relation to the rest of the trilogy.

As argued by [Robert Mugerauer](#) (*Anthropotechnology: Sloterdijk on environmental design and the foam worlds of co-isolation*, *Architecture and Culture*, 4, 2016, 2):

... a reinterpretation of space, architecture, and culture could help us to learn to design better and act by way of an "anthropotechnology" (Sloterdijk's word) that is simultaneously developmental and threatening -- that might enable us to find an orientation in a world of complexity, and thus more positively shape our lives and future world. Sloterdijk's intriguing concepts -- spheres of immunization (bubbles, globes, foams), co-isolation, dyads, tensegrity -- hold great promise for the next pulse of architectural, planning, and construction theory.

From bubbles to foams: From the perspective on biological cell structure of [Donald Ingber](#), there are fundamental design principles (*The Architecture of Life: a universal set of building rules seems to guide the design of organic structures, from simple carbon compounds to complex cells and tissues*, *Scientific American*, 278, 1998, 1). He notes that in any three dimensional foam, the bubbles will on average have 14 sides, as is well accepted and confirmed experimentally. Yet, some bubbles have 13, others 15, other 12, etc.; the shape of any particular bubble is impossible to determine; nevertheless, on average, they always come out to 14. For Ingber, one can deduce fundamental design principles that are certain in an 'uncertain' world (*Interview with Donald E. Ingber*, *Culture Machine*, *InterZone*, July 2002).

Discovered in 1994, the ongoing research focuses on the [Weaire-Phelan packing structure](#) of a set of bubbles in a minimum-surfaced foam:

- D. Weaire and R. Phelan: *Cellular Structures in Three Dimensions* (*Philosophical Transactions: Mathematical, Physical and Engineering Sciences*, 354, 1996, 1715).
- Roy M. Sullivan, et al: *A general tetrakaidecahedron model for open-celled foams* (*International Journal of Solids and Structures*, 45, 2008, 6)
- Erica G. Klarreich: *Foams and Honeycombs* (*American Scientist*, 88, 2000)
- Bart Buffel, et al: *Modelling open cell-foams based on the Weaire-Phelan unit cell with a minimal surface energy approach* (*International Journal of Solids and Structures*, 51, 2014)
- S.J. Cox et al: *Quasicrystalline three-dimensional foams* (*arxiv*, 2016)
- Morad Abd Elkader, et al: *Mathematics Behind the Cell Bubble Structure to Achieve Sustainability* (*International Journal of Engineering Research and Technology*, 5, 2016, 07)

The Weaire-Phelan structure currently offers the most efficient way to partition space into equal volume cells while minimising surface area -- something soap bubbles strive to do in nature. As a model it replaces the 14-faced [tetrakaidecahedron](#) (or Kelvin cell) proposed by Lord Kelvin in 1887. The new structure consists of two kinds of polyhedral bubbles with twelve and fourteen sides respectively. The challenge for physicists has been to design the perfect foam, where "perfect" means the lowest-energy configuration of packed bubbles of equal size.

The Weaire-Phelan structure is a compromise between the surface area of the bubbles and the stability of the many interlocking faces of the polyhedral bubbles in the foam. The structure has a repeating unit of eight polyhedra, six of them with 14 faces and two with 12, all with hexagons and imperfect pentagons and again slightly curved. (P. Ball, *Scientists make the 'perfect' foam*. *Nature*, 2011). It remains an open question whether an even more efficient space-filling shape, with the absolute minimum surface, is yet to be discovered.

Arrays of psychosocial bubbles in a psychosocial foam? The assumption excluding two of the 16 logical connectives in order to render the array coherent in three dimensions (rather than four) could be understood as having radical implications in practice. That possibility can be explored in terms

of other domains in which a pattern of distinctions has acquired fundamental significance. The point to be stressed is the manner in which the excluded two connectives can imply, symbolically or otherwise, other patterns which may be recognized as 14-fold.

This raises useful questions as to **how many "sides" are characteristic of psycho-social bubbles in a "psycho-social foam"**, whether in three dimensions or more -- with any articulation of a 14-fold pattern to be compared to such a reality bubble. Given the understanding of bubbles in a universe of n-dimensions, provocatively it might be asked whether the faculties of a university (as cognitive bubbles in their own right) could be understood as coalescing to form an "academic foam". Is the pattern of citations of a bubble-bound author or discipline characterized by plus-or-minus 14 interfaces, whether as tacitly "incestuous" co-citation pacts, or otherwise (Iztok Fister Jr., et al, *Toward the Discovery of Citation Cartels in Citation Networks*, *Frontiers in Physics*, 15 December 2016; Phil Davis, *Visualizing Citation Cartels*, *The Scholarly Kitchen*, 26 September 2016). Similarly provocative is the operation of **reality distortion fields** as bubbles of a particular kind.

Potentially of greatest relevance is whether the language of socio-economic growth -- with its particular bubbles (noted above) -- could be "translated" into the language of blowing viable bubbles, as it might be described by physics in systemic terms (*Pricking the Bubble of Global Complacent Complicity: Hyperdimensional insights from the physics of bubble blowing, bursting and collapse?* 2017). How does the pattern of surface bonding stretch and reconfigure to maintain coherence? It is somewhat ironic that soap is used metaphorically in relation to enabling social bubbles but is of course very significant in the production of physical bubbles (*Soap bubbles and detergents. Introduction to Surface Tension*, MIT).

There is the curious possibility that the limitations of the 14-fold bubble -- with its partial irregularity -- only acquires coherence in an 8-fold configuration of 14-fold bubbles. This arises from emerging recognition with regard to the Weiran-Phelan structure. Any quest for an effective "prick" in response to global complacency can be fruitfully informed by the critical philosophical perspective on spheres offered by the trilogy of Peter Sloterdijk.

Constraints on recognition of subtler patterns of order indicated by the periodic table

Periodicity of cognitive engagement? As noted above, another clue is offered by the pattern of order exhibited by the **Periodic Table of Chemical Elements** in which 14 is the maximum number of electrons that can fit in the f-sublevel of an atom (*How many electrons can occupy the f orbitals at each energy level?* 2018). The relevance to this argument derives in part from consideration of the possibility of a degree of periodicity in human engagement with different levels of knowledge -- or modalities of knowing (*Periodic Pattern of Human Knowing: implication of the Periodic Table as metaphor of elementary order*, 2009; *Periodic Pattern of Human Life: the Periodic Table as a metaphor of lifelong learning*, 2009).

The periodic table can be variously presented, whether relatively simply or to reveal otherwise hidden complexities using complex hypergraphs (Michelle Starr, *Mathematicians Have Proposed a New Structure to The Periodic Table*, *Science Alert*, 18 June 2019). This suggests simpler ways of developing the argument with the possibility of more complex refinements in the future. It is also noteworthy that there have been many attempts to render the periodic table comprehensible as a whole, given the subtle interrelationships it is possible to highlight (*Alternative periodic tables*, *Wikipedia*). It could be usefully assumed that the subtlety in the case of human cognition is potentially equivalent, if not greater,

With respect to any 14-fold pattern, this features in green in the tables below left as the f-sublevel (or subshell). It can be argued that human comprehension is most readily associated with the 2-fold pattern in red in the tables -- most obviously in the reliance on binary thinking under most circumstances, whether personal or global. This has been most succinctly argued by **Edward de Bono** (*I Am Right, You Are Wrong: from this to the New Renaissance*, 1968; *Water Logic: the alternative to I Am Right You are Wrong*, 1993). There is a considerable challenge in shifting to the 6-fold pattern in yellow in those same tables, which corresponds to Edward de Bono's other arguments (*Six Thinking Hats: an essential approach to business management*, 1985; *Six Frames for Thinking about Information*, 2003).

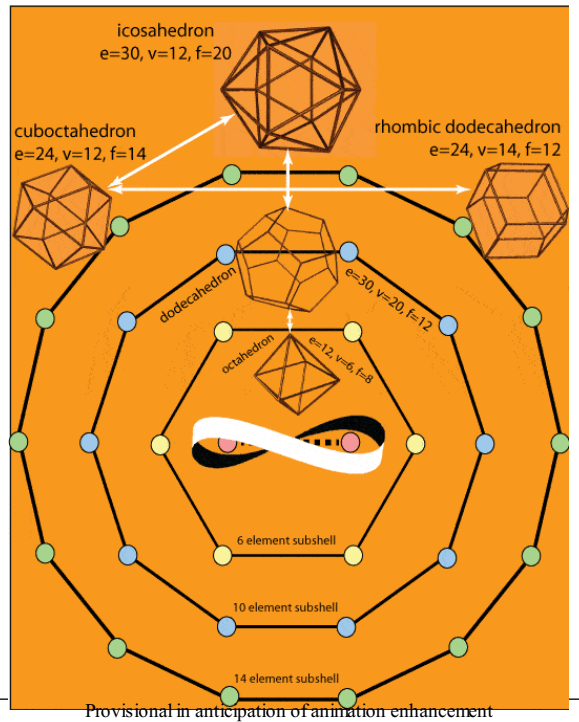
Presenting the 2-fold and 6-fold patterns at the centre of the concentric schematic on the right is then suggestive of a succession of cognitive challenges -- to which the 10-fold (in blue) and the 14-fold (in green) may then be added. Again it can be asked why the 14-fold is favoured in so many contexts, and how this relates to preference for the 10-fold. At a simpler level, the cognitive constraint at each stage is usefully argued by **Ron Atkin** with respect to a recognition of the coherence of a triangle of disparate elements using the mathematics of **q-analysis** (*Multidimensional Man; can man live in 3-dimensional space?*, 1981), as separately summarized (*Comprehension: Social organization determined by incommunicability of insights*).

The periodic table can be considered indicative of the relative occurrence of elements in nature, those indicated in green being appropriately named "rare earths". As a metaphor this suggests a way of thinking about 2-fold, 6-fold and 10-fold cognitive modalities -- relative to a rarer 14-fold modality. As implied by the periodic table, the 2-fold and 6-fold are readily recognizable as vital to the viability of organic life (at least at some level). Less evident is the importance of the 10-fold, although the principles articulated by that pattern have become fundamental to socio-economic conduct and organization -- as exemplified by the *10 Commandments*. The question raised by the checklist of 14-fold examples above is whether the 14-fold pattern constitutes a more fundamental recognition of coherence -- potentially vital to global governance in a manner as yet to be clarified.

Potential correspondences between periodic tables	
Periodic table of chemical elements with indication of shell and subshell capacity	Cognitive modalities suggested by periodic table shells with indication of transitions by polyhedral configurations
<p>Electron configurations of the chemical elements (neutral gaseous atoms in the ground state) [help]</p>	

$\ell \rightarrow$ $n \downarrow$	0	1	2	3	4	5	6	
Orbital	s	p	d	f	g	h	i	Capacity of shell
1	1s							2
2	2s	2p						8
3	3s	3p	3d					18
4	4s	4p	4d	4f				32
5	5s	5p	5d	5f	5g			50
6	6s	6p	6d	6f	6g	6h		72
7	7s	7p	7d	7f	7g	7h	7i	98
Capacity of subshell	2	6	10	14	18	22	26	

Reproduced from Wikipedia



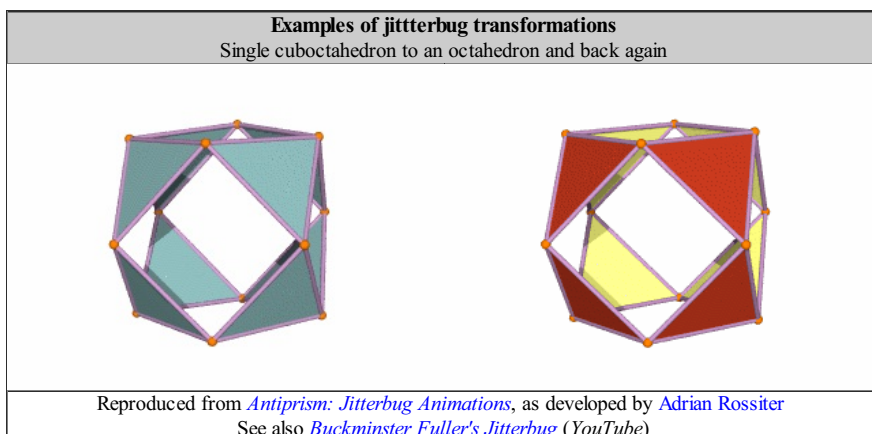
Provisional in anticipation of animation enhancement

The concentric schematic invites interpretation through another metaphor, namely as a transmission system -- as with the gearbox of a vehicle. This would then frame the cognitive challenge of how to shift from gear to gear according to circumstances -- specifically how to "get" from a 6-fold modality to a 14-fold modality, for example, or from 14-fold to 6-fold. The argument is that the 14-fold offers greater coherence over time whereas the others are more responsive to the immediate dynamics of a situation. This clarifies the advantage of the binary thinking associated with the 2-fold, despite the associated oversimplification and loss of sensitivity.

Enabling symmetry? Of particular interest in the animation is the indication of polyhedra with characteristics matching particular subshells. The suggestion is that **shifting cognitively and coherently between subshells is enabled by correspondences between symmetry elements in the associated polyhedra**. The potential role of symmetry in this respect has been extensively referenced by B. Pavlovic and N. Trinajstić (*On Symmetry and Asymmetry In Literature, Computers and Mathematics with Applications*, 12 1986, 1–2). The fundamental role of correspondences in the sciences and the arts has been clarified separately especially in relation to "monstrous" forms of symmetry (*Theories of Correspondences -- and potential equivalences between them in correlative thinking*, 2007; *Potential Psychosocial Significance of Monstrous Moonshine: an exceptional form of symmetry as a Rosetta stone for cognitive frameworks*, 2007).

Of primary significance to such a succession of shifts are the transformations associated with what was named by Buckminster Fuller as the **vector equilibrium** -- allowing for so-called "jitterbug" transformations from the cuboctahedron, via the icosahedron to the octahedron. Such shifts have been indicated by white arrows in the animation (*Vector Equilibrium and its Transformation Pathways*, 1980; H. F. Verheyen, *Computers and Mathematics with Applications*, 17, 1989, 1-3).

Associated with this pattern is the dual of the cuboctahedron, namely the rhombic cuboctahedron (as discussed above) -- necessarily sharing 14 as a symmetry characteristic. Duality also features in the indicated relation between icosahedron and dodecahedron. The dodecahedron is positioned on the 10-element subshell, since its 10 primary axes of symmetry are those linking its 20 vertices.

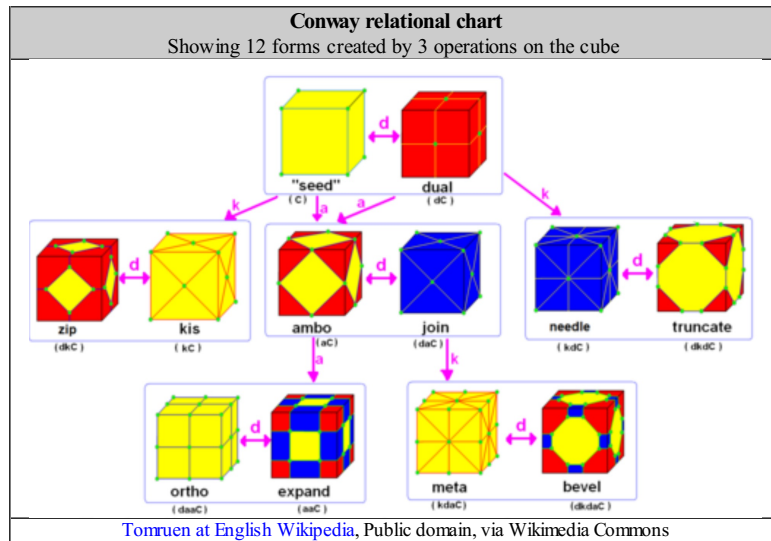


Coherence of a viable system: A particular concern in any quest for coherence is that **few, if any, of the checklists of 14-fold patterns address the issue of the systemic relations among the 14 items identified**. This tends also to be characteristic of the 10-fold and 6-fold patterns. This is even in the case of the remarkable set of 14 process elements of a viable system model as indicated discussed below. Curiously, although that study cites Stafford Beer, as the originator of such modelling, it fails to note the role played in his understanding of a 30-fold pattern, as articulated in *Beyond Dispute: the invention of team syntegrity* (1994) -- one of his final studies.

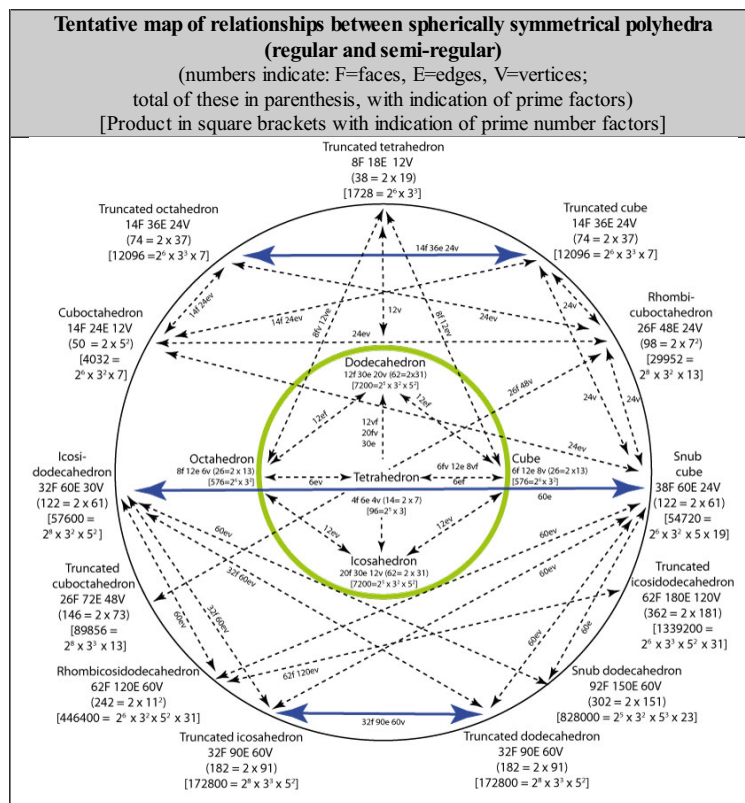
In that study Beer uses the 30-edged icosahedron as a way of representing and holding the dynamics of a viable system -- effectively as a tensegrity. Arguably what is required is a 30-fold pattern of relationships as a context or container for the set of distinctive elements identified in the 14-fold pattern. It is in that respect that the relationship with the preoccupation of Buckminster Fuller merits attention, especially his focus on the

cuboctahedron -- recognized by him as a vector equilibrium. In particular he focused on the transformational dynamic between the 14-faced cuboctahedron and the 30-edged icosahedron -- and the various intermediary structures .

Transformative dialogue through symmetry preservation: Framed in this way, a further clue is offered by the much-cited [Conway polyhedron notation](#), as discussed separately (*Encoding Coherent Topic Transformation in Global Dialogue: memorability of cognitive implication in symmetry-preserving operations on polyhedra*, 2021). Presented schematically (as below), this indicates the distinctive **symmetry preserving operations** through which polyhedra may be transformed between one another ([Hidetoshi Nonaka](#), *Visualization of Conway Polyhedron Notation*, *World Academy of Science, Engineering and Technology*, 50, 2009).



Missing from such a depiction is any sense of the "symmetry preserving cognitive operations" so fundamental to memorability and comprehension -- and the recognition of correspondences as discussed further below. Such depictions tend to omit any indication of the numeric characteristics of the polyhedra through which the symmetry is preserved and transformation is enabled -- potentially fundamental to Bach's 14 canons, for example. Some sense of this is evident in an alternative pattern highlighting this, reproduced from an earlier exercise (*Memetic Analogue to the 20 Amino Acids as vital to Psychosocial Life?* 2015).



The wider appreciation of such transformations through music is suggested by mapping the 14 canons onto the faces of a cuboctahedron, and noting the manner in which it unfolds. Of relevance to the above argument, Fuller's preoccupation with the management of global resources (notably in the light of the image of [Spaceship Earth](#)) was informed by geometric insights derived from the cuboctahedron (*Operating Manual for Spaceship Earth*, 1968). However, despite the intention implied by the title of his 2-volume magnum opus (*Synergetics: Explorations in the Geometry of Thinking*, 1975), this has not translated into cognitive facilitation of "living with the enemy" in the New Renaissance (*Geometry of Thinking for Sustainable Global Governance: cognitive implication of synergetics*, 2009).

Variety of "ways of looking" -- binary or otherwise

Extended interpretations of P and Q: Explanations regarding the logical connectives -- fundamental though these may be to algorithm-determined

governance -- are a major challenge to the comprehension of most. Of interest therefore are approaches to the variety of ways of looking, seeing and comprehending -- however these may be conditioned by logical connectives (*Interrelating Multiple Ways of Looking at a Crisis: beyond the pandemic discipline of the one right way*, 2021; *Hearing the Variety of Voices in Climate Change Discourse: recognizing the challenge of soundscape comprehension in controversy and emergency*, 2019).

The following table reframes the earlier focus on logical connectives by attributing less restrictive significance to the abstract generalizations of "P" and "Q" that are typical of conventional logical explanations -- however disconnected these may be from natural language. As a provocation of political relevance, these are respectively given mnemonic significance as:

- P = *privileged, priority, positive* -- as well as *good* and *right* -- or potentially *male* (given cultural assumptions in that regard)
- Q = *quashed, questionable* -- as well as *negative, evil* and *wrong* -- or potentially *female* (given common cultural assumptions in that regard)

The binary coding written **horizontally** (above, and below left) to denote conventionally the 16 distinctions is also presented **vertically** as a tetragram (given the origins of the binary encoding from *I Ching* hexagrams, as mentioned above). The **Venn diagrams used above are rotated 90 degrees clockwise** in each case (left-hand column) to determine whether memorability and comprehensibility are increased. In the Venn diagram variants on the right, the **colour convention is switched** from red=true (white=false) to green=OK (red=false) in the Venn variants (below right).

Cyclopean vs. Poly-ocular vision:The fundamental mistake at this time would seem to be confusion regarding the comprehensibility of "unity" -- associated with simplistic uses of "universal" and "global" (with the challenge to comprehension otherwise implied by the "unknot" or the *Ouroboros*). As argued separately, this might be termed the "**cyclopean syndrome**" -- na"ely the implication that depth may be comprehended through one eye (*Transcending One-eyed Global Modelling Perspectives: incorporating under-currents into global circulation of value*, 2010)

Aside from the physics of stereoscopic vision, a number of authors have explored its significance as a metaphor (cf *John A. T. Robinson, Truth is Two-eyed*, 1979). This binocular approach has been extended to a poly-ocular approach by Magoroh Maruyama (*Polyocular Vision or Subunderstanding? Organization Studies*, 25, 2004, pp. 467-480), notably considered as relevant to agriculture, as admirably described by Egon Noe, et al (*A semiotic polyocular framework for multidisciplinary research in relation to multifunctional farming and rural development*, 2005). In poly-ocular vision, the differences between several images enable detection of invisible dimensions, which cannot be obtained by adding several images (Maruyama, 1978).

The argument has been developed separately (*Cyclopean Vision vs Poly-sensual Engagement*, 2006). In relation to *Polyocular strategic vision* (2009) reference is made there to the much-cited tale regarding Vice-Admiral *Horatio Nelson* at the *Battle of Copenhagen* (1801) against the Danes. At a critical moment, when his superior signalled he should retreat. Nelson ordered that the signal be acknowledged. He informed his flag Captain: "*I only have one eye -- I have the right to be blind sometimes*," and then holding his telescope to his blind eye, said "*I really do not see the signal!*". By his continuing the engagement a British victory was achieved. Presumably, in ignoring feedback from their constituencies, the leaders of the world expect to emulate Nelson, raising to the "blind eye" any devices capable of correcting their defective vision.

Power implications in practice: However, as an exercise, the **Venn diagrams on the right are reattributed in the table below to the tetragram coding** in order to explore an alternative reading. The issue of directionality of reading of any schema merits careful consideration (*Unquestioned Bias in Governance from Direction of Reading? Political implications of reading from left-to-right, right-to-left, or top-down*, 2016). Traditionally hexagrams can for example be read top-down or bottom-up with distinctive implications.

Thus the top-most line of the tetragram in this exercise is used to signify the environmental context surrounding each diagram (green=OK, red=not-OK), and the remaining three lines are used to indicate whether the succession of spaces within the Venn diagram (reading down) are either OK (green) or not-OK (red) in the light of the extended interpretation of P and Q -- commencing with P (upper most circular space) and terminating with Q (lower-most circular space).

Such an unconventional presentation of Venn diagrams avoids the logical "illusion" that P and Q are in some way equivalent as propositions -- as with the two eyes at the same level in Robinson's theme -- when in practice one tends to take a remarkable degree of precedence over the other in psychosocial practice. The assumed neutrality of logical connectives reinforces this distortion which is visually highlighted to a greater degree in the right-hand column -- a more complex form of traffic light metaphor.

Tentative quest for correspondences between disparate binary frameworks (adapted from the table above; rows clustered in pairs -- the first two rows of the 16 being conventionally excluded)									
	Venn (red=true)	Binary coding	Extended interpretations to "non-logical connectives"	"Privileged" ("Priority")	P+Q	"Quashed" ("Questionable")	Environment (Context)	Tetragram	Venn (green=OK)
15		1111	(P OR NOT P) Privileged OR NOT Privileged Priority OR NOT Priority Positive OR NOT Positive Good OR NOT Good	OK	OK	OK	OK		
0		0000	NEITHER (Privileged NOR Quashed) NEITHER (Priority NOR Questionable) NEITHER (Positive NOR Negative) NEITHER (Good NOR Evil)	Not-OK	Not-OK	Not-OK	Not-OK		
14		0111	(P AND Q) Privileged AND Quashed Priority AND Questionable Positive AND Negative Good AND Evil	OK	OK	OK	Not-OK		
1		1000	NOT (P NOR Q) NOT (Privileged NOR Quashed)NOT (Priority NOR Questionable) NOT(Positive NOR Negative) NOT(Good NOR Evil)	Not-OK	Not-OK	Not-OK	OK		
13		1011*	(Q IMPLY P) Quashed IMPLY Privileged Questionable IMPLY Priority Negative IMPLY Positive) Evil IMPLY Good	Not-OK	OK	OK	OK		

2		0100*	NOT (Q IMPLY P) NOT (Quashed IMPLY Privileged) NOT (Questionable IMPLY Priority) NOT (Negative IMPLY Positive) NOT (Evil IMPLY Good)	OK	Not-OK	Not-OK	Not-OK		
12		0011*	(P) (Privileged) (Priority) Positive Good	Not-OK	OK	OK	Not-OK		
3		1100*	NOT (P) NOT (Privileged) NOT Priority NOT(Positive) NOT(Good)	OK	Not-OK	Not-OK	OK		

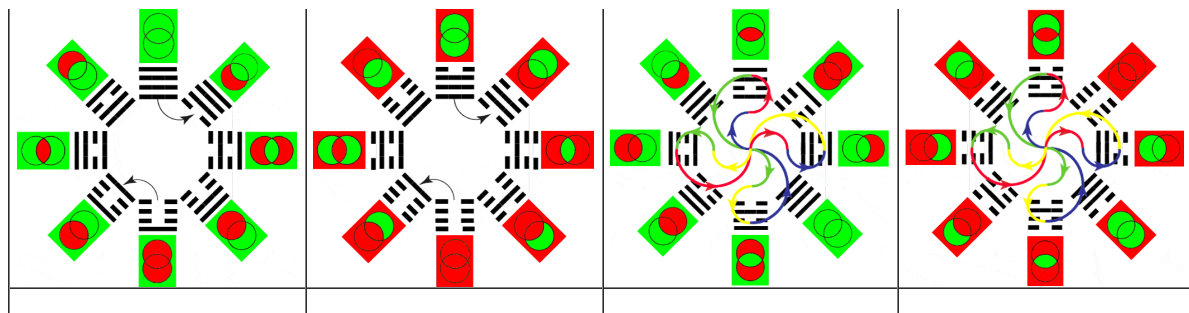
11		1101*	(P OR Q) Privileged OR Quashed Priority OR Questionable Positive OR Negative Good OR Evil	OK	Not-OK	OK	OK		
4		(0100)	NOT (P OR Q) NOT (Privileged OR Quashed) NOT (Priority OR Questionable) Positive OR Negative Good OR Evil	Not-OK	OK	Not-OK	Not-OK		
10		0101*	(Q) (Quashed) (Questionable) (Negative) (Evil)	OK	Not-OK	OK	Not-OK		
5		1010*	NOT (Q) NOT (Quashed) NOT (Questionable) NOT (Negative) NOT (Evil)	Not-OK	OK	Not-OK	OK		
9		1001	(P IF Q) (Privileged IF Quashed) (Priority IF Questionable) Positive IF Negative Good IF Evil	Not-OK	Not-OK	OK	OK		
6		0110	(P IF NOT Q) (Privileged IF NOT Quashed) (Priority IF NOT Questionable) Positive IF NOT Negative Good IF NOT Evil	OK	OK	Not-OK	Not-OK		
8		0001	(Q IMPLY P) (Quashed IMPLY Privileged) (Questionable IMPLY Priority) Negative IMPLY Positive Evil IMPLY Good	Not-OK	Not-OK	OK	Not-OK		
7		1110	NOT (P IMPLY Q) NOT (Privileged IMPLY Quashed) NOT (Priority IMPLY Questionable) NOT (Positive IMPLY Negative) NOT (Good IMPLY Evil)	OK	OK	Not-OK	OK		

Configuring the variety of "voices" and dialogue modalities coherently?

Clues from traditional insights into trigram dynamics: The exercise can be taken further by recognizing that the conventional **four-bit binary coding of 16 connectives corresponds to the four lines of the tetragram -- namely the lower four lines of the traditional hexagram**, which reinforced the original initiative of Gottfried Leibnitz. The **four-bit code (and the tetragram) therefore represent only one quarter of the array of 64 distinctions encoded by the I Ching hexagrams**. However the three lower lines of the hexagram (and of the tetragram) can be recognized as the traditional trigram. The set of 8 such trigrams -- the *BaGua* -- is traditionally configured in two ways, with which there are many traditional metaphorical connotations.

The tetragrams can be presented below with the juxtaposition of the relevant Venn diagrams to suggest the nature of possible dynamics between distinctive modalities.

Use of 8-fold <i>BaGua</i> -- with Venn diagrams -- to suggest the resonant dynamic relationships between "voices"			
Earlier Heaven (Fuxi) arrangement simple pattern of transformations between trigram "voices"		Later Heaven (King Wen) arrangement pattern of transformations between trigram "voices"	
Upper unbroken line (Environment OK)	Upper broken line (Environment Not-OK)	Upper unbroken line (Environment OK)	Upper broken line (Environment Not-OK)



"Aesthetic connectives"? The points above emphasize the logical nature of connectives, usefully evoking the question as to any recognition of a complementary set of aesthetic connectives. Of particular relevance is the part they might play in enabling comprehension of coherence in the face of complexity -- aside from their role in the appreciation of the arts and entertainment.

It could be asked whether comprehension of the set of connectives could be enabled in a poem, in a song, or through music. There seems to be little effort to do so, if only for mnemonic purposes. This contrasts with the use of an extensive set of songs to facilitate comprehension and memorability of the complex net of *metabolic pathways* (Harold Baum, *The Biochemists' Songbook*, 1995; MP3 files). The potential role of Bach's canons merit a degree of reflection in this light.

The point can perhaps be emphasized by a well known classical example by Lewis Carroll (*What the Tortoise Said to Achilles*, *Mind*, 104, 1895). It could be asked whether the author's popular novels (*Alice in Wonderland*, 1865; *Alice Through the Looking-Glass*, 1871) explore the full range of logical connectives in a similarly accessible manner (however disguised), given the preoccupations of the author -- as is apparent to a degree (*The Mathematical Aspects of Lewis Carroll's Alice in Wonderland*, *Bartleby Research*; Deepika Asthana, *The Hidden Math Behind Alice In Wonderland*, *The Curious Reader*, 13 February 2018; Melanie Bayley, *Alice's adventures in algebra: Wonderland solved*, *New Scientist*, 16 December 2009; Francine F. Abeles, *Mathematics: Logic and Lewis Carroll*, *Nature*, 527, 2015).

The case has been argued otherwise by Rosi Grillmair (*Code and Poetry: an exploration of logic throughout art, computation and philosophy* October 2019):

This thesis aims to put a finger on the overlay between mathematics and philosophy. Its method is to show that art and logic come together through language... when "code" is mentioned, it stands for mathematics, for computation in specific... "poetry" stands for the creative use of language and propositions. My interest from an artistic and analytical point of view is in the subversion of the two: If logic is the principal mode for exploring math, philosophy, computation and language -- how can it be played against itself in order to spark artistic, original thought?

There are seemingly no references to "aesthetic connectives", although metaphor would seem to be indicative of their function in many contexts -- perhaps exemplified by figures of speech (*Questionable Classification of Figures of Speech: as fundamental to the need for powerful rhetoric in governance*, 2016). It is intriguing to note that the binary coding system of 16 logical connectives derives from the early insights of Gottfried Leibniz -- reinforced by the traditional pattern of hexagrams of the Chinese *Yi Jing*. Commentary on the latter is articulated through what could be described as a pattern of 64 metaphors (*Transformation Metaphors derived experimentally from the Chinese Book of Changes (I Ching) for sustainable dialogue, vision, conferencing, policy, network, community and lifestyle*, 1997).

The adequacy of logical connectives could also be usefully challenged by the aesthetic role of tone-of-voice (*Varieties of Tone of Voice and Engagement with Global Strategy: alternating between a requisite variety of voices to engender coherence?* 2020). There it is noted that although the matter is subject to continuing review regarding *nonverbal communication*, it has been estimated that 7 percent of meaning is communicated through the spoken word, 38 percent through tone of voice, and 55 percent through body language according to the *7-38-55 rule*. This rule has been variously misinterpreted and subject to criticism, although considerable importance continues to be attached to tone-of-voice (irrespective of any rule and its relevance across cultures). Is the significance of logical connectives limited to 7 percent of communication?

The framing offered by the logical connectives alone would seem to reinforce modes of discourse which preclude other forms of connectivity as being necessarily "illogical", however they may be considered meaningful and persuasive -- fruitfully or misleadingly (Nazaria Solferino, et al, *Manipulating Persuasion in Debates: Fact Checking's Usefulness*, *Theoretical Economics Letters*, 5, 2015, 4; Michael Kaminski, *Nonstandard Connectives of Intuitionistic Propositional Logic*, *Notre Dame Journal of Formal Logic*, 29, 1988, 3).

Aesthetic connectives might be held to include "emotional connectives" -- potentially indicated by *emoji*, given the widespread popularity far exceeding that of logical connectives.

Music and song: As noted above, this exploration was triggered by the 14-fold pattern of Bach's *Fourteen Canons*. The question was "why 14" and whether their relationship could not be rendered more comprehensible to those inspired by other musical forms. Various clues have been presented of some value to that understanding.

Unfortunately missing is the sense of how Bach's articulation could be supportive of insights into subtler forms of governance -- beyond the tragic binary focus so widely prevalent. As noted, the possibility can be articulated separately (*A Singable Earth Charter, EU Constitution or Global Ethic?* 2006). The role of music and song can potentially also be explored metaphorically (*Envisaging a Comprehensible Global Brain -- as a Playful Organ*, 2019; *All Blacks of Davos vs All Greens of Porto Alegre: reframing global strategic discord through polyphony?* 2007).

The argument can be extended to the insights from improvisation in music, and song (*Improvisation in Multivocal Poetic Discourse: Basque lauburu and bertsolaritza as catalysts of global significance*, 2016). These are indicative of the challenge of recognizing the variety of relevant "voices" and their characteristic "tones" (*Hearing the Variety of Voices in Climate Change Discourse: recognizing the challenge of soundscape comprehension in controversy and emergency*, 2019; *Varieties of Tone of Voice and Engagement with Global Strategy: alternating between a requisite variety of voices to engender coherence?* 2020).

Whilst indicative of possibilities, none of these offer any focus on a 14-fold pattern. It is therefore somewhat surprising to note the degree of interest in 14-tone music, namely with 14 equal divisions of the octave *14-edo* (or 14 equal temperament 14-et), and in the relevant instruments (*Yin Bell, Study in a newly discovered 14-ET*, *Sound Cloud*, 2017). The *14-tone drum* has become a niche market and the sound is related appreciatively to the Javanese and Balinese *gamelan* (David B. Doty, *14-tone Just Intonation*, *Other Music*). Any such focus can now be usefully seen in the context of the

questionable dominance of equal temperament (Noel David Hudson, *Abandoning Nature: European philosophy and the triumph of equal temperament*, University of Massachusetts, 2007).

It has however been argued that there are no musical equivalents of other crucial parts of language such as the logical connectives: “and,” “but,” “or,” etc. (Andrew Kania, *Philosophy of Western Music: a contemporary introduction*, Routledge, 2020).

Patterns of dance: It could be readily assumed that dance has little to do with expression and comprehension of logical connectives. An exception is evident in the work of Andrea Hawksley (*A Binary Dance Workshop, Proceedings of Bridges 2014: Mathematics, Music, Art, Architecture, Culture*, 2014) who notes:

Binary operations and arithmetic are fundamental to how computers work, but are not always taught to students. This paper describes a mathematical dance workshop that can be used to visually display and kinesthetically teach the basics of binary including both basic binary logic as well as binary counting and addition.... the participants first learn and dance basic binary logic operations such as AND, OR, and XOR, before progressing to binary counting and addition. The workshop attempts to teach binary in a way that is particularly representative of a computer. Specifically, the state of the binary dance is stored by a group of people that are functioning as “registers”, and it is possible to add more bits than there are registers causing “overflow” behavior.

The [Bridges Conference](#) has long been a venue for related explorations (Karl Schaffer, *Math and Dance -- Windmills and Tilings and Things, Proceedings of Bridges 2012: Mathematics, Music, Art, Architecture, Culture*, 2012; Karl Schaffer and Erik Stern, *Workshop on Mathematics and Dance, Proceedings of Bridges 2010: Mathematics, Music, Art, Architecture, Culture*, 2010).

The variety of references to dance and the Venn diagram suggests the possibility of expressing the set of 16 connectives through dance -- in the light of the mappings presented here. Given the cultural traditions of the [sword dance](#) -- the possibilities of a "Venn dance" could be readily envisaged to that end ([Conditional Probability Using a Venn Diagram: Dance Categories](#), YouTube, 5 February 2019). Scoring in fencing is such that the winner is the first to achieve 15 points.

Curiously noteworthy is the testing challenge in figure skating of the 14-step dance routine (Franz Schöler, *Fourteen Step, Skate Dance Diagrams and Tools*, 1889; [Fourteen step](#), YouTube, 24 December 2010).

Haiku: This is essentially a very short poem depicting a specific experience in nature or in a human context. *Haiku* is contrasted with a related form, [senryu](#), which tends to be about human foibles while *haiku* tend to be about nature -- *senryu* are often cynical or darkly humorous while *haiku* are serious.

The traditional Japanese rules for *haiku* require the use of 17 syllables grouped into three lines composed of respectively 5-7-5 syllables. These rules are applied in a multitude of languages by a worldwide "haiku movement" (cf [World Haiku Club](#); [Haiku International Association](#)). However, as separately argued, the number of syllables may vary from 10 to 14 -- whether in Japanese or in other languages and especially English (Michael Dylan Welch, [Why "No 5-7-5"? NaHaiWriMo; Trump's Verbal Art: American Haiku in 12 Words and 14 Syllables](#), 10 January 2017).

[Dag Hammarskjöld](#), a writer of *haiku*, during his mandate as Secretary-General of the United Nations, was especially preoccupied with security issues. UNESCO, one of the funders of the WAAS gathering, featured *haiku* through the website of its Italian National Commission, in collaboration with the [World Haiku Club](#), on the occasion of [World Poetry Day](#) in 2002. As an aesthetic dimension of martial arts, its role with respect to governance merits careful attention ([Ensuring Strategic Resilience through Haiku Patterns: reframing the scope of the "martial arts" in response to strategic threats](#), 2006).

Why the constrained use of syllables should be especially significant remains far from clear -- whether 14 or 17. How indeed might the set of logical connectives be memorably held by a haiku?

Embodiment of logical connectives in sonnet form

A 14-line poem is traditionally called a “[sonnet](#)”. Most sonnets have 14 lines, with 10 syllables in each line, but some may have less and some may have more. For example, some sonnets have 12 lines, and some have 16 lines. Apart from the technical structure of a sonnet (rhyme and rhythm), the defining feature of a sonnet is the narrative form. Typically, the first few lines lay out a problem. The next few lines contain a proposal and the final lines, the resolution (Bob Holman and Margery Snyder, *The Sonnet: A Poem in 14 Lines*. ThoughtCo, 26 August 2020; Edward A. Snow *Loves of Comfort and Despair: A Reading of Shakespeare's Sonnet 138*, *ELH-English Literary History*, 47, 1980, 3),

The sonnet was a popular form of poetry during the [Romantic period](#): [William Wordsworth](#) wrote 523 sonnets, [William Shakespeare](#) 154, [John Keats](#) 67, and [Samuel Taylor Coleridge](#) 48. Those of Shakespeare are widely considered the finest in the English language.

Sonnets come in two major forms: Petrarchan, or Italian; and Shakespearean, or English. The [Petrarchan sonnet](#), named for its originator Petrarch, has two divisions in its 14 lines: a beginning set of eight lines known as an octave followed by six lines known as a sestet. The octave has a set rhyme scheme of ABBAABBA, while the rhyme scheme of the sestet varies. Shakespeare modified the sonnet to fit the English language. The divisions of the Shakespearean sonnet are three sets of four lines called quatrains and a final couplet. The Shakespearean sonnet has the rhyme scheme ABABCDDEFEFGG and is written in iambic pentameter ([What Is a 14-Line Poem Called? Reference](#), 28 March 2020). Two additional forms are recognized, the [Miltonic sonnet](#) and the [Spenserian sonnet](#) (What Are the Different Types of Sonnets? *MasterClass*, 16 August 2021).

As variously highlighted in the argument above, **there is seemingly little insight -- or interest -- in the justification for a 14-fold pattern**, any more than that for other common preferences of strategic significance. The early commentary in this respect by [William Sharp](#) is therefore unique ([The Sonnet: Its Characteristics and History, Sonnets of This Century](#), 1887):

The structure of the sonnet is arbitrary in so far that it is the outcome of continuous experiment moulded by mental and musical influences: it is not a form to be held sacred simply because this or that great poet, or a dozen poets, pronounced it be the best possible poetic vehicle for its purpose. It has withstood the severest test that any form can be put to: it has survived the changes of language, the fluctuations of taste, the growth of culture, the onward sweep and the resilience of the wave of poetry that flows to and fro, "with kingly pauses of reluctant pride," across all civilised peoples: for close upon six hundred years have elapsed since [Guittone](#) and Dante and Petrarca found the perfected instrument ready for them to play their sweetest music upon....

The Guittonian limitation of the sonnet's length to fourteen lines was, we may rest assured, not wholly fortuitous. *The musical and poetic instinct probably, have determined its final form more than any apprehension of the fundamental natural law beneath its metrical*

principles ... It became necessary, then, to find a mould for the expression of a single thought, emotion, or poetically apprehended fact, which would allow sufficient scope for sonority of music and the unfolding of the motive and its application, and which yet would not prove too ample for that which was to be put into it.

Repeated *experiments tended to prove that twelve, fourteen, or sixteen lines were ample for the presentation of any isolated idea or emotion*; again, that the sensitive ear was apt to find the latter number a shade too long, or cumbrous; and still later, that while a very limited number of rhymes was necessitated by the shortness of the poem, the sixteen reverberations of some three or four terminal sounds frequently became monotonous and unpleasing. Ten or twelve-line poems were ascertained to be as a rule somewhat fragmentary, and only worthily served when the poet was desirous of presenting to his readers a simple pearl rather than a diamond with its flashing facets, though here also there was not enough expansion for restricted rhyme, while there was too much for merely two or at the most three distinct terminal sounds.

Again, it was considered advisable that the expression should be twofold, that is, that there should be the presentation of the motive, and its application; *hence arose the division of the fourteen-line poem into two systems*. How were these systems to be arranged? Were seven lines to be devoted to the presentation of the idea or emotion, and seven to its application: seven to the growth of the tree, and seven to its fruitage: seven to the oncoming wave, and seven to its resurgence? The sensitive ear once more decided the question, recognising that if there were to be a break in the flow of melody -- and the necessity of pauses it had already foreseen -- it could not be at a seventh line, which would bring about an overbalance of rhyme.

Experience and metrical music together coincided to prove that the greatest amount of dignity and beauty could be obtained by the main pause occurring at the end of the eighth line. Here, then, we arrive at the two systems into which the sonnet is divided -- the major and the minor: and because the major system consists of eight lines, it is called the "octave," and correspondingly the minor system is known as the "sestet." It soon became evident, however, that something more was wanted: it was as if a harpist had discovered that with another string or two he could greatly add to the potential powers of his instrument. This was the number and the true distribution of rhyme-sounds. How many were to occur in the octave, how many in the sestet? or were they to pervade both systems indiscriminately? ... Again, Guittone had definitely demonstrated that *in length each sonnet-line should consist of ten syllables, the decasyllabic metre permitting a far greater sonority than the octosyllabic; and that acute experimentalist probably quite realised that continuous sonority and unbroken continuity of motive were two of the most essential characteristics of the sonnet*. No one who has any knowledge of the laws both of music and of poetical forms would be surprised if it were proved, as has been asserted, that Fra Guittone or his predecessors perceived and acted in accordance with the close analogy existing between their chosen metrical form and the musical system established by Guido Bonatti in the eleventh century. Throughout Fra Guittone's work it is evident that he is no blind blunderer, but a poet striving to make his vehicle the best possible, working upon it with a determinate aim. *[emphasis added]*

With respect to Shakespeare's sonnets, for [Harold Bloom](#) and [Brett Foster](#):

The sonnets stand as the record of a mind working out positions without the help of any pantheon or any systematic doctrine. *Shakespeare's speaker often considers, in rapid succession, any number of intellectual or ideological positions, but he does not move among them at random. To the contrary: in the first quatrain of any given sonnet he has a wide epistemological field in which to play, but in the second quatrain he generally queries or contradicts or subverts his first position (together with its discourse-field). By the third quatrain, he must (usually) advance to his subtlest or most comprehensive or most truthful position* (Q3 therefore taking on, in the Shakespearean sonnet, the role of the sestet in the Petrarchan sonnet). And the couplet -- placed not as resolution (which is the function of Q3) but as coda -- can then stand in any number of relations (summarizing, ironic, expansive) to the preceding argument. The gradually straitened possibilities as the speaker advances in his considerations give the Shakespearean sonnet a funnel-shape, narrowing in Q3 to a vortex of condensed perceptual and intellectual force, and either constricting or expanding that vortex via the couplet. (*The Sonnets*, Infobase Publishing, 2009, p. 294) *[emphasis added]*

Given the improbability that the literature on the 14 to 16 logical connectives (as noted above) would either make any reference to poetry or consider the possibility of their articulation in sonnet form, it is quite surprising to note the various references to "logical connectives" in discussion of sonnets. Thus for [Helen Vendler](#):

Many quatrains, taken singly, could well be called conventional, and paraphrases of them by critics make them sound stultifying. *What is not conventional is the sonnet's (invisibly predicated) set of relations -- of the quatrains to one another and to the couplet; of the words and images to one another; of the individual grammatical and syntactic units to one another*. Even though the appearance of logic is often smoothly maintained by a string of **logical connectives** (*When... When... Then*), some disruptive or contradictory force will enter the poem to pull one quatrain in two directions at once -- toward its antecedent quatrain by one set of words, toward its consequent by another; toward the couplet by its temporality; toward a preceding quatrain by its spatiality. Since quatrains often participate in several patterns simultaneously, their true "meaning" is chartable only by charting their pattern-sets (*The Art of Shakespeare's Sonnets*, Harvard University Press, 1999, p. 29) *[emphasis added]*

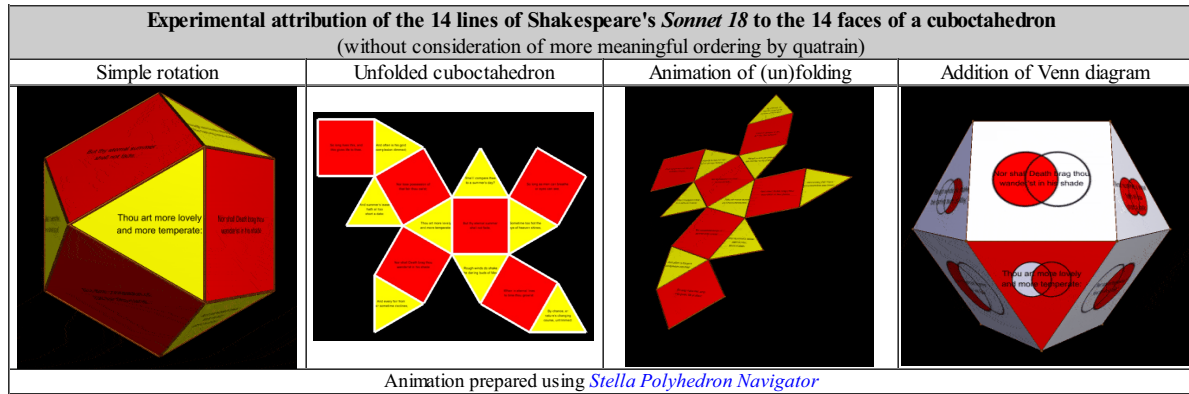
The distinction accorded to the [couplet](#) in sonnets, namely the two rhyming lines which may follow the four quatrains (as in Shakespeare's famed [Sonnet 18](#)), recalls the process of dissociating the 15th and 16th logical connectives. However in the case of the sonnet, the link to them would appear to accord a kind of meta-significance which is precluded from a purely logical perspective (as noted above). The analytical focus on Sonnet 18 in the literature may be assumed to clarify why its 14 lines "work" in such a special manner.

Easily forgotten by many is the extent of commentary on sonnets -- especially those of Shakespeare -- and on the Romantic period of which they are characteristic. A striking example of the problematic dynamics in that domain is offered by the critical review of [Roger Peters](#) (*Booth and Vendler: obsessive misinterpretation, Inquest*, 2009). This is contrasted with the author's own multi-volume study (Roger Peters, *William Shakespeare's Sonnet Philosophy*, Quaternary Institute, 2005). The critique justifies the bemused reaction -- as noted above -- of the historian of philosophy W. T. Jones (*The Romantic Syndrome; toward a new methodology in cultural anthropology and the history of ideas*, 1961). The predictability of such dynamics can then be understood as associated with positions within a framework of a set of axes of bias as presented above.

Given the degree of self-reflexivity characteristic of Shakespeare, and expressed in the sonnets, it could be usefully asked why such uncreative dynamics are not embodied in sonnet form by critics and commentators as an aid to reflection on the sonnet form -- so widely presented in educational settings.

With respect to any reconciliation of the "headless hearts" and the "heartless heads" -- exemplifying the challenge of C. P. Snow's *The Two Cultures* (1959) at this time -- **there is considerable irony to the contrasting status of the "line" in the realm of poetry and in that of logic** (or computer algorithms). **The sonnets relish the memorable connectivity between 14 lines of natural language, whereas that between 14 logical connectives could not be more inaccessibly obscure within an unmemorable framework of abstraction.** Unfortunately it is on the latter that decision-makers are dependent in global modelling and the detection of misinformation.

There are very few references to polyhedra in relation to the sonnets, although the 14-fold relation to the cuboctahedron may be noted. As an illustrative exercise there is therefore a case for configuring the lines of a much-cited sonnet on the faces of such a polyhedron to frame the question as to how that attribution might give another focus to the coherence of the sonnet. In the animation on the right, the contrasting Venn diagrams (above) are added -- potentially to be used to distinguish quatrains.



The special treatment of the final couplet of two lines in the set of 14 is suggestive of a more general issue, when it is two logical connectives which are omitted from the set of 16. There is some implication, as could be argued from the first group in the periodic table, that "two elements" are added or removed from any cluster of this kind for reasons which call for further exploration -- but of which the periodic table is suggestive. Thus whilst 14 is understood as 12+2, there is a suggestion of a particular relation to a cluster of 10 as 12-2, or 8 as 10-2, or 6 as 8-2, or 4 as 6-2.

Future challenge of problematic sets for governance -- strategic sonnets?

Application to other controversial issues: Given the fundamental role of logical connectives, despite the alienating abstraction of their articulation, there is a case for exploring the relevance of the distinctions made to other domains. As noted above, their clarification in English is frustratingly rare, highlighting the value of their articulation by Maarten van Wijk (*English language lexicalisations of all 16 connectives*, 2006). The column on the right below is a simplification of the example given there (possible losing some careful distinctions). The original is constructed on a distinction between two basic propositions: *the tiger is coming* (P) and *I brought a spear* (Q) -- with which the set of 16 connectives is developed.

As adapted in the central and right-hand columns below, these endeavour to highlight the relevance to discourse regarding COVID-19 and climate change respectively. It is of course noteworthy how subtle some of the distinctions appear (in this simplified rendering). This reinforces the tendency to consider some of them irrelevant in practice -- effectively reducing the set to a much smaller number, possibly just to the first two. This limited set tends to be an obvious feature of mainstream discourse with respect to the pandemic, for example.

In the light of the argument above with regard to the aesthetic connectivity between the 14 lines of a sonnet, there is clearly the challenge of rendering such distinctions into more attractively memorable poetic form. Given the popular appreciation of the [Eurovision Song Content](#), could such a challenge even take the form of an annual competition? Will any attempt be made to render the challenge of climate change action into some such form? The case can be argued more generally (*A Singable Earth Charter, EU Constitution or Global Ethic?* 2006). What renders articulation of a complex strategy "singable"?

With respect to the organization of the following 14-fold sets, it might be asked whether "P" and "Q" could embody some sense of "question: and "answer" -- possibly clustered from the most obvious in the first quatrain to the subtlest in the last (as noted above with respect to the sonnet form). That the last would tend to be ignored would then be all the more explicable. The elements are tentatively clustered by "quatrain" (following the above-mentioned organization of sonnets) with the potential implication that only the earliest "quatrains" are readily susceptible to comprehension -- and to processing by logic gates and algorithms for governance purposes.

In terms of comprehension, access from one quatrain to another might even be considered in terms of a succession of "glass ceilings" with considerable strategic implication -- given an obvious tendency of governance to avoid or repress the implications of any quatrain, with the exception of the first. As noted above with respect to Shakespeare by Harold Bloom and Brett Foster:

... in the second quatrain he generally queries or contradicts or subverts his first position (together with its discourse-field). By the third quatrain, he must (usually) advance to his subtlest or most comprehensive or most truthful position (*The Sonnets*, 2009, p. 294).

Tentative distinction of 16 logical connectives			
as potentially applicable to the challenging governance discourse of the pandemic and climate change			
	Adaptation of the articulation of Maarten van Wijk (to whom apologies)	Adaptation to discourse relating to the pandemic challenge	Adaptation to discourse relating to climate change
1	Tiger is coming, and I brought a spear	Virus is coming, and I got a jab	Climate change is coming, and I acted now
2	Tiger is coming, but I did not bring a spear	Virus is coming, but I did not get a jab	Climate change is coming, but I did not act now
3	Tiger is not coming, and I brought a spear	Virus is not coming, and I get a jab	Climate change is not coming, and I act now
4	Neither is tiger coming, nor did I bring a spear	Neither is virus coming, nor did I get a jab	Neither is climate change coming, nor do I act now

5	Tiger is coming, and maybe I brought a spear	Virus is coming, and maybe I get a job	Climate change is coming, and maybe I act now
6	Maybe tiger is coming, and I brought a spear	Maybe virus is coming, and I get a job	Maybe climate change is coming, and I act now
7	I bring a spear if and only if tiger is coming	I get a job if and only if virus is coming	I act now if and only if climate change is coming
8	I never have a spear when tiger is coming and when I have one it won't come	I never get a job when virus is coming and when I have one it won't come	I never act now when climate change is coming and when I act it won't come
9	Tiger is not coming, and maybe I brought a spear	Virus is not coming, and maybe I get a job	Climate change is not coming, and maybe I act now
10	Maybe tiger is coming, and I did not bring a spear	Maybe virus is coming, and I did not get a job	Maybe climate change is coming, and I did not act now
11	Tiger is coming, or I have a spear	Virus is coming, or I got a job	Climate change is coming, or I act now
12	If I have a spear, then tiger is coming	If I get a job, then virus is coming	If I act now, then climate change is coming
13	If tiger is coming then I have a spear	If virus is coming then I get a job	If climate change is coming then I act now
14	It is not true that tiger is coming and I have a spear	It is not true that virus is coming and I get a job	It is not true that climate change is coming and I act now
15	Whether tiger is coming or not , either I have a spear or I do not (always true)	Whether virus is coming or not , either I get a job or I do not (always true)	Whether climate change is coming or not , either I act now or I do not (always true)
16	Whether tiger is coming or not , I have a spear and I do not have a spear (always false)	Whether virus is coming or not , I get a job and I do not (always false)	Whether climate change is coming or not , I act now and I do not (always false)
NB: As clarified above, the set of 16 connectives is conventionally reduced to 14, with the argument that #15 is always true (tautology), and #16 is always false (contradiction). With thanks to Nadia McLaren for reviewing the adaptations			

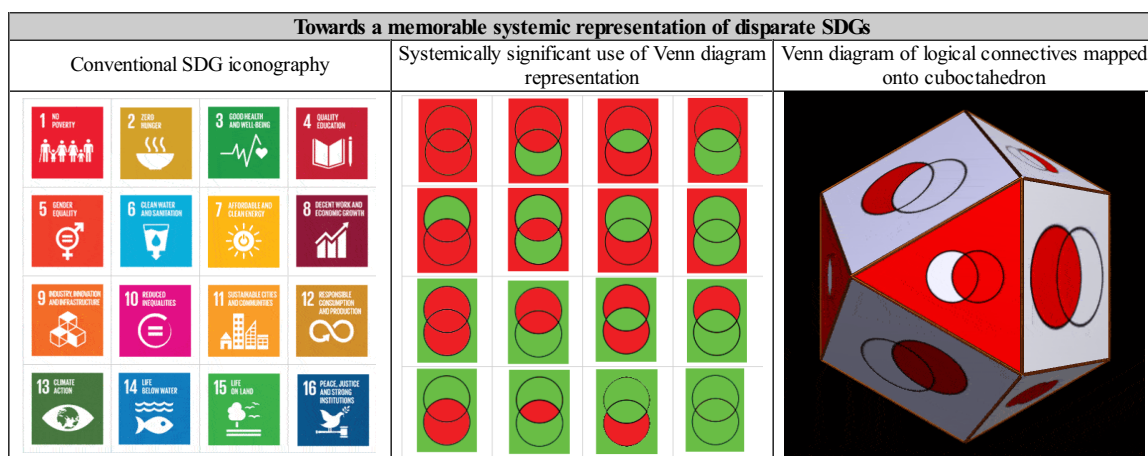
The alienating schematic articulations above can be usefully contrasted with the widely cited poetic tale: *Everybody, Somebody, Anybody and Nobody*. This can be adapted to issues of governance (*Responsibility for Global Governance Who? Where? When? How? Why? Which? What?* 2008)

Gender-identities now framed by acronyms (LGBTQ and its variants): There is considerable confusion regarding the emerging distinctions of gender identity (Mere Abrams, *46 Terms That Describe Sexual Attraction, Behavior, and Orientation*, HealthLine, 10 December 2019).

There is a case for exploring whether a 14-fold or 16-fold pattern of distinctions could be fruitfully elaborated -- potentially combining insights into logical connectivity with the aesthetic connectivity so characteristic of the sonnet form (*Encompassing the "attraction-harassment" dynamic with a notation of requisite ambiguity?* 2017).

17 (minus 1) Sustainable Development Goals: As noted above, the comprehensibility of the SDGs and their interrelationship poses a particular challenge to governance -- both in systemic terms and in evoking engagement. A fundamental question is how they reflect a coherent systemic perspective -- despite their apparently disparate nature. Given the significance attributed to the Venn diagram representation, in relation to the logical connectives, it might be asked whether each SDG could be understood as an exemplification of one such distinction. The challenge is presented below through juxtaposing the iconography of the set of SDGs with that of the connectives.

As argued separately the 17th coordinating goal is excluded from the pattern, but there is also the question of whether the 16 include 2 which are meta-systemic in some way -- justifying a reduction in representation to 14. It is in that sense that the 14 Venn diagrams associated with the 14 connectives are mapped onto a cuboctahedron as presented above. Again this poses the question of how they might best be configured to exemplify their systemic relationships.



Missing from such possibilities is of course the possibility of benefitting from any aesthetic rendering into memorable poetry or song.

Coherent ordering of 14 process elements: As noted above in identifying a set of 14 process elements, a valuable clue to systemic coherence is offered from a cybernetic perspective as constituting a comprehensive performative epistemology for the *viable system model* (VSM) process (David Lowe, Angela Espinosa and Mike Yearworth, *Constitutive Rules for Guiding the Use of the Viable System Model: reflections on practice*, *European Journal of Operational Research*, 287, 2020, 3). As noted by the authors, and of relevance to the disparate nature of the checklist above, *these are held to be representative of the range of VSM practice but not an exact reproduction of the coverage in each of the sources analysed, keeping with the requirement to capture process elements that would be generative of variability of practice rather than prescriptive of it.*

The authors in the latter case make a point of potential relevance to the comprehension of any 14-fold articulation:

The VSM has been the subject of criticism and in particular the cognitive accessibility of the VSM has been recognised to be an issue for many

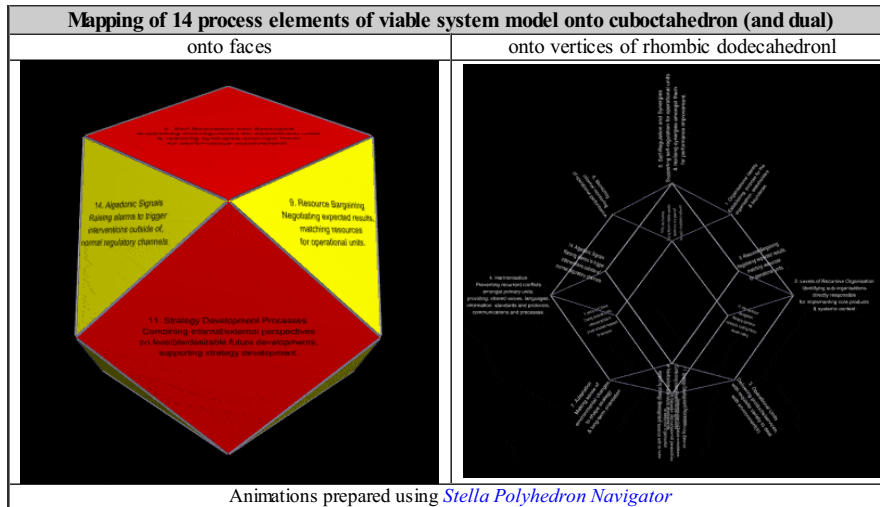
who have tried to apply it in everyday OR practice

As noted by Lowe et al (2020):

Beer (1975) defined Organisational Cybernetics as the "science of effective organization" with the aim of challenging traditional management models, which he found to be inadequate for addressing the many complex and messy situations faced by managers. Beer (1979, 1981, 1984, 1985) developed the VSM as a conceptual model for the design of organisations as self-organised networks, operating without a central control (i.e. heterarchies not hierarchies). He described the necessary and sufficient conditions for a organisational system to be viable, i.e. capable of maintaining an independent existence in a dynamic operating environment...

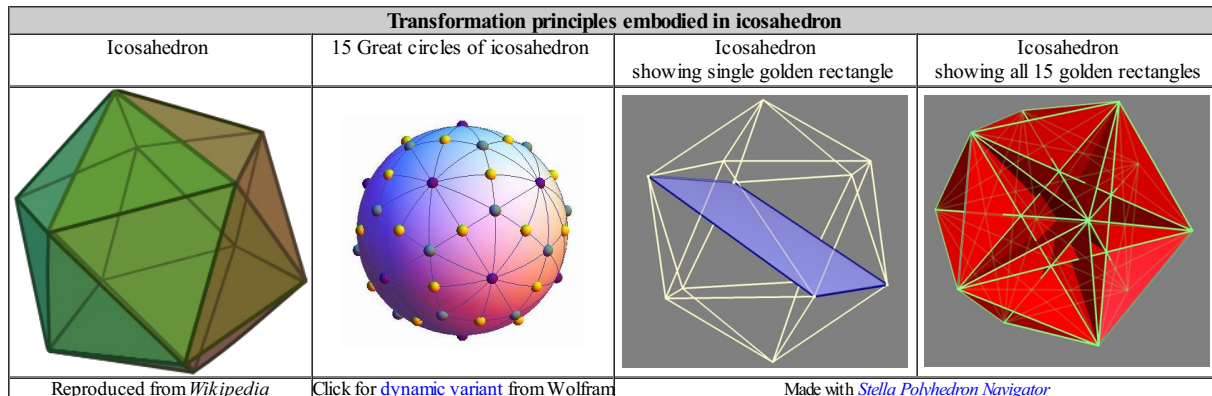
The VSM offers *a meta-language to map organizational complexity, and to analyse organizational viability*. In doing so, the VSM distinguishes between three main elements; Operations (O) – where the products or services are produced; meta-systemic management (M) – responsible for providing the operations with all the required technical and administrative support for effective production; and environment (E) – for which the operations produce their products or services and within which the organisation as a whole lives. *[emphasis added]*

It would seem that there is a curious relationship, or absence of one, between Edward Deming's seminal articulation of 14 principles of management (as noted above) and that of Stafford Beer. It is all the more curious in that Deming has also used the abbreviation VSM, but with the meaning [Value Stream Mapping](#) (Harish Jose, *Dr. Deming and Value Stream Mapping*, 30 June 2016). Value Stream Mapping with its 7-fold focus on waste management has become an essential part of Lean manufacturing, with its particular entanglement with Deming's principles.



Focal role of the icosahedral pattern? Whilst the icosahedron proved fundamental to the later 30-fold cybernetic reflections of Stafford Beer, and can be recognized as a nexus in transformational pathways (as noted above), it invites further consideration in the light of the multi-volume study by Christopher Alexander (*The Nature of Order*, 2003-4). He articulated the insights it engendered in a study of *Harmony-Seeking Computations: a science of non-classical dynamics based on the progressive evolution of the larger whole* (*International Journal for Unconventional Computing (IJUC)*, 5, 2009).

Of particular relevance to the argument here is Alexander's identification of 15 transformation principles. These invite recognition in psychosocial terms, as discussed separately (*Harmony-Comprehension and Wholeness-Engendering: eliciting psychosocial transformational principles from design*, 2010). There the question was raised as to whether the notions of wholeness and harmony could be rendered more evident through some form of icosahedral configuration of the 15 (*Geometrical configuration of Alexander's 15 transformations*). The point can be made most succinctly below through the images presented there.



Rosetta stone of meaning? In the case of the sonnet, the manner in which 12 are isolated as three quatrains recalls the importance attached to the astrological framework during the Romantic period (Sophie Chiari and Mickaël Popelard, *Spectacular Science, Technology and Superstition in the Age of Shakespeare*, Oxford University Press, 2017). As such they bear exploration in terms of the traditional quadruplicities of that framework. The division of the preceding Petrarchan sonnet of 14 lines into two divisions -- an initial 8 (known as an octave), followed by 6 (known as a sestet) -- may even reinforce such an argument. This suggests 2 quadruplicities and 2 triplicities from the perspective of that framework.

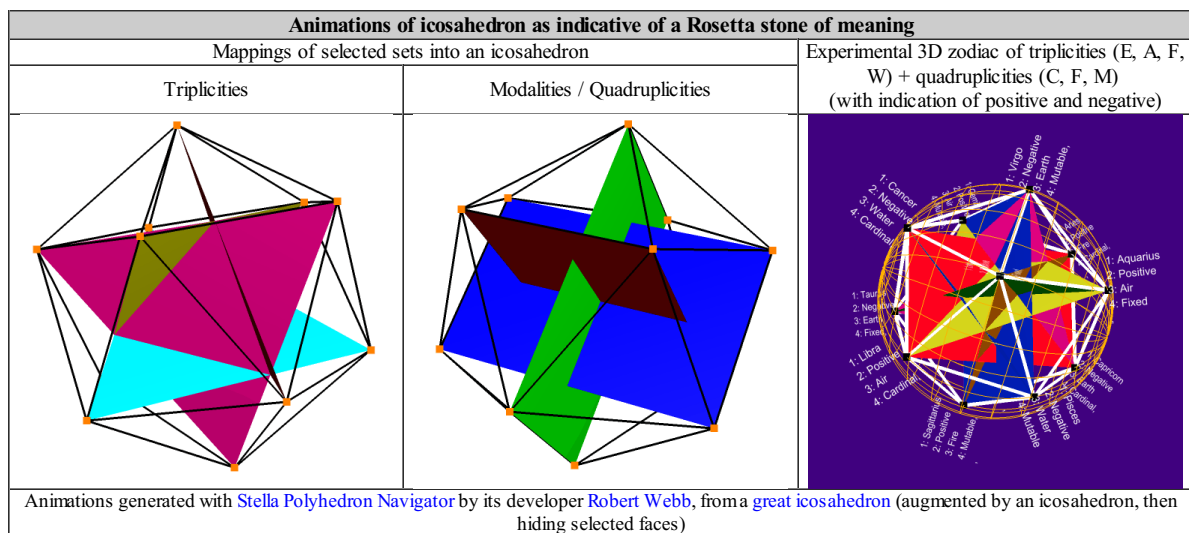
The argument can be taken further in the light of the explorations of [Arthur M. Young](#) (*The Geometry of Meaning*, 1976). As the designer of [Bell](#)

Helicopter's first helicopter, the Model 30, and inventor of the stabilizer bar used on many of Bell's early helicopter designs, he sought to generalize cognitive insights into the control of the flight of a helicopter. This he framed metaphorically through 12 standard physical "measure formulae" -- in the quest for the design of a "psychopter". Somewhat ironically a sonnet might be understood as a "psychopter" in its own right.

Young's approach might also be framed in terms of technomimicry, as separately discussed (*Engendering a Psychopter through Biomimicry and Technomimicry: insights from the process of helicopter development*, 2011). The essentially controversial intention of Young can usefully be framed in terms of the repudiated alchemical endeavour of "transmuting base metals into gold". He chose as his "base metals", a set of 12 standard formulae of physics, those most ironically characteristic of "Newtonian mechanics". His purpose was to elicit the design of a psychopter as a "winged self" (*The Bell Notes: a journey from physics to metaphysics*, 1979). The cognitive "transmutation" could be framed in terms of what is readily termed "generalization". It could be better understood in musical terms as "transposition of key" (*Paradigm-shifting through Transposition of Key: a metaphoric illustration of unexplored possibilities for the future*, 1999).

As discussed separately, Young uses the traditional pattern of 12 zodiacal signs to provide a circular (mnemonic) encoding of the **learning/action cycles** in terms of their psychological implications (*Geometry of meaning: an alchemical Rosetta Stone?* 2013). The pattern constitutes a commonly multifaceted container through which to engage with the infinite potential of a universe in all its senses. Young sees this pattern as constituting a **Rosetta Stone** of meaning -- readily associated with the **philosopher's stone** traditionally engendered by the Magnum Opus of alchemy. His argument invites interpretation in terms of strategic dialogue (*Typology of 12 complementary dialogue modes essential to sustainable dialogue*, 1998; *Typology of 12 complementary strategies essential to sustainable development*, 1998).

The 12 conditions which Young associated with the zodiac can be usefully mapped into an icosahedron (given its 12 vertices) as shown below -- as one significant approximation to a sphere. This could then be considered both as a **3D presentation of the zodiac** and as an indication of the distinct control functions envisaged by Young with respect to any "psychopter". Given his helicopter inspiration, the animations are reminiscent of requirements of **aircraft control in 3D** (yaw, pitch, and roll). As discussed separately, a distinction is made below between 4 sets of contrasting threefold quality ("triplicities") and 3 sets of contrasting fourfold modality ("quadruplicities"). In the central animation, the rectangles have long been recognized as having the proportion of **golden rectangles**. (*Insights into Dynamics of any Psychosocial Rosetta Stone*, 2016).



Perspective from the Romantic period? The emphasis on current understandings of polyhedra distracts from what may be intuitive understandings of such spherically symmetrical forms in an earlier period. In that light consideration could be given to one of the much appreciated poems of Samuel Taylor Coleridge -- also known for his 48 sonnets. Distinct from that form (with only 8 syllables per line), the partially completed poem of interest is *Kubla Khan: or, A Vision in a Dream: A Fragment* (1816) of which the first stanza famously reads (left below), inviting speculative inferences (right below):

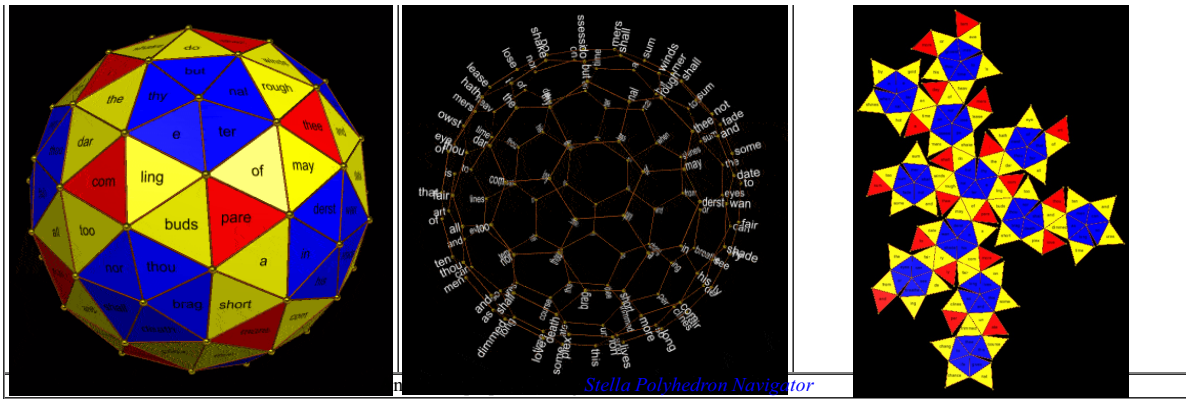
<i>In Xanadu did Kubla Khan</i>	Ideal framing/locus in architectural terms
<i>A stately pleasure-dome decree:</i>	Spherical polyhedron; globalization as promoted
<i>Where Alph, the sacred river, ran</i>	Indication of Aleph and its mysteriously integrative role
<i>Through caverns measureless to man</i>	Cells of higher dimensional polyhedron
<i>Down to a sunless sea.</i>	Down to a realm of incomprehensibility

Related inferences from an earlier epoch could be drawn from *The Conference of the Birds* (1177) by the Sufi poet **Farid ud-Din Attar**. Thirty birds, representative of individual human constraints, engage in a quest for collective wisdom and coherence -- finally to discover that they themselves are a reflection of what they seek.

Potential psychosocial implications of more complex polyhedra

The point was made above that the 4-bit encoding used to distinguishing the 16 logical connectives could be recognized as being only 50% of a richer 5-bit pattern, and only 25% of an even richer 6-bit encoding typical of the original Chinese hexagram which reinforced the influential thinking of Gottfried Leibnitz regarding binary coding. In that light it is of interest to note how any such richer pattern might be coherently represented on a polyhedron. This is indicated in the two animations below using the relatively unique attributes of the 64-edged drilled truncated cube, as discussed separately (*Proof of concept: use of drilled truncated cube as a mapping framework for 64 elements*, 2015).

Especially noteworthy is the manner in which the form of the 4-dimensional central schematic below is echoed in the 3-dimensional form through the **articulation of an internal structure** -- effectively hollowing out a cube by "drilling" it as the name indicates. This can be understood as a means of giving 3-dimensional reality to the two "logical" connectives which are so questionably omitted from the set of 16 logical connectives. The drilled truncated cube is therefore capable of "holding" 4x16 distinctions, whereas the recourse to the cuboctahedron and its dual could only "hold" 14, mapped **externally** onto the faces or vertices respectively. **The internal reflection of the outer form in the more complex structure can also be understood as honouring a degree of self-reflexivity** otherwise absent from the conventional set of 14 logical connectives -- but implied by the



Relevance of quantum field theory to cognitive organization? Quantum mechanics now represents an exciting frontier framed by the cautionary comment of [Richard Feynman](#) (an iconic exemplar) with words to the effect that: *if anyone claims to understand quantum physics, they do not understand quantum physics*. An early effort to derive implications for international relations is that offered by [Alexander Wendt](#) (*Quantum Mind and Social Science: unifying physical and social ontology*, 2015; [video](#); [interview](#)), as discussed separately (*On being "walking wave functions" in terms of quantum consciousness?* 2017).

With such precautions, it is appropriate to note how an understanding of a 14-fold pattern has been articulated in the obscure literature of the field -- notably characterized by unfamiliar references to [Feynman diagrams](#), [amplituhedron theory](#), [associahedron](#), [permutohedron](#), and [cyclohedron](#) (Pascal Lambrechts, et al, *Associahedron, Cyclohedron and Permutohedron as compactifications of configuration spaces*, *Bulletin Belge. Math. Soc. Simon Stevin*, 17, 2010)). In theoretical physics, a Feynman diagram is a pictorial representation of the mathematical expressions describing the behaviour and interaction of subatomic particles (*List of Feynman diagrams*). They have been recognized as the most succinct representation of present knowledge about the physics of [quantum scattering](#) of fundamental particles and are variously described and depicted (Tim Evans, *'Diagramology': Types of Feynman Diagram*, 2nd January 2018).

For [Nima Arkani-Hamed](#), et al (*Cosmological Polytopes and the Wavefunction of the Universe*, September 2017):

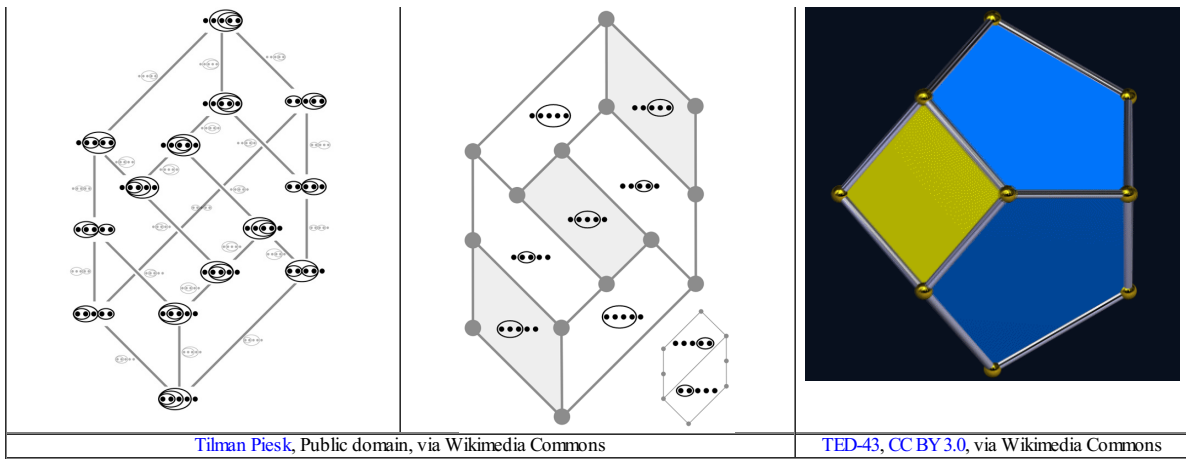
The contribution of each Feynman diagram to the wavefunction of the universe is associated with a certain universal rational integrand, which we identify as the canonical form of a "cosmological polytope", which have an independent, intrinsic definition, making no reference to physics. The singularity structure of the wavefunction for this model of scalars is common to all theories, and is geometrized by the cosmological polytope.

As noted by [Robin Ticciati](#) (*Quantum Field Theory for Mathematicians*, Cambridge University Press, 1999), all Feynman diagrams constitute a high-dimensional polytope. At second order there are 14 connected Feynman diagrams which represent scattering processes (p. 108). As confirmed by I. T. Todorov (*Analytic Properties of Feynman Diagrams in Quantum Field Theory*, Elsevier, 2014), a class of primitive diagrams for scalar [meson-nucleon scattering](#) consists of 14 Feynman diagrams, as shown below

14 Feynman diagrams for scalar meson-nucleon scattering	
2D array	Mapping onto cuboctahedron
<p>Reproduced from I. T. Todorov (<i>Analytic Properties of Feynman Diagrams in Quantum Field Theory</i>, Elsevier, 2014, p. 52-53)</p>	<p>Reprojection of array on left</p>

It is perhaps therefore somewhat unsurprising to discover diagrams corresponding to those used to represent the set of 14 logical connectives (presented above).

Representations of an associahedron		
Hasse diagram of the Tamari lattice T4	Faces of the associahedron of order 4 labelled with ovals ("vacuum diagrams")	Associahedron as an order-4 truncated triangular bipyramid (animation)



Tilman Piesk, Public domain, via Wikimedia Commons

TED-43, CC BY 3.0, via Wikimedia Commons

As noted by Bo Feng and Yaobo Zhang (*Note on the Labelled tree graphs*, arxiv.org, 4 September 2020; submission to *Journal of High Energy Physics*), all Feynman diagrams having non-compatible poles, can be removed leaving diagrams all having a singular pole, as exemplified in the case of the remaining 14 Feynman diagrams up to a sign (as shown below right). The authors reproduce images from an earlier paper (Xiangrui Gao, Song Hea, and Yong Zhang, *Labelled tree graphs, Feynman diagrams and disk integrals*, arxiv.org, 14 October 2017; *Journal of High Energy Physics*, 2017, 11). This clarifies the relation of **Cayley functions** to Feynman diagrams and reference to "poles".

14-fold representations of a set of Feynman diagrams from quantum physics		
Associahedron of $(PT(\{1, 2, 3, 4, 5, 6\}))^2$	Polytope of the Next-to-Star graph with $n=6$	Representation following removal of non-compatible poles
		$\frac{1}{812834856} + \frac{1}{8128568123} + \frac{1}{8238568123} + \frac{1}{8128348126} + \frac{1}{8168348126} + \frac{1}{8168238156} + \frac{1}{8168348156} + \frac{1}{8238568156} + \frac{1}{8348568156} + \frac{1}{816823845} + \frac{1}{8128123845} + \frac{1}{8238123845} + \frac{1}{8128126845} + \frac{1}{8168126845}$
Reproduced from Bo Feng and Yaobo Zhang (<i>Note on the Labelled tree graphs</i> , arxiv.org, 4 September 2020; submission to <i>Journal of High Energy Physics</i>)		

Implications of a 14th Archimedean polyhedron? Given the recognized relationship between Feynman diagrams and polytopes, visualization of the set of 14 of interest here might otherwise have been explored in terms of the widely referenced set of **Archimedean semi-regular polyhedra** -- although conventionally held to be 13 in number. However **Branko Grünbaum** has pointed out a frequent error in which authors define Archimedean solids using a **local** definition -- thereby omitting a 14th polyhedron, namely the **elongated square gyrobicupola**, or pseudo-rhombicuboctahedron (*An Enduring Error, Elemente der Mathematik*, **64**, 2009, 3). This has 18 square faces and 8 triangular faces

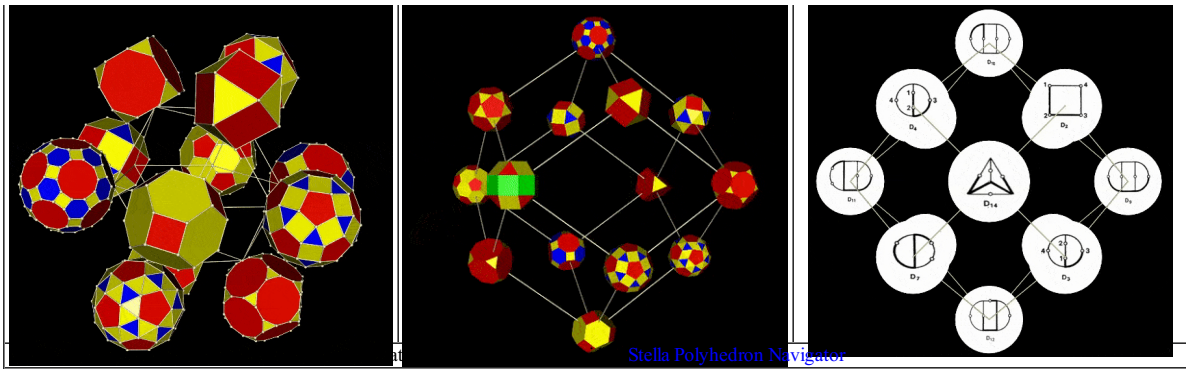
Indeed if only 13 polyhedra are to be listed in the set, the definition must use **global** symmetries of the polyhedron rather than **local** neighborhoods. The 14th meets a weaker definition of an Archimedean solid in which the faces surrounding each vertex are of the same types (i.e. each vertex looks the same from close up), so only a local isometry is required. Conventionally considered to be one of the 92 **Johnson solids**, it is not usually considered to be an Archimedean solid, even though its faces consist of **regular polygons** that meet in the same pattern at each of its vertices, because unlike the 13 Archimedean solids, it lacks a set of global symmetries that take every vertex to every other vertex.

The 14th is locally vertex-regular -- the arrangement of the four faces incident on any vertex is the same for all vertices; this is unique among the Johnson solids. However, the manner in which it is "twisted" gives it a distinct "equator" and two distinct "poles", which in turn divide its vertices into 8 "polar" vertices (4 per pole) and 16 "equatorial" vertices. Not being **vertex-transitive**, this is an additional reason for omitting it from the 13 Archimedean solids.

In the animation on the left, "12" Archimedean polyhedra are associated with the **12 vertices of a cuboctahedron**, rotating around an omitted 13th at the centre (the truncated tetrahedron), as reproduced from *Psychosocial Implication in Polyhedral Animations in 3D* (2015) in relation to the closest packing criteria for the 12.. By contrast, in the central animation, "14" Archimedean polyhedra are associated with the **14 vertices of a rhombic dodecahedron** -- the dual of the 14-faced cuboctahedron. The added "14th" is distinguished by a green colour.

In the animation on the right, the 14 Feynman diagrams associated with scalar meson-nucleon scattering, reproduced above from I. T. Todorov (*Analytic Properties of Feynman Diagrams in Quantum Field Theory*, Elsevier, 2014), are experimentally arrayed on the 14 vertices of a rhombic dodecahedron -- in order to explore correspondences with the central array. No effort has been made here in the attribution of the diagrams to that end.

Animation of contrasting polyhedral arrays (using distinctive design metaphors)		
Cuboctahedral array of 12 Archimedean polyhedra (attached vertex to face)	Rhombic dodecahedral array of 14 "Archimedean polyhedra" (vertex to centre)	Rhombic dodecahedral array of 14 Feynman diagrams



No attempt has been made to position the individual polyhedra in relation to one another in the configuration. Such possibilities would presumably follow from the work in the Chinese papers cited above.

Psychosocial implications? Such correspondences invite speculative reflection (*Potential of Feynman Diagrams for Challenging Psychosocial Relationships? Comprehending the neglect of an unexplored possibility*, 2013; *Credibility of Psychosocial Analogues of Feynman Diagrams: Cognitive engagement with challenging visualization*, 2013). **The question framed by the argument above is whether Bach, Shakespeare, and others, have some intuitive sense of a 14-fold array of cognitive modalities.** Missing is recognition that their various expressions of that intuitive pattern, in aesthetic media or otherwise, involve the use of particular (and seemingly incommensurable) "pattern languages" -- in the absence of any adequate facility to express that intuition otherwise.

Of some relevance is the manner in which ignorance of more complex possibilities is factored into such modelling, as might be inferred from the arguments of [Nicholas Rescher](#) (*The Strife of Systems: an essay on the grounds and implications of philosophical diversity*, 1985; *Pluralism: Against the Demand for Consensus*, 1993; *Ignorance: On the Wider Implications of Deficient Knowledge*, 2009; *Unknowability*, 2009).

Neural implications for cognitive coherence and strategy articulation? The composition of a sonnet in the light of the above presentations then calls for consideration in the light of the investigations of the [Blue Brain Project](#) using mathematics in a novel way in neuroscience. This has shown that:

... the brain operates on many dimensions, not just the three dimensions that we are accustomed to. For most people, it is a stretch of the imagination to understand the world in four dimensions but a new study has discovered structures in the brain with up to eleven dimensions -- ground-breaking work that is beginning to reveal the brain's deepest architectural secrets..... these structures arise when a group of neurons forms a clique: each neuron connects to every other neuron in the group in a very specific way that generates a precise geometric object. The more neurons there are in a clique, the higher the dimension of the geometric object...

The appearance of high-dimensional cavities when the brain is processing information means that the neurons in the network react to stimuli in an extremely organized manner. It is as if the brain reacts to a stimulus by building then razing a tower of multi-dimensional blocks, starting with rods (1D), then planks (2D), then cubes (3D), and then more complex geometries with 4D, 5D, etc. The progression of activity through the brain resembles a multi-dimensional sandcastle that materializes out of the sand and then disintegrates. ([Blue Brain Team Discovers a Multi-Dimensional Universe in Brain Networks](#), *Frontiers Communications in Neuroscience*, 12 June 2017)

Of interest in this respect, as noted above, is the use of artificial intelligence to generate sonnets (Jey Han Lau, Trevor Cohn, Timothy Baldwin, Julian Brooke, and Adam Hammond. *Deep-speare: A joint neural model of poetic language, meter and rhyme*. *Proceedings of the 56th Annual Meeting of the Association for Computational Linguistics (Long Papers)*, 2018), summarized by the authors as [This AI Poet Mastered Rhythm, Rhyme, and Natural Language to write like Shakespeare](#), *IEEE Spectrum*, 30 April 2020).

Such insights merit consideration in the light of the elaborate interweaving of many of the above arguments (however seemingly disparate) in the consideration of the mathematical abstractions of [space groups](#). In mathematics, physics and chemistry, a space group is the symmetry group of an object in space, usually in three dimensions. In crystallography, space groups are also called the crystallographic or Fedorov groups, and represent a description of the symmetry of the crystal.

There is indeed a degree of recognition of "[cognitive space](#)" by psychology, understood by analogy to location in two, three or higher dimensional space, in order to describe and categorize the thoughts, memories and ideas (Marcelo Soria-Rodríguez, *Total Cognitive Space: from AI to organizational changes*, *Towards Data Science*, April 2021; David J Piggins, *Cognitive Space*, *Perception*, 4, 1975). The term has been adopted as the name of a major machine intelligence corporation having with a particular focus on space operations. Unfortunately these preoccupations are not informed by the mathematical abstractions of "space groups", nor are those abstractions in any way informed by the cognitive challenges of comprehension.

The presentation of this argument could be usefully challenged due to the absence of any attempt to articulate it in poetic form, as explored by [Sam Illingworth](#) (*Are scientific abstracts written in poetic verse an effective representation of the underlying research?* *F1000 Research*, 2016; *The Poetry of Science*). Could the section headings of the argument convey a higher order of connectivity if presented in the form of a sonnet?

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