



laetus in praesens

Alternative view of segmented documents via Kairos

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Interactive Polyhedral Configuration of Preoccupations

Use of force-directed layout to explore coherence of contrasting memorability

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Introduction

Frequent reference is made to complexity as it is increasingly perceived to be characteristic of challenges of governance. A primary indicator is the explosion of information variously deemed to be relevant to any issue -- and the degree of connectivity with other issues. This is reflected in the increasing multiplicity of organs of governance, whether official or of a nongovernmental nature. A major consequence is how people and institutions are required to cluster preoccupations, prioritising some and reframing others as irrelevant to immediate concerns -- or simply negligible and to be ignored. The tendencies are further reflected in the clustering of issues deemed worthy of media coverage -- on the assumption that audiences have little tolerance for the confusion inherent in the inability to comprehend higher orders of complexity.

The approach explored here is the use of force-directed layout to enable exploration of configurations of different orders of complexity. The emphasis is placed on the use of polyhedra of different degrees of complexity to order sets of preoccupations. The approach offers the possibility to users of shifting between such polyhedral clusters to provide a coherent focus on varying degrees of complexity and connectivity. With the current efforts of search engines and browsers to offer AI enhanced interfaces, the approach explored here is an indication of possibilities that may be readily implemented. This would offer an alternative to the presentation of search results in list form.

The approach follows from an experiment with the 64 psychosocial conditions of relevance to governance, as identified by the much-studied Chinese *Yi Jing*, otherwise known as *The Book of Changes* (*Polyhedral Configuration of 384 Governance-relevant Yi Jing Transformations*, 2023). That exercise is an experimental interactive mapping of 64 6-linked hexagrams using force-directed layout. It provides access to an array of separate documents commenting on those conditions -- variously presented in relation to the challenges of sustainable dialogue, vision, conferencing, policy, network, community and lifestyle. As noted in the description of that experiment, focus was finally given to a singular polyhedral form able to present the full array of 64 conditions with a pattern of 192 reversible transformations between those conditions. The possibility of other polyhedral forms in 4 and 5 dimensions was also discussed -- given the importance of time to the dynamics of governance (*Strategic Embodiment of Time Configuring questions fundamental to change*, 2010)

The approach was further developed to enable users to switch between polyhedral clusters ranging from the simplest **tetrahedral form** (4 "preoccupations") to the **truncated icosidodecahedron** (120 "preoccupations"). The approach was tested with documents presented on this website, as variously preoccupied with "population". Arguably there are many situations in which 4-fold, 6-fold or 8-fold configurations are as much as can be "handled" in any policy process, as clarified by 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*, 63, 1956, 2)

Provision must necessarily be made, however, for configurations of greater complexity, as indicated by the unexplained proclivity of governance for 12-fold articulations, further challenged by the UN's 17-fold set of **Sustainable Development Goals** (*Checklist of 12-fold Principles, Plans, Symbols and Concepts*, 2011). There is also the challenging articulation of the more complex treaties and human rights charters -- with their questionable implications for comprehensibility and memorability, whether individual or collective (*Dynamic*

Exploration of Value Configurations Polyhedral: animation of conventional value frameworks, 2008).

In developing this approach with respect to strategic preoccupations, of particular insight have been the possibilities and constraints associated with use of the [force-directed graph layout](#) methodology. It became apparent that the factors rendering a particular configuration coherent and meaningful to the user were dependent on parameters which could be simply adjusted according to the complexity of the polyhedron. Although defined in the technical terms by which such displays are controlled, these parameters can be recognized as suggesting (through their metaphorical interpretation) valuable insights into the manner in which coherence and memorability can be refined. Of further relevance is the degree to which users are called upon to "play" interactively with the array of possibilities to elicit configurations they themselves find meaningful -- in contrast to those favoured by others .

Given the flexibility offered by force-directed layout, of further interest are other features which could be added to the displays and the manner by which they are controlled. Some of these are tentatively noted here, in anticipation of their consideration by those with higher expertise.

In order to clarify the wider relevance of the approach (beyond that of population), it has been applied to an array of other issues of potentially "global" significance. Ironically these can be understood as an array of "constellations" through which coherence is elicited from a plethora of concerns -- the "stars" of the universe of knowledge. This can be seen as consistent with the [Global Sense-making agenda](#) (Victoria Wibeck and Björn-Ola Linnér, *Sense-making Analysis: a framework for multi-strategy and cross-country research*, *International Journal of Qualitative Methods*, 20, 2021).

Whilst use of polyhedra as a means of eliciting memorable order can be considered questionable from some perspectives, arguably this is no more questionable than the widespread use of lists. More intriguing however is the degree to which spherical symmetrical polyhedra feature in culture symbols and aesthetic design -- where they offer an appreciated sense of coherence.

Application of force-directed layout to arrays of particular preoccupations

In order to explore further the relevance of this approach as means of enhancing comprehensibility of a set of documents variously relevant to a particular preoccupation, advantage was taken of the set of some 2,700 documents on the Laetus website -- together with the segmentation of those documents into the [Kairos](#) content management system of some 14,000 documents.

To facilitate the exploration, a simple program was developed enabling use of one or more keywords to select document titles and to format the various force-directed layout polyhedral presentations. The presentations were designed to provide the user with the ability to shift from one presentation to another in order to explore their value in offering a sense of coherence and memorability -- whatever the preference for complexity in integrating documents into a configuration or excluding them from it.

As producer of documents on a relatively wide range of research interests, a personal motivation was to explore whether the approach gave a greater sense of coherence through variously clustered "constellations" of documents. This was seen as contrasting with other efforts to cluster those documents by category into lists (*Research themes and topics on the Laetus in Praesens site and this Kairos facility*).

One merit of the force-directed configurations was to enable users to access directly any document whose title was presented as the label associated with a node in the display -- by double-clicking on that node.

For the initial exploration, the selection of nodes for inclusion in a polyhedral presentation of any given size was based on the number of references from that document to other documents in the extended data set -- not necessarily associated with the theme defined by keywords. The number of documents selected were then mapped arbitrarily into the relevant polyhedra. This meant that the simplest polyhedron, for example a tetrahedron, would configure 6 labels associated with the nodes of that force-directed array -- a tetrahedral array of the 6 documents citing the most other documents. Other nodes would then be included as a "cloud" of unconnected nodes in the presentation -- or potentially to be excluded from it to give focus to those in the polyhedral configuration. As the complexity of the polyhedron is increased, more of the previously excluded nodes would be embodied in the polyhedron -- thereby reducing the number in the contextual "cloud".

A consequence of including a larger number of nodes in a configuration -- reducing the number in the "cloud" -- necessarily required more complex configurations. Given the set of [Platonic](#) and [Archimedean](#) polyhedra provisionally used as templates, these could range through 4, 6, 8, 12, 20, 24, 30, 48, 60 to 120 nodes. A further distinction was made in that, for a given number of nodes in a configuration, the number of links between them could then vary, given the existence of polyhedra with the same number of vertexes, but differing numbers of edges. Thus for 12 nodes, the configuration could be presented as alternates of: 12-18, 12-24 and 12-30. For 24 nodes, alternates offered included: 24-36, 24-48, 24-60. For 60 nodes, those offered included: 60-90, 60-120, 60-150. Increasing the number of links is then potentially suggestive of an increasing sense of coherence.

Clearly there may be a case for using other polyhedra as templates, notably in the light of other preferences for degrees of symmetry. Options include, for example: [Kepler-Poinsot symmetric polyhedra](#), [prisms](#) and [antiprisms](#), [pyramids](#) and [cupolae](#), [Johnson solids](#), as well as 3D projections of 4D structures, as discussed separately (*Boundary complexification: 3D, 4D, and more*, 2022). Potentially intriguing is the recognition in the polyhedral literature of what are termed "near misses". The sense of a "near miss" was exploited in the mapping of 64 *Yi Jing* hexagrams onto a 4 frequency octahedral [geodesic sphere](#) with 66 vertexes in a pattern of 192 links between them. In this case, the 192 links offer a mapping of the 192 2-way transformations between those conditions encoded by hexagrams.

An obvious weakness of the arbitrary attribution of document titles to nodes in a polyhedral configuration is any sense of the "systemic" links between the documents within the configuration. Such data is readily available from the Kairos content management system. It can be used to present a force-directed layout of the connectivity -- but without the sense of coherence offered by the polyhedral configurations. Citation analysis could potentially be adapted to "elicit" polyhedral configurations from that connectivity -- a project for

the future. At the present stage the concern is with the memorability of configurations of preoccupations otherwise understood to be priorities. Further possibilities are discussed below.

Criticism of any use of arbitrary configurations calls for recognition of the tendency to arbitrary, asystemic presentation of global strategies -- exemplified by the list of 17 Sustainable Development Goals of the UN. Curiously, the polyhedral frameworks explored can be seen as having a basket-like form -- reminiscent of metaphorical reference to the four "baskets" of issues into which *The Helsinki Final Act* was divided on the occasion of the *Conference on Security and Cooperation in Europe* (1975). The metaphor has been employed in framing Sino-US relations (*Differences buried in 'basket' of issues*, *South China Morning Post*, 26 October 1997). More recently the metaphor has featured in discussion of UN reform (*Member States Move Towards a "Basket" Approach*, *Global Policy Forum*, 21 March 2008). Articulation of strategies might well be explored in terms of "basket-weaving" (*The Future of Comprehension: conceptual birdcages and functional basket-weaving*, 1980).

In addition to those generated in the preliminary experiment for the *384 Yi Jing transformations* (mentioned above), force-directed displays have been generated experimentally for the following, each offering configurations through 16 polyhedra of differing complexity (with NN potentially ranging from 4 to 120). As a point of entry, enabling access to other variants, NN is fixed arbitrarily at 20-30 in the following (a dodecahedral configuration):

- *Experimental Polyhedral Configuration of Documents on NN Dialogue-related Issues*
- *Experimental Polyhedral Configuration of Documents on NN Metaphor-related Issues*
- *Experimental Polyhedral Configuration of Documents on NN Strategy-related Issues*
- *Experimental Polyhedral Configuration of Documents on NN Polyhedra-related Issues*
- *Experimental Polyhedral Configuration of Documents on NN Value-related Issues*
- *Experimental Polyhedral Configuration of Documents on NN Population-related Issues*

The array of polyhedra could have been extended in each case to all 18 Platonic and Archimedean polyhedra, however 2 were omitted (truncated cube and truncated dodecahedron) because they had the same vertex-edge configurations as others (truncated octahedron, 24-36; truncated icosahedron, 60-90). This simple numeric duplication posed an additional programming difficulty for the generation of both -- considered unnecessary to resolve for the experiment.

The extensive array of displays could readily be considered excessive. However it served to clarify the question of whether and how any such display was meaningful and interesting as a means of giving coherent focus to a given preoccupation (given the number of nodes selected in a given case). Of particular concern was the inadequacy of displays of a given scope and the need for their optimization as discussed below.

Challenges of optimizing representation of polyhedral clusters of preoccupations

As noted above, four factors determine the manner in which a polyhedron approximating to a sphere is represented in a force-directed display. These are termed, force, charge, gravity and link distance. If these are not optimized for a polyhedron of a given complexity, the configuration may disappear off the screen, be too large, or be too small. This is a known technical issue discussed separately (*Optimize d3 force directed layout, via charge/gravity properties, based on number of nodes*, *StackOverflow*). One simple means of circumventing this to some extent is to change the magnification of the screen -- offering other advantages and disadvantages, partial dependent on the dimensions given to the window within which the display is presented.

In the case of social networks of any kind, force-directed displays have further enabled the well developed efforts to visualize such networks, as clarified by Tommaso Venturini, et al (*What do we see when we look at networks: Visual network analysis, relational ambiguity, and force-directed layouts*, *Big Data and Society*, 8, 2021, 1).

These algorithms may be implemented according to different recipes but they all rest on the same physical analogy: **nodes are charged with a repulsive force driving them apart, while edges introduce an attractive force between the nodes that they connect. Once launched, force-vectors vary the position of nodes trying to balance the repulsion of nodes and the attractions of edges. At equilibrium, force-directed layouts produce a visually meaningful disposition of nodes, where nodes that are more directly or indirectly related tend to be closer.**

This technique to visualize graphs has become so common that we often fail to notice its accomplishment. Force-directed layouts do not just project networks in space—they create a space that would not exist without them. This is why this process is better called “spatialization” rather than “visualization”. Spatialization creates a space in which the multidimensionality of networks can be flattened, in a process of “graph embedding”... that has applications even outside visualization. Spatialization creates a space that retains key properties of a network. *[emphasis added]*

In considering how to optimize the configurations, of particular interest is the "metaphorical" interpretation of force, charge, gravity and link distance from the perspective of the psychosocial and communication sciences in which those terms are frequently used -- but with other connotations. For example link distance has been associated with conceptual distance by Anthony Dekker, offering many illustrations and animations (*Conceptual Distance in Social Network Analysis*, *Journal of Social Structure*, 6, 2005). That journal offers many other [papers of relevance](#).

An interesting feature of the experimental exercise were the constraints of the experimenter in exploiting the many possibilities of force-directed layout. As a metaphor in its own right, whilst access to relevant expertise is possible in principle, acquiring timely expertise typically proves to be a considerable constraint in practice -- despite the helpful response in many fora (as illustrated by the

StackOverflow case).

Given current debate regarding the problematic aspects of AI, there is therefore considerable irony to the instant availability of useful advice from ChatGPT, for example.

Question to ChatGPT: Unfortunately the current selection of the force-directed parameters for link distance, gravity and charge do not separate the nodes of the polyhedron into an approximately spherical form in order to enable any inadequacies to be apparent. This issue of adequate separation is apparently a known issue. Do you have any comment on an optimum combination of values of those parameters

Response from ChatGPT: Determining the optimum combination of force-directed graph parameters, such as link distance, gravity, and charge, can be a complex task as it often depends on the specific characteristics of the graph and the desired layout outcome. Achieving an approximately spherical form for a polyhedron can be challenging, especially when dealing with complex and densely connected graphs.

However, you can try adjusting these parameters to see if you can achieve a better separation of nodes. Here are some general guidelines:

- **Link Distance:** Increase the link distance to encourage more spacing between connected nodes. This can help prevent nodes from overlapping and provide a clearer visualization. Experiment with different values to find a suitable balance.
- **Gravity:** Adjust the gravity parameter to control the overall force that pulls nodes towards the center of the graph. Increasing the gravity value can help in spreading out the nodes more evenly.
- **Charge:** The charge parameter affects the repulsive force between nodes. Higher charge values result in stronger repulsion, which can help in separating nodes further apart. However, excessively high charge values can lead to excessive node scattering. It's recommended to start with moderate charge values and adjust accordingly.

Additionally, you may consider other layout algorithms specifically designed for spherical layouts or polyhedral graphs, as they might provide better results for your specific use case. Keep in mind that achieving a perfect spherical form may not always be possible, especially for graphs with complex connectivity patterns. It's important to strike a balance between aesthetics and preserving the underlying graph structure.

The reference to spherical layouts engendered the following of potential relevance:

- Oh-Hyun Kwon, et al: *Spherical layout and rendering methods for immersive graph visualization* (2015 *IEEE Pacific Visualization Symposium (PacificVis)*, Hangzhou, 2015)
- Dario Rodighiero: *Drawing Network Visualizations on a Continuous, Spherical Surface* (2020 *24th International Conference Information Visualisation (IV)*).

Whilst the parameters could be readily modified, the challenge remains how to determine the balance between them for a useful display. A potentially helpful indication in that regard is the interactive *Spherical Force Directed Layout* (*Codepen*, 2023) enabling parameters to be adjusted to render the results accordingly.

Question to ChatGPT: Could you clarify your helpful articulation of what is effectively a "3-body problem". I understand the need for experiment. Can you suggest useful values for each as a point of departure -- perhaps in the light of your suggestion for adaptation to spherical form.

Response from ChatGPT: While the force-directed graph layout is a simplified representation of the physical "3-body problem," it shares some similarities in terms of balancing attractive and repulsive forces between nodes. Here are some initial values you can use as a starting point for each parameter:

- **Link Distance:** Start with a value that provides some initial spacing between connected nodes. Depending on the scale of your graph, a value between 20 and 100 might be a reasonable starting point. For example, you can begin with a link distance of 50 and adjust from there.
- **Gravity:** Begin with a moderate gravity value to encourage nodes to move towards the center. A value between 0.1 and 0.5 can be a good starting point. You can start with a gravity value of 0.3 and adjust it as needed.
- **Charge:** Set a moderate charge value to balance the repulsion between nodes. A value between -500 and -2000 might work well. You can start with a charge value of -1000 and experiment from there.

Keep in mind that these suggested values are not universal, and the optimal values can vary depending on the specific characteristics of your graph, such as size, density, and desired layout outcome. It's important to experiment with different values and observe the effects to find the configuration that best suits your needs.

Additionally, consider adjusting other parameters specific to the force-directed layout algorithm you are using, such as the cooling factor, iterations, and temperature, as these can also influence the layout outcome.

Remember to iterate and fine-tune the parameters based on the observed results, and don't hesitate to experiment with different combinations until you achieve a satisfactory visualization that aligns with the desired spherical form.

In response to such suggestions, the application generating the displays was adjusted to ensure that a different combination of parameters was used for polyhedral displays of different complexity. The possibility of identifying optimal combinations remains a continuing

concern.

Ideally, with further development and additional expertise, users could themselves be enabled to modify relevant parameters in order to adjust displays in quest of focus and significance. Users could themselves specify the keywords with which a display could be generated -- avoiding the production of multiple experimental displays. This may be a possibility which search engines and web browsers will offer (as noted above), now that these facilities are being extensively promoted as "AI-enhanced".

Of some relevance to any articulation in graph form as explored here, is the extensive literature on the "readability" of displays in relation to their "aesthetics", of which examples are noted in the references below. This usefully highlights the question of the "readability" of any listing of organs of governance and their preoccupations of which the UN's 17 Sustainable Development Goals offer a prime example, as discussed separately (*Coherence of Sustainable Development Goals through Artificial Intelligence*, 2023; *Memorable Packing of Global Strategies in a Polyhedral Rosetta Stone*, 2023).

As an intriguing **technical parenthesis**, the link pattern for the most complex Archimedean polyhedron had been incorrectly derived for this exercise from the **OFF file** exported (like the others) from **Stella 4D**. The resulting polyhedral display was a mess. The difficulty is that OFF files specify edges around a polyhedral face, not the vertex pairs required for the force-directed displays. The conversion, whilst logical, is tedious for complex polyhedra. ChatGPT proved willing to convert the OFF file to the required adjacency list. Unfortunately the result was erroneous -- willingly corrected through several iterations by ChatGPT. It remained erroneous. It then proved easier to produce a simple program which would convert any such OFF file into an adjacency list. This reinforces the concern that AI can generate errors about which it is necessary to be vigilant. On the other hand, without timely access to human expertise, ChatGPT proved especially helpful in indicating amendments to the d3.js coding by which the force-directed displays were rendered.

Integrating systemic relationships within arbitrarily coherent polyhedral configurations

As emphasized above, the polyhedral format was used to order the documents within the selected set of titles. For a given number of titles on which it is desired to focus, a polyhedron with a suitable number of vertex nodes could then be used. The question is on what basis the selection of a number of documents is based. In this exercise, data from the Kairos content management system was used on the number of other documents therein which were cited by any given document. Priority was then given to those which cited the most other documents -- in using polyhedra with 4, 6 or 8 vertexes, for example. Prioritising documents in this way could indeed be deprecated as a rather crude approach to providing coherent focus, whatever advantages it offers for memorability.

By contrast, in the preliminary exercise with the 64 conditions of the *Yi Jing*, each condition (encoded in a 6-digit binary form) has a clearly specified possibility of transformation into 6 other conditions (through modification of any one of the 6 digits). This offered a pattern of 2x192 "systemic" transformations for which the 4-frequency octahedral geodesic sphere was used (66 vertexes, 192 edges).

Alternative approaches could then be sought for any set of documents -- in this case those extracted from the Kairos dataset. One possibility readily implemented is prioritising by number of citations to a document (rather than from it). This is an approach basic to citation analysis.

A complementary approach could be the enhancement of either polyhedral display with indication of citations between documents included in the polyhedral array. Coloured otherwise, such links would be **displayed internally** within the polyhedral array -- across it. Adjustment would be required to the parameters of such links to minimize their impact on the force-directed rendering of the polyhedron -- they would need to be made relatively "weak".

A similar approach could be taken to those documents in the "cloud" surrounding the polyhedron -- excluded from its configuration of nodes. Again coloured links (and "weaker") could be provided from the nodes in the polyhedron to those **displayed externally**. A further option would be to provide links **between documents in the cloud** according to their citation of one another.

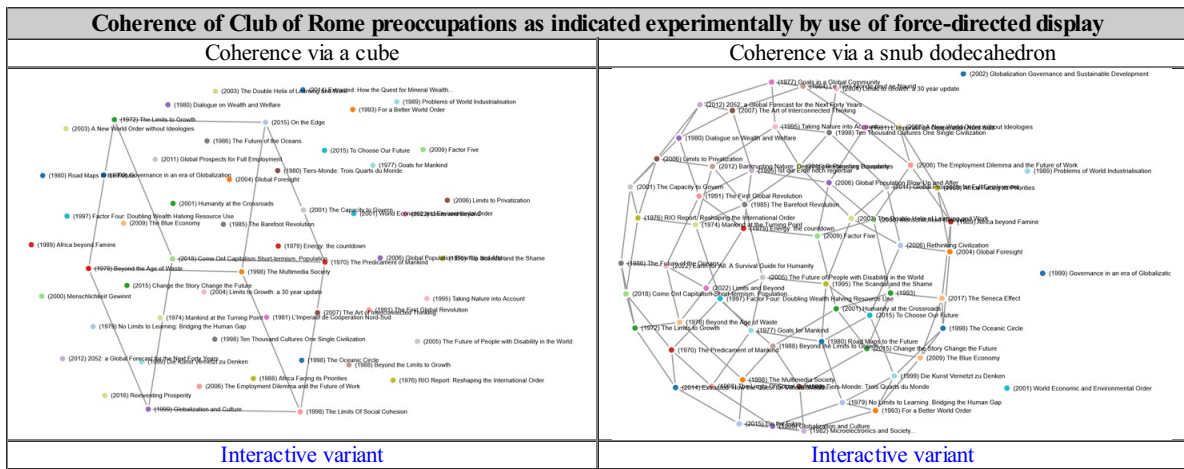
In order to explore the possibility, and **for illustrative purposes only** (as shown below), "systemic" links were arbitrarily added between documents within one of the optional polyhedral arrays (an icosidodecahedron). Those within the configuration are coloured blue, whilst those linking to documents external to that array are coloured red. No distinction is made in this case for links between documents when both are external to the configuration. It is of course the case that a more complex polyhedron would "integrate" more of the external links -- rendering them blue within the configuration. As with other variants, double clicking on a node accesses the relevant document.

Indicative integration of systemic links into an interactive force-directed polyhedral array of preoccupations (blue links within polyhedral array; red links external to polyhedral configuration)

In quest of degree of coherence in anticipation of such future developments, the array of reports offers the immediate possibility of experimental interactive representation through force-directed layout. An obvious question is how the reports could be distinguished and related in any such display. In the absence of any citation analysis, a form of coherence can be suggestively explored by using data on the degree to which the reports are cited. A crude but indicative measure, in the absence of any other, is the number of search results ("hits") from a search engine such as Google. An unexplored alternative would focus on report authors using the citation analysis metrics provided by Google.

Google makes provision for the extraction of such data for a fee by program ([Google Knowledge Graph Search API](#), [Extract the number of results from google search](#)). Given the limited number of reports (65), it proved easier to extract the search results manually using as search string: "Name of report" "Club of Rome". This implies a variety of assumptions which could challenge their use in any display. [Somewhat relevant to the challenge of extracting such data was the interruption of the succession of searches by Google security requiring an indication on 5 occasions of whether the queries were being made by a human or a robot]

The range with the most hits included: *Extracted: How the Quest for Mineral Wealth...* (564,000), *On the Edge* (437,000), *The Multimedia Society* (352,000), *Beyond the Age of Waste* (347,000), *The Limits to Growth* (263,000), *The Blue Economy* (232,000), *Come On! Capitalism Short-termism, Population...* (202,000). As a crude ranking these took no account of other language editions and other factors. The results were used to order the reports so as to enable those ranked highest to appear in any polyhedral display of the lowest complexity -- as indicated in the screen shot on the left below -- with others in the "cloud" surrounding it. Using a more complex polyhedron, most in the cloud were incorporated into that configuration as shown below light.



Double-clicking on the nodes in the interactive variants provide access to the report in question (where available) or -- more typically -- to a summary of it. As indicated above, such displays call for much further refinement (with far greater technical expertise) in terms of readability, comprehensibility and aesthetic appeal -- from a design perspective.

Totalling 64 reports in the dataset, there is a delightful irony to any "correspondence" with the 64 conditions of the *Yi Jing* featuring in a previously mentioned experiment. Given the conclusion in that case to use as polyhedron the 4-frequency octahedral geodesic sphere (66 vertexes; 192 edges), that is also offered as a possibility for the set of Club of Rome reports ([Experimental Polyhedral Configuration of 66 Club of Rome-related Documents](#)) -- with 2 named as "undefined".

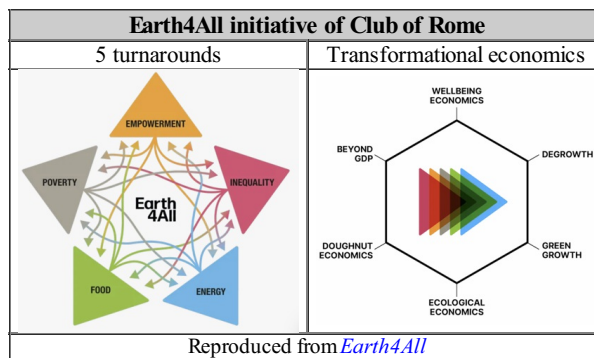
Application to a 5-fold strategy?: The use of this approach is most readily adaptable to **even numbered sets of preoccupations**, therefore challenging its relevance to **odd-numbered preoccupations**. This is especially obvious in the focus on 5-fold strategic preoccupations, as discussed separately ([Requisite dimensionality: coherence in 4-fold, 5-fold or 6-fold terms?](#) 2023).

Examples of 5-fold articulations are also presented in that context as instances of *Five Principles of Strategic Communication*. They include the 5 Turnarounds of *Earth4All* (to create wellbeing for all), 5 Dimensions of *Inner Development Goals*, 5-fold *Viable System Model*, Chinese 5-phase *Wuxing* cycle, the *Hygieia* Pentagram of Pythagoreans, . Buddhism distinguishes a 5-fold set of hindrances (*Kleshas*): **ignorance, attachment, aversion, pride, jealousy**. A 5-fold set tends to be presented in 2D as a pentagram of some kind.

As with the US Pentagon and the 5-pointed Star of Islam, it can be asked how the coherence offered by this pattern could be rendered otherwise -- notably in 3D or even 4D ([Envisaging NATO Otherwise -- in 3D and 4D?: potentially hidden faces of global strategy highlighted through polyhedra](#), 2017). As discussed there, is there a credible *Reframing NATO and The Pentagon?*

Application of a force-directed polyhedral approach to a 5-fold articulation calls for preliminary consideration of 5-fold polyhedra -- especially given the probability that 5-fold strategies may be further articulated calling for polyhedra of greater complexity. One indication, for example, is the possibility that the 5-fold pattern might be mapped 12-fold onto the 12 faces of a dodecahedron of 20 vertexes, consistent with other recognized patterns of strategies, rules, methods and insights ([Requisite 20-fold Articulation of Operative Insights?](#) 2018).

Rather than the polyhedra used for this exercise, candidates for representation of a 5-fold initiative include the 8 edged **square pyramid** and the 9-edged **triangular dipyramid**. What might these suggest for strategic exploration of the Club of Rome's "5 turnarounds" -- framed as the five extraordinary turnarounds to achieve the Giant Leap scenario? (as presented below left). These can be contrasted with its convocation of leading economic thinkers in the Transformational Economics Commission to explore new economic paradigms (as presented below right).



The fundamental implication of the iconography above is the transformation from a 5-fold to a 6-fold pattern, however that is to be understood -- as previously argued with respect to the symbolism of conflict in the Middle East (*Middle East Peace Potential through Dynamics in Spherical Geometry*, 2012). This focused on engendering connectivity from incommensurable 5-fold and 6-fold conceptual frameworks. Of potential significance to any such transformation in the Earth4All framing is the fact that in geometric terms (as indicated below) the triangular dipyrmaid (mapping the 5 turnarounds) is the dual of the triangular prism (mapping the 6 transformations). The obvious geometrical mirroring of the square pyramid in the octahedron also calls for commentary.

5-fold Polyhedral configuration of 5 turnarounds		6-fold Polyhedral configuration of transformational economics	
Triangular dipyrmaid (5 vertexes; 9 edges)	Square pyramid (5-vertexes; 8 edges)	Triangular prism (6 vertexes; 9 edges)	Octahedron (6 vertexes; 12 edges)
Animations prepared with Stella 4D			

As a strategy deemed fundamental to current crises of global governance, key categories featured in the depictions above are however questionable. For example, it is unfortunate that focus is given to the "doughnut model", both in the light of its typical 2D depiction and as emblematic of the economics of fast food consumerism which it is hoped to transcend. This can be argued with respect to both a psychological reframing of that model and the merits of a 3D "pineapple model", for example (*Exploring the Hidden Mysteries of Oxfam's Doughnut*, 2012; *Integrating the doughnut, helix and pineapple models towards global strategic coherence*, 2020).

Given the focus by Earth4All on the 2D iconography required by many media, it may be provocatively suggested that this reinforces a "flat earth" perspective when any global strategy necessarily calls for engagement with a "global" 3D perspective -- challenging the limitations of 2D understanding..

With the emphasis of Earth4All on economics, potentially far more problematic is the manner in which this is considered fundamental to issues relating to the environment. The problem is highlighted by the fact that economics has traditionally been challenged by recognition of any work which is held to be undetectably remunerated -- as in the case of housework, gardening, crime, prisoners, voluntary work, and the like, all variously vital to the dynamics of social systems in practice. This deficiency is even more regrettable in the failure of "ecological economics" to recognize the work done by non-human species and by natural processes -- as is evident from the focus of the many references to "work" in the extensive summary of that discipline in *Wikipedia*. Held to be unremunerated, bees, ants, spiders, worms, and the like, are not understood to "work" or to be "employed" -- as with slaves and "beasts of burden".

All non-human "actors" in the global ecosystem are consequently held to be "unemployed". Ironically this justifies the negligence of the International Labour Organization with respect to any "environmental workforce". The "4All" of Earth4All implies humanity alone. The expertise assembled would seem to have a blindspot with respect to its exclusion of the myriad species and processes on which humanity is otherwise recognized to be dependent. "Work" is however recognized more generally by thermodynamics -- a discipline of considerable relevance to climate change and presumably to the energy focus of Earth4All.

Transforming from 5-fold to 6-fold? The Earth4All initiative has chosen to frame the key to the "5 turnaround" in terms of a "6-fold set of transformations". There are few comprehensible guidelines to any such transformation. Clues are however to be found in the complementarity of the dodecahedron (12-fold pentagons) and the icosahedron (12 vertexes). As noted above the challenge is relevant to Middle East peace ((*Middle East Peace Potential through Dynamics in Spherical Geometry*, 2012).

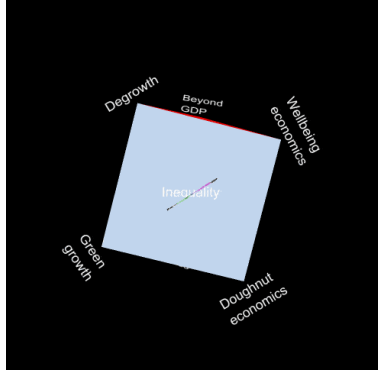
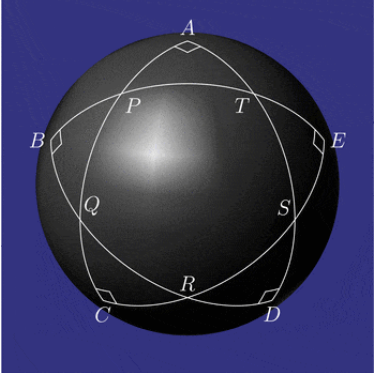
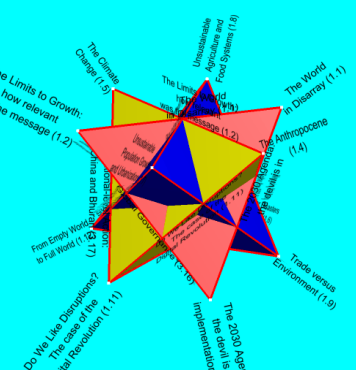
If geometry is to be explored as offering guidelines to a transition so fundamental to global governance, there is a case for visualizing one dynamic embodying the pattern shift in the form of geometric morphing between duals portrayed above. There are a number of other morphing processes meriting consideration as a means of cognitively navigating the transition.

As with any [pentagram map](#), the question invites exploration in terms of the historical importance for "global" navigation purposes of what is known as the [Pentagramma Mirificum](#) (below centre) given its potential significance when rendered in 3D (*Global Psychosocial Implication in the Pentagramma Mirificum*, 2015). It could then be asked whether the Club of Rome's recent 5-fold initiative, framed as

the "5 turnarounds" of the Earth4All strategy, merits representation in 3D (*Eliciting systemic answers from a 5-fold web of meaning?*, 2019). In psychosocial terms, does the pentagram configuration iconography of Earth4All suggest a need to discover a "pentahedrum myrificum" to enable global strategic navigation? Virtual variants exist in 4D and 5D. Arguably these suggest possible designs of forms of "wellness/illness" cubes through which patterns of coherence can be explored.

A major report to the Club of Rome, immediately preceded that of Earth4All (Ernst von Weizsaecker and Anders Wijkman, *Come On! Capitalism, Short-termism, Population and the Destruction of the Planet*, 2018). This distinguished 12 unsustainable trends and 18 strategic initiatives, potentially to be recognized as indicative of a degree of unrecognized coherence.

As noted in a separate commentary these can be effectively mapped onto a **compound of 3 tetrahedra** (*Exhortation to We the Peoples from the Club of Rome*, 2018). This has 18 edges, 12 faces and 12 vertices -- as with its dual. As mapped below right, this could be the most compact visualization. The question is whether the labels could be more meaningfully positioned to highlight systemic patterns.

Morphing Earth4All preoccupations from triangular dipyramid to triangular prism	Illustrative configurations of Pentagramma Mirificum	Mapping of <i>Come On!</i> issues onto 3-tetrahedra compound
		
Animation prepared with Stella 4D	Mciura, CC BY-SA 4.0, via Wikimedia Commons	Animation prepared with Stella 4D

It is unclear how the framework of *Come On!* has been related to that of *Earth4All* -- and if not, why not? Is either to be considered strategically sustainable? The question is all the more pertinent in the light of the configuration of global strategies implied by the 17 Sustainable Development Goals of the UN (SDGs). Further to the experimental configuration of the preoccupations of *Come On!* (above right), a related exercise has been explored with respect to 16 of the SDGs (*Towards a configuration of 16 SDGs in 3D*, 2022).

The SDGs are themselves "challenged" in the light of the UN Secretary-General's vision for the future of global cooperation in the form of a report titled *Our Common Agenda* (2021) -- "to get the world back on track by turbocharging action on the Sustainable Development Goals". This is presented with a view to the formulation of an action-oriented *Pact for the Future* which is expected to be agreed by Member States through intergovernmental negotiations on issues they decide to take forward on the occasion of the *UN Summit of the Future* planned for 2024. *Our Common Agenda* builds on the *12 commitments contained in the Declaration on the commemoration of the 75th anniversary of the United Nations*.

The contrasting expertise offered by 5-fold, 6-fold, 12-fold and 17-fold strategic frameworks can be explored metaphorically as "gears" that need to engage appropriately with one another -- as in the *transmission system* of any automobile. Not to be forgotten is the strategic unsustainability of the UN's 8-fold *Millennium Development Goals*.

Speculative configurations of the array of human organs

Recognition of the number of "organs" of relevance to governance of social systems, especially at the global level, invites use of the polyhedral approach presented here as a means of eliciting coherence from what is typically presented as an inherently unmemorable list - - as suggested above. However it is also intriguing to recognize that the possibility also applies to the number of organs distinguished in the human body.

How indeed are the organs to be coherently and memorable rendered -- beyond the typical use of lists? This could be understood as of particular importance given the relevance to healthy integration of bodily function in systemic terms -- its "governance" metaphorically understood -- and as such a focus for the health disciplines. How does any articulation relate to a personal sense of identity? Parallels have long been made with the governance of the social system -- for rhetorical purposes.

Of particular interest to engagement with polyhedral configurations is the work of Dario Rodighiero and Loup Cellard (*Self-Recognition in Data Visualization: how individuals see themselves in visual representations*, *EspacesTemps.net*, 2019). How indeed do groups and organizations see themselves in such representations?

With regard to the human body, the question is summarized by Dani Levis (*How many organs are in the human body?* *LiveScience*, 11 October 2020). As presented by *Wikipedia* (*List of organs of the human body*):

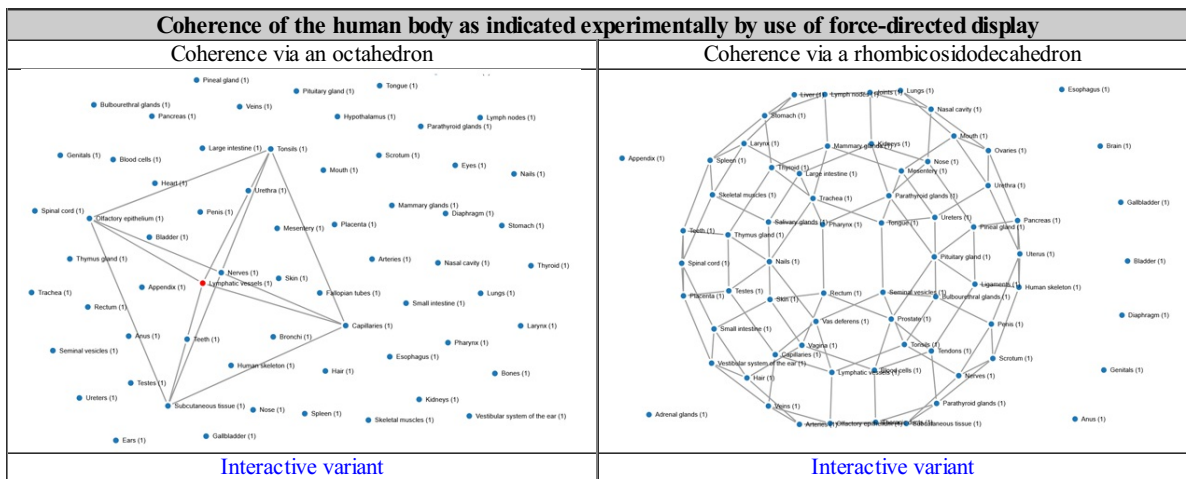
A general consensus is widely believed to be 79 organs (this number goes up if you count each bone and muscle as an organ on their own, which is becoming more common practice to do); however, there is no universal standard definition of what constitutes an organ... Since there is no single standard definition of what an organ is, the number of organs varies depending on how one defines an organ. For example, this list contains much more than 78 different organs.

The *Wikipedia* entry clusters the organs in terms of the following "systems":

- [Musculoskeletal system](#)
- [Digestive system / Excretory system](#)
- [Respiratory system](#)
- [Urinary system / Renal system](#)
- [Reproductive system](#)
 - [Female reproductive system](#)
 - [Male reproductive system](#)
- [Endocrine system](#)
- [Circulatory system](#)
 - [Circulatory system](#)
 - [Lymphatic system / Immune system](#)
- [Nervous system](#)
- [Integumentary system / Exocrine system](#)

Wikipedia also offers other relevant listings: [List of systems of the human body](#); [List of bones of the human skeleton](#) and [List of muscles of the human body](#). In systemic terms again, how might any articulation of organs of the human system -- required for its "governance" in systemic terms -- be compared with the articulation of the pattern of organs of the United Nations deemed to be of relevance to the governance of the global system?

For the purpose of this exercise, the force-directed method was applied to a conventional list of 78 organs (Karthik Kumar, et al, [What Are the 78 Organs of the Human Body? MedicineNet](#), 3 November 2022). The screen shot on the left is indicative of a focus on an 8-fold pattern of organs, whereas that on the right incorporates 60 organs into the configuration. In the interactive variants, double-clicking on any node typically gives direct access to a description of the organ in *Wikipedia*.



In contrast to the exercise with the Club of Rome dataset, no effort was made to rank the organs such that those of greatest "importance" (however evaluated) were brought into focus in the simpler polyhedra. Again many refinements merit reflection, notably with respect to the connectivity between the organs, as well as other systemic considerations.

The exercise highlights the fact that there is a continuing struggle to render systemically comprehensible the components of the human body, potentially recognized as "organs", but in simpler terms as the set of 206 bones in the body. Of some relevance is the articulation of the challenge in even simpler form as a song for children, as [Dem Bones](#), featured in various forms on *YouTube*.

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