14 May 2018 | Draft

Governance as "juggling" -- Juggling as "governance"

Dynamics of braiding incommensurable insights for sustainable governance

-- / --

Introduction

There is a case for recognizing the extent to which governance of many kinds is a matter of "juggling" parameters, variables, resources, people, schedules, risks, and disparate skills. If "juggling" is used metaphorically to describe this process, the question here is whether skillful "juggling", as practiced in governance, may well involve skills which can be explored to some degree through juggling as practiced with multiple objects -- and between several jugglers. A similar question can be asked with regard to the disparate concepts, principles and values with which many are obliged to "juggle".

Reference is frequently made to the need of parents to "juggle" career, spousal commitment, child care, and recreational priorities -- and the stress this may entail if it proves difficult to manage skillfully. This can be recognized as a common challenge of domestic governance. However it is seldom clear what meaning is then to be associated with "juggle", other than handling conflicting demands as proves most feasible. With an allusion to the challenge of juggling, reference is also made to "keeping balls in the air" successfully or to the challenge of "too many balls in the air".

It is too readily assumed that successful governance can be based on achievement of a relatively simple understanding of consensus. Similarly it is perhaps too readily assumed that the various quests for conceptual unity, or the coherence of sets of principles and values, can be achieved through what is effectively a static assemblage of building blocks. As separately argued, this may be misleading (*The Consensus Delusion: mysterious attractor undermining global civilization as currently imagined*, 2011). The possibility for sustainable governance may lie in the kind of dynamic coherence exemplified by juggling, rather than in any essentially static framework -- unfortunately symbolized by the association of global governance with "states". This can be argued with respect to reporting of global issues (*Dynamic Transformation of Static Reporting of Global Processes: suggestions for process-oriented titles of global issue reports*, 2013).

It is appropriate to note that the skills and practice of juggling have long been of interest to mathematics (Burkard Polster, *The Mathematics of Juggling*, 2003). Notations like Siteswap have been developed to clarify the complexity of the different possible juggling patterns and to enable the discovery of new patterns. Various detailed animations have been developed to enable these to be more readily comprehended. The movements of juggled objects necessarily trace out patterns which can be explored as helical braids (as with braided cords). Braiding possibilities are also of great interest to mathematics -- as illustrated with respect to the basic 3-ball juggling pattern by Polster.

There is widespread current interest in the Triple Helix thesis (as a focus of the Triple Helix Research Group of Stanford University)

regarding the potential for innovation and economic development in a knowledge society. This is framed in terms of a more prominent role for the university and in the hybridisation of elements from university, industry and government to generate new institutional and social formats for the production, transfer and application of knowledge. It is in this sense that the triadic thinking underlying the activities promoted by the Triple Helix Association merits particular attention, as instigated by Henry Etzkowitz (*Triple Helix: a new model of innovation*, 2005).

As articulated by its Vice-Rector, the Triple Helix is a flagship strategic framework for the University of Melbourne (Glyn Davis, *Growing Esteem: a discussion paper*, 2014). Somewhat ironically, the mathematical study of juggling by Burkard Polster has been developed in Monash University, a major competitor to the University of Melbourne in the Australian State of Victoria. In this context, metaphorical use of "braid" has been curiously made in reconciling the Triple Helix concept with a triadic framing in sociophysics by Paris Arnopoulos (*Braiding the Triadic Codex and Triple Helix: the sociophysics of nature-culture-nurture and academy-industry-polity*, 2000).

Extensions of the Triple Helix concept are currently envisaged to Quadruple and Quintuple variants. One approach to the further exploration of such conceptual "braiding" is in the geometrical terms which it suggests, notably in 3D form now possible in virtual reality (*Visualization in 3D of Dynamics of Toroidal Helical Coils*, 2016). These beg the question as to the nature of the bonding between the threads, so fundamental to the double helix of DNA which has been an inspiration for the Triple Helix model. A related metaphor is offered by the manner in which disparate themes can be "woven" together (*Interweaving Thematic Threads and Learning Pathways*, 2010; *Warp and Weft of Future Governance: ninefold interweaving of incommensurable threads of discourse*, 2010).

The particular interest in what follows is in how metaphors themselves can be cognitively "juggled", given the degree to which metaphor offers a valuable insight into subtlety, whilst avoiding premature definitional closure. In such terms, it is appropriate to note the variety of studies from a semantic perspective. The value of this approach is also emphasized by the extent to which the psychological and neurosciences are exploring the role of juggling in cognitive development.

Might it indeed be the case that the challenges of governance could be more fruitfully explored both through metaphor and through how metaphors can be juggled -- necessarily dynamically -- in the light of both the skills of practitioners and insights into possible patterns from mathematics? In that sense the functions of governance -- whether associated with particular departments or ministries -- then also draw upon the mythical figures of pantheons which are so frequently used in iconic symbols of such departments, most notably in the case of international agencies of the United Nations.

Multitasking: the work-life balance understood through the metaphor of juggling

There are numerous references to the insights to be gained from juggling as a metaphor, as noted by Arthur Chandler (*Life Juggling*, *Juggler's World*, 42, 1996, 4):

> I've seen the term "juggling" in a number of contexts... Newspaper articles are headed "Juggling Family and Career", and friends speak of "juggling too many commitments". The public at large seems to be adopting juggling as a figure of speech for trying to keep parts of life in sync with each other. Juggling, as a 1990s metaphor, comes to stand for the attempt to attain a state of dynamic equilibrium in which several ongoing commitments are kept in balance through constant effort.... "Juggling" in 1991 has become the metaphor for life's major hassles -- not just the little annoyances of waiting in line at the checkout stand, or even getting audited by the IRS. "Life Juggling" is a defensive activity.

An insightful comparison is made by Venkatesh Rao (*Work-Life Balance: Juggling, Spinning or Surfing? Ribbonfarm experiments in refactored perception*, 19 September 2007)

> I have encountered three metaphors for what most people call the 'work-life balance' issue. These are: juggling, keeping multiple plates spinning on sticks, and surfing. Each has its strengths and flaws. All share in common the problems that arise from calling the whole thing a 'balance' problem in the first place, but the 'balance' point of view has some merits.

For Janet D. Stemwedel (*Pushing the juggling metaphor a little further*. *Adventures in Ethics and Science*, 31 July 2007):

> The juggling act, for those of us with career and family balls in play, doesn't work if either crashes to the ground... But if we want to juggle different kinds of things in our lives, the awareness of how those slices of our experience are different from each other is part of the fun: the feel of the delicate crystal, the fresh firm apple, or the taped grip of the flaming club as we confidently catch it and then send it back up.

Other indications of the widespread use of the metaphor in describing the challenge of balancing career, home life, and other priorities, are illustrated by the following -- readily understood as a challenge of personal "self-governance":

- Decio Coviello, Andrea Ichino and Nicola Persico: *Time Allocation and Task Juggling* (January 2013)
- Peter Scupelli, et al: *Juggling Work Among Multiple Projects and Partner* (System Sciences, 2007)
- Christine Schmalenbach & Mechthild Kiegelmann: *Juggling and Joining Perspectives and Relationships; Multicultural Researchers in Multilocal Frames of Reference* (*Qualitative Research*, 19, 2018)
- Patty Ramirez: *The perils of juggling motherhood and academia* (*Times Higher Education*, 4 June 2015)
- S. Katherine Nelson-Coffey: *Juggling family and career: parents' pathways to a balanced and happy life*. (*ResearchGate*, January

2015)

- Heidi K. Gardner and Mark Mortensen: *How to Stay Focused If You're Assigned to Multiple Projects at Once* (*Harvard Business Review*, 7 November 2017)
- Seralynne Vann: *Juggling science and motherhood* (*NatureJobs*, 6 Apr 2016)
- Jane S. Gould: *Juggling: A Memoir of Work, Family, and Feminism* (Feminist Press at CUNY, 1997)
- Mary Lizabeth Gatta: *Juggling Food and Feelings: Emotional Balance in the Workplace* (Lexington Books, 2002)
- Janice Chua: *Juggling Work and Study* (*Science*, 20 December 2002)
- Theresa Johnston: *Power Couples Explain How They Juggle Career, Family, and the Laundry* (*Stanford Business*, 2 June 2016)
- Jessica Brown: *The Weirdness of Juggling Many Different Roles at Work* (*The Cut*, April 2017)
- J. Phillips, et al: *Juggling Work and Care: The Experiences of Working Carers of Older Adults* (Keele University, 2002)
- Usha Raman: *Juggling values* (*The Hindu*, 6 May 2018)
- *How to Juggle Caregiving Responsibilities and Work* (*MindTools*)
- *Juggling Work and Family Life: An Impossible Dream?* (*The Huffington Post*, 6 December 2017)

It does not appear to be the case that any particular insights into the process of juggling in practice are used to clarify these challenges of personal governance. The metaphor is used loosely to frame the struggle to deal with conflicting demands -- possibly just by "muddling through" in an effort to avoid "dropping the ball". Although loosely used, when does use of the metaphor imply intuitive recognition of use of a distinctive set of juggling skills?

Clearly a quite different perspective is offered if there is a sense of "being juggled", whether by obligations, employers or other agencies. This is typically recognized through any sense of "manipulation", which would indeed be the perspective of the juggler -- possibly then to be recognized as a puppet master. The experience of structural violence could be usefully explored as the sense of "being juggled".

Juggling as a metaphor in governance and policy implementation

One constrained use of the metaphor is illustrated by the remark of Indian economist Raghuram Rajan:

> Monetary policy is like juggling six balls... it is not "interest rate up, interest rate down". There is the exchange rate, there are long term yields, there are short term yields, there is credit growth.

As with the case of balancing personal priorities (indicated above), "juggling" is widely used as a metaphor to describe the challenge of responding to conflicting priorities in governance, as variously illustrated by the following:

- A. Sommerville: *Juggling law, ethics, and intuition: practical answers to awkward questions* (*Journal of Medical Ethics*, 29, 5)
- Sharon Gilad: *Juggling Conflicting Demands: the case of the UK Financial Ombudsman Service* (*Journal of Public Administration Research and Theory*, 19, 2009, 3, pp. 661-680)
- Nona Mikhelidze: *Juggling security, democracy and development in the Caucasus: What role for the EU?* (*ResearchGate*, July 2013)
- Ann-Charlotte Nedlund: *Designing for Legitimacy: Policy Work and the Art of Juggling When Setting Limits in Health Care* (LinkÖping University, 2012)
- Christopher P. Skroupa: *Juggling Human Rights And Business Priorities - Striking A Balance Between People, Planet And Profit* (*Forbes*, 28 September 2015)
- Monica Den Boer: *Juggling the Balance between Preventive Security and Human Rights in Europe* (Brill, 2015)
- Christiana Wyly: *The Juggling Contest: Balancing the Global Economy: An interview with Economist James Quilligan* (*The HuffingtonPost*, 3 August 2009)
- Lykke Friis and Anna Murphy: *Enlargement: A Complex Juggling Act* (Oxford University Press, 2000)
- Anne M. Fitzgerald: *Juggling information policy, rights to information and copyright licensing to enhance the accessibility and reusability of spatial data* (Leuven University Press, 2012)
- Claudia Rosett: *Trump juggles the foreign policy balls Obama dropped* (*The Hill*, 16 April 2017)
- Elias Muhanna: *Syria's Foreign Policy: A Juggling Act* (*Al-Akhbar*, 17 July 2012)
- Isabelle GuÉrin: *Juggling with Debt, Social Ties, and Values* (*Current Anthropology*, 55, 2014)
- Emma Hagqvist: *The Juggle and Struggle of Everyday Life: gender, division of work, work-family perceptions and well-being in different policy contexts* (Mid Sweden University, 2016)
- Janet Lloyd: *Juggling Knowledge, Juggling Power: The Role of the Professional Indigenous Activist in San Pablo, Ecuador* (Liverpool Univesity Press, 1998)
- *Juggling More than One Role as a Board Member* (Texas Association of School Boards, 2017)
- *Trump Forced to Juggle Syria Response, Rage Over Mueller Probe* (*The Wall Street Journal*, 13 April 2018)
- *Trump juggling 75 pending lawsuits with a presidential campaign* (*CNBC*, 27 October 2016)
- *The art of juggling political values and Trump* (*The Washington Post*, 13 April 2018)

"Dropping the ball": As with the use of the metaphor to frame the management of conflicting personal demands, it does not appear to be the case that any particular insights into the process of juggling in practice are used to clarify these challenges of collective governance. The metaphor is used loosely to frame the struggle deal with conflicting priorities -- again, possibly just by "muddling through" in the struggle to avoid "dropping the ball". Again however, although loosely used, when does use of the metaphor imply intuitive recognition of use of a distinctive set of juggling skills?

In addition to any sense of "keeping the ball in play", of particular interest is the experience framed by "dropping the ball" -- necessarily a

common experience in engaging with more complex challenges of governing:

- *Is the Federal Government dropping the ball on whistleblower protection?* (*The Conversation*, 29 August 2012)
- *Are African heads of state dropping the ball in Burundi?* (*Institute for Security Studies*, 2 February 2016)
- *Juggling fiduciary responsibility -- how to avoid dropping the ball* (*Journal of the Medical Association of Georgia*, 1992).

Such failure may result from failure to "catch the ball" or from failing to ensure that it avoids colliding with another ball in play -- engendering incompatibility or a "clash".

So framed, the existence of "windows" of opportunity becomes of great interest -- exemplified by the launch windows through which spacecraft are launched, such as to avoid the thousands of objects of orbiting space debris. How might "cognitive launch window" be recognized -- or those relating to any strategy?

Juggling priorities: Common to use of juggling as a metaphor, as indicated by the example above, is the experiential sense in which priorities are juggled. The priorities could be understood as strategic initiatives, preoccupations with problems, or cultivation of values. The metaphor is appropriate when the number in each case (or together) becomes a challenge to handling or coping. Greater skill is required as the number increases.

It is interesting that a very common device for handling such complexity is through some form of scheduling, typically requiring a 2D spreadsheet. This is of interest in that that tool was used to configure the visualizations described here. Given the timing issues involved, it is appropriate to ask what patterns might need to be designed in 3D and 4D, or more, as speculatively considered elsewhere (*Spherical Accounting: using geometry to embody developmental integrity*, 2004).

In general, and with respect to any form of governance, it is of particular interest to note recognition of juggling strategies/policies, obligations, concepts/categories, or factors:

- Terence Roche and Bob Roth: *Juggling Priorities* (*CUES*, 37, 2014, 6)
- Michael Settles: *Juggling Priorities as a Management Challenge* (2013)
- *Juggling Multiple Priorities for Administrative Professionals* (Management Research Association)
- Mary Ryan: *Juggling Priorities: balancing economic and social drivers to address the language, literacy and numeracy needs of students in the VET sector* (*International Journal of Training Research*, 14, 2016, 2)
- *Big caseloads being juggled with little support* (*Irish News*, 21 June 2012)

One insightful articulation of balancing multiple policies, specifically framed as "juggling", is summarized in the work of Evelyne de Leeuw, et al. (*Juggling Multiple Networks in Multiple Streams, European Policy Analysis*, 2, 2016, 1):

> This paper suggests a new conceptual gaze at theorizing the policy process. Alternating between practical, empirical, and theoretical perspectives, we describe how the hybridization of Multiple Streams, Policy Network, and Frame theories leads to a juggling metaphor to describe the process. From the initiation of this research program, we found that the information our research yielded was vastly more complex and dynamic than what is generally reported in similar research. In particular we discovered that dynamic interactions between actors in the different (policy, problem, and politics) streams, when appraised through a policy network lens, produce different network configurations in each stream. We also found that Kingdon's *Policy entrepreneurs* are likely to engage more in shaping the problem stream network configuration (through the process Kingdon labels *alternative specification* -- which requires great perspicacity with words) than in the other streams. We therefore postulate that hybridization of policy network theory with Multiple Streams theory would create a more powerful conceptual toolbox. This toolbox can be enhanced further by insights from network management conceptualisations and frame theory. Finally, we have embraced the criticism that has been voiced of the stages heuristic and proposes that **a more useful metaphor for policy processes is juggling**: those processes may appear chaotic, but keen discipline, coordination, and acuity are required for policy students and operators to keep all balls in the air *[emphasis added]*

Braiding the Triple Helix and beyond -- as an exercise in juggling?

Triple Helix: The argument noted above relating to the Triple Helix is remarkably well highlighted in relation to modelling learning as an extension of institutional innovation, as reproduced from *Contrasting the implications of "triple helix" -- cognitive and otherwise* (2017). It would seem that the institutional model has inspired exploration of a "triple helix" approach in domains such as learning, especially in the light of the cognitive implications of innovation (Eva Rydberg Fåhræus, *A Triple Helix of Learning Processes: how to cultivate learning, communication and collaboration among distance-education learners*. Stockholm University, 2003).

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

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

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

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

Triadic thinking -- an Australian specialty?	
Triple Helix University of Melbourne	3-ball juggling pattern as a braid Monash University, Melbourne
	

Juggling patterns as braids: As indicated by Burkard Polster (*The Mathematics of Juggling* [excerpt], Monash University, 2003), the diagram above-right shows what the trajectories of juggling the basic 3-ball pattern look like (viewed from above). The three trajectories form the most basic braid. Braids are recognized as important mathematical objects. It has been shown that every braid can be juggled in that sense (Polster, 2003; Matthew Macauley, *Braids and Juggling Patterns*, 2003; Satyan Devadoss and John Mugno, *Juggling braids and links*, *The Mathematical Intelligencer*, 29, 2007). The implications have been further discussed separately (*Potential cognitive implications of toroidal helical movement*, 2016; *Category juggling reframed through visualization dynamics*, 2016).

Sociophysics: As noted above, an effort was made to reconcile understandings of sociology and physics through a triadic framework by Paris Arnopoulos (*Sociophysics: Cosmos and Chaos in Nature and Culture*, 1993). As a consequence of the emergence of interest in the Triple Helix concept, Arnopoulos articulated the correspondence with that framework on the occasion of the Third Triple Helix International Conference (*Braiding the Triadic Codex and Triple Helix: the sociophysics of nature-culture-nurture and academy-industry-polity*, 2000). This suggests a greater degree of articulation between the three strands than is seemingly available from other sources.

However, given the recent data mining scandals in use of profile data in manipulation of democratic elections, the proponents of other flavours of "sociophysics" as a discipline merit a degree of challenge in claiming paternity of it, as with Serge Galam (*Modeling the Forming of Public Opinion: an approach from sociophysics*, *Global Economics and Management Review*, 18, 2013). The issue also merits attention in the light of the so-called Sokal Affair and related commentary (Alan D. Soka and and Jean Bricmont, *Fashionable Nonsense: postmodern intellectuals' abuse of science*, 1998). This is especially the case with the progressive development of algorithms of relevance to aspects of governance by artificial intelligence.

Elusive implications of helical geometry for governance?

The question is then how meaning could be appropriately associated with "braids" of higher order in proposing any framework for a transdisciplinary analysis of sustainable development and social ecology (Elias Carayannis and D. F. Campbell (*Triple Helix, Quadruple Helix and Quintuple Helix and how do knowledge, innovation and the environment relate to each other? International Journal of Social Ecology and Sustainable Development*, 1, 2010, 1, pp. 41-69).

The question is partially addressed separately (*Psychosocial Learnings from the Spiral Form of Hurricanes: implications of the triple helix and the 3-fold triskelion as "cognitive cyclones"?* 2017) in the following sections (with animations):

- Systemic closure: fourth helix -- and beyond?
- Relevance of any helical model to global governance?
- Reconciling triskelion and triple helix: a topological transformation with psychosocial implications?
- Suggestive representation of dynamics of a "cognitive wormhole" associated with a quintuple helix
- Attribution of significance: considering meaningful pattern mapping

The argument with regard to disparate threads is further developed in *Framing Cyclic Revolutionary Emergence of Opposing Symbols of Identity: Eppur si muove: Biomimetic embedding of N-tuple helices in spherical polyhedra* (2017) through the following:

- Dynamic bonding patterns in n-tuple helices engendering n-fold rotating symbols
- Embedding the triple helix in a spherical octahedron (with screen shots and animations)
- Embedding the quadruple helix in a spherical cube (with screen shots and animations)
- Embedding the quintuple helix in a spherical dodecahedron and a Pentagramma Mirificum (with screen shots and animations)
- Embedding six-fold, eight-fold and ten-fold helices in appropriately encircled polyhedra
- Embedding twelve-fold, eleven-fold, nine-fold and seven-fold helices in appropriately encircled polyhedra

Recognition of juggling in practice in relation to cognitive development and creativity

A primary reason for the widespread current interest in the Triple Helix model is in terms of enabling innovation -- as facilitated by the interweaving of the agendas and practices of academia, industry and government. Less evident, as noted above, is the meaning to be associated with the "interweaving" (or "braiding") of themes, as it might be otherwise understood metaphorically, whatever the relational implications in practice.

The current period is one in which understandings of "correlative thinking", however defined, are considered valuable -- if not desperately needed. It is therefore appropriate to note recognition of a widespread juggling culture centered on the International Jugglers Association and enabled by the Juggling Information Service. It is in this sense that it is useful to explore recognition of the value of juggling for desirable cognitive development and creativity.

Cognitive development: It is however appropriate to note the kinds of studies of the role of juggling in practice in facilitating cognitive development as may be implied by the quest for innovation:

- Jeremy Dean: *The Mental Benefits of Juggling* (*PsyBlog*, July 2013)
- Jessica Hamzelou: *Learning to juggle grows brain networks for good* (*New Scientist*, 11 October 2009)
- Edson Filho, et al: *The juggling paradigm: a novel social neuroscience approach to identify neuropsychophysiological markers of team mental models* (*Frontiers in Psychology*, 2015)
- *Juggling increases brain power* (*BBC News*, 12 October 2009)
- J. F. M. Hugo and I. D. Couper: *Teaching consultation skills using juggling as a metaphor* (*South African Family Practice*, 8, 2006, 5, pp. 5-7)
- Raoul Huys, Andreas Daffertshofer, and Peter J. Beek: *Multiple Time Scales and Multiform Dynamics in Learning to Juggle* (*Motor Control*, 2004, 7, pp. 188-212)
- Vaughan Bell: *Juggling can change brain structure within 7 days* (*MindHacks*, 29 July 2008)

Juggling as a practice is of considerable interest to studies of cognitive development and neuroscience, notably in terms of a "juggling paradigm" (Petra Jansen, et al, *The influence of juggling on mental rotation performance*, *Biomedical Human Kinetics*, 3, 2011; U. Wolfensteller, *Juggling with the brain: thought and action in the human motor system*, *Progress in Brain Brain Research*, 174, 2009; Edson Filho, et al, *The Juggling Paradigm*, *Frontiers in Psychology* 6, 2015).

Certain aesthetic processes may be understood as a form of juggling. For the process of self-regulation to work and to facilitate the emergence of unforeseen patterns of order, any contribution must necessarily be complemented or offset in some way. This is exemplified in dance where the role of a "partner" acting in a complementary or even challenging "opposing" manner is essential to the interest of the whole. This is also evident in musical group improvisation (jamming) or dance (jam circle). Jamming is itself recognized as a valuable metaphor for group innovation (John Kao, *Jamming: the art and discipline of business creativity*, 1997).

Iconic scientists as jugglers: Especially intriguing are cases of iconic scientists renowned for their creativity -- but also for their playfullness, partially expressed in their enthusiasm for juggling. Frequently cited examples include:

- Richard Feynman, theoretical physicist and recipient of the Nobel Prize in Physics in 1965. Noted for arguing that: *A theorist who can juggle different theories in his mind has a creative advantage when it comes time to change the theories.*
- Ronald Graham, mathematician and and past president of the International Jugglers' Association. Known for declaring: *Juggling is sometimes called the art of controlling patterns, controlling patterns in time and space.*
- Claude Shannon, *Mathematician, Engineer, Genius...and Juggler?* (*International Jugglers' Association*, 18 August 2017)

It is not difficult to argue that this juggling facility in some way corresponded to their capacity to juggle the concepts which characterized the creativity for which they were otherwise recognized. There is of course a degree of irony to the manner in which their indulgence in such playfulness has typically been deprecated as "unserious" and "unworthy" of their academic renown.

Juggling of concepts, theories and topics

The vocabulary of discourse establishes the relevance of a juggling perspective: "making a point", "taking a point", "ball in your court", "over to you", "missing the point", and "dropping the ball", as discussed more completely (*Nature of the "ball" in game-playing and governance*, 2016).

There are numerous references (in passing) to the challenge for academics and others of "juggling theories" and "juggling concepts". As a form of integration of multiple string theories, arguably M-theory required extensive preliminary creative "juggling" of the individual theories in metaphorical terms, with the resultant theory constituting an exemplar of juggling in a more articulated sense. In that light, however, Oscar Heath asks the question *Are string theorists the smartest group of people on the planet?* (*Quora*, 20 September 2005), and provides a preliminary answer:

> However, I'd find it hard to say that string theorists were much smarter than, for instance, engineers....They could take over the world if they really wanted to. Seriously though, to my mind that ability to juggle theoretical and practical considerations at quite an advanced level, and constantly be adjusting the theory to fit the application, combined with the creativity required to get anywhere is easily on par with the task of string theory.

In this case "juggling" is exploited as a metaphor to describe the subtlety with which a degree of relationship is established -- and

potentially sustained dynamically -- between seemingly incommensurable insights. Of related interest are references to "juggling arguments", "juggling points", and including "points of view" (Joyce Chapman and Jeff Essic, *Juggling Points and Polygons: GIS Researchers' Metadata and Search Needs* (*Journal of Library Metadata*, 11, 2011, 1). Where three such insights are "juggled", this could be considered comparable to engaging mathematically with the law of the excluded middle or the classical 3-body problem of physics.

Indicative examples are provided by:

- Daniel Rancour-Laferriere: *Juggling Poetics, Semiotics and Psychoanalysis* (1978).
- Petra Jansen, LÉonie F. Lange and Martin Heil: *The influence of juggling on mental rotation performance in children* (*Semantic Scholar*, 2011)
- Sanket Patel: *Juggling: What are the different processes taking place when learning motor skills?* (*Quora*, 11 July 2015)
- Jonathan Hare: *Some Notes on Juggling* (*The Creative Science Center*, 1999)
- Olivia Fox Cabane and Judah Pollack: *How To Train Your Brain To Have More Breakthrough Ideas* (*Fast Company*)
- Stephen A. Mitchell: *Juggling Paradoxes: Commentary on the Work of Jessica Benjamin* (*Studies in Gender and Sexuality*, 1 2000, 3, pp. 251-269).

In the light of the analysis of juggling patterns, this highlights the question as to how many patterns of discourse there might be, whether 2-person or multi-person -- given the cognitive and coordination constraints -- and usefully illustrated by the 46 ball-passing animations offered by *Wikipedia*? Are there dialogue records to be recognized by analogy with those of juggling noted above?

As noted by Polster in a discussion of enumerating and creating new interesting patterns:

> Using algorithms that are based on results in this book, computers have been programmed to enumerate all juggling sequences satisfying any conceivable set of constraints. Many new interesting juggling sequences have been found in this way. Since we now know "all" possible juggling sequences, what remains to be done is to identify those that, in themselves, are interesting from either a juggler's or a mathematician's point of view (pp. 137-138)

With respect to patterns of dialogue, Polster's subsequent comment is especially valuable: *Also, if you want to find out how you can smoothly move from one pattern to the next, tools such as state graphs are very helpful* . One accessible summary is provided by Harri Varpanen (*Toss and Spin Juggling State Graphs*, 12 May 2014). Use of "spin" in that title might offer particular insights to a world in which dialogue is increasingly characterized by "spin".

Notably using the weaving metaphor, to which Polster alludes through braiding, dialogue can be explored otherwise (*Interweaving Thematic Threads and Learning Pathways: noonautics, magic carpets and wizdomes*, 2010; *Varieties of Dialogue by Number: experimental overview by number of perspectives represented*, 1998). Dialogue processes have been configured in 3D patterns of tensegrity in the light of insights from management cybernetics by Stafford Beer (*Beyond Dispute: The Invention of Team Syntegrity*, 1994). The resulting process of syntegration is described by Martin Pfiffner (*From Workshop to Syntegration: the genetic code of effective communication*, 2004).

Juggling of metaphors as a dynamic key to elusive challenges of governance

The Open University offers a course on managing complexity which features juggling (*Systems Practice: unpacking the juggler metaphor*). The benefits of teaching students how to juggle is held to be that it embodies system thinking and grounds environmental metaphors, thereby helping to transcend paradigms, and promote well-being (Brendon M. H. Larson, *Embodying the path of sustainability: reflections on "learning to juggle" in environmental pedagogy* (*Journal of Environmental Studies and Sciences*, 2015) .

Other examples include:

- Kevin Eikenberry: *Leadership and Juggling: the unlikely lessons* (*Leadership and Learning*, 17 June 2013)
- Philip N. Cohen: *A lot of juggling metaphors in the air -- but what are people juggling?* (*Family Inequality*, 19 July 2012)
- Bill Giduz: *Trickle Down Juggling: Buzan and Gelb Try to Change the World by Teaching Juggling to the Corporate Elite* (International Jugglers Association, Winter 1994-95)
- J. F. M. Hugo: *Teaching consultation skills using juggling as a metaphor* (*South African Family Practice*, 48, 2006, 5)
- Margaret W. Ferguson: *Juggling the Categories of Race, Class and Gender* (In: A. R. Jones and Betty S. Travitsky, *Women in the Renaissance: An Interdisciplinary Forum*, 1991)

The arguments to this point tend to emphasize that what is juggled is either extremely loosely defined (when the term is loosely used) or is very well-defined -- appropriately symbolized in the latter case by the similar balls which are typically juggled in practice. Those skills of course extend to objects of disparate form -- clubs, and the like.

The argument may however be taken further by exploring the situation in which the objects are not bounded like balls through being well-defined, even if of a conceptual nature. Their boundaries may be more permeable and fluid as is characteristic of conditions when they are susceptible to definitional nuances, potentially even a source of fundamental disagreement. In such a case, as with fundamental particles, their definition may be subject to an uncertainty principle. They may then be better handled conceptually through one or more metaphors -- as with an electron distinguished either as a wave or as a particle.

Further insight into the process is available through the arguments of Douglas Hofstadter (*Fluid Concepts and Creative Analogies: computer models of the fundamental mechanisms of thought*, 1995). This notably includes an introductory chapter on *The Unconscious Juggling of Conceptual Objects* (1995). Unfortunately, other than being implied, this theme is not developed in a subsequent study (Douglas Hofstadter and Emmanuel Sander, *Surfaces and Essences: analogy as the fuel and fire of thinking*, 2013). The original

emphasis on flow is consistent with the emphasis on flow in juggling as practiced, readily framed in aesthetic terms (Todd Strong, *Juggling and Flow*, *Perceptual Motion*)

The point can be explored through the arguments of Edward de Bono (*Six Thinking Hats*, 1985; *Six Action Shoes: designing or choosing an appropriate course of action*, 1991; *Six Value Medals*, 2005). In each case it is a matter of engaging through the metaphor with contrasting cognitive modalities. A major merit of his framework is that the contrasting modalities are understood to be complementary. Ironically, some jugglers would indeed be able to juggle hats and shoes in practice -- rather than metaphorically.

From this perspective, there is a case for exploring the schema of governance as having been overdefined. Typically this would be evident through the sets of labels which are held to be unambiguous -- possibly having been strictly defined in legal documents. This applies as much to the naming of government ministries, departments, and international agencies as to the sets of categories through which the challenges of governance are framed by management consultants. There are many examples of the latter, typically associated with the franchised use of such schema (Team Role Inventories, etc).

Rather than considering the functions to be neatly and unambiguous defined in this way, there is a case for considering each function to be framed by one or more metaphors -- possibly such as to elicit even more. **The challenge of governance can then be understood as one of juggling such metaphors** -- whichever are preferred and however they are communicated. Such use of "juggling" can of course be readily deprecated if it is communicated. However it is clear that any leader is free to juggle such metaphors personally in using them as cognitive lenses through which to frame the challenges faced.

The metaphors can be shared for rhetorical purposes or treated as confidential -- if not recognized to be of significant proprietary value, as separately discussed (*Future Coping Strategies: beyond the constraints of proprietary metaphors*, 1992). Hypothetically, very powerful metaphors may be of very high strategic value -- justifying their existence and use as secret, as has been done with the geographic maps of centuries past.

Juggling highly controversial metaphors as a key to higher orders of governance?

There is a certain elegance to the use of traditional schemas, such as pantheons, as a means of framing the challenges of governance -- whether this is a confidential practice of leadership, or whether it is used for popular communication. The Greek and Roman pantheons merit particular consideration in this respect. Ironically relevant to this argument, the deities are associated to a high degree with the symbolism of significant international agencies. Curiously there are few deities in such pantheons which have not already been appropriated as trade marks for commercial products (*Religious "Plastic Turkeys" -- Hermes vs. the Hijab*, 2003).

It is fairly obviously the case that the characteristics and attributes of such deities are only mined to a limited degree for their significance for governance. The connotation is limited to characterizing a complex nexus of qualities and values with which the deity has been traditional associated through myth, imagery and otherwise. Most obviously missing are the implications of the stories of the relations between deities for the systemic challenges of governance -- irrespective of the degree to which the stories are interwoven, if not braided together.

More relevant to the argument is the manner in which such sets of archetypal figures may be used more secretively and deliberately by secret societies and cults to provide coherence for their systemic insights into the manner in which they are governed. More evident is the manner in which reference may be made by some constituencies to ordered hierarchies of angels (and the like) to provide such coherence -- supported to some degree by tales as to their relationship (*Engaging with Hyperreality through Demonique and Angelique? Mnemonic clues to global governance from mathematical theology and hyperbolic tessellation*, 2016). Analogous examples are provided by certain traditional epics, valued at all levels of society (*Mahabharata*, *Kalevala*, etc).

It is in this sense that astrology can be explored as a complex exercise in juggling -- widely valued down the centuries. There is of course the irony of the extent to which astrology has been used in relative secrecy by leaders of governments (*White House Confirms Reagans Follow Astrology, Up to a Point*, *The New York Times*, 4 May 1988; *Joan Quigley, and 5 stories of astrology in the White House*, *The Washington Post*, 28 October 2014). Clearly, in some contexts, it offers a means of framing communications to a wider population for which that framework is meaningful. A similar argument could be made with respect to *feng shui* as a subtle exercise in juggling which has considerable credibility at all levels of some societies (*Feng Shui in the boardroom*, *GAA Accounting*, 12 April 2012; *China Officials Seek Career Shortcut With Feng Shui*, *The New York Times*, 10 May 2013). The structure of the geomantic compass (*luopan*) merits consideration in the light of the argument developed here.

Missing from the argument however is how "juggling" is to be understood with respect to either astrology or *feng shui*, given the mystification typically cultivated to the satisfaction of all concerned -- and widely deprecated by those alienated by that framing.

Juggling as a "Rosetta dynamic" -- as its own metaphor of governance?

The argument can be taken further through the framework elaborated by Arthur Young in the light of his preoccupation with cycles of learning (*Geometry of Thinking*, 1976). His inspiration derived from the innovative insight he acquired in developing the original Bell helicopter with its unusual piloting challenges -- usefully recognized as a form of juggling in its own right. He subsequently generalized this in philosophical terms to include the speculative possibility of designing a "psychopter". It could be argued that the quest of global governance for sustainability bears comparison with the challenge of getting the psychosocial system "off the ground" and enabling it to "fly" -- as with a "psychopter" (*Clues to 'Ascent' and 'Escape*' -- in *Navigating Alternative Conceptual Realities: clues to the dynamics of enacting new paradigms through movement*, 2002).

With respect to piloting a helicopter, as noted by Ray Prouty:

> *Deadman's Curve:* No matter how clever the pilot is in juggling the energy in both the entry into and the flare from autorotation, there remain some combinations of initial attitudes and speeds from which he will surely crash (*Helicopter Aerodynamics*, 2009, p. 189)

The sense offered by Young that there may be cyclic learning processes which could offer a new kind of overview (or integrative perspective) justifies a degree of speculation in that regard (*Engendering a Psychopter through Biomimicry and Technomimicry: insights from the process of helicopter development*, 2011). The 12-fold framework he developed provided a patterned interrelationship between the measure formulae of the physics basic to the operation of a vehicle like a helicopter -- in effect to its governance. This is variously evident in adaptations of that framework (*Typology of 12 complementary strategies essential to sustainable development*, 1998; *Characteristics of phases in 12-phase learning / action cycles*, 1995; *Typology of 12 complementary dialogue modes essential to sustainable dialogue*, 1998).

Young highlighted the inferred significance of the systemic 12-fold framework by naming it as a ***Rosetta stone of meaning*** (Young, 1976, pp. 38-50, 159). He attributed to each of the 12 physical conditions of governance of a vehicle (as conventionally named) one or more terms indicative of their psychosocial significance. Curiously, irrespective of the significance to physics or to the psychosocial realm, the terms which can be variously applied to distinguish the 12 conditions can be best explored as metaphors (or as metaphorical connotations) -- as discussed below. Understood in this way, premature definitional closure on each condition is avoided.

The elusive nature of the underlying meaning then remains a matter of continuing reflection. Given the nature of the different isotopes of chemical elements, the distinct metaphors of each condition could be (playfully) termed "isotropes" (sic). Framing the effort to comprehend them in terms of "grasping their meaning" may itself be misleading, as can be otherwise argued speculatively (*Authentic Grokking Emergence of Homo conjugens*, 2003; *Emergence of Homo undulans -- through a "grokking" dynamic?* 2013).

Of major implication, in contrast to the absence of systemic insights into the 12-fold Greek and Roman pantheons (for example), is the manner in which Young's Rosetta stone is systemically organized. In this sense it is unfortunate that it is named as a "stone" -- when in fact those relationships render it essentially dynamic. This is indeed obvious in the light of its implication for "governing" the movement of a helicopter. Use of "stone" offers the misleading implication that piloting the helicopter is a question of consulting a manual of prescriptions of some kind, when the challenges of its governance are essentially dynamic -- as of those of any collectivity or with respect to any understanding of self-governance.

Controversially, Young however takes his argument further by indicating how his Rosetta stone is consistent with the traditional pattern of signs of the zodiac -- with all the qualitative connotations they have offered to so many for so long, in a variety of cultures worldwide. Here again however, rather than being locked into that particular framing, their consideration as one possible set of metaphors is more fruitful.

Missing however from the argument of Young is how to work with his Rosetta stone. Again this is arguably as a consequence of it being framed as a "stone". Practioners of astrology give themselves greater flexibility in "juggling" with the variables to which significance is attributed. However, another approach may be explored. given the manner in which Young associates each condition with a physical process fundamental to juggling in practice. -- itself with a fundamental commitment to flow.

Succinctly stated, **juggling is effectively its own metaphor of governance** -- and a very powerful one at that, most notably as it applies to self-governance. All the considerations required of a juggler of "balls" are those required of piloting a helicopter. However, when the "balls" are concepts or metaphors (as discussed above), analogous considerations are required in "juggling" the functions of psychosocial governance. The perspective of helicopter pilots who are skilled jugglers could offer further insight.

Framed and experienced cognitively as metaphors, the engagement with the 12-fold multiplicity of functions is then far more intimate (and "hands-on") than when those functions are (overly) defined as concepts -- especially when such "instrumentalization" cognitively distances the governor from engaging with the juggling process. The functional coordination required for coherent governance is then disenabled. The helicopter will not fly in a controlled manner; it will crash, sooner or later -- if it gets off the ground. Missing is any sense of the cognitive requirement to "fly by the seat of one's pants".

Fundamental operational concepts, jury size, financial ratios and "the Greeks"

"Fundamental concepts": In exploring the possibility of such correspondences, there is a case for clarifying what are signified by the "fundamental concepts" of physics. Young offers a set of 12 in terms of "measure formulae". Arnopoulos offers a set of 15. A search of the literature reveals that there are numerous treatises on the "fundamental concepts of physics". Ironically however there appears to be little consensus on what constitutes a fundamental set -- other than at the level of the standard model of particle physics, presumably to be considered irrelevant to further insights into juggling (at least provisionally). A relevant commentary in *Wikipedia* (*Category talk: Concepts in physics*) is introduced with an irritable discussion of *What is fundamental?*

The quest can be framed otherwise by asking the question as to how many "operational concepts" a juggler requires in order to be able to juggle? Or a helicopter pilot to manage a helicopter? How do these relate to the fundamental concepts identified by Young and Arnopoulos? How would a juggling physicist identify the set of such fundamental concepts? Related issues can be explored more generally (*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 issue is then how such a set of concepts (insights or functions) can be understood to inform the challenge of "juggling" in governance -- beyond the extremely loose use of the metaphor in the citations above. A valuable indication is presumably offered by the extent to which **a 12-fold pattern has been widely valued over centuries in many domains for reasons which remain obscure**

(*Checklist of 12-fold Principles, Plans, Symbols and Concepts: web resources*, 2011).

This checklist necessarily includes the Greek and Roman pantheons, as mentioned above -- with the particular implications they offer for governance. However, given the tenuous nature of the systemic links between those deities (as noted), there is a case for exploring whether they embody functions which bear a degree of equivalence to those of the set of physical concepts. The question can be explored more generally, which was the initial reason for establishing that checklist (*Eliciting a 12-fold Pattern of Generic Operational Insights: recognition of memory constraints on collective strategic comprehension*, 2011).

The mysterious enthusiasm for a pattern of 12 is currently illustrated by the bestseller by Canadian clinical psychologist and psychology professor Jordan Peterson (*12 Rules for Life: An Antidote to Chaos*, 2018), subject to the highly critical review by Adam A. J. DeVille (*Jordan Peterson's Jungian best-seller is banal, superficial, and insidious*, *The Catholic World Report*, 3 April 2018). With respect to "why12", the reviewer argues:

> And why 12 rules? Here my mind freely associated to the droll story Margaret MacMillan tells in her splendid book *Paris 1919* of Georges Clemenceau, with delicious Gallic hauteur and sarcasm, dismissing Woodrow Wilson: *God himself was content with 10 commandments. Wilson modestly inflicted fourteen points on us...the fourteen commandments of the most empty theory!*)

But why are so many projects framed in that way?

Operational challenge exemplified by jury size: With respect to requisite variety in decision making, insights are emerging in the light of studies of jury size (Evan Moore and Tali Panken, *Jury Size: Less in not More*, Cornell University Law School, 2010; Dana Mackenzie, *What's the Best Jury Size? Slate*, 25 April 2013; Jeff Suzuki, *Constitutional Calculus: the math of justice and the myth of common sense*, JHU Press, 2015). These merit particular reflection, given the fundamental role attributed to juries in the process of governance -- notably the particular commitment to 12-person juries.

As noted by Chris Gorski (*The Mathematics of Jury Size*, *Inside Science*, 23 March 2012):

> Could different jury sizes improve the quality of justice? The answers are not clear, but mathematicians are analyzing juries to identify potential improvements. Nowhere in the U.S. Constitution does it say that juries in criminal cases must include 12 people, or that their decisions must be unanimous. In fact, some states use juries of different sizes.
>
> One primary reason why today's juries tend to have 12 people is that the Welsh king Morgan of Gla-Morgan, who established jury trials in 725 A.D., decided upon the number, linking the judge and jury to Jesus and his Twelve Apostles. The Supreme Court has ruled that smaller juries can be permitted. States such as Florida, Connecticut and others have used -- or considered -- smaller juries of six or nine people. In Louisiana, super-majority verdicts of nine jurors out of 12 are allowed. However, in 1978 the Supreme Court ruled that a five-person jury is not allowed, after Georgia attempted to assign five-person juries to certain criminal trials.
>
> To mathematicians and statisticians, this offers a clear division between acceptable and not acceptable, and therefore an opportunity for analysis.

In the undertaking of such analysis Gorski notes that no good models exist for how jurors interact with each other: *The real challenge is that the data doesn't really exist*. Ironically this echoes the problem with other 12-fold sets, including the deities and the set of 12 Apostles (on which preference for a 12-member jury is seemingly based). How might Jesus be understood to have "juggled" (with) the 12 Apostles at the arcetypal Last Supper -- or King Arthur with the Knights of the Round Table?

Much more data and research is available for the size of the committees used in processes of governance. Most recently the optimal group size has been confirmed to be 7, as frequently cited (*What is the optimum Board size? Governance Today*, 2018; Marcia W. Blenko, Michael C. Mankins, and Paul Rogers, *Decide and Deliver: 5 Steps to Breakthrough Performance in Your Organization*, Harvard Business Press, 2010). However other factors and data have concluded that 11 is the optimal number (Russell Kashian and Heather Kohls, *Committee Size and Smart Growth: an optimal solution*, e-Publications@Marquette, 2009).

It might then be assumed that the "jury is still out", and that there may well be greater wisdom in 12. **How the number relates to the requisite variety of distinctive perspectives and cognitive skills is clearly a concern**, especially if distinctive functions are called for -- as implied by the *Six Thinking Hats* **and** the *Six Action Shoes* of Edward de Bono, and otherwise discussed (*Comprehension of Numbers Challenging Global Civilization*, 2014). It would appear that there is indeed a possibility of reducing the number recognized to 6, as argued by Edward de Bono (*Six Frames For Thinking About Information*, 2008) and presented diagrammatically. This reduction may well obscure in some way the need for complementary perspectives which would raise the number to 12, for example.

If it is widely assumed that it takes a jury of 12 to juggle wisely the arguments presented in a trial -- then how (in)effective and (unwise) might the capacity of an executive committee of 7 then be assumed to be? What "balls" might it then tend to "drop"? Is this kind of question of relevance to the functioning of committees with regulatory and oversight responsibility?

Insights from the set of financial ratios and "the Greeks": Governance of a commercial operation typically makes use of a set of standard financial ratios in evaluating and tracking performance. Each is a relative magnitude of two selected numerical values taken from an enterprise's financial statements (Joe Lan, *16 Financial Ratios for Analyzing a Company's Strengths and Weaknesses*, *American Association of Individual Investors*. September 2012).

To the extent that the challenges of governance are defined by a set of risk sensitivities, mathematical finance offers a set of quantitative measures representing the sensitivity of the price of derivatives such as options to a change in underlying parameters on which the value

of an instrument or portfolio of financial instruments is dependent. Also known as risk measures or hedge parameters, these are collectively termed "the Greeks" because the most common of these are denoted by Greek letters.

Given their purpose, these two sets of measures can be considered comparable to the set of 12 measure formulae which are the basis for the arguments of Arthur Young -- in the light of the challenge of "governing" a helicopter. Clearly the issue with respect to the "healthy" governance of any collective initiative, is how non-quantitative tools essential to governance are supplemented (if at all) by an array of analytical tools. Arguably the tools can to some degree be considered as metaphors indicative of qualitative modes of cognitive engagement with the dynamics of governance.

The question of how many such tools are considered essential (when used) clearly remains a matter of debate -- especially in the light of distinctions between profit-making and non-profit-making undertakings (Andrew C Holman, et al, *The Analysis of Key Financial Ratios in Nonprofit Management*, June 2010; Dumisani Hlatswayo, *7 Important Financial Ratios Every Charity Leader Should Know*, 20 March 2017; Kevin Leder, *Financial Metrics and Benchmarking for Non-Profit Organizations*, May 2012).

For the purpose of this exercise, the tools (as identified in *Wikipedia*) are simply listed to encourage further reflection, notably as to how they might be clustered, combined, ignored or "juggled" in practice.

Financial ratios (see also *List of financial performance measures*):

- Profitability ratios: measuring the use of assets and control of its expenses to generate an acceptable rate of return
  - Gross margin, Operating margin, Profit margin,
  - Return on equity (ROE), Return on assets (ROA), Return on net assets (RONA), Return on capital (ROC), Return on capital employed (ROCE)
  - Efficiency ratio, Net gearing
- Liquidity ratios, measuring the availability of cash to pay debt.
  - Current ratio (Working Capital Ratio), Acid-test ratio (Quick ratio), Cash ratio, Operating cash flow
- Activity ratios (Efficiency Ratios), measuring the effectiveness of use of resources
  - Average collection period, Degree of Operating Leverage (DOL), DSO Ratio, Average payment period, Asset turnover, Stock turnover ratio, Receivables Turnover Ratio, Inventory conversion ratio,
- Debt ratios (leveraging ratios), measuring ability to repay long-term debt (financial leverage)
  - Debt ratio, Debt to equity ratio, Debt service coverage ratio
- Market ratios, measuring investor response to owning a company's stock and also the cost of issuing stock.
  - Earnings per share (EPS), Payout ratio, Dividend cover, Dividend yield, Price/sales ratio
- Capital budgeting ratios

Risk sensitivities ("the Greeks"):

- First-order Greeks
  - Delta: measures the rate of change of option value with respect to changes in the underlying asset's price.
  - Vega: measures sensitivity to volatility. It is the derivative of the option value with respect to the volatility of the underlying asset.
  - Theta: measures the sensitivity of the value of the derivative to the passage of time: the "time decay."
  - Rho: measures sensitivity to the interest rate: it is the derivative of the option value with respect to the risk free interest rate (for the relevant outstanding term)
  - Lambda (Omega): is the percentage change in option value per percentage change in the underlying price, a measure of leverage, sometimes called gearing.
- Second-order Greeks
  - Gamma: measures the rate of change in the delta with respect to changes in the underlying price.
  - Vanna: (or DvegaDspot and DdeltaDvol): is a second order derivative of the option value, once to the underlying spot price and once to volatility.
  - Vomma (Volga, Vega Convexity, Vega gamma or dTau/dVol) measures second order sensitivity to volatility. It is the second derivative of the option value with respect to the volatility, or, stated another way, vomma measures the rate of change to vega as volatility changes.
  - Charm (or delta decay, or DdeltaDtime): easures the instantaneous rate of change of delta over the passage of time.
  - DvegaDtime: measures the rate of change in the vega with respect to the passage of time. It is the second derivative of the value function; once to volatility and once to time.
  - Vera (or Rhova): measures the rate of change in rho with respect to volatility. It is the second derivative of the value function; once to volatility and once to interest rate.
- Third-order Greeks
  - Color (gamma decay or DgammaDtime): measures the rate of change of gamma over the passage of time
  - Speed (or the gamma of the gamma or DgammaDspot): measures the rate of change in Gamma with respect to changes in the underlying price.
  - Ultima (or DvommaDvol): measures the sensitivity of the option vomma with respect to change in volatility.
  - Zomma (or DgammaDvol): measures the rate of change of gamma with respect to changes in volatility.

In the context of this exploration it is extraordinary to discover the importance of gamma in financial trading. There it offers a measure of the rate of change in the delta with respect to changes in the underlying asset's price. In a world focused on change, gamma is an indicator of the change in the rate of change. With respect to finance, this must necessarily be understood as the change in one of the most tangible forms of value -- if notional and symbolic. Given the argument for the value of playing (as noted above), it is strange that

"playing the markets" is a well-recognized phrase and that gamma should be so fundamental to the skills involved.

This suggested further speculation (*Psychosocial Implication in Gamma Animation: Epimemetics for a Brave New World*, 2013). The argument is notably developed with respect to:

Fruitful gamma resonance within a pattern of mnemonic associations?	Unsustained awareness implied by gamma inversion
Gamma as change in the rate of change of value	Relational insight dynamics in terms of a "gamma" perspective

As the second derivative of the value function with respect to that underlying price, gamma is an important measure of the convexity of a derivative's value, in relation to the underlying price. It is important because it corrects for the convexity of value. Convexity refers to non-linearities in a financial model. In other words, if the price of an underlying variable changes, the price of an output does not change linearly, but depends on the second derivative of the modeling function. Geometrically, the model is no longer flat but curved, and the degree of curvature is called the convexity.

With "the Greeks" clustered in terms of first, second and third-order derivatives, this readily recalls those derivatives in the measure formulae of Young's table (indicated below). They also raise the question of the problematic relevance of "derivative thinking" (*Vigorous Application of Derivative Thinking to Derivative Problems*, 2013). The requisite vigilance for sustainable governance also recalls the sene in which "finance" can be recognized as a surrogate for confidence and the focus of attention implied by derivatives of a higher order (*Investing Attention Essential to Viable Growth: radical self-reflexive reappropriation of financial skills and insights*, 2014).

Correspondences between juggling and governance

In terms of this argument, there is therefore a kind of weaving (or braiding) to be explored through metaphor between archetypal figures (of governance), the zodiacal pattern of archetypes, and the fundamental physical concepts -- as they apply to juggling (or to piloting a helicopter). The extensively articulated understanding of financial measures in relation to governance is clearly also a source of insight -- notably to the extent that considerations of such measures are "juggled" in practice. Presumably insights from each would then inform the others to some degree. **The value of the juggling emphasis is that it is an experiential skill**. As yet to be discovered is a means of translating between such modalities, as exemplified by the challenge of the Triple Helix approach. The need for a form of "Rosetta stone" then becomes apparent, as argued by Arthur Young,

Although physicists and mathematicians may indeed be fascinated with juggling, few have the capacity to apply their understanding of the fundamental concepts of physics to juggle a set of balls -- however limited. **The experiential dimension is also essential to any relevance to governance** -- hence the value attached to "experience" in that context. Again, few academic experts with an insight into the "fundamental concepts" of governance are renowned for their governance capacity in practice. How many are known for their juggling capacity -- other than in metaphorical terms? The zodiac pattern offers a valuable communication template accessible to the many, however much it is currently deprecated by the few who are otherwise handicapped.

Juggling offers the additional advantage in that a number of interactive animations have been produced with sets of parameters which can be explored -- to a greater degree than is possible with the challenges of governance as currently conceived. Do such parameters also offer a basis for exploring the correspondences as argued here?

Adaptation of Arthur Young's table configured below as a "Rosetta stone of meaning" (terms in bold are those from physics; those in italics are the meaning attributed to them by Young)					
	T^0	T^{-1}	T^{-2}	T^{-3}	
Actions	**[L]** **position** *observation*	**[L/T]** **velocity** *change*	**[L/T^2]** **acceleration** *spontaneous act*	**[L/T^3]** **control** *control*	**M^0L**
States	**[ML]** **moment** *significance*	**[ML/T]** **momentum** *transformation*	**[ML/T^2]** **force** *being*	**[ML/T^3]** **mass control** *establishment*	**ML**
Relations	**[ML^2]** **moment of inertia** *faith*	**[ML^2/T]** **action** *impulse*	**[ML^2/T^2]** **work** *fact*	**[ML^2/T^3]** **power** *knowledge*	**ML^2**

The question is then how to explore possible correspondences between governance in an organization, of a helicopter (for example) and juggling -- as tentatively presented in the following table.

Correspondences of governance and juggling to physical significance (items in italics from the physical context tend to be interpreted otherwise with respect to governance and juggling)			
Formula	**Significance** (in piloting)	**Governance**	**Juggling**
[L]	position	*position* / observation / vigilance	*position* / observation / vigilance / judgment
[L/T]	velocity	*change*	*velocity*
[L/T^2]	acceleration	*initiative* / *acceleration* / spontaneous act	*acceleration*

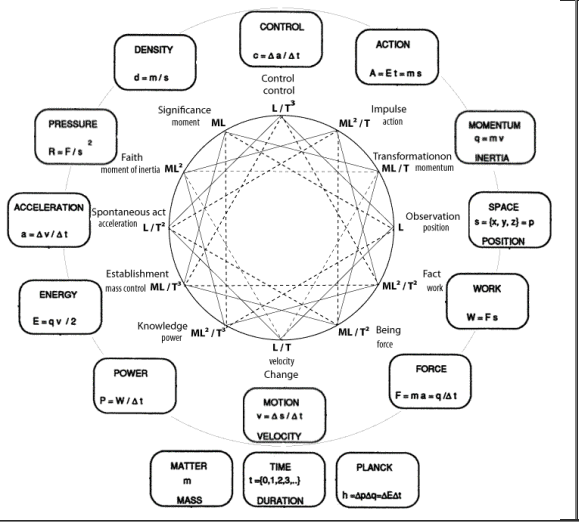
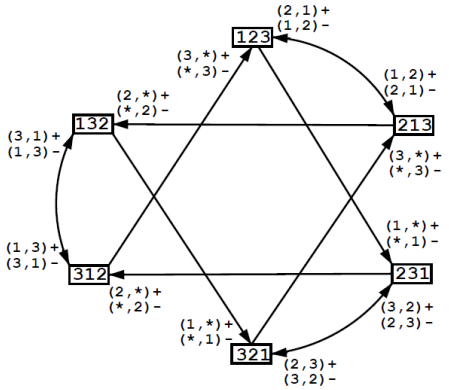
$[L/T^3]$	control	*control*	*control*
[ML]	moment	*significance*	*moment*
[ML/T]	momentum	*momentum* / transformation	*momentum*
$[ML/T^2]$	force	*force* / being	*force*
$[ML/T^3]$	mass control	*mass control* / establishment	*mass control*
$[ML^2]$	moment of inertia	*inertia* / faith / commitment / belief	*inertia*
$[ML^2/T]$	action	*action* / impulse	*action*
$[ML^2/T^2]$	work	*work* / fact	*work*
$[ML^2/T^3]$	power	*power* / knowledge	*power*

With respect to governance in the table, the indications could be completed by web searches for related terms commonly used, as in previous adaptations of the table (*Typology of 12 complementary strategies essential to sustainable development*, 1998; *Typology of 12 complementary dialogue modes essential to sustainable dialogue*, 1998). A similar approach could be taken with respect to terms of importance in juggling and other physical disciplines, notably the martial arts and acrobatics. The question is how insights in one column are to be "translated" into their tentative correspondences in the other columns. The cognitive implications are further discussed separately (*Cognitive implication in contrasting modalities*, 2018; *Rosetta stone of meaningful cycles?* 2018).

The attributions can be usefully compared with the articulation in a seemingly different "language" by Kevin Kelly (*The Inevitable: understanding the 12 technological forces that will shape our future*, 2017):

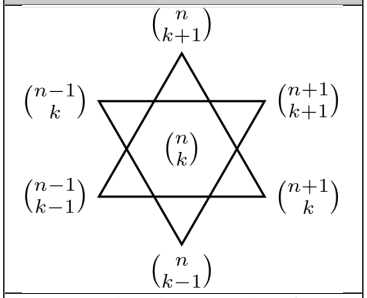
• Becoming: Moving from fixed products to always upgrading services and subscriptions • Cognifying: Making everything much smarter using cheap powerful AI that we get from the cloud • Flowing: Depending on unstoppable streams in real-time for everything • Screening: Turning all surfaces into screens • Accessing: Shifting society from one where we own assets, to one where instead we will have access to services at all times. • Sharing: Collaboration at mass-scale.	• Filtering: Harnessing intense personalization in order to anticipate our desires • Remixing: Unbundling existing products into their most primitive parts and then recombining in all possible ways • Interacting: Immersing ourselves inside our computers to maximize their engagement • Tracking: Employing total surveillance for the benefit of citizens and consumers • Questioning: Promoting good questions is far more valuable than good answers • Beginning: Constructing a planetary system connecting all humans and machines into a global matrix

The circular presentation of the table by Young in relation to his arguments with respect to the pattern of the zodiac is presented on the left below -- tentatively augmented with the 15 fundamental concepts of Arnopoulos (2000). Note that 3 of the latter's concepts have been set below, arguably because they do not lend themselves to direct experience in the same manner as the other 12.

"Rosetta stone of meaning" of Arthur Young tentatively supplemented by fundamental concepts of sociophysics (Paris Arnopoulos, 2000)	**Stack-graph for 3-ball juggling pattern** (reproduced from Macauley, 2003)
	

The intriguing question, highlighted by the schematic on the right, is **can the pattern of governance functions on the left be "juggled"** in some way -- especially when informed by the braiding pattern? Can it be simulated by juggling, whether with more balls or more partners? The image on the right derives from the juggling of only 3 balls by one juggler. A more complex pattern would naturally result from juggling more balls -- presumably then approximating more closely to the pattern on the left. Of potential relevance is the so-called Star of David theorem -- is a mathematical result on arithmetic properties of binomial coefficients, representes succinctly as follows (with the rows of the Pascal triangle shown as columns).

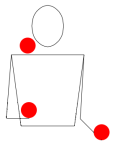
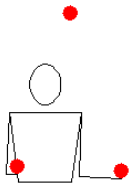
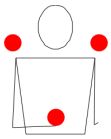
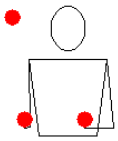
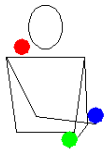
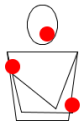
Star of David theorem



Reproduced from *Wikipedia*

As a simulation of processes in governance, it is intriguing to explore whether the various 3-ball patterns offer valuable insights into the manner in which topics and priorities are juggled in any context, and especially how issues may be juggled in a 2-party system. The simulation of the movements of the left and right hands are a useful trigger to reflection.

Selection of animations of 3-ball juggling patterns by one juggler
(derived from juggling patterns in *Wikipedia*)

3-ball cascade	3-ball shower	3-ball columns	3-ball box	3-ball Mills mess	3-ball Burke's barrage
					
attribution	attribution	attribution	attribution	attribution	attribution

Clearly of even greater potential interest are the many animations of 4 or more balls with two or more juggling partners -- namely the possibilities of keeping more balls "in the air".

Determining the requisite number of patterns, partners and "balls" in governance

Clearly mathematics has a major role to play in clarifying what amounts to a pattern language usefully encoded in the process of juggling, as discussed separately (*Category juggling reframed through visualization dynamics*, 2016). As noted above, *Wikimedia* provides access to 46 patterns (as gif animations) -- distinguishing the number of "balls" and jugglers.

In his study Burkard Polster explores the question of how many ways there are to juggle -- as being the question most frequently asked of jugglers. His response is "infinite" when unconstrained, usefully raising the question whether such jugging possibilities are comparable to infinite games (James P. Carse, *Finite and Infinite Games: A Vision of Life as Play and Possibility*, 1986; Niki Harré, *The Infinite Game: How to Live Well Together*, 2018).

Polster does however offer a preliminary answer to the effect that:

> However, it still makes sense to ask for the number of juggling sequences that are distinguished in some way. The three most natural parameters used to define distinguished classes of juggling are:
>
> - the number of balls used to juggle a juggling sequence
> - the period of a juggling sequence
> - the maximum height of a throw in a juggling sequence
>
> If we only fix the number of balls, or the period, or a maximum throw height, the resulting class of juggling sequences will still be infinite, except for some trivial exceptions. Fixing the period p and a maximum throw height h yields a finite class of juggling sequences. Clearly, there are no more than (h+1)p such sequences. (p. 37)

He also offers a more complex indication in the following terms:

Numbers of juggling sequences

(N1) The number of all juggling sequences of period p and at most b balls is

$$S^{\leq}(b,p) = (b+1)^p.$$

(N2) The number of all b-ball juggling sequences of period p is

$$S(b,p) = S^{\leq}(b,p) - S^{\leq}(b-1,p) = (b+1)^p - b^p.$$

(N3) The number of all minimal b-ball juggling sequences of period p, with $b \geq 1$, is

$$MS(b,p) = \frac{1}{p}\sum_{d|p} \mu\left(\frac{p}{d}\right)\left((b+1)^d - b^d\right)$$

if cyclic permutations of a juggling sequence are not counted as distinct. Here, μ denotes the *Möbius function*.

(Burkard Polster, *The Mathematics of Juggling*, 2006, p. 40)
See explanation of MÖbius function

These formulae are also discussed by Steve Butler, et al (*Juggling Card Sequences*, 6 April 2015). The issue could be framed otherwise through the extensive study of passing patterns in other ball sports, most notably football and basketball (Howie Long and John Czarnecki, *American Football Passing Patterns*).

Fruitful questions might be framed in the following terms:

- If one expert juggler can "manage" 7 balls (say), how many balls can a team of 12 expert jugglers "manage" together?
- What is the mimimum number of "balls" and partnes reauired to sustain a viable pattern, with the maximum number of "balls" similtaneously "in the air"?
- What constraints become evident when the jugging capacity of the parners is significantly different?

Of relevance here is the apparent absence of consideration of constraint on the number of balls which can be effectively juggled, notably as these might relate to the number of participants between which they are passed. Some constraints are evident from the details listed by *Wikipedia* with respect to juggling world records. It is curious that the number for an individual is consistent with the psychological constraint famously highlighted by George Miller (*The Magical Number Seven, Plus or Minus Two: some limits on our capacity for processing information*, *Psychological Review*, 1956). How this constraint might relate to a limited group of individuals (or a group of limited individuals) is another matter.

Given the frequently cited difficulties for global governance of addressing issue complexity, also of interest -- if the "balls" are strategic issues -- is the question of how many issues can be effectively juggled in the light of the number of juggling partners. How many "balls" can be successfully "kept in the air" without being "dropped" given the relative juggling incompetence of some partners? Is this the challenge of sustainable governance?

Acquiring a "sense" of 12 modalities for viable system awareness?

Contrasting intelligences: It is appropriate to emphasize the contrast between an analytical understanding of the different modalities and experiential engagement with them -- recalling the distinction between analytical intelligence and kinesthetic intelligence. With respect to the variety of intelligences, it is curious to note that the number currently recognized is greater than 7 and less than 12, potentially suggesting a degree of correspondence with the number of functions vital to governance in practice.

As noted by Charles Beck in describing the experience of his students (*Juggling Makes Physics Fun: elementary students learn the physical science concepts behind juggling*, *Science and Children* March 2008):

> They soon learned that they had to control the direction, amount of force, and distance between the objects. The students were overjoyed when they learned to keep the objects in motion without dropping them. The very act of tossing and catching objects helped students to understand the basic physical principles involved in rotating a set of objects. ... To help students understand the juggling skills required to keep a set of rotating objects under control and in a predictable pattern. ... To suggest a simple set of tossing, dropping, and catching exercises designed to help students literally grasp a set of juggling concepts.

A similar contrast could be framed with respect to governance -- then typically offered by the contrast between an MBA qualification and the subtlety of "experience", as is held to be vital in the selection of candidates to any executive position. Beyond the arguments of Edward de Bono, how do individuals or groups acquire an experiential sense of the variety of functions required -- a sense of requisite variety beyond that theoretically identified by cybernetics?

Cycles and viable systems: One approach to this question is through the insights of viable system theory as originally developed by management cybernetician Stafford Beer. So framed the issue might then be understood in terms of the number of feedback loops in a viable system of governance -- and how these are to be recognized and experienced. In this respect the distinction between first-order, second-order, and higher-order feedback loops is highly relevant, however these are to be understood, as argued by Maurice Yolles and Gerhard Fink (*Generic Agency Theory, Cybernetic Orders and New Paradigms*, 2014). Given the emphasis of Young on learning cycles, are such loops to be understood as related to those cycles? These and related distinctions are discussed separately (*Revisioning a tabular configuration of categories*, 2018).

Especially in the light of the cycles so evident in patterns of juggling, another approach is through a sense of the number of cycles effectively required to get a particular pattern to "work" -- namely to "keeping the balls in play", avoiding any tendency to "dropping the ball". This recalls insights into 8 thermodynamic processes, and some 12 thermodynamic cycles. Are 3-fold, 4-fold, and N-fold cycles to be usefully distinguished -- some of which might be implied in the circular representation of Young's Rosetta stone of meaning?

Given the uncertainty regarding the number of fundamental operational concepts, of interest is how any sense of viability is affected if the requisite variety is reduced to 6, 7, 8, or 9, or icreased to 15 or more. Young's tabular Rosetta stone of meaning could be stripped down to to sets of that number by dropping rows or columns. Could a helicopter then be piloted by ignoring wha is omitted? Could an organization then be sustainably governed? Can the 8-fold Chinese *BaGua* be understood as "stripped down" in some way, or has the significance of the 12-fold set been "redistributed" within the 8-fold set?

Transcending the binary modality: Given Young's consideration of binary operators, with their sense of positive and negative, a potentially related approach is through the psychosocial implications of the pioneering work of Nikola Tesla on the rotation of magnetic fields (*Potential implications of alternation and rotation in psychosocial fields* in *Reimagining Tesla's Creativity through Technomimicry: psychosocial empowerment by imagining charged conditions otherwise*, 2014). Ironically this is somewhat reminiscent

of the rotation of the pattern of constellations of the zodiac as perceived from Earth.

Might such a systemic understanding of "positive" and "negative" offer a more fruitful manner of handling the potentially catastrophic dynamics to which they currently give rise?

Cognitive embodiment: Any engagement with juggling evokes recognition of the manner in which cognition is deeply engaged in the process, hence the particular relevance of the arguments of Lakoff, as previously anticipated (*Philosophy In The Flesh: the embodied mind and its challenge to western thought*, 1999). With respect to the concerns of this exercise, the point can be variously argued otherwise in that light (*Existential Embodiment of Externalities: radical cognitive engagement with environmental categories and disciplines*, 2009; *Strategic Embodiment of Time: configuring questions fundamental to change*, 2010).

In addition to the arguments of Polster (*The Mathematics of Juggling*, 2003), of particular relevance are those from a cognitive perspective of George Lakoff (*Where Mathematics Comes From: how the embodied mind brings mathematics into being*, 2001). It is also appropriate to note those of quantum physicist Richard Feynman with regard to spinning plates (Ben Weinlick, *Spinning Plates and The Serious Play of Richard Feynman*, *The Creativity Post*, 6 August 2012).

Self-reference: An interesting extreme in this respect is the classical statement regarding governance by General de Gaulle: *L'Etat c'est moi*. Especially insightful with respect to the above argument is however the case study of Heidi Lee Mew (*Juggling a Way of Being: a grounded theory of how one group of nurses navigates tension among personal and professional values 'in the moment'*. Dalhousie University. 2013). This is summarized as:

> Despite nursing's espoused professional values of caring and social justice, some patients are stigmatized and receive discriminatory nursing care. There is a gap in existing literature about how nurses deal with the tension they experience when personal and professional values collide. The purpose of this study was to generate a substantive theory of the process that nurses use when faced with values tension in clinical practice and how this affects their behaviour. Using constructivist grounded theory methodology informed by symbolic interactionism and critical social theory, the theory of *Juggling a Way of Being* was co-constructed with data obtained through interviews with registered nurses (n=8) who provide frontline care in an emergency department in Atlantic Canada. The study's findings revealed a process fraught with tension as nurse participants assimilated internal and external stressors, adjusted the patient-centered/nurse-centered lens according to their interpretation of the situation, and achieved a point of action or inaction. Implications for nursing practice and administration, education and research are discussed.

Perspective of non-western cultures: It is appropriate to note a quite distinct approach to cognitive embodiment of juggling -- as braiding or interweaving -- as offered by reflections within the logic and practice of other traditions, namely kundalini yoga or the *neidan* process of Zen. The serpentine coiling of kundalini within the human body could be provocatively compared to the Triple Helix preoccupations with regard to institutional creativity -- and their global implications. Both frame the question of "what flows" when juggling is governed successfully (*Circulation of the Light: essential metaphor of global sustainability*, 2010).

This question can also be explored in terms of the psychology of flow, as articulated by Mihály Csíkszentmihályi, (*Flow: The Psychology of Optimal Experience*, 1990; *Finding Flow: The Psychology of Engagement With Everyday Life*, 1998; *Good Business: Leadership, Flow, and the Making of Meaning*, 2003). Insight from other perspectives are presented separaely (*Navigating Alternative Conceptual Realities: clues to the dynamics of enacting new paradigms through movement*, 2002).

References

Paris Arnopoulos:

- Sociophysics: Cosmos and Chaos in Nature and Culture. Nova Publishers, 1993
- Sociopolitics: Political Development in Postmodern Societies. Guernica Editions, 1995
- Braiding the Triadic Codex and Triple Helix: the sociophysics of nature-culture-nurture and academy-industry-polity. Paper for Third Triple Helix International Conference (Rio de Janeiro, 2000) [text].
- Sociophysics and Sociocybernetics: an essay on the natural roots and limits of political control. 2001 [abstract]

James P. Carse. Finite and Infinite Games; A Vision of Life as Play and Possibility. Free Press, 1986

MihÁly CsíkszentmihÁlyi:

- Flow: The Psychology of Optimal Experience. Harper and Row, 1990
- Finding Flow: The Psychology of Engagement With Everyday Life. Basic Books, 1998
- Good Business: Leadership, Flow, and the Making of Meaning. Basic Books, 2003

Edward de Bono:

- Six Frames For Thinking About Information. Vermilion, 2008 [summary]
- Six Thinking Hats. Back Bay Books, 1985 [summary]
- Six Action Shoes: designing or choosing an appropriate course of action. HarperCollins, 1991 [summary]
- Six Value Medals. Ebury Press, 2005 [summary]

Satyan Devadoss and John Mugno. Juggling braids and links. *The Mathematical Intelligencer*, 29, 2007, pp. 15-22 29 [text]

Henry Etzkowitz and Chunyan Zhou. Triple Helix: University-Industry-Government Innovation and Entrepreneurship. Routledge, 2017

Niki Harré. The Infinite Game: How to Live Well Together. Auckland University Press, 2018 [contents]

Douglas Hofstadter:

- The Unconscious Juggling of Conceptual Objects. In: Fluid Concepts and Creative Analogies, 1995
- Fluid Concepts and Creative Analogies: computer models of the fundamental mechanisms of thought. Allen Lane, 1995 [summary]
- I Am a Strange Loop. Basic Books, 2007 [summary]

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

John Kao. Jamming: the art and discipline of business creativity, HarperCollins, 1997

B. I. Kurpita and K. Murasugi. A Study of Braids. Kluwer Academic Publishers, 1999.

Matthew Macauley. Braids and Juggling Patterns. Harvey Mudd College, 2003 [text]

D. Margalit, N. Picciotto, S. Babineau and J. Llobrera. Topology and juggling

Anthony Mays. Combinatorial aspects of juggling. Univerity of Melbourne, 2006 [text]

Heidi Lee Mew. Juggling a Way of Being: a grounded theory of how one group of nurses navigates tension among personal and professional values 'in the moment'. Dalhousie University. 2013 [text]

Burkard Polster:

- The Mathematics of Juggling. Springer Verlag, 2003 [excerpt]
- Juggling, maths and a beautiful mind. *PlusMaths*, September 2009 [text]

Jarold Jacob Tawney. Jugglinks: Tangling Together the Worlds of Knot Theory and Juggling. Ohio State University, 2001

Bengt Magnusson and Bruce Magnusson. The physics of juggling. *Physics Teacher*, 27, 1989, pp. 584-589

Jochen Voss. *The Mathematical Theory of Juggling* (2012)

Maurice Yolles and Gerhard Fink:

- A General Theory of Generic Modelling and Paradigm Shifts (part 1): the fundamentals. *Kybernetes*, 44, 2015, 2, pp. 283-298 [abstract]
- A General Theory of Generic Modelling and Paradigm Shifts (part 2): cybernetic orders. *Kybernetes*, 44, 2015, 2, pp. 299-310 [abstract]
- A General Theory of Generic Modelling and Paradigm Shifts (part 3): the extension. *Kybernetes*, 44, 2015, 2, pp. 311-328 [abstract]