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THERE ARE SYSTEMS AND SYSTEMS: TOWARDS AN INTEGRATED GENERAL SYSTEMS THEORY

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Abstract
This paper provides an overview of the key concepts of *Biomatrix Systems Theory* and a framework for classifying systems methods by means of mindmaps.

The theory was co-developed by the *Biomatrix Research Group* in an interdisciplinary PhD programme at the University Cape Town, South Africa with the aim of co-producing an integrated trans-disciplinary systems theory.

We suggest that the concept of the biomatrix and its different types of systems and their organising principles can be the foundation on which an integrated *General Systems Theory* and *General Systems Methodology* can be further developed.

Integrating key concepts of the theory are briefly described in the paper and illustrated with graphics.

Some insights from co-producing an integrated trans-disciplinary systems theory and its application are shared.

Keywords
integrated general systems theory; integrated systems methodology; biomatrix theory as trans-disciplinary meta-systems theory; framework for classifying general systems concepts; framework for classifying systems methods; the biomatrix as field and web; different types of systems.

1 | Background

Challenge
In a mini-symposium prior to the ISSS conference 2023, Jamie Rose (2023) asserted that *General Systems Theory* has not progressed further during the last four decades and that *"it is time to take ourselves 'back to school …and dismantle - remantle foundational General Systems observations, recognitions and concepts about this Universe … ".*

Response
The *Biomatrix Research Group* has "dismantled" general systems concepts from different scientific disciplines and "remantled" them into *Biomatrix Systems Theory*.

Thus, in response to the challenge of Rose, we propose that *Biomatrix Systems Theory* could be an example of an integrated *General Systems Theory*.

Purpose
The purpose of the paper is to present *Biomatrix Systems Theory* as a possible integrated *General Systems Theory,* suggest the creation of a *General Systems Methodology* and to share some insights on creating them.

About Biomatrix Systems Theory and Methodology

Biomatrix Systems Theory was co-developed by the *Biomatrix Research Group* during a PhD programme at the University of Cape Town. It produced four PhDs *(i.e. Cloete, 1999, Edwards, 1996, Dostal, 1997 and Muller, 2006)*, as well as some Master's theses and several scientific papers in which the theory and its application in different contexts are argued. *(See the full list of publications on* *http://www.biomatrixtheory.com/scientific-publications-on-systems-theory/.)*

The aim of the group was to co-produce a w/holistic and trans-disciplinary *General Systems Theory*. *(NOTE: The spelling of w/holism denotes that the theory deals with wholes, while the term holism, as coined by Smuts in 1926, refers to the tendency of the universe to form wholes).*

Although the group co-produced a trans-disciplinary theory, it did not explore its application through a trans-disciplinary *General Systems Methodology*. The following methodology mindmap is therefore a creation of this author, albeit being concerned with social system methods only. She is of the opinion that an internally consistent body of methods *(i.e. a General Systems Methodology)* would contribute to a more effective and w/holistic transformation of the current problem-riddled societal systems.

About Biomatrix Graphics

One of the unique features of *Biomatrix Systems Theory* is its graphic alphabet, which consists of a few symbols that can be assembled to illustrate and visually explain the different concepts of the theory. *(Dostal. 2005b)*

The visual representation of the theory makes it easier to learn and understand systems thinking. *(See some examples in Part 3.)*

2 | MINDMAPS

Mindmaps provide an overview of concepts and show how they relate to each other. They are useful tools for learning and generating understanding.

Theory Mindmap

The following theory mindmap contains both, unique conceptual contributions of the *Biomatrix Research Group*, as well as widely used and referred to concepts of other systems thinkers.

Unique biomatrix concepts include the biomatrix as field and web; the web of the biomatrix as consisting of activity and entity systems; tapping; the seven forces of system organization; a clockwise versus counter-clockwise dynamics of change; a distinction between an inner and outer environment, entity systems as emergent middle and the co-evolution of systems across levels. They are briefly discussed in Part 3.

The general systems concepts and their integration within *Biomatrix Systems Theory* was argued and referenced in the PhD theses of the research group. They are derived from the following authors:

Ackoff RL; Ashby WR; Banathy BH; Bateson G; Beer S; Bohm D; Boulding KE; Capra F; Checkland P; Churchman WC; Cilliers P; Coates J; Coyle RG; Flood RL and Jackson MC; Forrester JW; Gharajedaghi J; Gleick J; Gomez P; Probst GJB; Greene B; Hawkins DR; Heines SG; Jantsch E; Johnson S; Katakis D and Katakis C; Kauffmann DL; Keeney BP; Keys P; Koestler A; Laszlo E; Lilienfeld R; Lovelock JE; Luhmann N; Maruyama M; Masson RO and Mitroff II; Maturana HR and Varela FJ; McNeil DH; McTaggart L; Meadows DH; Miller JG; Nadler G; Prigogine I and Stengers I; Probst GJB; Reason P; Riedl R; Robbins SS and Olivia TA; Sabelli H; Senge PM; Sheldrake R; Skyttner L; Starik M. and Rands GP; Strümpfer J; Ulrich W; Uprichard E and Byrne D; Van der Hoorn SM; Varela FJ; Vickers G; Von Bertalanffy L; Warfield J; Wheatley MJ; Weinberg GM; Wiener N; Wolstenholme EF; Woodhill J; Young AM; amongst others.

(See list of references on http://www.biomatrixtheory.com/references-on-systems-theory/.)

Methodology Mindmap

The methodology mindmap contains the methods encountered and used by the author during her management consulting career. *(NOTE: The listing of methods in the mindmap does not imply ownership of their IP.)*

The proposed mindmap is far from complete, nor are the methods discussed and their amendment according to *Biomatrix Systems Theory* explained. This has been done in various Biomatrix publications and will also be the subject of a follow-up paper. For example, the *Biomatrix Ideal Design Method (which is a method for social system (re)design)*, is described in the book *Biomatrix: A Systems Approach to Organisational and Societal Change.* (Dostal et al. 2005a) and as a more recent version in Part 2 of an online cartoon book *Journey to an Ideal Future. (http://biomatrixweb.com/wp-content/uploads/2021/08/Part-3-Engl-Journey-to-an-ideal-future-Final-small.pdf).*

Structure of the Mindmaps

The mindmaps have various conceptual levels, distinguished through the use of shaded color.

To make them not too cluttered, only the first few levels were included. Further levels would refer to further principles associated with a concept. They are however described in the biomatrix publications and online courses.

FIGURE: Mindmap of key concepts of *Biomatrix Systems Theory*

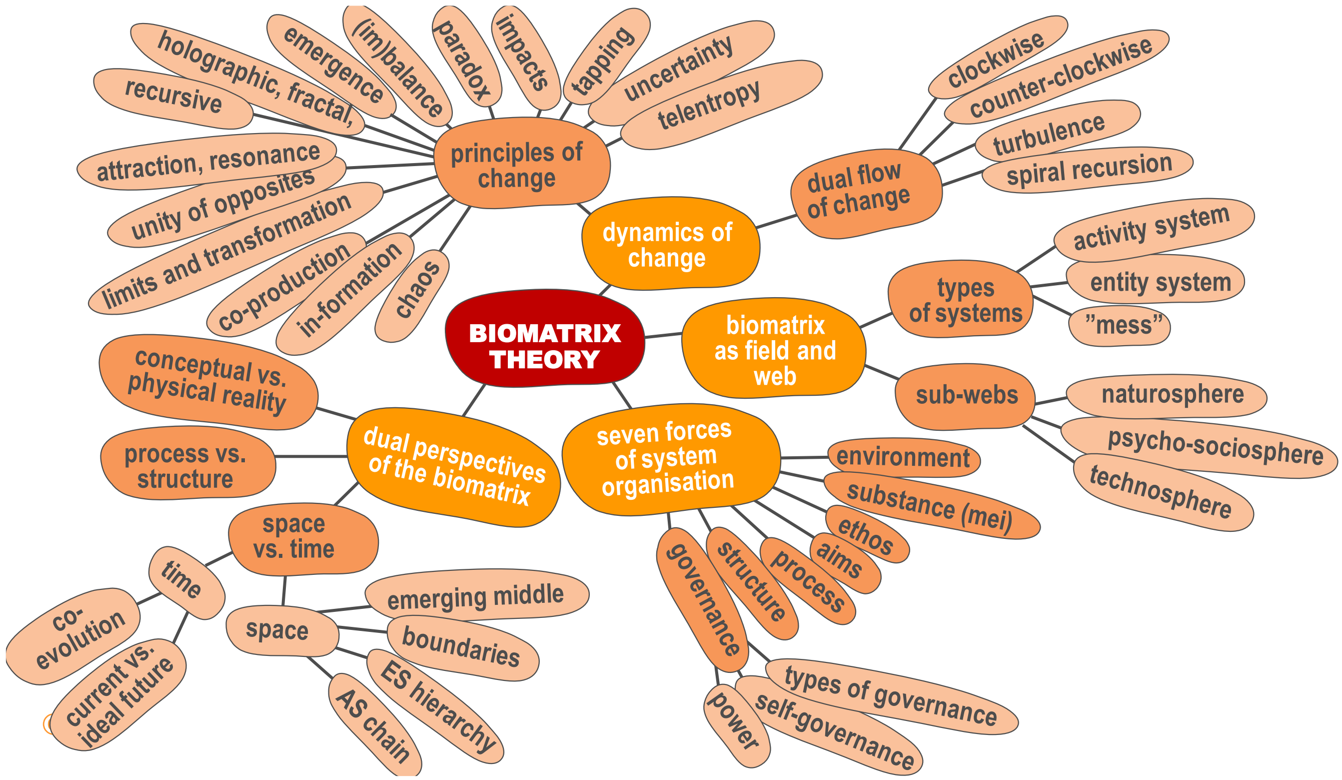
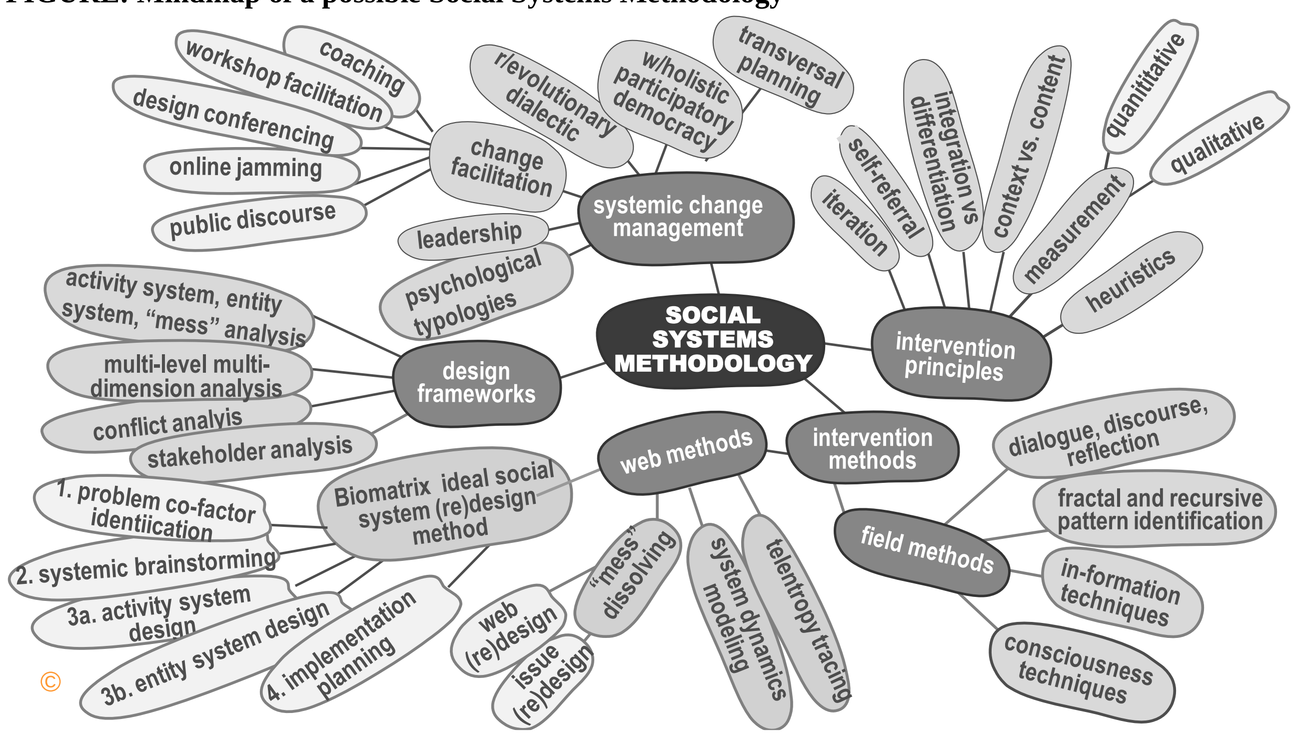


FIGURE: Mindmap of a possible Social Systems Methodology



Summary

Besides arguing the individual concepts of a theory in detail *(as we did in various biomatrix publications),* it is useful to present them as a mindmap. This develops both, detailed and synergistic *(i.e. emergent)* knowledge of systems thinking.

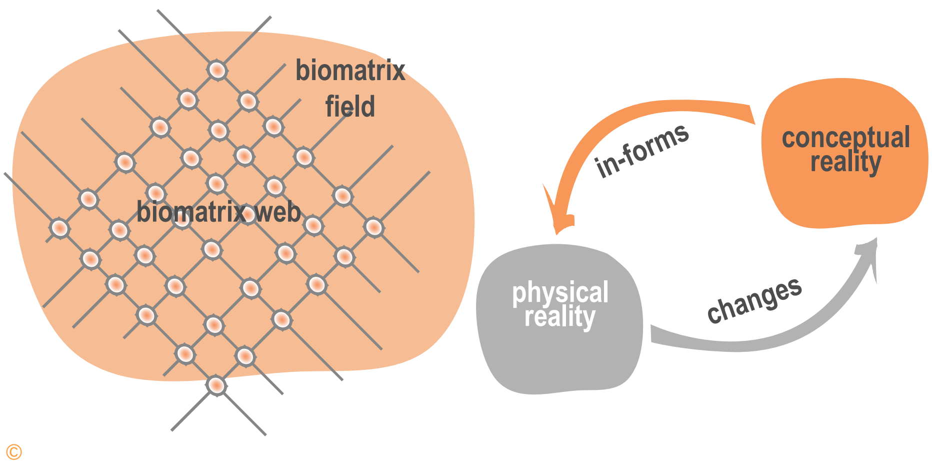
The author therefore suggests that any integrated *General Systems Theory* should also be presented as a mindmap,

Likewise, a mindmap which describes various intervention methods, frameworks and change management approaches would be useful to guide practitioners in system interventions.

3 | Key concepts of *Biomatrix Systems Theory*

This section introduces some of the conceptual contributions of *Biomatrix Systems Theory*, which facilitate the synergistic integration of various systems concepts into one coherent *General Systems Theory*.

Concept of the Biomatrix



The biomatrix is the unifying concept of *Biomatrix Systems Theory*. It represents the universe as the space within which all reality in all spheres and dimensions exists, as we observe it.

This term is composed of bios *(meaning life)* and *matrix (which is Greek for womb or pattern)*. This could be freely translated as *how "life" is organized*.

The reference to "life" implies that the theory regards everything in the universe as being "alive" (based on a series of criteria), while the dual meaning of matrix as womb and pattern suggests a dual perspective from which the universe can be viewed:

- As **pattern**, the biomatrix a **web** of interrelated activity and entity systems.
  It refers to the physical reality of systems. *(NOTE: Physical does not necessarily imply material, as in matter, but also refers to the intangible, like electro-magnetic waves.)*
- As a **womb,** the biomatrix represents the space *(i.e. the universal field of in-formation)* from which all systems are "born" *(i.e. in-formed, or generated)*. This represents the conceptual reality of a system. *(See also Part 4, the Section on Physical versus Conceptual Reality.)*
  NOTE: Information is Latin for "putting form into". Likewise, the term "morphogenetic field" coined by Sheldrake (1988) is derived from Greek and implies "generating form".

The physical and conceptual reality of the biomatrix and each of its systems are not separate from, but interact with, shape and give rise to each other, analogous to the yin and yang of Chinese philosophy. They represent opposite, yet interconnected forces within the unity of the system. Or, using the analogy of light as wave or particle, one can view the biomatrix as a matrix of interacting waves of activities or as a field of universal in-formation, as well as the unique fields of in-formation focalized around specific systems.

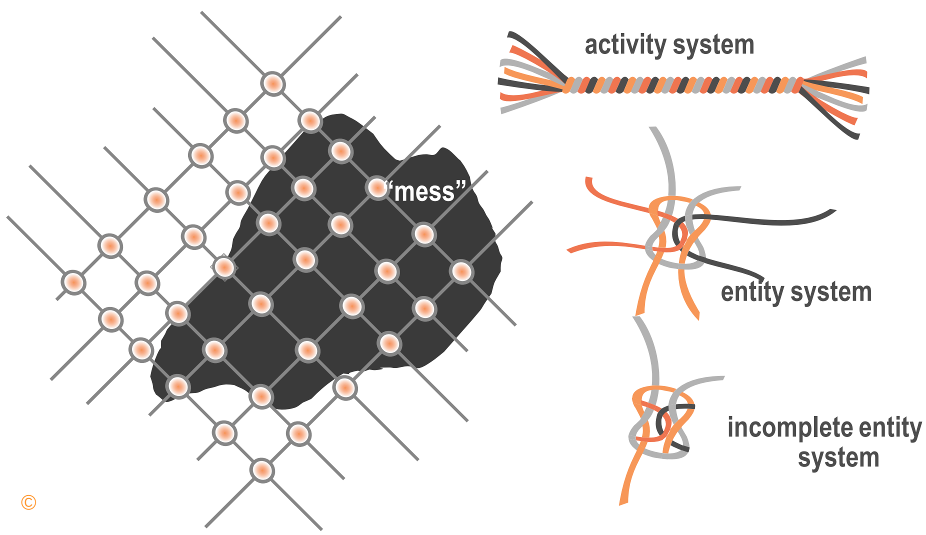
The two realities differ in terms of their organizing principles. While the web-perspective and its systems have been widely researched by systems thinkers, as well as Biomatrix Systems Theory, the organization of the in-formation field needs to be further explored. The *Biomatrix Research Group* has contributed to this through the PhD by Muller (2006), which uses music as analogy. Some distinctions are:

- **Physical reality** *(especially in its expression as material reality)* is characterized by *either / or*, *win / lose* and *competition* for scarce resources, because resources can either be consumed by one system or another.
- **Conceptual reality** is characterized by *as well as* and *win / win*, because information that is shared is not lost to the giver and is gained by the receiver. Moreover, information *(and thereby conceptual reality)* is characterized by synergy and *emergence*, because in sharing information with each other, new ideas can arise that were not previously known to the interacting parties.

This distinction also characterizes the difference between the materialist, reductionist and competitive industrial age and the conceptual and synergistic information age. The current political, economic and cultural institutions *(including science)*, are legacy systems of the industrial age. They become increasingly problem-riddled in their unfolding and are therefore in need of redesign and transformation.

To effect such a transformation requires a change in worldview and according changes in the way the systems function. To produce synergies and emergence requires w/holistic interaction and cooperation, not competition. *(For example, the concept of Intellectual Property may be a relic of the material paradigm of the industrial age and hampers synergistic development.)*

Systems within the Web of the Biomatrix



Analogous to a fishing net consisting of knots and strings, the web of the biomatrix consists of string-like activity systems and knot-like entity systems. One can also observe other systems, like incomplete entity systems and "messes".

Activity and entity systems are relatively stable wholes with a boundary that separates them from other systems, marked by tapping *(as explained below)*.

They co-produce and emerge from each other, analogous to knots emerging from strings and strings apparently arising from knots in a net.

Thus the biomatrix is a continuum in which each knot-like entity system is connected to other entity systems via its string-like activity systems. Analogous to each knot being connected to all other knots in a net, each entity system is connected to all others within the biomatrix. Thereby each entity system *(knot)* can be viewed as the center of the biomatrix *(net)*.

The underlying nature of the biomatrix is activity, analogous to the nature of the fishing net being string *(i.e. a knot being merely intertwined string)*. Since activity involves the flow of substance *(consisting of matter-energy-information, abbreviated as mei)*, the biomatrix can also be described as a continuous, ever changing and purposeful flux of mei.

Activity Systems

Activity systems are string-like systems that connect systems with each other. They are also called process systems or functions *(such as a metabolic, neural, thinking, production, education, governance, technological, or ecological function)* and are organized by seven forces *(as explained below)*.

Entity Systems

Entity systems are knot-like -, or field-like -, or organismic systems *(such as the planet, a species, a society, organization, individual, cell, or atom)*.

They are a field of interacting activity systems that is in-formed by an ethos and governed by a "self" and is also organized by the seven forces of organization. *(See more explanations below.)*

Incomplete Entity Systems

Artefacts *(like a machine, house, car, computer, and robot)* are incompletely developed entity systems.

However, technological developments move them increasingly towards becoming more complete *(e.g. through AI and the incorporating of biological in-formation into technical systems, as advocated in trans-humanism)*.

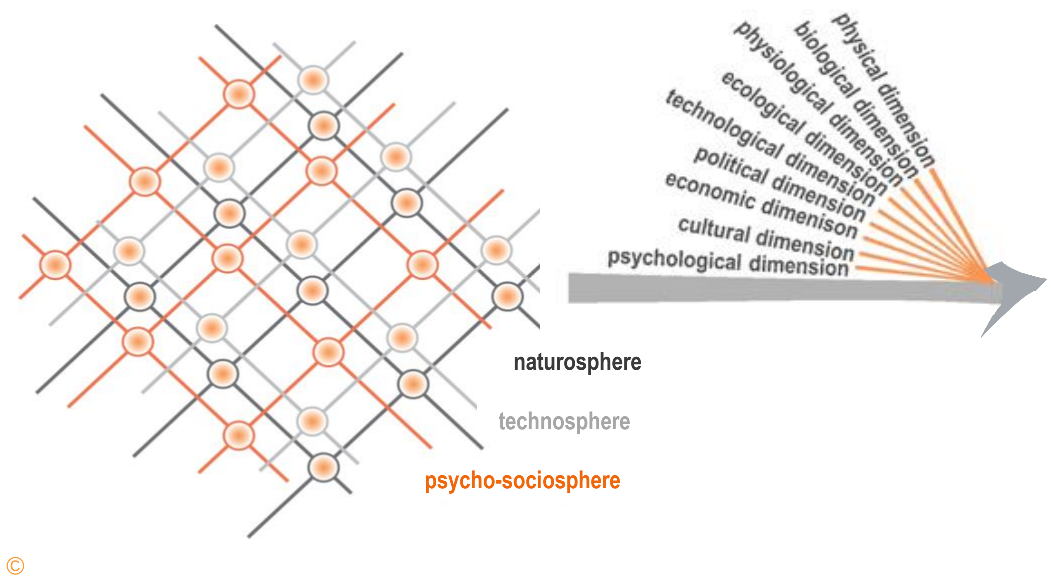
"Mess"

"Mess" is a term coined by Ackoff (1974) and refers to a complex problem as being a system of interrelated problems *(such as inflammation in the body, corruption and poverty in society and climate change on the planet)*.

A "mess" emerges from the interaction of different activity and entity systems within the biomatrix and interferes with their organization and intended functioning, analogous to a tar-slick spreading to and clogging up different knots and strings in a fishing net.

A "mess" is multi-dimensional, spreads across levels in the systems hierarchy and looks different, depending who looks at it.

Sub-webs of the Biomatrix



One can distinguish the following sub-webs of the biomatrix:

- nature's systems called **naturosphere** *(other researchers call it ecosphere)*
- psychological and social systems called **psycho-sociosphere** and
- technological systems called **technosphere.**

The sub-webs differ in terms of their functioning:

- systems in the naturosphere *(from planetary to atomic level)* have relatively fixed functioning which is observed through the laws of nature;
- systems of the *(human)* psycho-sociosphere are characterized by a large degree of freedom (i.e. free will) in determining their development and future
- technological systems, once produced, are also characterized by a fixed functioning according to their design, while the design of new technologies is also governed by free will and creativity.

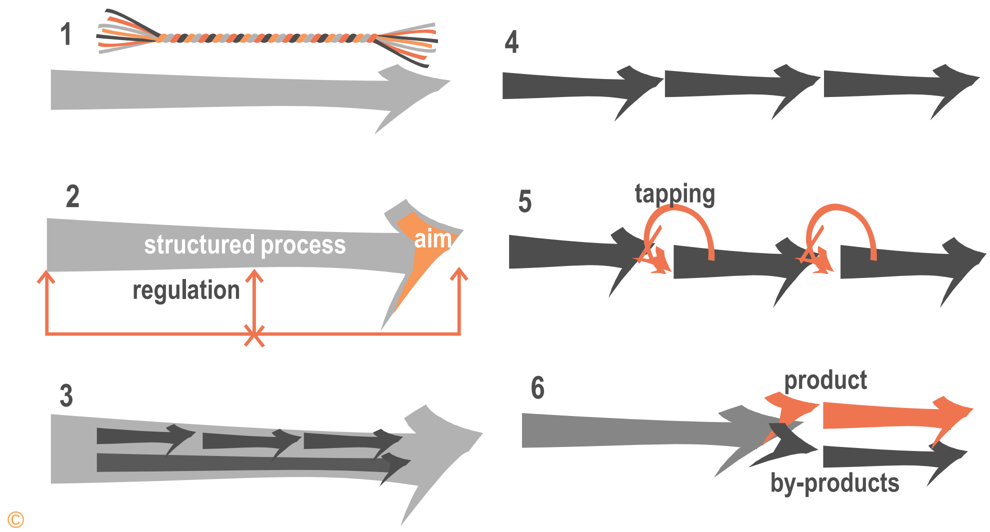
These sub-webs represent different dimensions, such as the physical, biological and ecological dimensions of the naturosphere, the cultural, economic and political dimensions of the psycho-socio-sphere. Moreover, a dimension consists of sub-dimensions *(and their associated systems).* For example, the sub-dimensions of culture refer to the pursuit of truth *(through science and media),* good *(through religion and morals)* and beautiful *(through the arts),* etc. Of course one can use even more sub-and sub-sub dimensions.

As the systems of the biomatrix connect and interact across the sub-webs, they reflect each other's dimensions. For example the education system of a society is a cultural system in the socio-sphere. At the same time it has sub-systems that reflect and are concerned with a psychological, aesthetic, moral, political, economic technological, biological, ecological, etc. dimension.

Organization of Systems

String-like activity and knot/field-like entity systems are organized in different ways. They link up with each other within a containing systems hierarchy.

Activity Systems



(1) A string-like activity system *(or process system or function)* is depicted as an arrow.

(2) It is defined as a process that is structured and governed to achieve an aim *(or teleos)*. Thus an activity system is a process system.

(3) It consists of sub-activity systems, which can be parallel or sequential.

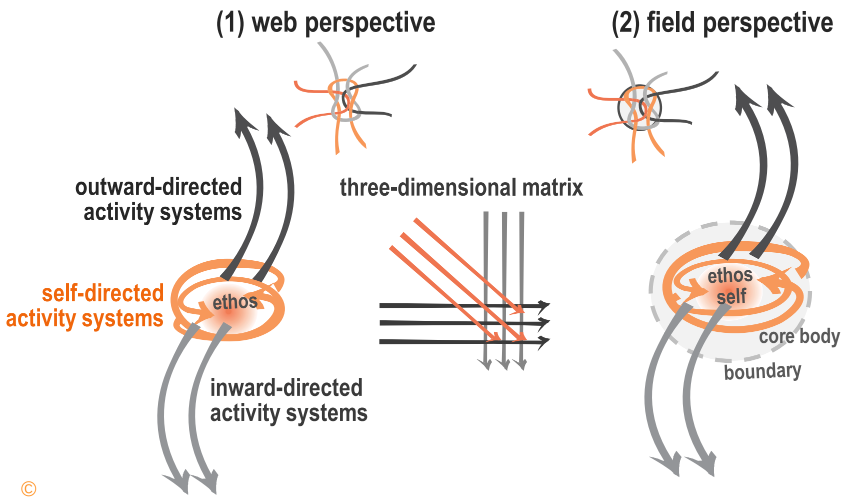
(4) It links up with other activity systems to form value / supply chains, whereby

- value chain represents the conceptual reality of the chain which describes the value of the teleos that is and should be achieved *(as represented by the arrow tip)*, based on governance criteria and evaluation measures;
- supply chain refers to the physical reality of process mei *(e.g. the flow of products)* and structure mei *(e.g. the machines, people, infrastructure involved in the processing)*.

(5) The flow of substance continues through tapping. This means that the output from one system must be accessed *(i.e. tapped)* by another system to continue and be incorporated in it.

(6) During processing an input substance is transformed into an output substance *(whereby a processing phase describes an activity system or sub-activity system)*. The mei fields of the input substance are broken up and reassembled, thereby producing the desired products, as well as *(mostly undesired)* by-products *(e.g. waste and pollutants*). The products and by-products are tapped by different systems and continue along different value / supply chains.

Entity Systems



Based on the definition of a knot-like entity system *(e.g. a planet, society, individual, cell)*, it can be viewed from a web or field perspective.

(1) From a **WEB PERSPECTIVE** an entity system is defined as a multi-functional system that consists of bundles of outward-, inward- and self-directed activity systems *(whereby the directedness is determined by purpose, not the flow of substance)*. For example, a person's parenting and work functions are directed at systems in the outer environment, while nutrition, exercise and sleep are inward-directed at the cellular level and thinking, learning, planning are self-directed activity systems.

The development of an entity system depends on the nature of each of its activity systems, as well as on the interaction and balance between them. By analogy, the same strings can be intertwined in different ways and thereby give rise to different knots with different emerging qualities *(e.g. a strong and firm granny knot versus a decorative and loose Chinese knot)*. For example, an organisation that is structured as a traditional hierarchy is poorly coordinated and will have many problems. Most of them will dissolve, if its functions are organized into a 3-dimensional organizational matrix which optimizes the information flow and promotes coordination and cooperation. will be optimised. Or, for example, a person's development will be more balanced through proportionality between outward-, inward- and self-directed activity systems, as exemplified by the famous work / life balance.

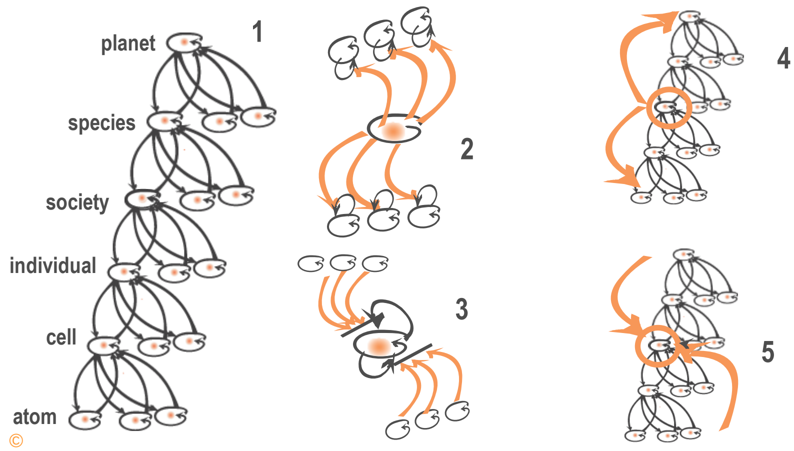
The web view represents the "DOING" perspective of an entity system.

(2) From a **FIELD PERSPECTIVE** an entity system is viewed as an organism *(analogous to a knot being a solid "thing")*. It is defined as

- having a core body that emerges from the interaction of its activity systems
- which has a boundary *(e.g. the membrane of a cell, the skin of an organism, the border of a nation, the atmosphere of the planet, or the conceptual boundary of an organisation)*,
- occupies a space *(e.g. the containing territory of a nation)*
- and is in-formed *(or shaped)* by an ethos *(or in-formation, or morphogenetic field)* that is
- focalized around a "self" *(or governing centre)*.
  NOTE: Depending on worldview and inner experiences, the self can be viewed scientifically as a dense field within a physical "thing" like the nucleus of a cell; as a sense of self being an epiphenomenon of brain functioning and as the government of a society and organisation. Or it can be viewed metaphysically *(and not yet scientifically)* as a spirit or soul of an organisation, a nation *(e.g. the famous German spirit and Russian soul)* and the planet *(i.e. Gaia)*.

The field view represents the "BEING" perspective of an entity system *(e.g. an individual as a physical and mental being)*.

Containing Systems Hierarchy



Most systems thinkers propose that systems are organized as a containing systems hierarchy. *Biomatrix Systems Theory* specifies this further:

(1) Each entity system links up with entity systems at outer and inner levels of its environment by means of its outward- and inward-directed activity systems.

(2) During interaction they exchange mei with each other, whereby an entity system offers its outputs to other systems, which

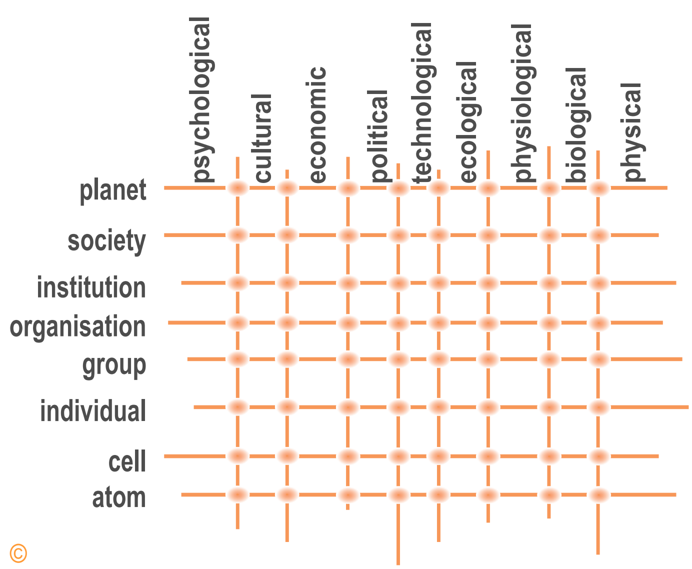
(3) tap them *(or not)* in a self-referring manner.

(4) Thereby each entity system co-produces the entity systems in its outer and inner environment, and

(5) is also co-produced by them.

In summary, all systems co-produce each other across levels and each entity system develops as an emerging middle within the containing systems hierarchy. From a temporal perspective this implies that all systems co-evolve and that co-evolution occurs across levels.

Frameworks



Frameworks are useful in understanding, discussing, analyzing and (re)designing a system or a complex issue.

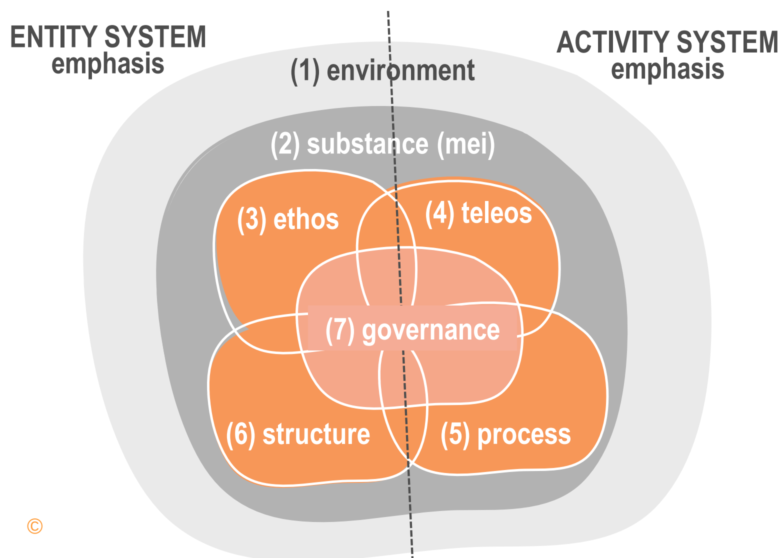
The above Figure depicts the spatial framework of the biomatrix, which combines the dimensions and levels of the biomatrix. For example, a complex issue *(e.g. a "mess" like poverty)* is co-produced by the interaction of co-factors arising from systems at various levels and dimensions. Moreover, since the systems continue to change over time through their interaction, the "mess" continues to change also.

Likewise, (dis)solving a "mess" or *(e.g. poverty)* or transforming an issue or a system is a multi-dimensional and multi-level effort involving different co-producing systems. If strategies are derived from an ideal design, they can be changed with changing circumstances while continuing to produce desirable interaction *(e.g. wealth-producing interaction to dissolve poverty).*

There are also other frameworks, such as a temporal framework, which is especially useful in describing the continuous development of a conflict by the multi-dimensional co-production of conflicting parties from different levels.

Using frameworks develops contextual and w/holistic thinking and would also improve public discourse. For example, a typical dinner discussions or TV talk-show is characterized by people arguing with each other across levels and dimensions. Arguments which would be "true" in the context of a specific level and dimension become false and irrelevant, if they are viewed from or pitched against arguments associated with other levels and dimensions.

Seven Forces of System Organization



The following seven forces determine how entity and activity systems are organized based on the

1. **ENVIRONMENT** *(i.e. an outer and inner, transactional and contextual environment*) within which a system finds itself;
2. **SUBSTANCE** which makes up a system and consists of mei fields *(i.e. matter-energy-information fields)*;
3. **ETHOS** which consists of the unique values that in-form a specific system *(out of all possible values of the universal biomatrix in-formation field);*
4. **TELEOS** *(or aim)* which describes what a system wants to achieve;
5. **PROCESS** which refers to the flow and transformation of substance *(or mei)* that occurs during the activities of the system;

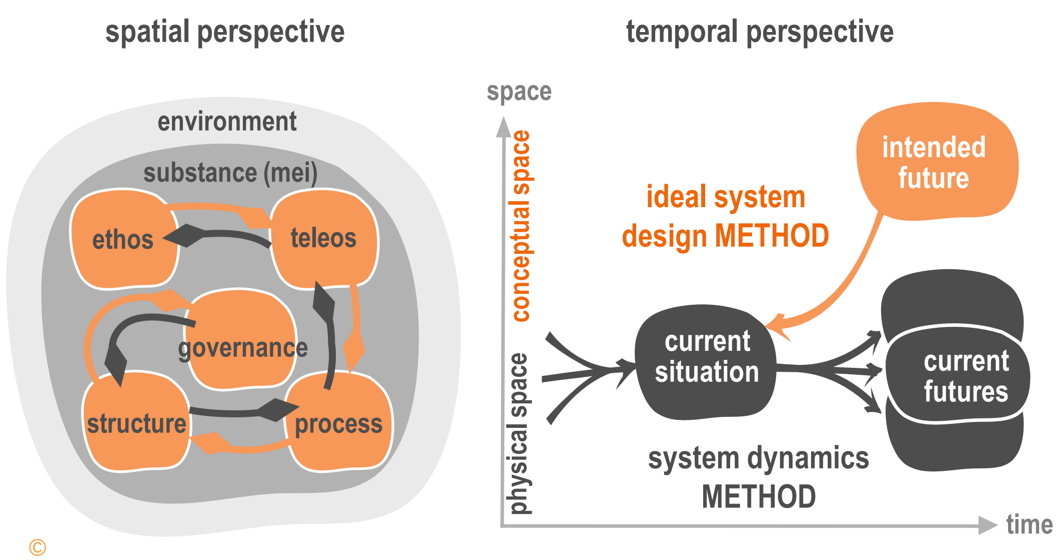
6. **STRUCTURE** which is the configuration of substance *(or mei)* that does the processing (*i.e. processing structure*), or channels the flow of activities of a system (*i.e. organizational structures*);
7. **GOVERNANCE** which consists of aims setting (*e.g. determining the purpose, mission, objectives, and goals*) and regulation (*e.g. the feed-forward and feedback procedures and evaluation criteria that guide the system to achieve its aims).*

Each force is associated with organizing principles, as for example (2) the distinction between information *(i.e. data that describe phenomena)* and in-formation *(i.e. as a force effecting change)*, or (4) the cascading of aims throughout the system by alternating aims as ends and means, or (7) the distinction and balancing of form-creating, form-maintaining and form-destroying governance of a system.

The seven forces determine the organization of both, activity and entity systems, albeit with a difference in emphasis, namely

- activity system organization emphasizes aims *(e.g. related to outputs)*, process, processing structure and regulation
- entity system organization emphasizes ethos, aim *(e.g. its mission)*, organizational structure *(which organizes its activity systems)* and overarching coordinating governance.

Dynamics of System Change



Spatial perspective

From a spatial perspective the dynamics of change is derived from the interaction of the seven forces of system organisation. It continuously changes the system and gives rise to two contradictory flows of change, a clockwise and a counter-clockwise one.

- The **CLOCKWISE** flow of change is intended change. It represents the force that pushes for change and prescribes the sequence in creating an ideal design and implementing it. Typically prompted by a change in the outer or inner environment, some of the values of the system change; this gives rise to a new aim, which requires a change in processing *(so that the new aim can be achieved)*, a change in processing structure *(to facilitate the changed processing)* and changing regulation *(to guide and control the intended change)*.

- The **COUNTER-CLOCKWISE** flow of change is resistance to change. It represents the momentum of the system which perpetuates its current organization and behavior. More specifically, current governance and regulation reinforce the current structure, which channels current process, thereby achieving current outcomes *(i.e. aims*) and perpetuating current values *(i.e. ethos).* Thereby the system could be alienated from its continuously changing environment and become increasingly problem-riddled.

The two flows of change clash and can create conflict and turbulence in each of the seven forces. This is experienced in any change intervention, as management consultants will confirm. In the course of time the system will become more familiar with the new developments and its resistance will weaken and eventually disappear.

The actual change that occurs in the system is always an emergence of the two interacting forces, whereby the current counter-clockwise flow tempers the clockwise one and vice versa.

A system is transformed as soon as the clockwise change is implemented and also becomes the counter-clockwise change. Thereby the intended change has become the momentum of the system which continues to propel the system into the direction intended by the design.

Temporal perspective

From a temporal perspective, the dual counter-clockwise and clockwise flows of change represent the current and ideal *(i.e. intended)* future of the system.

- A **current future** is derived from the system carrying on doing what it is doing now. It is propelled by its current momentum. However, because the environment does not remain static, the current functioning and its outcomes will become increasingly inappropriate. Depending on the nature of the environmental change, different current futures are possible. Forecasting and scenario development explore a range of possible current futures.

  Systems with fixed functioning *(e.g. systems of nature and existing technological systems)* only have a current future. It arises by default from their evolved or designed inherent functioning.
- Systems of the human psycho-socio-sphere can formulate an ideal or intended future. They have *(some degree of)* free will and thus are responsible for creating their own future, either unconsciously *(e.g. by default due to the current momentum, or by submitting to external governance),* or consciously through deliberate intent *(e.g. through design and planning).*

  Increasingly, even systems of the naturo- and technospheres can change their future towards one that is deemed more desirable *(e.g. through genetic manipulation and the coupling of biological and technological systems as in trans-humanism).*

4 | Part 3: Systems theory versus traditional science

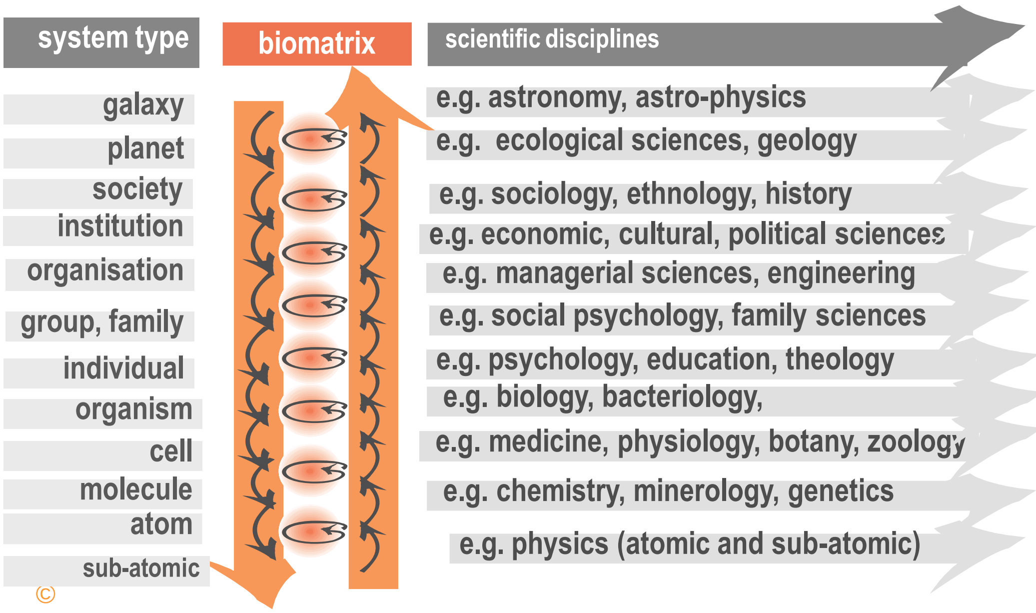
Systems theory poses serious challenges to the traditional scientific method and to philosophy of science, as exemplified by the following systemic observations:

Challenge of the “emerging middle”

The Figure below exemplifies the current organization of science as separated disciplines associated with the different levels of the containing systems hierarchy of life.

The systems at each level are explored by different scientific disciplines in isolation from each other, because research is conducted “ceteris paribus” *(Latin for keeping the environment constant*), as dictated by the traditional scientific paradigm.

By comparison, *Biomatrix Systems Theory* postulates the emergence of the systems at each level from their co-production by systems from the outer and inner levels *(as indicated by the upward and down-ward pointing orange arrows),* as well as from their own co-production *(as illustrated by the* *rounded black self-referring arrow that is focalized by the self and its ethos, which are represented by the orange dot)*. This is referred to as “emerging middle” *(i.e. the emergence of system in the middle from the co-production by systems at its outer and inner levels)* or as “co-production of systems across three levels”.



The “ceteris paribus” view of systems gives rise to a fragmented view of the world which perceives phenomena in isolation from each other. It also leads to reductionist thinking, which looks at the parts of a system and assumes that by understanding their functioning *(i.e. its inherent properties)*, the whole system is understood *(i.e. as being explained by the sum total of the inherent properties of the parts).*

By comparison, systems thinking is synergistic. *(NOTE: Synergy is Greek for “working together”)*. It emphasises the emergence of new properties *(i.e. emergent properties)* that arise from the interaction and co-production of systems across levels.

Through their continuous interaction and co-production across levels, systems keep changing continuously and in mostly unpredictable ways. They display systemic complexity.

By comparison, by keeping the environment static *(i.e. “ceteris paribus”)*, change is reduced to allow observation of isolated impacts on the system, thereby giving rise to the perception of causality and predictability.

To be w/holistic, the scientific worldview of the future must embrace both, a reductionist and a synergistic approach to the study of life’s phenomena. It must look into systems to understand their inherent functioning and properties, as well as out of systems into their synergistic interaction with an ever changing environment to observe and understand the changing properties that emerge from this.

On the one hand, this requires the continuity of the specialisation of disciplines and on the other hand, an inter-disciplinary cooperation within a trans-disciplinary framework, approach and terminology.

Challenge of difference between the sub-webs of the biomatrix

As previously mentioned, the functioning of systems in the sub-webs of the biomatrix differs:

The systems of the naturosphere have evolved relatively fixed functioning propelling them into a current future. If experiencing problems, the interventions are aimed at restoring their evolved functioning.

By comparison, the systems of the *(human)* psycho-socio-sphere have *(a relatively large degree of)* freedom and can deliberately co-produce change in their environment and in themselves. They are creative and can transform and reinvent themselves in different ways.

Another distinction relates to governance. Although systems thinking asserts that all systems are self-referring and *(to a large extent)* self-governing, this is more self-reflexive *(i.e. automated)* in the systems of the naturosphere and self-reflective *(i.e. deliberate)* in *(human)* psychological and social systems. The difference between reflexive and reflective could suggest a transformation or evolution of consciousness between the two spheres.

From the perspective of the scientific paradigm those differences are likely to require and give rise to different methods of research, observation and intervention.

Challenge of a conceptual *(or information)* reality of systems

The current scientific paradigm is largely materialistic. Many scientists regard matter and energy as the fundamental reality of systems and view their conceptual reality as an epiphenomenon *(e.g. the current medical paradigm beliefs that the mind is an epiphenomenon of the brain).*

Yet, spiritual and religious traditions throughout the ages have acknowledged the existence of a non-material realm *(e.g. of an in-forming spirit and consciousness)*. There is also scientific evidence of various consciousness related phenomena *(e.g. the impact of the mind on the body)*, methods based on in-formation *(e.g. homeopathy)* and subtle energies *(e.g. acupuncture)*, as well as various quantum-healing approaches *(e.g. even remote across time and space)*.

Also, some systems thinkers acknowledge the existence of a universal and unifying in-formation field that underlies the universe *(or biomatrix)*. Examples are Bohm's Implicate Order; Sheldrake's Morphogenetic Fields; Laszlo's Akashic Field; Jung's Collective Unconscious; Chopra's Quantum Field; Boulding's Noosphere; and the Ethos Field of *Biomatrix Systems Theory*.

Questions concerning the existence of a universal in-formation field and its in-forming role of physical reality, as well as the difference in organising principles of the physical and conceptual *(or in-formation)* reality, are a fundamental challenge to the traditional scientific paradigm *(which keeps ignoring them).* Their exploration will transform science.

5| Reflections and Conclusion

Reflection on theory

In co-developing *Biomatrix Systems Theory* as an integrated trans-disciplinary *General Systems Theory,* the following insights were gained:

- To "dismantle" existing systems concepts and "remantle" *(i.e. integrate and contextualize)* them into a coherent and internally consistent theory, demands interdisciplinary cooperation (*such as that of the Biomatrix Research Group)*, considerable time investment *(it took the group about 7 years)* and a motivating purpose *(e.g. the completion of PhDs and research papers).*
- The integration of existing concepts requires an overarching unifying and contextualizing concept *(such as the concept of the biomatrix as field and web and the different types of systems it is composed of)*. Without a unifying context, the dissecting and reassembling of concepts is likely to merely reproduce a *(if not the same, then a similar)* conceptual patchwork that makes up the current field of systems thinking.
- Applying the theory in praxis *(which the group members did in their respective disciplines)* occasionally prompted amendments to or extensions of the theory or a method. Thus iteration between deduction and induction contributed to theoretical and methodological development.
- The exploration of similar concepts from different scientific disciplines revealed their shared, as well as different meaning and thereby facilitated the discovery and formulation of an underlying universal trans-disciplinary concept.
- Creating a meta-systems terminology in the context of existing discipline-specific systems terminologies is a continuing challenge.

Commonly used words have different meanings in different disciplines *(e.g. the terms "chaos" and "energy" are clearly defined in physics, but are often used to mean something different in social systems).* To avoid ambiguity and confusion, the *Biomatrix Research Group* created a new terminology and initially adhered to it in its publications and presentations.

However in applying the theory as management consultant and teaching it in management education, the author encountered resistance to the new terminology. She therefore began to use more familiar discipline specific terms *(which caused resistance in the Biomatrix Research Group).* For example, "doublet" became "entity system" and "teleon" was replaced with "activity system", which later was also referred to as function, process system, or value / supply chain, depending on context. While this made application and teaching easier, it also occasionally caused sloppiness *(e.g. a process system is more than just a process)* and confusion *(e.g. function as noun and verb can relate to different types of systems).*

Also, using more familiar terms can lead to loss of meaning. For example, by replacing "teleos" with "aim" or "purpose" *(which are more familiar terms in management),* the deeper and more fundamental meaning of viewing the universe from a teleos perspective could be lost, or could lead to wrong interpretations. For example, the statement "the universe has aim and purpose" *(which are typically associated with intent)* has a subtly different meaning from saying that "the universe is teleonic" *(which can mean both, emergent or intentional aims and directedness).*

- Differences in definition of the same or similar concepts within the different disciplines and even between different systems thinkers within the same discipline are challenging for creating a universal and inclusive definition within a trans-disciplinary theory *(such as Biomatrix Systems Theory).*

  Clear definitions are also a solution for the confusion that can arise from substituting a meta-terminology with a discipline-specific one.
- A coherent systems theory is an emergence from the interaction of its conceptual parts, whereby the various concepts explain, co-produce, and interact with each other *(i.e. they are synergistic).*

  Viewing them in isolation from each other *(e.g. by dissecting them),* they lose this synergistic quality and become reductionist *(i.e. a trap into which systems thinkers can fall).*

  From a learning perspective, the synergistic nature of concepts within a unifying theory implies that one cannot fully understand a single concept before understanding the others. Thus systems thinking cannot be learned in a linear manner, but requires iterative learning *(e.g. going over the whole material at least twice, if not repeatedly),* as well as iterating between zooming in *(to gain more detailed knowledge of each concept)* and zooming out *(e.g. by means of mindmaps to show relations to other concepts).*

Reflection on Methodology

Concerning the *Methodological Mindmap,* some insights are:

- A diversity of methods is useful, because different change situation require different types of intervention. Ideally, a framework *(i.e. in-formed by a theory)* indicates the appropriateness of different methods in different contexts.
- Different systems thinkers use the apparently same method in different ways *(e.g. according to their own understanding of the systems approach they follow)*, or evolved different versions.

  To integrate the diverse methods and develop a coherent *General Systems Methodology* requires their "dismantling" and "remantling" within a framework and based on principles derived from a theory.

  For example, different systems thinkers use different approaches to create an ideal system design. The *Biomatrix Ideal System Design Method* has been developed by exploring them and incorporating some of their elements into a coherent design method in accordance with the principles of *Biomatrix Systems Theory* and adding some elements derived from it. (Dostal, 2005a and http://biomatrixweb.com/wp-content/uploads/2021/08/Part-3-Engl-Journey-to-an-ideal-future-Final-small.pdf).

- It is necessary to explore the application of a specific method in different contexts and assess their appropriateness, also based on generic theoretical principles.

  For example, systems dynamics modeling is useful to analyze an existing system, to identify problems of mal-functioning in systems with relatively fixed functioning. It is not suitable for generating an ideal design in systems which have a large degree of freedom and can be creative.

- Methods evolve further through applying them in different contexts. For example, large-scale interventions *(e.g. public policy design in a w/holistic democracy)* require public participation.

  Conventional workshopping and dialoguing approaches are of limited use in this context, which also requires approaches such as online jamming and public design conferencing guided by systemic frameworks that channel and contextualize the information flow without generating overload or more conflict and confusion. *(E.g. the Biomatrix Ideal System Design Method can be delivered in such a manner).*

- Depending on the size and nature of an intervention, (sub-)phases of a method can be shortened, left out, combined or new ones added.

  For example, delivering the *Biomatrix Design Method* in a public context necessitates adding the (sub-)phases such as creating alternative design notebooks for categorizing the online generated information *(i.e. according to the generic organizing principles of Biomatrix Systems Theory),* as well as jamming phases on design iteration and public impact analysis of design alternatives.

- Different methods and even different phases of a method require different facilitation skills *(e.g. facilitation of team dialogue, a brainstorming session, design workshop or online jamming differs).*

  Likewise, interactions with clients which have different worldviews *(e.g. communities versus technocrats, visionaries versus analysts, revolutionaries versus visionaries)* require differences in facilitation and often the skill of "translating" between them.

  Psychological typologies can guide the facilitator. Ideally, the methodology framework provides such information.

- The author has also observed a lack of success of systemic applications for various reasons. For example, some systems thinkers apply the wrong method for the intended outcomes *(e.g. using systems dynamics modeling in a design context),* or using an incomplete method *(e.g. redesigning a supply chain without consideration of tapping).*

  Sadly, this has given systems thinking a "bad name" in some areas. Hopefully, an integrated *General Systems Methodology* could prevent this in future.

Reflection on Principles versus Heuristics

The peer review of this paper contained the comment that from a heuristic perspective the reviewer is parting ways with our proposed methodology. This prompted a deeper reflection and produced the following *(initial)* insights:

- Heuristics was listed as a method in the first draft of the methodology mindmap. This was clearly wrong as it is actually a principle that guides all application.
- Heuristic philosophy deals with decision-making under consideration of complexity, uncertainty and unpredictability. It is associated with risk-taking and interpretation *(e.g. based on past experience, rules of thumb and intuition, amongst others)* and can involve cooperative inquiry (e.g. as in action research).

Since systems thinking emphasises continuous change and emergence, there can never be certainty what the “right” decision is or that it will produce the desired outcome. Thus heuristics is a principle of application.

- Heuristics - per se - can lead to self-perpetuating, inappropriate, random, or chaotic analyses and decisions, unless its methods are derived from or incorporate principles of a universal theory.

  For example, the cooperative identification of the variables for determining the dynamics of the shared system, the participants are likely to reproduce their understanding of the current system. However, if they are prompted by generic systemic organising principles *(i.e. ontological prompters)*, their exploration is likely to reveal insights about the current system that they would not have had otherwise *(i.e. for various epistemological reasons).*

  Thus we suggest that an integrated *General Systems Methodology* that is derived from an integrated *General Systems Theory* would be useful for guiding application through heuristics.

Conclusion

The author suggests that *Biomatrix Systems Theory* is an example of a unified *General Systems Theory (i.e. as one of possible others that could be developed based on other criteria of integration).*

It *(they)* can serve as a meta-paradigm for inter-and trans-disciplinary cooperation and introduce more w/holistic thinking into the current scientific paradigm, thereby transforming it.

It is also proposed that an integrated *General Systems Methodology* should be developed, based on a *General Systems The*ory. The mindmap proposed in this paper is intended as an initiating example of this.

6 | References

Biomatrix Systems Theory

Cloete, A. (1999). *The biomatrix model: The development and formalisation of a general systems model*. PhD thesis, Department of Biomedical Engineering, University of Cape Town, South Africa

Dostal, E. (1997). *Application of the biomatrix model to education systems design - with special reference to South Africa.* PhD thesis, Department of Biomedical Engineering, University of Cape Town, South Africa

Dostal, E. in collaboration with Cloete, A and Járos, GG. (2005a). *Biomatrix: A Systems Approach to Organisational and Societal Change.* BiomatrixWeb. Cape Town, South Africa

Dostal, E. in collaboration with Cloete, A and Járos, GG. (2005b). *Biomatrix, a Theory in Graphics* BiomatrixWeb. Cape Town, South Africa

Edwards, L. (1996). *Developing teleonics as a process-based systems methodology for psychological practice.* PhD thesis, Department of Biomedical Engineering, University of Cape Town, South Africa

Muller, L. (2006) *Music as metaphor and mediator: Creating an integrative paradigm for education.* PhD thesis, Department of Biomedical Engineering, University of Cape Town, South Africa

A list of all publications on *Biomatrix Systems Theory* can be viewed on:
http://www.biomatrixtheory.com/scientific-publications-on-systems-theory/

Other

Ackoff, RL. (1974) *Redesigning the future*. New York: Wiley.

Rose, J. (2023). *The future of GST*. Abstract of a talk presented on 22. May 2023 in a mini-symposium prior to the ISSS conference 2023.

Sheldrake, R. 1988. *The presence of the past.* Rochester, Vermont: Parkstreet Press.

Smuts, J.C. (1926). *Holism and Evolution*. New York: Macmillan

The list of general systems thinkers *(as referred to in Part1)* and their publications *(which contributed to the development of Biomatrix Systems Theory)* can be viewed on: http://www.biomatrixtheory.com/references-on-systems-theory/.