Catalog of Linkage Propositions for a System of Systems Processes GST

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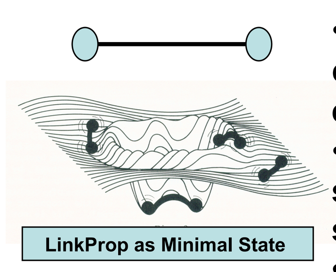
Assumptions and Limits on a General Theory of Systems

- Please see previous poster or reprint collection (1978 on) entitled "Intro to A System of Systems Processes (SSP)" as a general theory of systems for a more complete description of this model and approach. This poster is focused only on further elaboration and discussion of the Linkage Proposition (LP) part of that theory.
- Connectedness of entities is the fundamental assumption underlying research on systems, in particular, as well as systems-in-general.
- However, many past efforts at establishing general theories have not explicitly described the "connections" between things and rendered them discrete & workable for those new to the field.
- Further, due to the wiring of the human brain and habits of perception, humans focus mostly on rather static, physical entities and not on the more abstract and dynamic PROCESSES by which the entities act. These interactions may be very large in number which are very difficult for humans to follow at one time.
- The SSP-LP-GST is designed to overcome these obstacles.

What are Linkage Propositions?

- The main goal of the SSP is ID & documentation of the interactions between systems processes in great specificity and quantity, in much greater detail than other GST's.
- We call these interactions "Linkage Propositions" (hereafter LP's) because they tie together (unify, synthesize) the systems processes (linkages) & because they are not proven in the scientific sense in every system yet, so remain as only partially proven "conditionals." They are stronger than conjectures in math because some proof exists.
- To become a candidate LP, strong evidence has to be documented for the interaction in some range of well-studied particular, real systems. But the full range of their transdisciplinarity need not yet be determined. Their specification will help doing this.



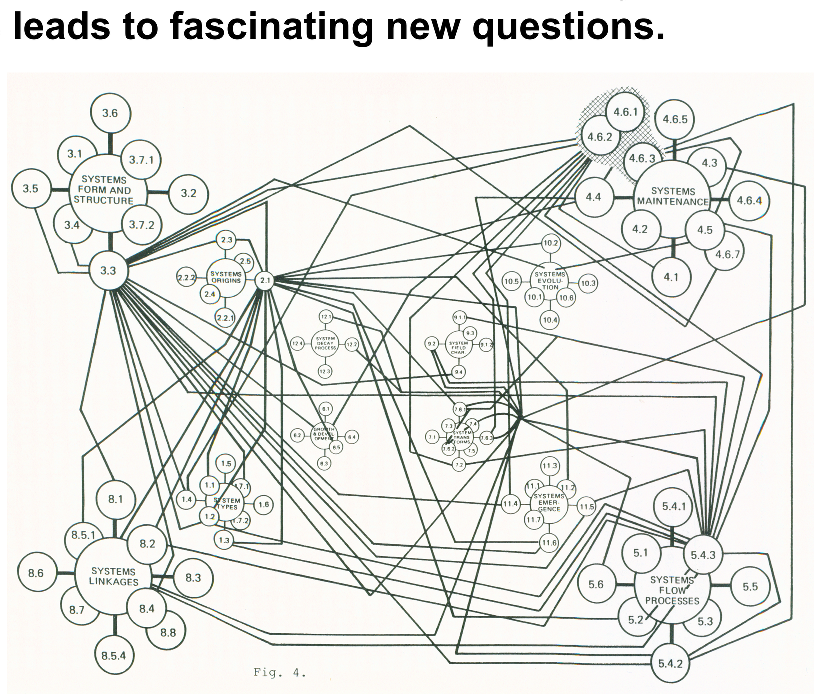
- The basic description of a unit LP is shown above as a basic dyad, a line connecting two nodes. Each node is a systems process (one of the isomorpies); each line is the mutual interaction, influence, or relation between them (one LP).
- These interactions are between minimal energy, time, space, material isomorphs, so they also are minima as shown in the cartoon at left. Given enough time, and sufficient trials, new systems not only "find" the systems processes, they also spontaneously "fall into" the LP's.

- Each Linkage Proposition states how one systems process influences another as in "positive feedback is a partial cause of (necessary condition for) growth and development." Or "coupled feedbacks are a partial cause of oscillations.
- LP's are most easily expressed in language. Our convention at present is to show each systems process as an underlined phrase connected by a standard phrase chosen from our Association Classes that describes the mutual influence.
- Sometimes the LP requires more than two systems processes working together.
- Each systems process has many influences on and is influenced by many other systems processes. This illustrates the "entitation" concept of Gerard, one of the Founders of the ISSS. It also explains the non-linear behavior of many systems.

Some Sample Linkage Propositions

- Here are some general examples of Linkage Propositions we are studying…….
- Transitions/Phases/Modes are in part the result of Symmetry Breaks in Linkages.
- Symmetry Breaking is a partial cause of Scalar Emergence.
- Hierarchical Structure is a partial result of Scalar Emergence.
- Diffusion Limited Aggregation (DLA) is a type of Systems Flow
- Non-Equilibrium Thermodynamics is a necessary condition for DLA.
- Diffusion Limited Aggregation is a partial cause of Fractal Structure.
- Non-Equilibrium Thermodynamics is a necessary condition for Fractal Structure.
- Boundary Conditions are a partial cause of the Exclusion Principle.
- Concrescence Ratio is a partial cause of new Boundary Conditions.
- Notice that several of this small example set are interrelated and so result in paths, or cycles, or subclusters within the complex networks of 100's of LP's in the System of Systems Processes. For example, note the chain from symmetry breaks to emergence to phase states or from DLA to Fractals. Also note that the very existence of these specific interaction sets leads to fascinating new questions.

- When many dozens of LP's are shown connecting systems processes, the graphic at right emerges as a "image" of the SSP.
- This diagram only shows a small sample of the LP's acting on just four of the isomorphic systems processes.
- It shows that this GST not only describes how networks arise and are maintained, but actually is a complex network itself.
- The image at right is a generic dynamic representative of many systems; it is a "template" for systems dynamics. As a template, it can be used to represent and/or analyze many manifest, real systems.
- It can also be used to determine how real systems sometimes malfunction (see posters on Systems Pathology).



Dependency Analysis of Linkage Propositions

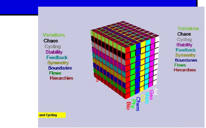
- Designing discrete interaction statements like the LP's makes it possible to do a search for which of the isomorphic systems processes is most fundamental.
- We call this a "prerequisites list" or a "dependency analysis" because it describes which LP's cannot occur without others first occurring. We still maintain that all systems processes included are axiomatic and all are needed in "mature" systems. But even within the axiomatic set there are inner dependencies. These become a new set of Linkage Propositions.
- For example, Binding Interactions require Boundary Conditions require Flows.
- For example, Oscillations require Coupled Feedbacks require the presence of Positive Feedbacks and Negative Feedbacks which require Cycling which requires Flows.
- But as an additional example, Flows requires Potential Fields.
- So from these we can suggest which systems processes are more funamental.

How Are LP's Different from Text Descriptions?

- So how is the Linkage Proposition portion of the System of Systems Processes different from other text based discussion of how systems work, or other treatments such as mathematical expositions?
- They are much more concise than long text explanations.
- They are restricted to single directional or mutual influences so are more discrete.
- They are clearly not as concise as formal mathematics treatments, but they are understood and communicable to a wider audience.
- The statements are not necessarily less rigorous than formal equations though because they are closely tied to empirical studies of particular systems.
- They enable diversity of assembly just as discrete words do in language.

Based on Systems Integrated Science

- The pictures at right depict the scales of seven natural sciences studied in 270 case studie for the Integrated Science GE Program. The conventional science behind these are the sources for the Linkage Proposition statements. So extensive refereed literatures exist that support the interactions that are codified in the LP's. These literatures extend from the physical sciences, thru the biological sciences, to the social and applied sciences as indicated in the accompanying student posters for selected systems processes and their Linkage Propositions.



Hierarchical Outline of Linkage Propositions

- Below we have encoded 174 sample Linkage Propositions formulated since the beginning of the SSP in 1978. These were included in the workbook accompanying the Pre-Conference Workshop on "Intro to Systems Science Praxis" at the 50th Annual ISSS Meeting.
- Because of their early coining, these are being updated to current standards & formats.

1. Boundary Conditions.

1.1. To be properly defined, Boundary Conditions must consider the full ranges of Inputs/Outputs acting on the bounded system.

1.2. Defining the Boundaries of a system is identical to identifying the included systems as components, entities, elements or subsystems.

1.3. Boundary Conditions must be known to properly define internal versus externally generated Goals/Purposes for the system.

1.4. Restructuring can only be defined if Boundary Conditions are clearly recognized.

1.5. Boundary Conditions must be known to define whether a system is open or closed.

1.6. Intrasystem Coupling contributes to the establishment of Boundary Conditions.

1.7. Life Cycles are a type of Boundary Condition that specifically defines temporal Boundaries.

1.8. Transitions/Phases/Modes are transformations in the predominant types of subsystem interrelationships that in turn change some but not all of the parameters used to define the system's Boundary Conditions.

1.9. Identifiable Boundary Conditions are in part the result of achievement of Steady State, whether this is achieved by static or dynamic Equilibrium.

1.10. Boundary Conditions contribute in part to the cause of the Exclusion Principle.

1.11. Hierarchical relativity is in part the result of applying different Boundary Condition parameters and getting different Bounded systems.

1.12. Hierarchical relativity is in part the result of applying different Boundary Condition parameters to a set of systems resulting further in differently Coupled subsystems.

1.13. Patterns in Incremental Trends are the partial result of comparing the magnitudes of parameters of Boundary Conditions (and forces acting across the Boundaries) across the levels of modular Hierarchies.

1.14. Temporal Boundaries of a system results from selection by its environment for the most optimal Cycling times. This means that temporal Boundaries and Cycling time are types of externally-generated goals of a system.

1.15. Recognition that a system has Components/Entities/Elements that are sometimes called subsystems is the same as recognizing the system as Decomposable.

1.16. For a Component/Entity/Element to be properly defined it must be placed in the appropriate Hierarchical level.

1.17. For a Component/Entity/Element to be properly defined all of its Linkages/Interrelationships must be documented.

1.18. This Diversification Processes are a partial cause of Transgressive Equilibrium. Systems organization allows a greater variety and higher level of behavior than can be achieved by any of the systems elements alone (paraphrased from Ackoff, 1971).

1.19. Boundary Conditions of a system are in part the result of the strength and duration of the linkages between its subsystems.

1.20. The participation of Entities/Components/Elements as subsystems in a supersystem is in part the cause of their transtemporal stability.

1.21. In cases of Synergy, Boundaries are expanded from tightly drawn around the bounded entity to a much wider Boundary including the other participants in the Synergy.

1.22. Intra-system Coupling contributes to the establishment of Boundary Conditions.

1.23. The mechanics of unity/wholeness is in part the result of Boundary Conditions.

1.24. Boundary Conditions are involved in the distinction between insulated and non-insulated linkages.

1.25. Temporal capture of Energy Flux must occur within the Boundary of a system.

1.26. Concrescence Ratio can lead to the establishment of new stable Boundary Conditions by causing, in part, new levels of Transgressive Equilibrium.

1.27. Concrescence Ratio can lead to the establishment of new Boundary Conditions as well as the associated features of Transgressive Equilibrium.

1.28. Boundary conditions in part result from the establishment of a Steady State, whether it is the result of either static or dynamic Equilibrium.

2. Linkage and Interrelations

2.1. Transitions/phases/modes are in part the result of alterations in the Linkages among subsystems of a system.

2.2. Inputs/Outputs are classifications of the broader category of Linkages. These classifications are based on the function they perform in the self-reference space of the system.

2.3. Linkages across levels in different Hierarchies cause three-dimensional, topological Hierarchies.

2.4. Linkages are the medium by which subsystems become systems, and systems become supersystems.

2.5. Periodic Cycles are the result of special types of Linkages, which are deterministic in the sense that the same sequence of States always obtains and the same specific state is always found in the specific time zone of the periodicity

2.6. Temporal capture of Energy Flux is a function of Linkages which results in transtemporal stability

2.7. Similar Linkage strengths, times, and distances (incremental parameter trends) characterize the Entitation within a level of the Hierarchy and help to define the levels empirically and non-humanocentrically.

2.8. Similar Linkage strengths, time, and distance determine what is inside and what is outside a system in applications of the Exclusion Principle.

2.9. Linkage influences what is considered inside and outside a system and so results in recognition of its Boundary Conditions.

2.10. Linkages must be known to define whether or not a system is open or closed.

2.11. The Uncertainty Principle is caused by the number of Linkages being never entirely knowable

2.12. All Linkage Propositions are generic cases of real systems Linkages indicating how the attributes of systems are produced in nature.

2.13. Temporal capture of Energy Flux can only be found in Open Systems.

2.14. Positive And Negative Feedback mechanisms are often found Coupled together.

3. Feedback

3.1. Goal-seeking Feedback is in part the cause of Teleological/Purposive systems.

3.2. Goal-seeking Feedback is in part the cause of Oscillations.

3.3. Goal-changing Feedback is a characteristic feature of Evolving systems of the biological/sociological type.

3.4. Feedback paths may be within levels of a Hierarchy or between levels.

3.5. Feedback is one of the few types of Linkages that operates across widely separated levels of the Hierarchy.

3.6. Feedback from the environment of the system is in part the cause of shifts in phases and modes.

3.7. Feedback is a special type of Coupling between subsystems of a system.

3.8. Positive Feedback contributes to Growth Processes.

3.9. Negative Feedback contributes to Equilibrium.

3.10. Coupled Positive And Negative Feedback generates the sigmoid curve characteristic of all systems Growth Processes and decay Cycles.

3.11. Coupled positive and negative feedback contributes to transtemporal stability.

3.12. Coupled positive and negative Feedback mechanisms are in part the cause of the Oscillations around the ideal median typical of Cycles.

3.13. There is no Feedback in static regulation.

3.14. Either positive or negative Feedback can be found in dynamic regulation.

3.15. Positive and negative Feedback mechanisms are often found linked together as a partial cause of dynamic Equilibrium.

3.16. Positive Feedback is a partial cause of amplification of rates of Growth Processes and Development Patterns and Laws or Decay Processes.

4. Equilibrium

4.1. Dynamic Equilibrium is the same as Oscillations around an ideal median of system behaviors, where the limits of behavior which the environment of this system will allow leads to a version of the limit Cycle for the system.

4.2. Transgressive Equilibrium is in part the cause of levels in Hierarchy.

4.3. Transgressive Equilibrium is, in part, the result of the probabilistic, random nature of subsystem Interactions to form systems

4.4. Instability in the form of unsatisfied Counterparity leads, in part, to systemic Evolution.

4.5. Equilibrium is a mechanism for achieving transtemporal stability.

4.6. Static Equilibrium is found in Open Or Closed Systems, while dynamic Equilibrium is found only in Open Systems.

4.7. Restructuring is a mechanism for achieving Equilibrium.

4.8. Temporal capture of Energy Flux contributes to achievement of Equilibrium

4.9. Equilibrium is, in part, the result of dynamic regulation.

4.10. Metastability is destructive of Equilibrium and transtemporal Stability.

4.11. Recycling of systems Components/Entities after systems Lifecycle death contributes to Equilibrium of the next higher level of the Hierarchy.

4.12. Instabilities in small amounts built upon larger magnitudes of stability are the most conducive to systems level Evolution, which, in turn, yields new Transgressive Equilibria and transgressive attributes (new qualities).

4.13. Instability is the opposite of Stability, and their pairing in nature makes them one of the most fundamental of Counterparities.

4.14. Non-Equilibrium Thermodynamics is a necessary condition for Diffusion-Limited Aggregation.

5. Cycles and Oscillations

5.1. Consonant Cycling is a special case of Synergy.

5.2. Cycling reduces the Energy Flow necessary to maintain a Negentropic, deterministic succession of States in a system.

5.3. Instability to Stability back to Instability is a flow typical of life Cycles and Recycling of Components/Entities/Elements.

5.4. Goal-seeking Feedback is in part the cause of Oscillations.

5.5. Metastability is a partial inhibitor of Recycling of Components/Entities/Elements.

5.6. As Cycling requires continuous Energy Input for its maintenance, it is found most often in Open Systems and is Negentropic in nature.

5.7. Cycling (of the life Cycle variety) is the same as the temporal Boundaries of the system in question.

5.7.1. Life Cycles are a type of Boundary Condition, specifically defining temporal Boundaries.

5.8. Recycling of components of a system is a special type of Linkage between the system and other systems in its environment.

5.9. Cyclic behavior is planned Instability.

5.10. Synergy between systems which are a large number of levels distant from each other in the natural Hierarchy provide for greater Stability on the lower levels. For example, animal life Cycles in alignment with the geological/seasonal Cycles.

5.11. Deterministic sequences of subsystem Transformations lead to periodic Cycling.

5.12. Reductions in required Energy Flow for Cycling are partially dependent on contributions of Recycling of components to Autopoiesis of systems in succeeding Hierarchical levels.

6. Evolution & Emergence or Origins

6.1. Neutrality Quest causes systems structures to form.

6.2. Neutrality Quest causes a small number of pocket of Negentropy to form, and drives their Evolution.

6.3. Neutrality Quest is caused by the fundamental Dualisms (counterparities) on each level of the Metahierarchy.

6.4. Dichotomies such as Open/Closed, Internal/External, and Input/Output are not Counterparities because though opposite, they are not necessarily always equal or acting in opposition to each other.

6.5. The ability of Feedback to act as a coupling between widely separated levels of the Hierarchy contributes to hierarchical relativity.

6.6. Counterparity (dualism) is in part cause of the Neutrality Quest.

6.7. Counterparity acted upon by Neutrality Quest can sometimes cause Transgressive Equilibrium, or the Origin of a new level of entities and a new portion of the Hierarchy.

6.8. A small amount of unsatisfied Counterparities in a population of Entities with mostly satisfied Counterparities will result in Concrescence.

6.9. Concrescence leads to transtemporal Stability.

6.10. Coupled positive and negative Feedback mechanisms are a generic example of Counterparity.

6.11. Hierarchical organization contributes to the mechanics of unity or wholeness.

6.12. Neutrality Quest is the result of the universal trend toward Entropy death.

6.13. Instability in the form of unsatisfied Counterparity leads, in part, to Systemic Evolution.

7. Hierarchical (Heterarchical) Structure & Function

7.1. Hierarchically organized systems, especially of the modular type, are Decomposable.

7.2. Hierarchical organization is highly Negentropic.

7.3. Flatness in a Hierarchy is Stable in static systems, but Unstable in dynamic systems.

7.4. Hierarchical organization increases the probability of transtemporal stability of ever-larger complexes through systemic Evolution and thus causes higher levels of Negentropy.

7.5. Hierarchical organization contributes to systemic Growth and Development and allowable complexity limits.

7.6. The deterministic aspect of hierarchical organization (once probabilistically evolved) enhances the deterministic aspect of Cycling.

7.7. Counterparity and Neutrality Quest acting together cause Transgressive Equilibrium, which is synonymous with genesis of a new level of the Hierarchy. (Systemic Evolution)

7.8. Gaps in Hierarchical levels are the result of the appearance of new magnitudes of Bonding strength, distance, time, and energy due to the appearance of new unsatisfied Counterparities.

7.9. Subsystems are the same as Components/Entities/Elements of a system while the system so formed is a Component/Entity/Element of the next level in the Hierarchy.

7.10. Hierarchical levels determined in part by incremental parameter trends are in part the cause of the exclusion principle.

7.11. The transtemporal Stability of hierarchical organization is enhanced by cross-level Feedback.

7.12. Each new Hierarchical Level achieves a new Transgressive Equilibrium.

7.13. Each new Hierarchical level is in part the result of a new Counterparity.

7.14. Each new Hierarchical Level contributes to the sudden Emergence of a new quality of systems over and above that of the levels below. (Transgressive Equilibrium)

7.15. Transgressive Equilibrium is in part the cause of levels in Hierarchy.

7.16. Symmetry Breaks are a partial cause Hierarchical Structure (Clustering).

7.17. Diffusion Limited Aggregation is a partial cause of Hierarchical Structure.

7.18. Recycling of systems components/entities after systems lifecycle decay contributes to Equilibrium of the next higher level of Hierarchy

8. Fractal Structure

8.1. Non-Equilibrium Thermodynamics is a necessary condition for Fractal Structure.

8.2. Diffusion Limited Aggregation is a partial cause of Fractal Structure.

9. Energy Flow

9.1. The systems that get the most energy and use it the most effectively are the systems that are the most likely to survive.

9.2. Neutrality Quest is a special case of Energy Flows and provides them with direction.

9.3. Energy flows derive from counterparities seeking their complement to achieve a neutrality balance.

10. Duality

10.1. Uncoupling of Dualities is a partial cause of Symmetry Breaks.

10.2. Spontaneous breakage of Duality-based Coupling Forces results in Symmetry Breaks and is a partial cause of Phase Transitions.

10.3. Symmetry Breaks are a partial cause of Gap Discontinuities.

10.4. Instability and its opposite Stability are paired in nature as partial cause of one of the most fundamental of Counterparities (dualism).

10.5. A small amount of unsatisfied Counterparities in a population of entities with mostly satisfied Counterparities will result in Concrescence and Emergence of Hierarchical Structure.

10.6. Coupled Positive and Negative Feedback mechanisms are a generic example in Counterparity.

11. Fields

11.1. Field Dynamics neutralizes the consequences of Complexity (Computational Explosion).

12. Entropy

12.1. For certain types of Open Systems, the rate of Entropy production tends to a minimum. (From Rapoport, in Klir, 1971)

12.2. Closed Systems are characterized as proceeding irreversibly to Entropy and disorder

12.3. Entropy is an expression of the more universal Neutrality Quest.

12.4. Components avoid Entropy death by Restructuring.

12.5. If Entropy death results in a structure, then that structure is Metastable?

12.6. Types of systems such as astronomical, physical, and chemical tend toward Entropy.

12.7. As there is Entropic loss to all Flows (energy, informational, etc.) and Linkages, the Linkages that survive the longest are those that are based on Transformations from a State of great available energy to lesser. This relationship is partly the source of incremental trends across Hierarchical levels such as decreasing numbers and increasing size. It also explains the probabilistic nature of transtemporal Stability.

12.8. Open systems can locally increase their order or Negentropy if energy is constantly supplied for throughput.

12.9. Open Systems can reverse the universal tendency toward Entropy in their local space/time continuum only if energy is constantly supplied.

12.10. Negentropy requires permeable Boundary Conditions.

12.11. Systems with internally derived goals actually design Negentropy in the environment. Systems with externally derived goals cannot although cluster of such systems increase the probability of Negentropy in the local area.

12.12. Restructuring leads to Negentropy.

12.13. Transtemporal Stability is a case of Negentropy.

12.14. Types of systems such as biological, sociological, and man-made tend toward Negentropy in the short-term, but succumb to Entropy in the long-term.

12.15. Temporal capture of Energy Flux, when coupled with Restructuring, increases Negentropy.

12.16. Coupled Feedback favors Negentropy.

12.17. Both dynamic and Transgressive Equilibrium increase Negentropy in a system.

12.18. Energy required for maintenance is proportional to the Negentropy of a system. (Odum and Odum, 1976)

12.19. As Negentropy increases in systems the effectiveness of these systems in utilizing energy increases as well as their ability to exploit a variety of energy sources.

12.20. Entropy Measures are a Dual Opposite Counterparitor to complexity of a system.

12.21. Uncoupling of Dualities is a partial cause of Entropy.

12.22. Symmetry Breaks are a partial cause of Entropy.

12.23. Neutrality Quest is in part the result of the universal trend toward Entropy death.

12.24. Hierarchical organization is highly Negentropic.

13. Synergy

13.1. Synergy is a special type of positive Feedback characteristic of purposive systems.

13.2. Synergy contributes to Negentropy.

13.3. Synergy sometimes results (cooperates?) in achieving a Transgressive Equilibrium.

13.4. Synergy increases the ability of the cooperating entities to achieve to achieve Restructuring.

13.5. Synergy is a special relationship of Input/Output processes such that the components sharing the relationship have achieved an unusual focusing of their outputs on each other as stimulatory input. (Aspects of inbreeding)

13.6. Synergy is the result of an intensified set of Linkages between a group of entities.

13.7. Does Synergy enhance transtemporal Stability?

13.8. Synergy is a type of Coupling.

13.9. Synergy maximizes temporal capture of energy flux.

13.10. Synergy in Purposive systems disfavors both Instability and Metastability?

13.11. Synergy may result from consonance in Cycles.

13.12. Synergy contributes to Transitions/Phase Shifts/Accelerated modes.

13.13. Synergy may act within or between levels of the natural Metahierarchy.

13.14. Synergy implies directionality of systems Energy Flows when in purposive systems, and also in non-purposive?

13.15. Synergy is favored by Neutrality Quest selection of some ranges of Concrescence Ratio over others.

13.16. Synergy intensifies purposiveness of teleological systems while having no such effect on non-teleological systems.

Unassigned:

Non-Equilibrium Thermodynamics is a necessary condition for Diffusion Limited Aggregation

Symmetry Breaks are a partial cause of Entropy.

Some Uses & Applications of LP's

- The SSP & its LP's would have multiple other uses. It could be used…..
- As a comprehensive knowledge base for more detailed and improved systems education programs.
- As a source of novel information & insight for rapidly expanding, well-funded new specialties such as Systems Biology & Earth Systems Sciences.
- To provide a detailed basis for a unified Sciences of Complexity, and for new fields like Systems Allometry & Systems Pathology.
- To provide practical design alternatives for a wide range of Systems Design Applications of all types.
- To improve systems models and systems simulations of real and artificial systems.
- To improve communications among the wide range of systems workers from many different disciplines by providing standards and translations among the different systems studied.
- To enrich the meaning & understanding of each isomorphic systems mechanism or process.
- To assess the rigor and completeness of alternative general theories of systems & the completeness & rigor of alternative real systems models and simulations.
- To improve our understanding of the sources of complex behavior in complex systems.