A Few Words First

Courtesy – Please mute your phone (*6 toggle).

Upcoming Chapter Meetings:

- **Sep 22, Tutorial: Integrating Systems Engineering, Project Management and Quality Management**
  Dr. Heidi Hahn, Los Alamos National Lab; Ann Hodges, Sandia National Labs
- **Oct 05, 4:00-6:30pm, FREE ASEP/CSEP Knowledge Exam at NM Tech**
- **Oct 06-07, Socorro Systems Summit at NM Tech**
- **Oct 11, 2017, Why is Human-Model Interactivity Important to the Future of Model-Centric Systems Engineering?**
  Dr. Donna Rhodes, Massachusetts Institute of Technology
- **Nov 9, Architecting Cyber Physical Systems**
  Dr. Cihan Dagli, Missouri University of Science & Technology

CSEP Courses by *Certification Training International:*
Course details | Course brochure
Course Schedule (close by, but many more locations and dates):
2017 Oct 30-Nov 3 | Las Vegas, NV
2018 Feb 26-Mar 2 | Las Vegas, NV
2018 Apr 02-Apr 5 | Denver

First slide, not recorded but retained in pdf presentation.

And Now - Introductions

Enchantment Chapter Monthly Meeting

13 September 2017 – 4:45-6:00 pm:

Beyond Biomimicry to Systems Mimicry: Can SE Use Evidence from the Natural Sciences to Design Better Systems?

Len Troncale, California State Polytechnic University, lrtroncale@cpp.edu

Abstract: The sciences study natural phenomena using experimental methods. Their evidence and discoveries are widely used in engineering design and implementation. This talk proposes to use their vast data to establish a new specialty called "systems mimicry." This new knowledge base would provide tested, evidence-based solutions to the challenges that all systems face whatever their scale or particular function. The talk will describe the features of systems mimicry and suggest a new tool to explore its data for designing on the systems-level. It will list similarities and differences between the established *biomimicry* and the proposed *systems mimicry*. It will outline how general theories of systems like SPT (Systems Processes Theory) can provide a stimulus for adding the general systems focus to conscious SE praxis and provide a framework for integrating the unintegrated results of several systems science and natural science knowledge bases. Five possible examples of use of systems mimicry in systems design will be presented as case studies (use of hierarchies in materials design; chaos & robotics; using principles of exaptation in design; use of systems evolutionary algorithms; and use of awareness of systems pathology. The talk will end by suggesting a wider, future vision of systems design and SE.

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NOTE: This meeting will be recorded

Today's Presentation

Things to Think About

How can this be applied in your work environment?

What did you hear that will influence your thinking?

What is your take away from this presentation?

Speaker Bio

Dr. Len Troncale is Professor Emeritus of Cell and Molecular Biology, and past Chairman of the Biology Department at California State Polytechnic University. He is also Founder/Director Emeritus of the Institute for Advanced Systems Studies, and Coordinator of its NSF-supported Systems Integrated Science General Education (ISGE) Program. He has served as VP and Managing Director of the International Society for General Systems Research (SGSR) from 1980-88, and President of the International Society for the Systems Sciences (ISSS), in 1990. He was a member of the Board of Directors for the International Federation for Systems Research (IFSR) from 1982-85 and a Research Associate at the Int'l Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria.

He is currently serving as VP/Managing Director of the new professional society, ISSP, Int'l Society for Systems Pathology. He is also Project Lead for two projects of the Systems Science Working Group (SSWG) of INCOSE. Dr. Troncale has published 120 articles, abstracts, editorials and reports, served as Editor on 11 projects, delivered 125 invited and computerized presentations and demo's in 23 countries and served as P.I. on 52 grants and contracts for $5.3M.

He is the Author of Systems Processes Theory, and Systems Pathology Theory (as well as new spin-off specialties such as Systems Allometry, Systems Mimicry, and SysInformatics). In Systems Biology his specialties are Evolution of Cell Division, Cell Differentiation Models, chromosome territories, and the nuclear matrix (nucleoskeleton).

He is currently President of GSRDC (General Systems Research, Development, and Consulting) and a Lecturer, for the new Masters in Systems Engineering Program, College of Engineering, California State Polytechnic University.

Beyond Biomimicry to Systems Mimicry:

Can SE Use Evidence from the Natural Sciences to Design Better Systems?

TOPICS COVERED I.

1. **Tenets/Benefits/Contributions of Systems Mimicry**
2. **Systems Mimicry is Different from Biomimicry**
3. **Single Exemplar Case Study of Systems Mimicry**
   a) Hierarchies and Materials Engineering (CSER paper had four)
4. **Systems Mimicry is based on Systems Processes Theory (SPT): Brief Intro to SPT** (& usability for SysMimicry)
5. **New Tool & Four Strategies for Systems Mimicry**
   a) Initially Translate Biomimicry Tool; See asknature.com
   b) (ISP-GST) Strategy; "Network" Research "Motif" Strategy; Gen'l Morphology Strategy; **"Systems Pathology" Strategy**
   c) Action Projects for "Birthing" Systems Mimicry

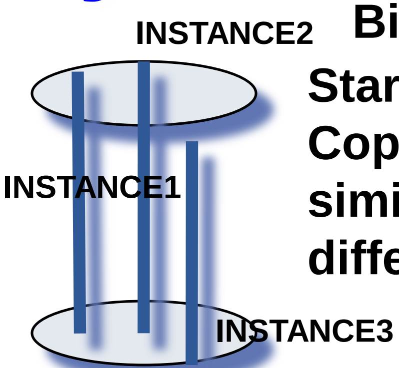
(1) Tenets of Systems Mimicry

SPT Systems Mimicry: Gen’l Mimicry

focuses on systems processes, not particulars

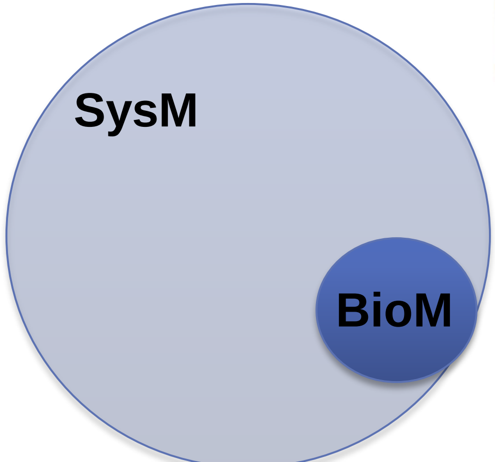
SPT starts the NEW discipline “SYSTEMS MIMICRY” which is biomimicry at the more abstract systems architectural level

Biomimicry

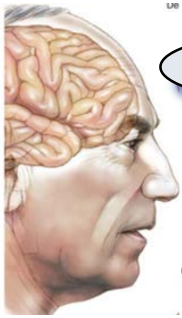


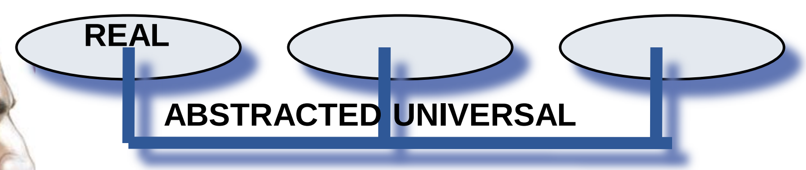
Starts w specific biosys: Copies real properties with similar scalar relations but different materials

- Shark skin
- Spider web
- Gecko feet
- Plant velcro
- Leaf anhydry



Systems mimicry





But who does what abstraction?

Compare many scalar levels to get abstract <u>operating relations</u> & <u>copy those</u> NOT properties of any one scale of components or limited to only biosystems =

- ✓ Hierarchical Str; Cycles; Fractal;
- ✓ Feedbacks; Self-Organiz;

BIOMIM → SYSMIM VIA SPT

Some Initial Tenets: (assumptions/working hypotheses)

- **Many Engineering Problems are "systems"-level problems**
  - So solve them on systems architecture level as well as particular level
  - Some of the most messy problems are hybrid Nat/Hum Sys = !!!level!!!
- **In many cases, nature is a good engineer of systems**
- **The natural sciences study many phenomena**
  - Most phenomena are systems-level; science studies at great depth
  - →Vast natural science literature, insufficiently used in SE; not just ST
  - SSWG (NSWG; CxSWG; SoSWG) trying to integrate ST & SS domains
  - If isomorphic across all scales, disciplines, types of systems = proven useful for systems sustainability
- **Systems Mimicry would imitate natural systems solutions**
  - Find "patterns" "processes" "pathologies" common to many scales/types
- **So base design on how systems work (GTS) or don't work (syspath)**

BIOMIM → SYSMIM VIA SPT

Some Initial Benefits/Contributions:

- **Systems Mimicry has a much broader range of scales/levels to explore than Biomimicry** (includes physical, bio, human, hybrid sys's)
- **Systems Mimicry from SPT is much expanded in test/scope**
  - Natural systems are tested immediately; simultaneously; extensively
  - More variants; more iterations; more time scales represented
  - Systems Mimicry would address & solve different, >>generic problems
- **If based on SPT, has more detail for design & cure**
- **If based on SPT, uses unused, vast sci literature**
  - ALL of the lit of ALL of the natural sciences on all phenomena…
  - To search for unusual unexpected solutions
  - Need not be based only on SPT
  - Or on Bio; based on ALL sciences
  - Provides leverage & secret knowledge

(2) Systems Mimicry is Different from Biomimicry

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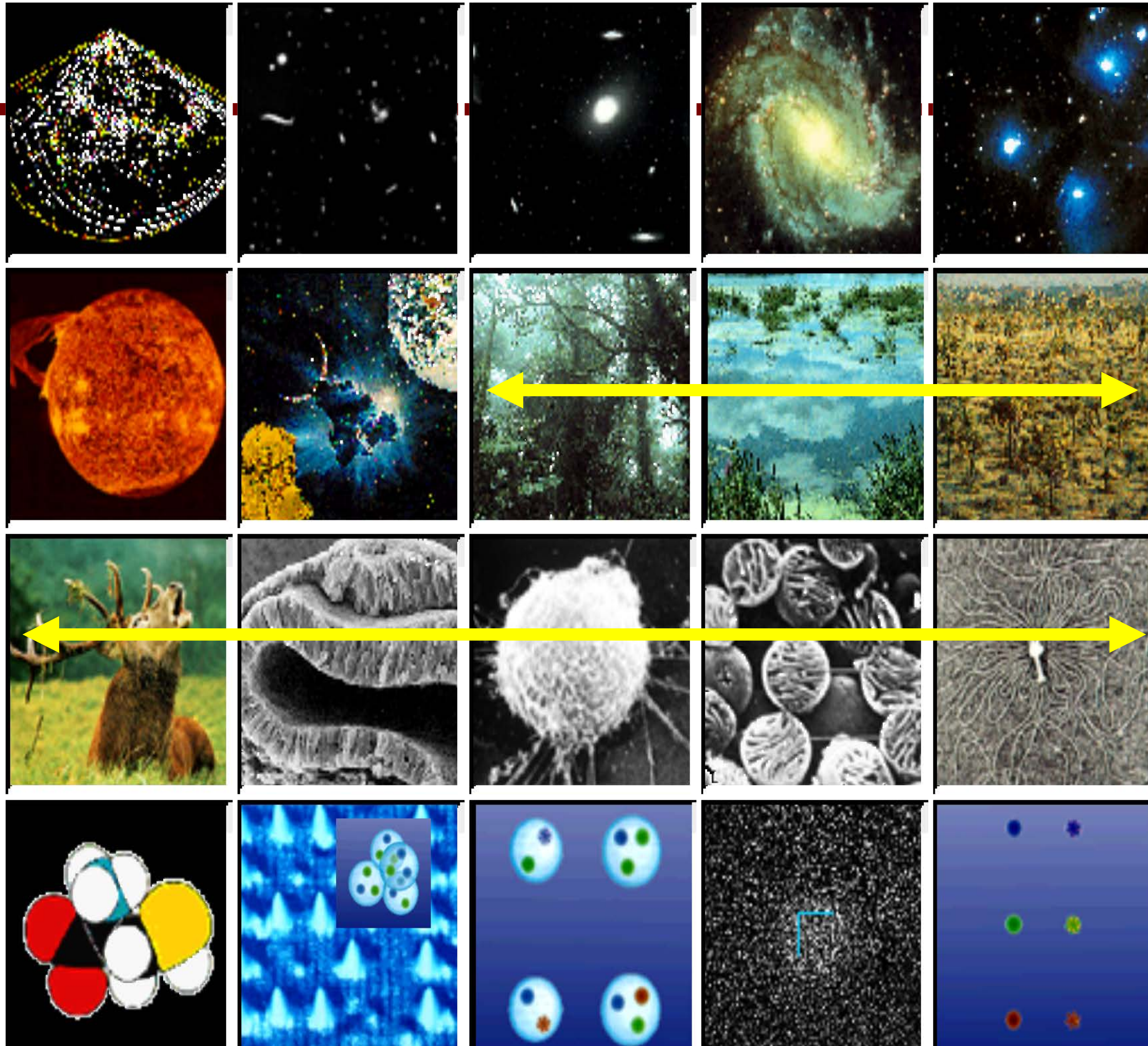
Entire range studied by diff't sci's & diff't tool's; FRAG-MENT-ED…

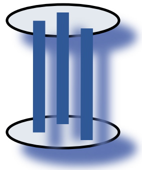
BUT syssci & SPT studies across all scales and domains to find universals



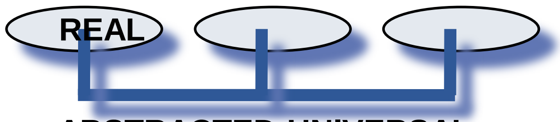
BIO ~ eight of twenty Scalar levels in nature; Bio-mimicry limited to these; but systems mimicry covers all 20 at more abstract level of architect-ure & solutions

Hint of Engineering Differences

Biomimicry



Systems mimicry



ENGINEER SPECIFIC SOLUTIONS:

- velcro
- structural color
- high performance composites
- smart material
- sticky surface
- anti-drag, anti-friction surfaces like shark skin
- anti-wetness surface
- self-cleaning surface
- thermoregulatory skin
- micro muscle
- nanorobotics
- anti-reflective surface
- sensing surface
- artificial photosynthesis
- artif. compound eye
- pores & channels
- micro flyers
- high performance fiber
- smart structures
- scaffolds
- artif. camera eye
- micro motors
- anti-adhesive surface
-

ENGINEER GENERIC SOLUTIONS:

- design in opposing forces
- design in opposing functions
- employ chaos functions in design
- maintain stability with increasing complexity of parts
- maintain stability with increasing interaction of parts
- maintain functionality in changing contexts or environments
- increase generation of innovation or variability
- decrease fracture with increasing stresses
- novel control systems

Summary Table: Compare Sys vs. Bio Mimicry

Designs in both:
(i) solve a problem or fulfil a need or perform a specific function
(ii) exploit a potential or find a new potential;
(iii) use former or established components in a unique way

BIOMIMICRY	SYSTEMS MIMICRY
S-Based on past experiments	S-Same
S-Mimics feature of natural system	S-Same
S-Based on past peer-reviewed science lit	S-Same
D-ONLY living, biodomain and discipline	D-ALL systems domains and disciplines
D-Particular manifested feature	D-Abstracted general mechanism
D-Solution bioevolution has fixed	D-Solution systems sustainability demands
D-One problem: one solution	D-Many problems: one solution
D-Detail from highly constrained specialties	D-Detail from comparative systems analysis
D-Based on bioevolution	D-Based on systems science theory
D-Short time-line solutions	D-Very long time-line solutions
D-Tighter range of application	D-Wider range of application
D-Mainly biological systems	D-Physical, social, symbolic systems as well as biological
D-Millions of years, trials, events,	D-Billions of years, trials, events
D-More limited background literature	D-Much larger background literature
D-Particular solutions; particular problems	D-Generic solutions; generic problems

BOTTOM LINE: Biomimicry uses Biology: Systems Mimicry uses ALL of SCIENCE plus the new Systems Science; next three slides give LEVEL, TIME & DATA TESTS to compare bio to sys MIMICRY!

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13.6 BY condensed into one yr: Revealing systmimicry yields more potential

PHYSICAL SYSTEMS HISTORY & DATA BASIS FOR SYSTEMS MIMICRY so 75% of yr

BIOSYSTEMS DATA: BASIS FOR BIOMIMICRY

Compare time-span for systems mimicry to time-span for Biomimicry! Which gives the most selection & literature?

BIOSYS DATA: BASIS FOR BIOMIMICRY (~25% of year)

Known from radiocarbon dating, DNA extraction from remains

Written record

LAST MINUTE OF THE ENTIRE YEAR OF >HALF MILLION MINUTES (525,600 TO 1 RATIO)

IS SOCIAL SYSTEMS HISTORY & DATA & so the TARGET for applications of sysmimicry & biomimicry to human engin'g

We feel that "selection" is not found only in biosys; phys natural sys are also "selected" by their contexts or env so give examples of syssuccess

Case Study Data Test for SysMimicry

note sample of only 7 ISP's

((a case study is also a recognized phenomena in that discpline with a substantial literature for each individual one))

	………PHYSICAL SCI'S…………						BIO			
	Astronomy	Physics	Chemistry	Geology	Math	CompSci	Biology	Engineering	Human	Total for ISP
Totals per Discipline =	44	52	46	55	30	42	86	33	87	
Cycles, Oscillations	7	6	8	16	5	3	9	5	14	73
Feedback Processes	5	4	4	4		7	12	8	12	56
Flows as a Process	8	10	5	15	4	5	16		12	75
Networks	3	7	6	8	2	6	14	6	15	67
Hierarchies	5	3	5	3	7	7	9		7	46
Self-Organization	9	5	7	3	1	9	15	9	14	72
Duality/Symmetry	7	17	11	6	11	5	11	5	13	86

53 average/discipline

Total Physical **269**

68 average/ISP

Total Biological **86**

Total all ISP as Sci Phenomena **475**

(3) One Exemplar of Systems Mimicry

(3) Use Hierarchy (Process/Pattern) in Materials Engineering

Systems Mimicry in Materials Engineering

- A test to determine if one SPT isomorph (hierarchies) can be found in and applied to materials engineering. **If proven efficacious, then evidence in favor of (1) hierarchies as a Systems Mimicry KB; (2) SPT itself; (3) SysMim itself**

- **Hierarchies** (1 of 110 SPT-SP's isomorphies); **Use Identifying Features & Functions for that (or any ISP):**

1. Subsumption = Super system – System – Sub system (Gerard) Subunit structure
2. Clustered (opposite of a spectrum)
3. Significant change in scale between levels
4. Levels are in a specific order
5. Constrained from above and below

- **Use Hierarchical Linkage Propositions to other isomorphs (Use LP's)**
  - Self-Organization is a partial cause of hierarchies (physics, chemistry)
  - Hierarchies are key organizers of networks (Troncale, 2016)
  - Hierarchies require flows between levels
  - Hierarchies significantly effect intra-level and inter-level feedback processes
  - BELOW SUBSTITUTE "SYSTEMS LAWS" for "Physical laws"

- Materials Engineering – the study, development and testing of materials and their properties
- Looking to develop new materials with application specific properties
  - Stronger, more flexible, >temperature resistant; fracture less;
  - High performance spacecraft, smaller batteries

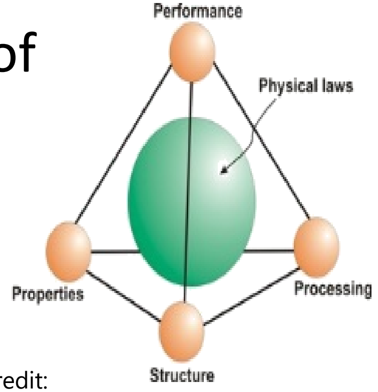
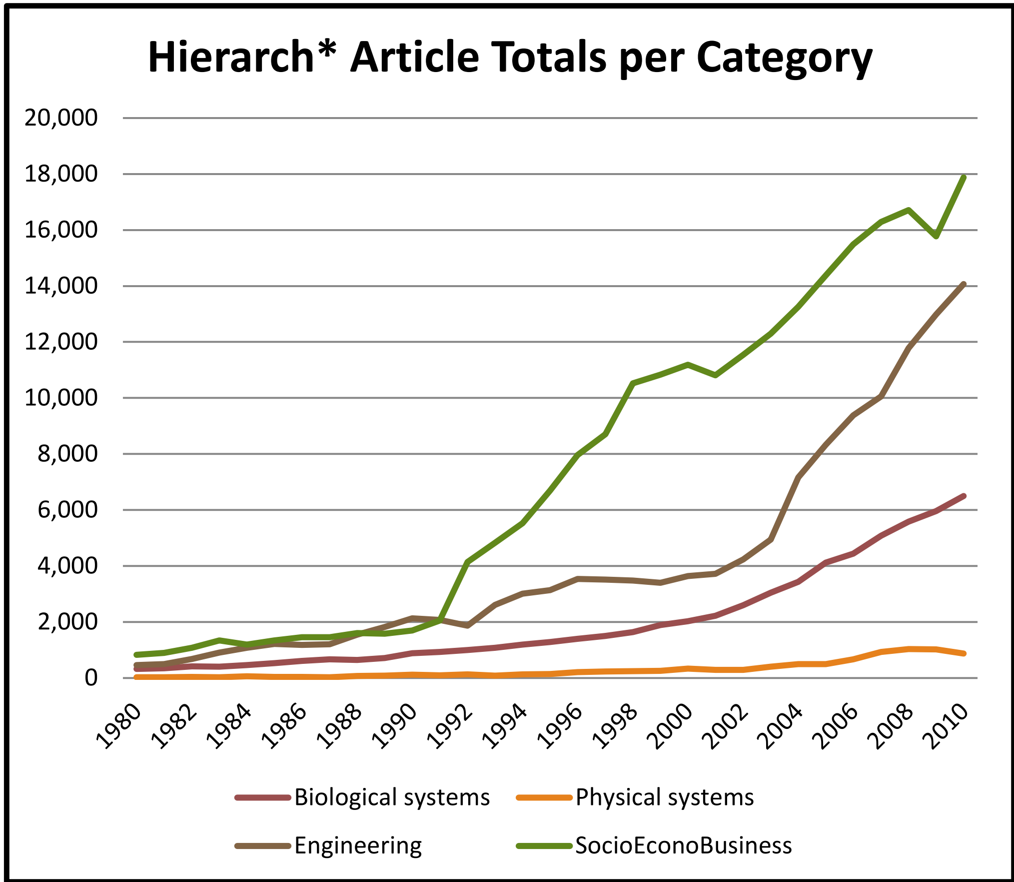


Image credit: http://www.cme.engineering.ualberta.ca/Undergraduate/MaterialsEngineering.aspx

Systems Mimicry in Materials Engineering

- By applying SPT and specifically hierarchies, we can enrich engineering design of specifications and materials production

- What follows are some selected case studies of a DOD/NASA study of the potential of mimicking hierarchical structure & processes in materials research
- If adopted as a Systems Mimicry, note the wealth of lit from the natural sciences on Hier available
  - Annual counts of reviewed articles
  - Trend across 30 yr period….
  - From hundreds/yr to tens of thousands/yr
  - From diff't sciences to human



Systems Mimicry in Materials Engineering

Case study - Tendons

- Tendons have complex material property requirements
  - Stiff to transmit force
  - Elastic to allow for movement
- The hierarchical structure (shown left) **distributes stress** and **minimizes risk of failure**

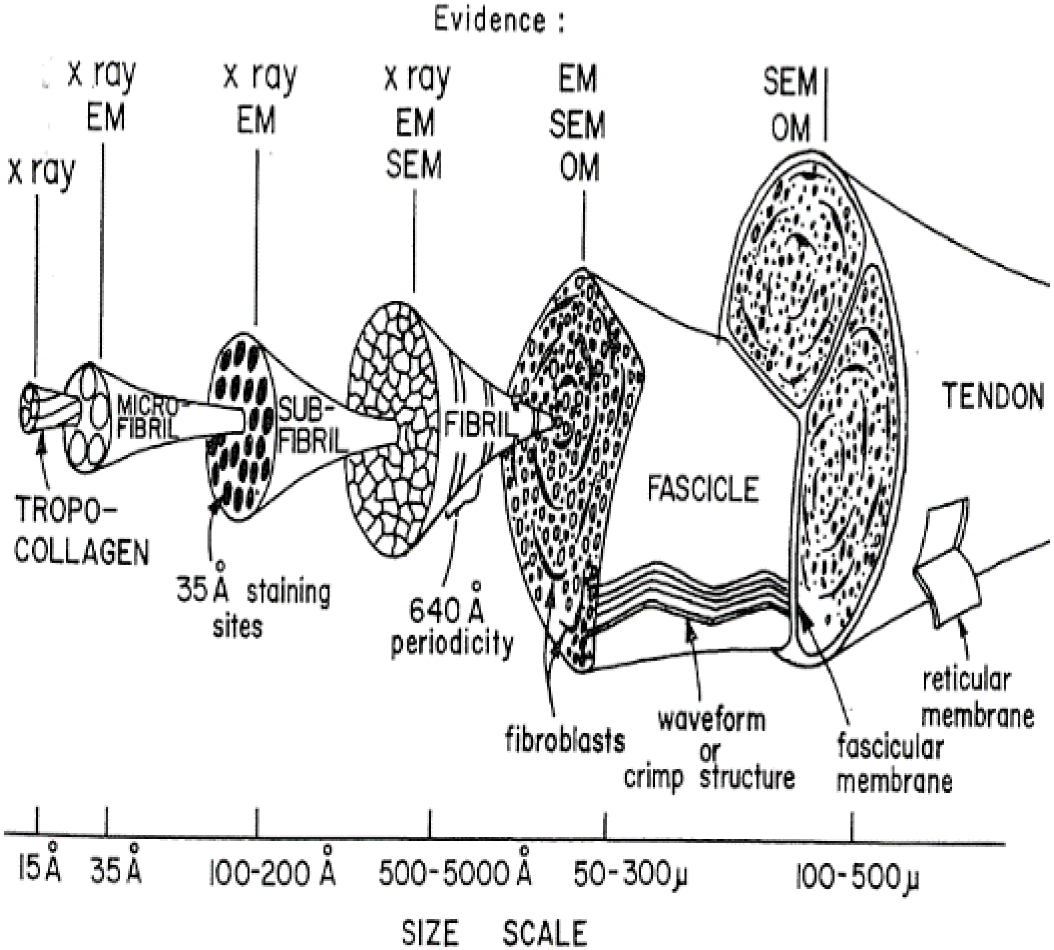


Image credit: http://www.intechopen.com/books/regenerative-medicine-and-tissue-engineering-cells-and-biomaterials/skeletal-regeneration-by-mesenchymal-stem-cells-what-else-

Systems Mimicry in Materials Engineering

Case study - Tendons

- Can use Systems Mimicry as copying of ISP or as Pathology of Hierarchies (Heteropathologies)
  - When the clusters in a hierarchy no longer directly feed into one another or if one level disappears the system fails
  - This can be seen when a tendon is placed under high strain
    - The subfibers, fibrils and microfibrils disassociate, leaving voids in the hierarchy
    - This causes permanent, irreversible damage to the tendons
    - Without the hierarchical structure the stress can not be distributed and can lead to dangerous loading (Hierarchical Structures, 1994)

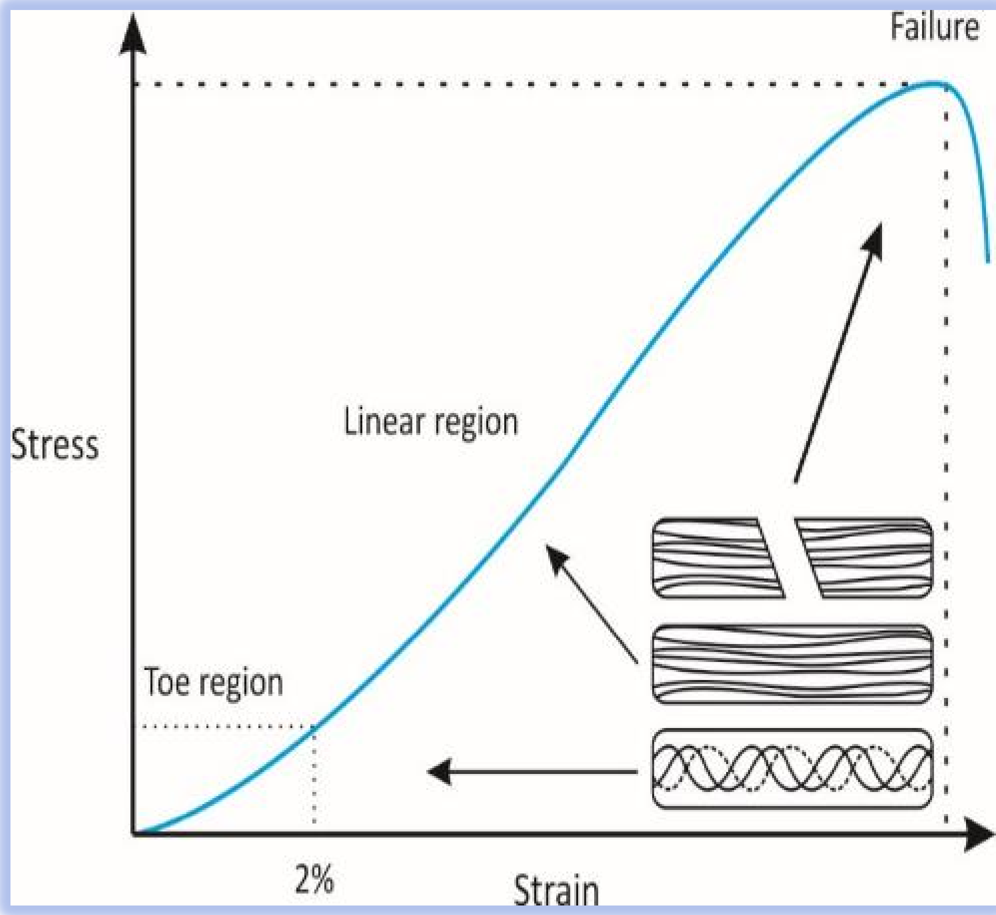


Image credit: http://www.intechopen.com/books/current-issues-in-sports-and-exercise-medicine/the-physiology-of-sports-injuries-and-repair-processes

Systems Mimicry in Materials Engineering

Case study – Wood, Glass

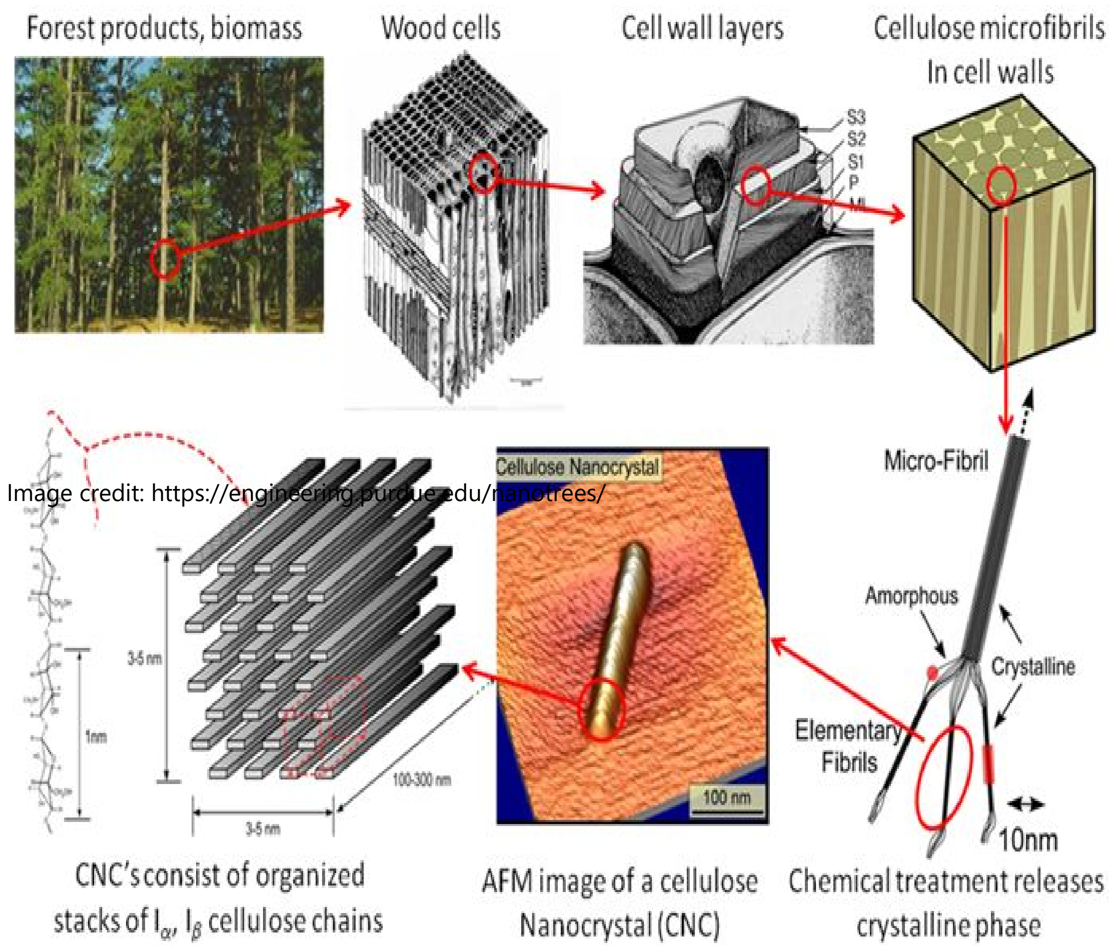
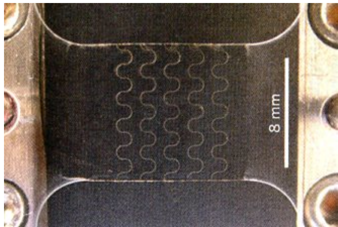


Image credit: https://engineering.purdue.edu/nanotrees/

- Wood cellulose is composed of microscopic cylinders that are oriented parallel to the trunk, providing increased stiffness
- The hierarchical structural arrangement gives the tree great fracture toughness
- Because of the controlled orientation of the cylindrical cells, if the cells fail they will do so in a direction that does not encourage fractures (Hierarchical Structures, 1994)
- Also found true for “glass” or any material suffering stress fractures; hierarchical structure reduces vulnerability to fracturing stress



Summary of Findings

The **National Research Council** in a study for DOD & NASA found these dozen potential uses of H. in metals, ceramics, polymers and hybrids involving these dozen needs and solutions:

(1) Recurrent use of constituents in Hierarchies
(2) Hierarchy-Controlled orientation
(3) Durable interfaces in Hierarchies
(4) Increased Variation in properties under Hierarchies
(5) Role of water in Hierarchies
(6) Fatigue resistance & self repair in Hierarchies
(7) Shape control in Hierarchies
(8) 1-, 2-, and 3- dimensional synthetic Hierarchies
(9) Hierarchical basis for mechanical behavior
(10) Hierarchical basis for synthetic processing procedures
(11) Compared with Hierarchy-based biology processing
(12) Moisture-friendly, energy absorbing, more durable synthetic systems

Hierarchical Structures in Biology as a Guide for New Materials Technology. Washington, D.C.: National Academy, 1994.

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SPT INTRODUCES >105
Isomorphic Systems Processes (here alpha list)

- Adaptation Processes
- Allometry, Systems-Level
- Allopoiesis
- Anergy Mechanisms
- Ashby's Conjecture (Requisite)
- Attractors
- Autopoiesis & Autocatalysis
- Bifurcations
- Binding Processes
- Boundary Conditions as a Proc
- Boundary Limits & Constants
- Catastrophe Processes
- Causality Processes (linear vs net)
- Chaotic Processes
- Circuits & Network Motifs
- Closed Systems
- Competitive Processes
- Complexity Processes
- Constraint Fields & Analysis
- Cooperative Processes
- Counterparity Diagrams & Proc's
- Criticality, Self-, Tipping Pts
- Cycles and Cycling, General
- Cycles, Rechargeable Loops Limit
- Decay, Autolytic & Senescent Proc
- Deterministic/Directive Process
- Deutsch's & Dollo's Conjecture
- Development Patterns & Laws
- Dissipative Processes
- Diversity & Variation Processes

- Equifinality as a Process
- Equilibrium & Steady State Proc's
- Ergodic Processes
- Evolutionary Processes
- Flow Processes
- Fractal Structure & Processes
- Functions, System (Goals)
- Growth Patterns & Laws
- Hierarchies & Clustering as a Process
- Integration Processes
- Interactions, Linkages, Connections
- Least Action/Energy Principles
- Limits, Informational
- Limits, Physical
- Limits, Wilson-Troncale
- Maximality Principles
- Minimization Principles
- Morphodynamic Processes
- Network Structure & Processes
- Non-Equilibrium Therm as SPs
- ems Processes
- ocesses
- s
- ocesses
- Processses

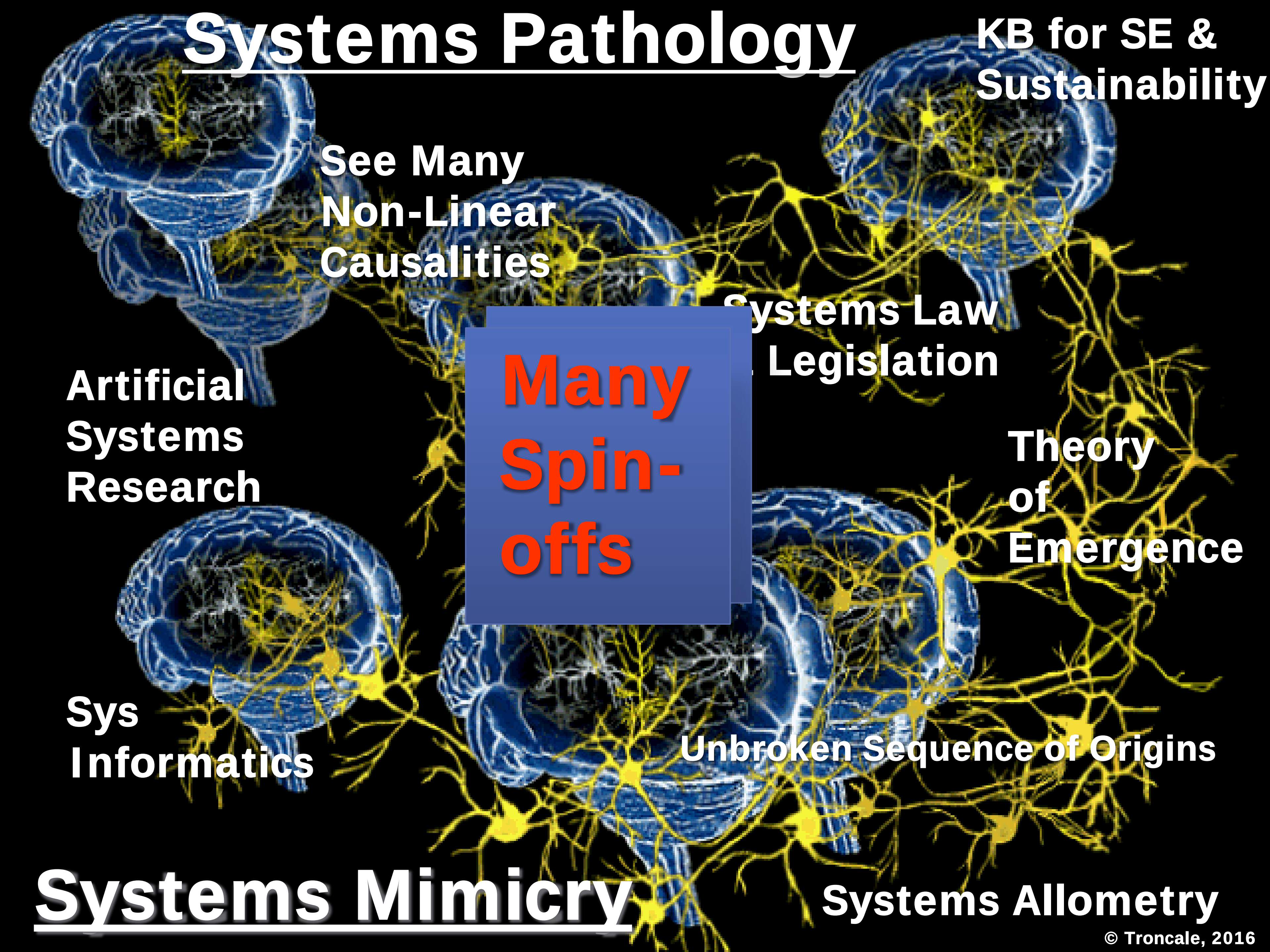
- Periodic Processes
- Phases, Stages, Transitions
- Pleioetiology as Process
- Pleiotrophy as Process
- Restructuring Rules
- Scaling & Scaled Processes
- Self-Organization
- Self-Reference Processes
- Singularities
- Soliton Theory (Long Waves)
- Spin Processes
- Stability Processes
- States, Systems
- Steady State Mechanisms
- Storage Processes
- Strings, Generic Systems
- Sub-Specialization Processes
- Symmetry, Systems-Level
- Symmetry-Breaking as a Process
- Synergetic-Synchrony Processes
- System Identification, Sub-, Super-
- Systems of Systems Processes
- Thermodynamic Processes
- Transducer Processes
- Transgressive Equilibrium
- Variation Production as a Process
- Zipf's/Pareto's Patterns (as Proc's)

….IMAGINE USING HIERARCHY FOR OTHER ENGINEERING DISCIPLINES AND USING 104 OTHER ISOMORPHIC SYSTEMS PROCESSES

….the dynamic aspect of hierarchy = heteropoiesis

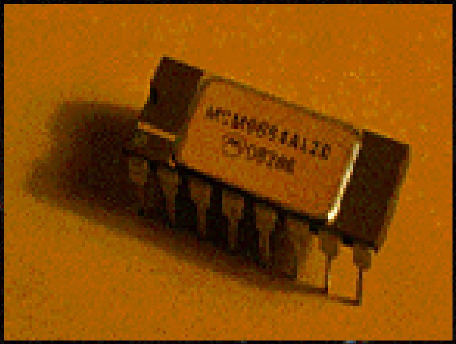
FOR THISTALK WE USED ONLY ONE ISP TO ILLUSTRATE SYSTEMS MIMICRY….

(4) Systems Mimicry is a Spin-Off of SPT

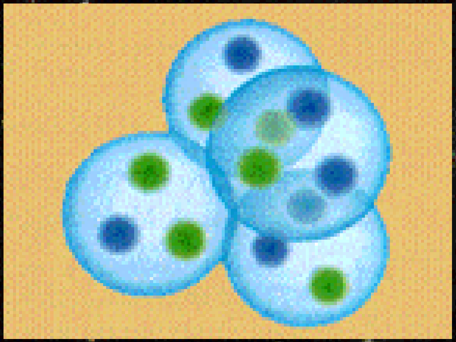

Systems Pathology
KB for SE &
Sustainability
See Many
Non-Linear
Causalities
Systems Law
Legislation
Many
Spin-
offs
Artificial
Systems
Research
Theory
of
Emergence
Sys
Informatics
Unbroken Sequence of Origins
Systems Mimicry
Systems Allometry
© Troncale, 2016

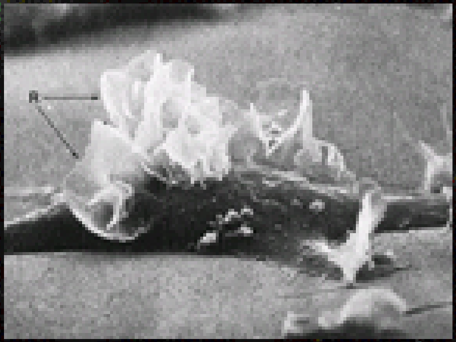
(4) Brief Intro to SPT

Although, on the surface, these many objects in the Universe originated at different times, at widely different scales, & appear to be very different…



First, what do we mean by Isomorphy…



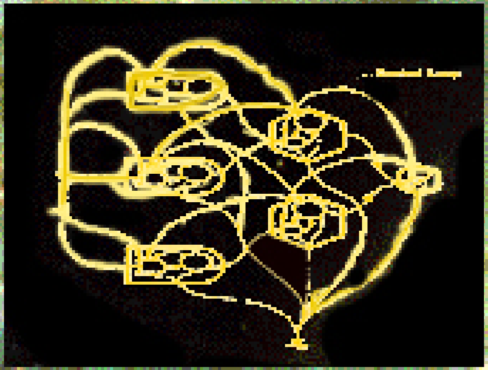


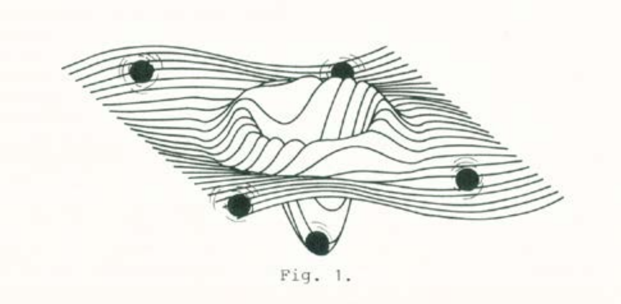

…when you go beyond their
particulars to their general
dynamic structure & function…

…fundamentally, they exhibit identical key processes & dynamics

WE CALL THESE UNIVERSALS…

ISOMORPHIC SYSTEMS PROCESSES (ISP’s)





…Why? Especially if their origin times and mechanics of origins are so completely separate and different from each other…

…This unified Systems Processes Theory (SPT) states it is because the SP’s are the multi-parameter MIN/MAX CASES…

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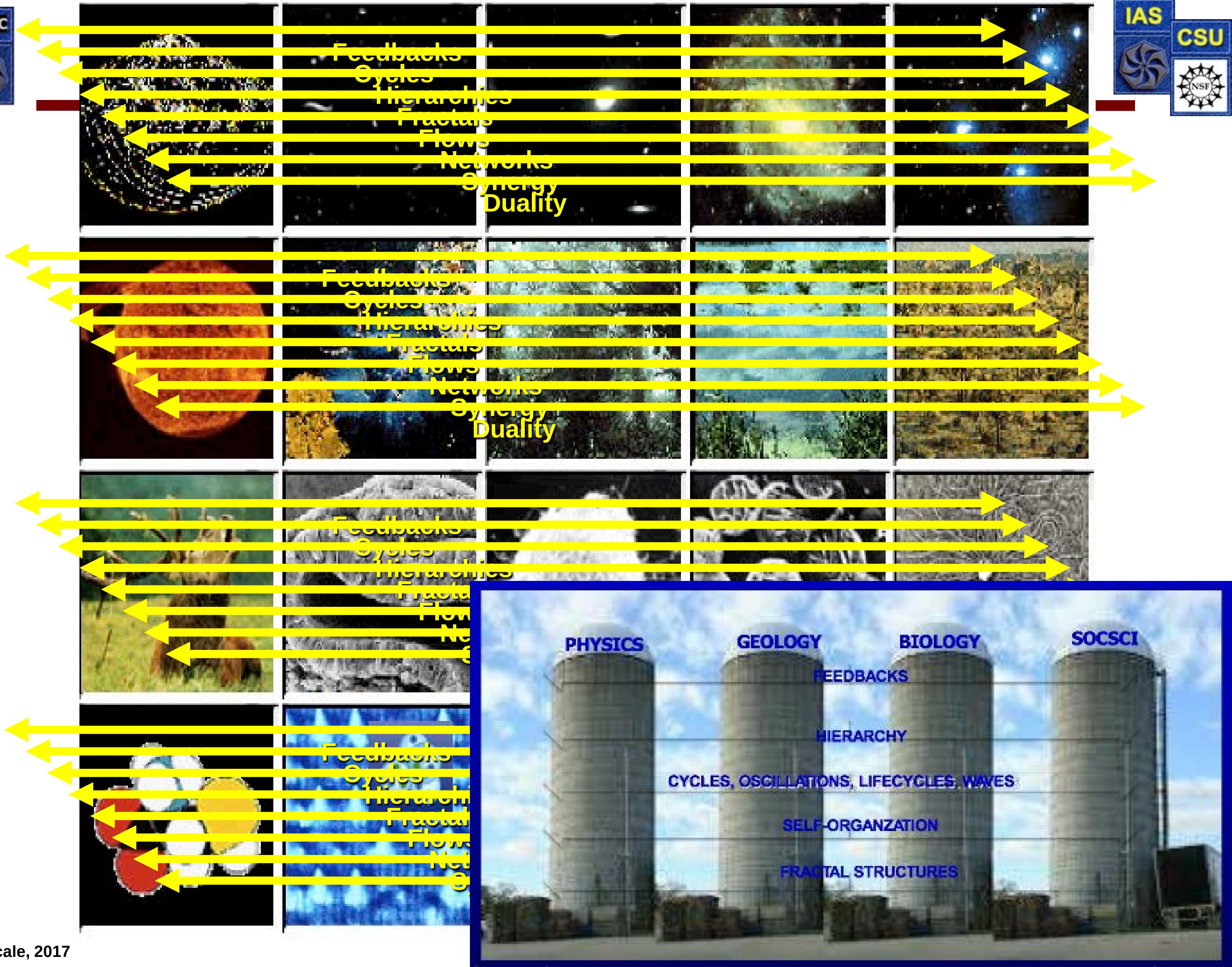


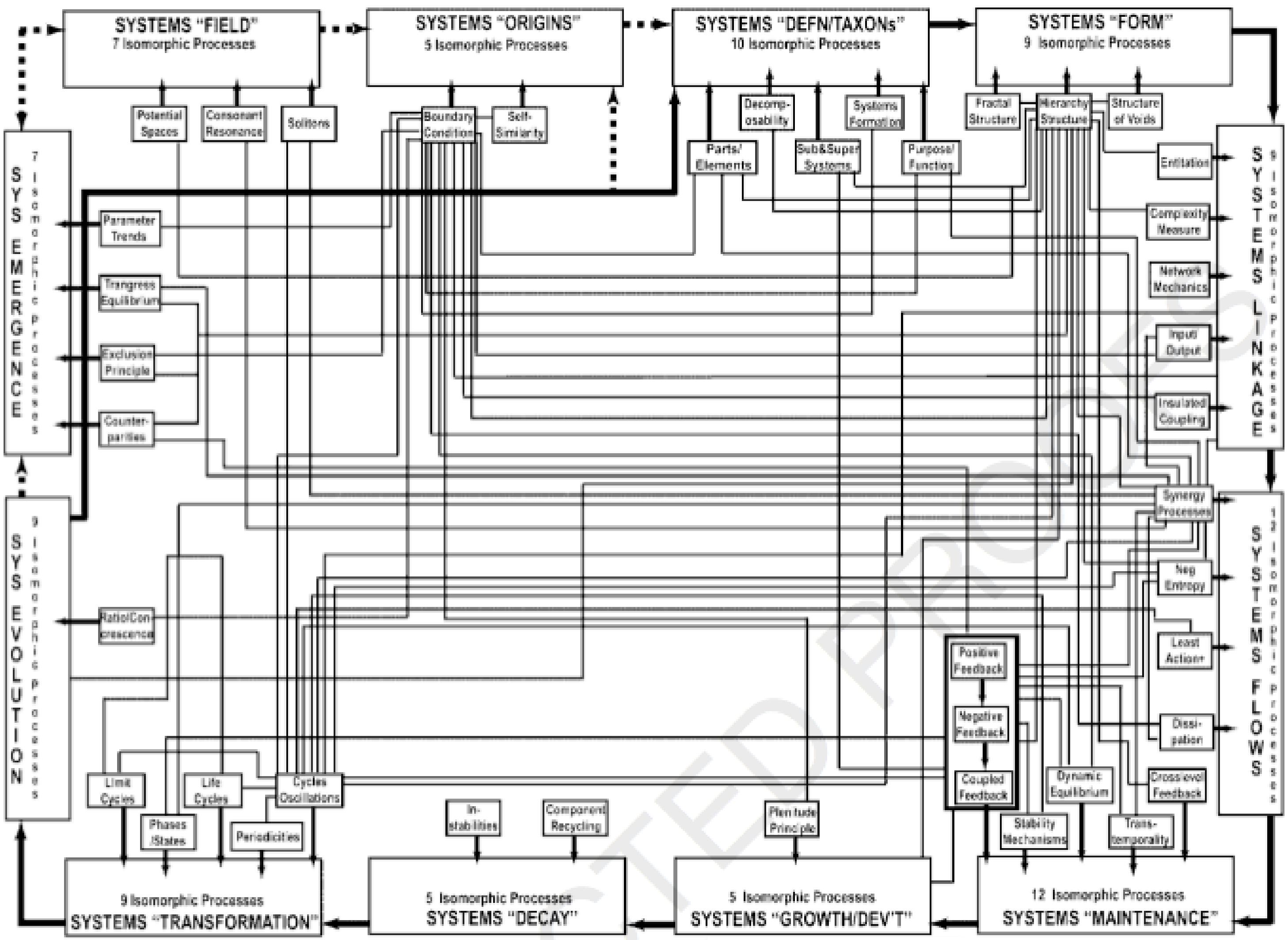
So Main-Basic SPT Features/Advances

- Rigorous focus on science-basis for Systems Processes
  - Documents 110 "candidate" isomorphic sys processes/patterns valid across all the natural sciences from science experiments
- Adds new level = Linkage Propositions; documents each
  - Identifies how these many SP's influence each other; SoS network
  - Explain systems dynamics & complex systems in unprecedented detail with hundreds of LP's; details how systems work
  - Thus delivers a general model of successful systems
- Describes in Rich Detail How Systems Don't Work
  - Identifies, explains numerous Systems Pathologies (dysfunctions)
  - Once you know details of "steps" in each universal process,
  - You can easily see the ways a universal process can go wrong
- Rich, as a theory should be, in SPIN-OFF's (previously shown)
- Provides a FRAMEWORK for S/I/U of fragmented Sys KB
  - Reserved place for all possible details on systems design/behavior
  - Can be formalized in Math later (e.g. use Graph & Category Theory)

> 20 KEY CONTRIBUTIONS OF SPT

1. MANY MORE ISOMORPHIES
2. NEW ISOMORPHIES FROM THE PHYSICS OF COMPLEX SYSTEMS
3. UNIQUE ISOMORPHS NOT FOUND ANYWHERE ELSE
4. MUCH MORE INFORMATION PER ISOMORPHY
5. GIVES EVIDENCE OR TESTS OF ISOMORPHY (TRUE SCIENCE)
6. “ROOTS”/”PRECEDENCE” FOR EACH ISOMORPHY
7. INTROsLINKAGE PROPOSITIONS: EXPLAIN HOW SYSTEMS WORK
8. LIST OF PATHOLOGIES HOW SPECIFICALLY SYS DON’T WORK
9. MODEL THAT TRANSFERS WELL BETWEEN SCIENCE DISCIPLINES
10. BRIDGES ‘GAPS’ BETWEEN PHYS, LIVING, SOCIAL SYSTEMS
11. PROVIDES CONSISTENT FRAMEWORK FOR UNIFICATION
12. >>CASE STUDIES LINKING EACH ISOMORPH TO SCI PHENOM’S
13. SIGNIFICANTLY GREATER SPECIFICITY & DETAIL ON LP’s
14. RULES FOR ABSTRACTION
15. RULES FOR DE-ABSTRACTION
16. LISTS OF DOZENS OF NON-LINEAR CAUSALITY
17. HANDLES & LEVERS (TOOLS) FOR DEEPER APPLICATIONS
18. SOURCE OF DEEP HYPOTHESES FOR THE NATURAL SCIENCES
19. SUPPLIES PRACTITIONERS WITH MASSIVE DATA BASE
20. INTRODUCES DISCINYMS
21. TIES INTO ALLOMETRIES DATA
22. ENABLES MOREMODEL TRANSFER

SPT Adds 100's Linkage Propositions
(how ISP's influence each other)



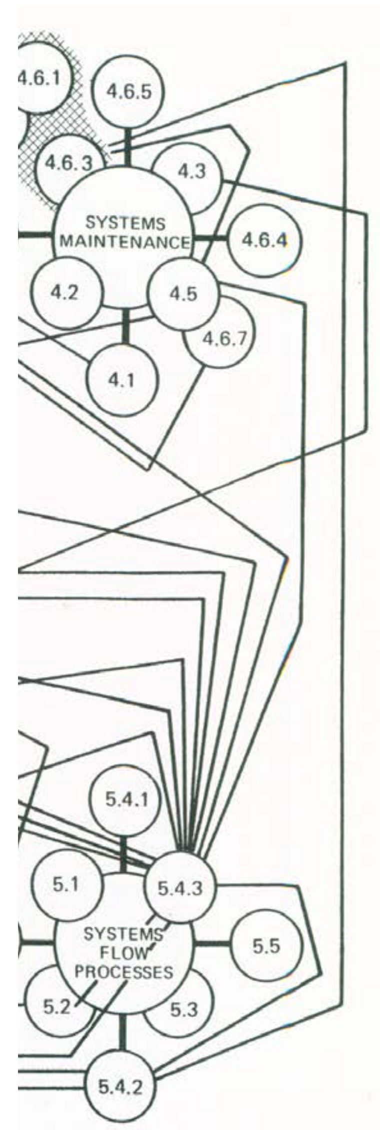


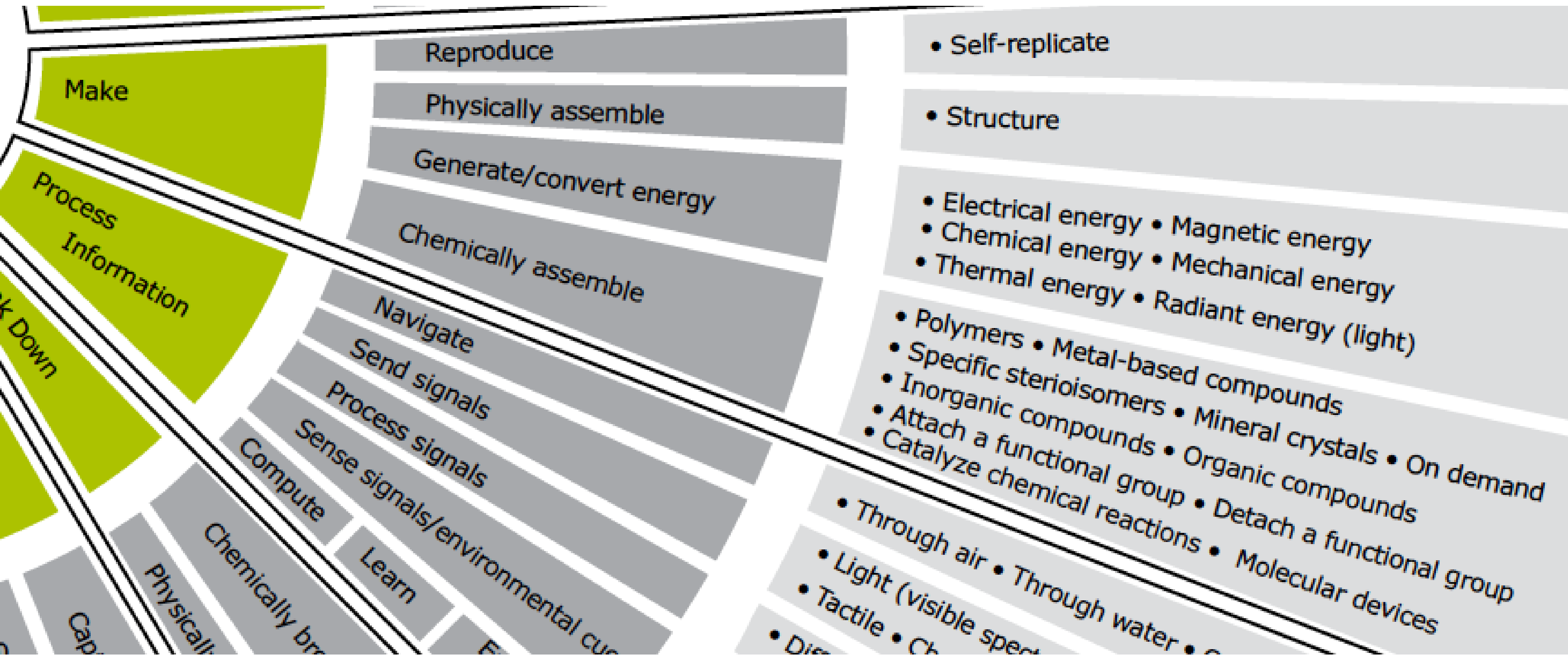
Figure 2. Network map showing ~85 linkage propositions between 5 systems "functions" *and the 42 systems processes with which they experience mutual influences*

Please see INCOSE CAB, Fellows, SSWG Webinar #'s 28, xx, xx for >>SPT Info

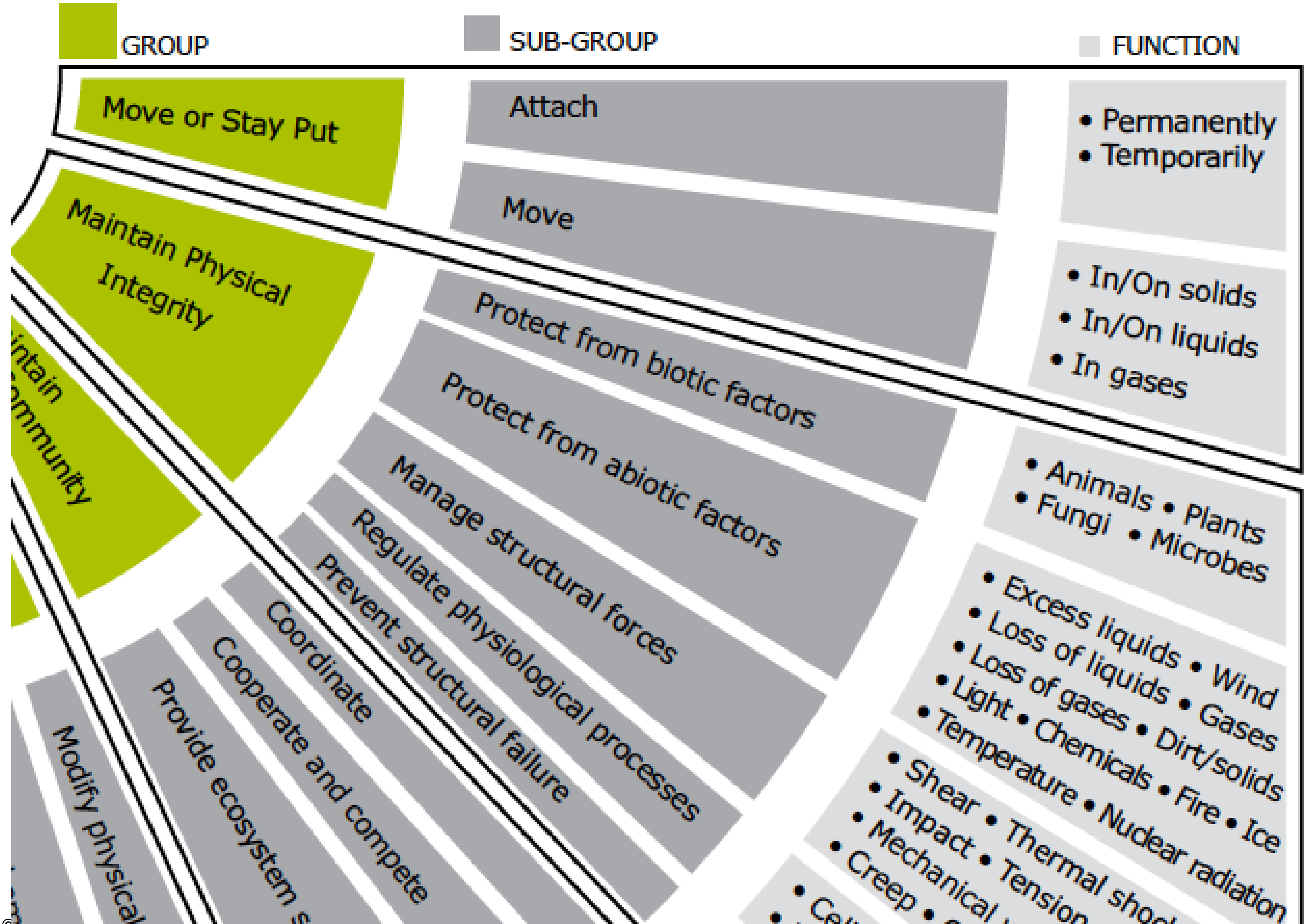
(5a) NEW Tool & Strategies for Guiding Systems Mimicry

AskNature Biomimicry Taxonomy

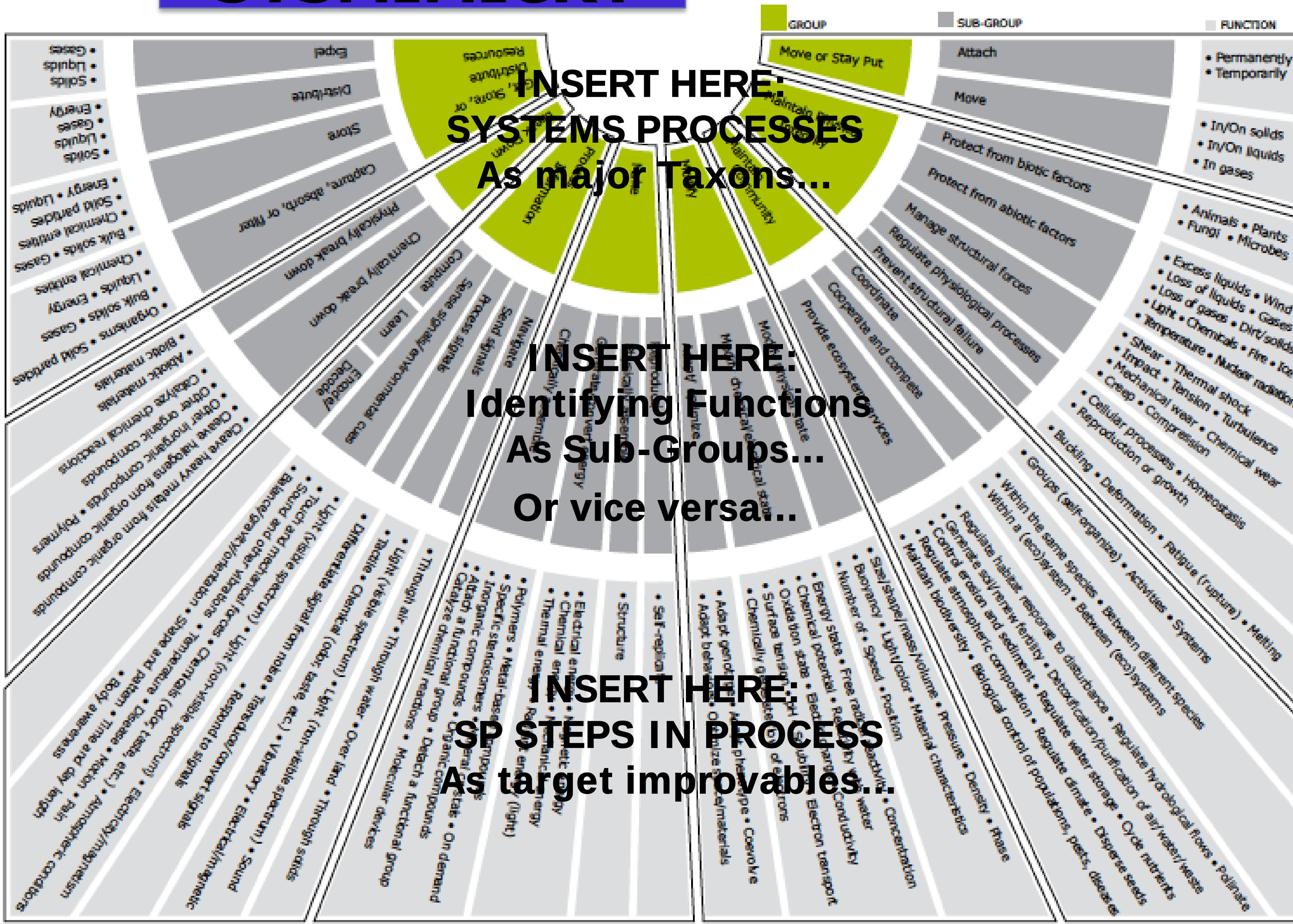
- **At-A-Glance format; all in one page; impressive; useful**
  - **But fairly arbitrary, experiential categories; liked early groups more**
  - **Wetting? Less friction? Fiber strengths? Flex, no break? Adhesion?**
- **For source biomimicry website go to….**
  - **http://www.asknature.com** **altho' I cannot find it there (McNamara)**



AskNature Biomimicry Taxonomy



SYSMIMICRY TAXONOMY



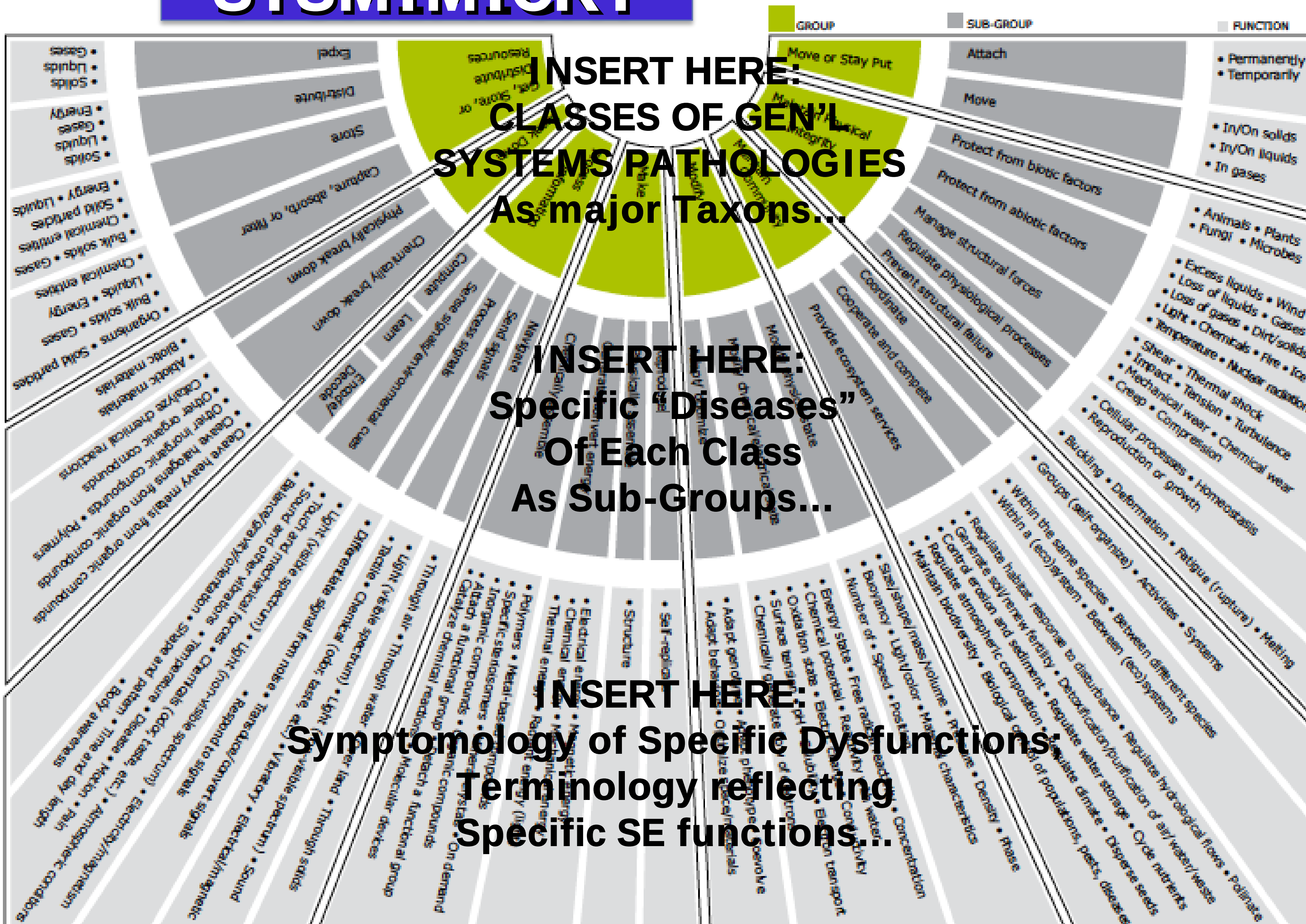
INSERT HERE:
SYSTEMS PROCESSES
As major Taxons…

INSERT HERE:
Identifying Functions
As Sub-Groups…

Or vice versa…

INSERT HERE:
SP STEPS IN PROCESS
As target improvables…

SYSMIMICRY TAXONOMY



INSERT HERE:
CLASSES OF GEN'L SYSTEMS PATHOLOGIES
As major Taxons…

INSERT HERE:
Specific "Diseases"
Of Each Class
As Sub-Groups…

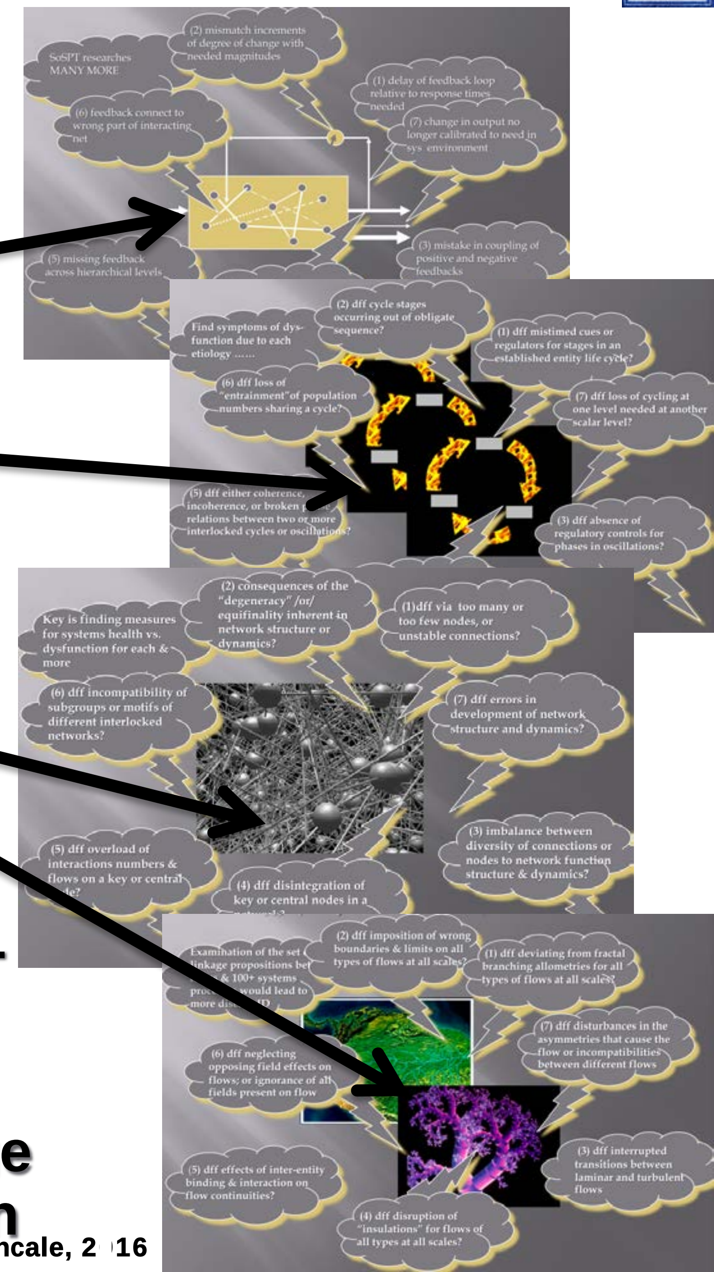
INSERT HERE:
Symptomology of Specific Dysfunctions;
Terminology reflecting
Specific SE functions…

(5b) Using SPT new Systems Pathology As A Strategy

Glimpse of Sys Pathology

What do I mean by a NEW Top-down strategy…….

- **ID MAJOR CLASSES OF SYSTEMS-LEVEL DISEASES BASED ON SPT SYSTEMS PROCESSES: <u>NAME THEM</u>**
- **Then IDENTIFY many specific diseases for each CLASS of Dysfunction**
  - **Cyberpathologies: errors in feedback**
  - **Cyclopathologies: errors in cycling, oscillation**
  - **Nexopathologies: errors in network str & dynamics**
  - **Rheopathologies: errors in flow**
  - **Heteropathologies: errors in modular structure, etc.**
  - **AS MANY AS FIFTY CLASSES OF SPT PATHOLOGIES** each with dozens of specific dysfunctions = resolution of hundreds of specific malfunctions
- **SYSTEMS MIMICRY would use knowledge of SysPath to "fix" errors in fcn or design**



(5c) Action Projects for Birth of Systems Mimicry

ACTION NOW

- **POPULATE ACCESS TOOL: (Make available free online)**
  – Provide up front taxonomy of general systems functions; tied to each ISP & application
- **OPEN ACCESS Systems Mimicry Relational Data Base:**
  – If already thousands of data; organized place for every possible entry; relational; graphic
- **WRITE SYSTEMS MIMICRY BOOK: (Benyus, 1997)**
  – Several of the referenced books on biomimicry are collections; (Ed.’s)
  – Often dozen or more authors, each a specialist, each a diff’t applic’n
  – Do the same for Systems Mimicry (will you join me, write a Chapter?)
- **INCORPORATE INT’L SOCIETY FOR SYSTEMS PATHOLOGY (ISSP)**
  – Already underway; Written/Passed By-Laws; First Officers; Manifesto
  – Board of Director’s app’td; Founding Members until 2020
- **WRITE TWO DEADLINED SYSTEMS TEXTS**
  – “Systems Processes Theory: The Other Theory of Everything”
  – Will have Chapters on Systems Mimicry & Systems Pathology as SPT Spin-Off’s
  – “Introduction to Systems: Unification of a Spectrum of Fragmented Approaches”
- **Each Above Contributes to Other’s Above: Synergy**

END

END

QUESTIONS???

Biblio of 28 ref's follows

Some follow-up references I.:

- **On Biomimicry as a basis for Systems Mimicry**
  - [Note: Searching on *biomimicry* on Amazon retrieves more than 250 book titles. A search on Google gets nearly half a million hits.].
  - Benyus, J.M. (1997) *Biomimicry: Innovation Inspired by Nature.* Morrow, N.Y., 308 pp. [Hon T 173.8 B45]
  - Allen, R., Ed. (2010) *Bulletproof Feathers: How Science Uses Nature's Secrets to Design Cutting-Edge Technology*. University of Chicago Press, Chicago, 192 pp.
  - Bar-Cohen, Y. Ed. (2006) *Biomimetics: Biologically Inspired Technologies*. CRC Taylor & Francis, N.Y., 527 pp. [Spr QP 517 B56]
  - Sarikaya, M. & I.A. Aksay (1995) *Biomimetics: Design and Processing of Materials*. AIP Press, Am, Woodbury, N.Y., 285 pp.
  - Lahtakia, A. & R. J. Martin-Palma (Ed.'s)(2013) *Engineered Biomimicry*. Elsevier, MA. 465 pp. [17 Chapters on wide range of biomimicry applications] [Hon T 173.8 E53]
  - Scipione, A. (Ed.) (2013) *Focus on Biomimetics Research*. Computer Science, Technology & Applications Series. Nova, N.Y., 161 pp. [Hon Q320 F63]
  - Liu, Y. & D. Sun (Ed.'s) (2012) *Biologically Inspired Robotics*. CRC Press, Taylor and Francis, N.Y., 324 pp. [Hon TJ 211 B5553]

Some follow-up references II.:

- **On Biomimicry as a basis for Systems Mimicry**

  - Lee, M. (Ed.) (2014) *Remarkable Natural Material Surfaces & Their Engineering Potential*. Springer, N.Y., 163 pp. [Hon T 173.8 E46] [almost all 13 Chapters written by Ed.]
  - Jelinek, R. (2013) *Biomimetics: A Molecular Perspective*. DeGruyter, Germany. 252 pp. [Hon QP 517 B56 J45] [more biology oriented especially at molecular level]
  - Forbes, P. (2006) *The Gecko's Foot: Bio-Inspiration: Engineering New Materials from Nature*. Norton, N.Y., 272 pp. [Hon T 173.8 F63] [popular reading level]
  - Harman, J. (2013) *The Shark's Paintbrush: Biomimicry and How Nature is Inspiring Innovation*. White Cloud, Oregon. [Hon T 173.8 H373] [popular reading level]
  - Neville, A.C. (1993) *Biology of Fibrous Composites: Development beyond the cell membrane*. Cambridge Univ. Press, UK, 214 pp. . [Hon QH 603 C96 N48]
  - Dillow, A.K. & A.M. Lowman (Ed.'s) (2002) *Biomimetic Materials and Design: Biointerfacial Strategies, Tissue Engineering, and Targeted Drug Delivery.* Dekker, N.Y., 679 pp. [Hon QP 517 B56 B546] [much more biological than engineering focused]

Some follow-up references III:

- **On Systems Mimicry**
  - Troncale, L. (2014) "SysInformatics and Systems Mimicry: New Fields Emerging from a "Science" of Systems Processes Engineering." Procedia Computer Science, CSER Conference. Modni, Boehm and Wheaton (Ed.'s)
  - Troncale, L. (2016) "Beyond Biomimicry to Systems Mimicry: Using Evidence from the Natural Sciences To Design Better Systems." INCOSE Insight Article.
  - National Research Council (1994) *Hierarchical Structures in Biology as a Guide for New Materials Technology.* Committee on Synthetic Hierarchical Structures, National Materials Advisory Board. NMAB-464. National Academy Press, US-Washington, D.C., 130 pp.
  - Numerous ISSS Annual Conference presentations since 2000.

Some follow-up references IV:

- **On Systems Mimicry Case Studies**

  - Bartlett, N.W., M.T. Tolley, J.T.B. Overvelde, J.C. Weaver, B. Mosadegh, K. Bertoldi, G. M. Whitesides, and R.J. Wood. 2015. "A 3D-printed, functionally graded soft robot powered by combustion." *Science* 349(6244): 161-165.
  - Eiben, A.E. and J. Smith. 2015. "From evolutionary computation to the evolution of things." *Nature 521*:476-482.
  - Liu, Z.F. 2015. "Hierarchically Buckled Sheath-Core Fibers for Super-Elastic Electronics, Sensors, and Muscles." *Science* 349(6246): 400-404.
  - National Research Council (1994) *Hierarchical Structures in Biology as a Guide for New Materials Technology.* Committee on Synthetic Hierarchical Structures, National Materials Advisory Board. NMAB-464. National Academy Press, US-Washington, D.C., 130 pp.

Some follow-up references V:

- **On Strategies for Systems Mimicry**
  - Zwicky, F., "Morphological Astronomy", The Observatory. Vol. 68, No. 845, Aug. 1948, S. 121-143.
  - Zwicky, F., A.G. Wilson, (Ed.'s) 1967. New Methods of Thought and Procedure. Springer-Verlag, N.Y., 338 pp.
    - Out-of-print; in my library; obtained directly from Mrs. Zwicky thru help of my Institute Fellows, Dr. Emil Herzog and Dr. Al Wilson, his former Caltech doctoral students; "brain trust" members of early aerospace companies
  - Zwicky, F., Discovery, Invention, Research - Through the Morphological Approach, Toronto: The Macmillian Company (1969).
  - See Swedish Morphological Society (swemorph.com) Dr. Tom Ritchey

  - Greenstein J. & Wilson A.(1974) "Remembering Zwicky". Engineering and Science 37:15-19. Thanks to the Swiss Fritz Zwicky Foundation.
  - Milo et. al. (2002) "Network motifs: Simple building blocks of Complex Networks." Science 298: 824.

Some follow-up references VI.:

- **On Intro to Systems Processes Theory (SPT)**

  - Troncale, L. 1978. "Linkage Propositions between Fifty Principal Systems Concepts." In G. J. Klir, (Ed.) *Applied General Systems Research: Recent Developments and Trends.* N.A.T.O. Conference Series II. Systems Science. Plenum Press, US-NY. pp. 29-52. THE ORIGINAL PAPER ON SPT
  - Friendshuh, L., and L. Troncale. 2012. "SoSPT I.: Identifying fundamental systems processes for a general theory of systems (GTS)" in *Proceedings 56th Annual Conference, International Society for the Systems Sciences (ISSS)* ISSN 1999-6918. http://journals.isss.org/index.php/proceedings56th/article/viewFile/2145/676
  - McNamara, C. and L. Troncale. 2012. "SPT II: How to find and map linkage propositions for a GTS from the natural sciences literature." in *Proceedings 56th Annual Conference, International Society for the Systems Sciences*, ISSN 1999-6918
  - Troncale, L. 2011. "Would A Rigorous Knowledge Base in Systems Pathology Add Significantly to the SE Portfolio," *CSER'11 Proceedings*, Conference on Systems Engineering Research, April 14-16, Redondo Beach, CA. Troncale, L. Systems Processes and Pathologies: Creating an Integrated Framework for Systems Science. *Proceedings of the INCOSE 23rd International Symposium,* 24 pp.

Today's Presentation

Things to Think About

How can this be applied in your work environment?

What did you hear that will influence your thinking?

What is your take away from this presentation?

Please

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