INTEGRATION OF SOURCES ON FLOWS-INTERACTIONS AND NETWORKS FOR A SYSTEM OF SYSTEMS PROCESSES (SSP) MODEL AND APPLICATION TO ECOSYSTEMS - THE GENSYSML TOOL

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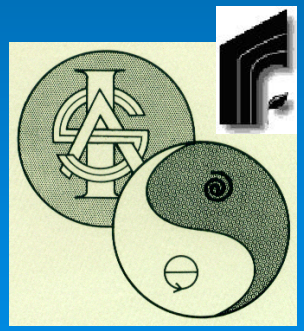
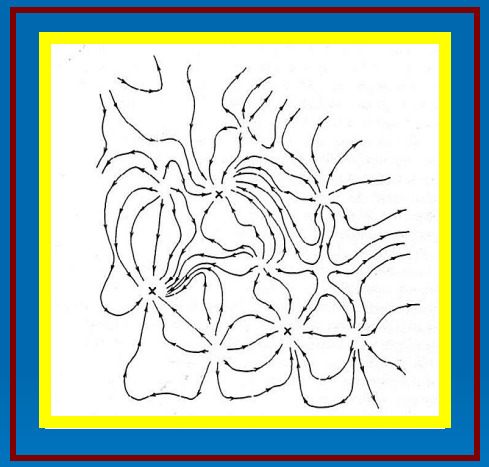


PURPOSE

- Contribute to the knowledge of complex systems by adding information to the current set of isomorphies.
- Contribute to the identification of the common processes of any real systems.
- Investigate possible interaction between systems processes known as "Linkage Propositions"



- Identify the position of candidate isomorphies in a general system theory (the SSP) and its life cycle.
- Investigate trends in the scientific literature of the last thirty years for Flows-Interactions and Networks.
- Contribute to the development of a coordinated GENSYSTML database for use by scholars and students.

WORKING DEFINITIONS

The collaborating student teams collected a diverse sample of definitions for each isomorphic system process for comparison and synthesis of various definitions. These are some samples:

Networks:

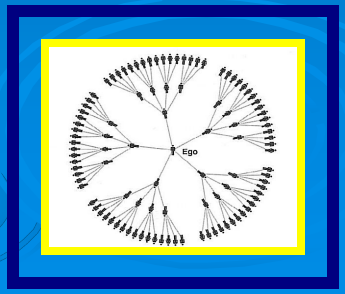
- **"A system of channels, communication links, paths of information flow, roads etc., resembling a fabric of wiring diagram and describable as a graph". (Krippendorff)**
- **"A fluid flexible and dense pattern of working relationships that cut across…..boundaries".(Eccles)**

Examples*: *electronic information systems, neural pathways.

Flows–Interactions:

- **"To move with a continual change of place among the constituent particles" (Webster's Medical Dictionary) e.g. blood flows in veins - water flow in rivers.**
- **"Any of four fundamental ways in which elementary particles and bodies can influence each other" (American Heritage Dictionary).**

Examples*: *strong - weak - electromagnetic - gravity.



IDENTIFYING FEATURES AND FUNCTIONS

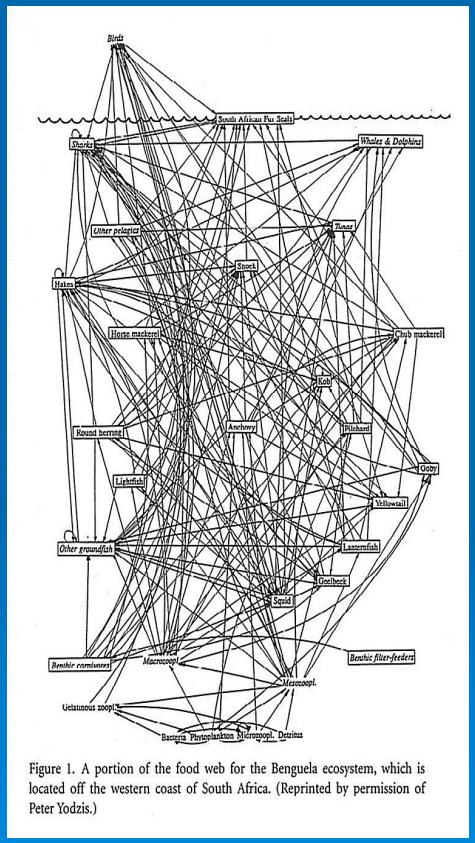


Figure 1. A portion of the food web for the Benguela ecosystem, which is located off the western coast of South Africa. (Reprinted by permission of Peter Yodzis.)

NODES

CONNECTIONS (EDGES)

MULTIPLE PATHS

CLUSTERS/GROUPS

EFFICIENCY-ROBUSTNESS

INCREASES POSSIBLE PHASES AND STATES

TYPES AND TAXONOMIES

Types and taxonomies of networks for comparison, analysis, diagnosis, and input into GENSYSML:

- **Complex Networks:** "Combination of randomness and precise rules."
- **Scale-Free Networks:** "poor connectivity with few nodes highly connected" (Barabasi).
- **Small World Networks:** "a constant number of nodes linked according to a regular order." (Horst)

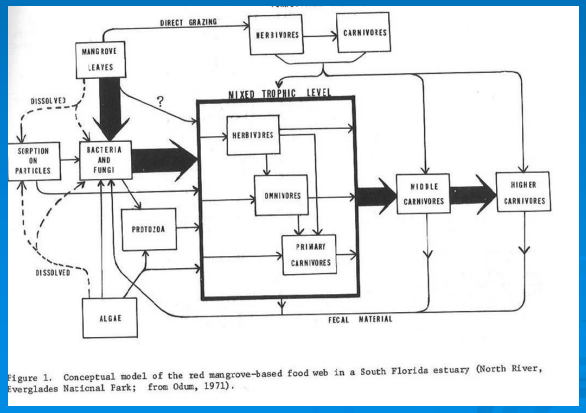
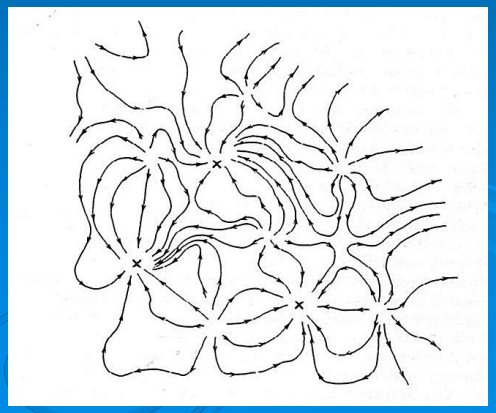


Figure 1. Conceptual model of the red mangrove-based food web in a South Florida estuary (North River, Everglades National Park; from Odum, 1971).



TYPES AND TAXONOMIES

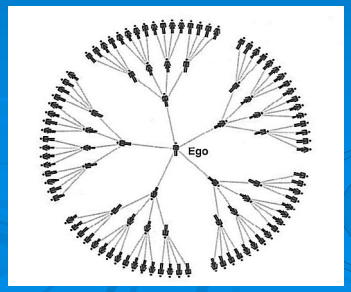
- **Multiscale:** "(ecological) Networks connected across different hierarchical levels with links extending through the hierarchy." (Watts)

- **Social:** "networks between people, individual or groups evolving under social forces (Watts)

- **Linear:** " a network in which all nodes or stations are connected by a single line (Bus) (ATIS)

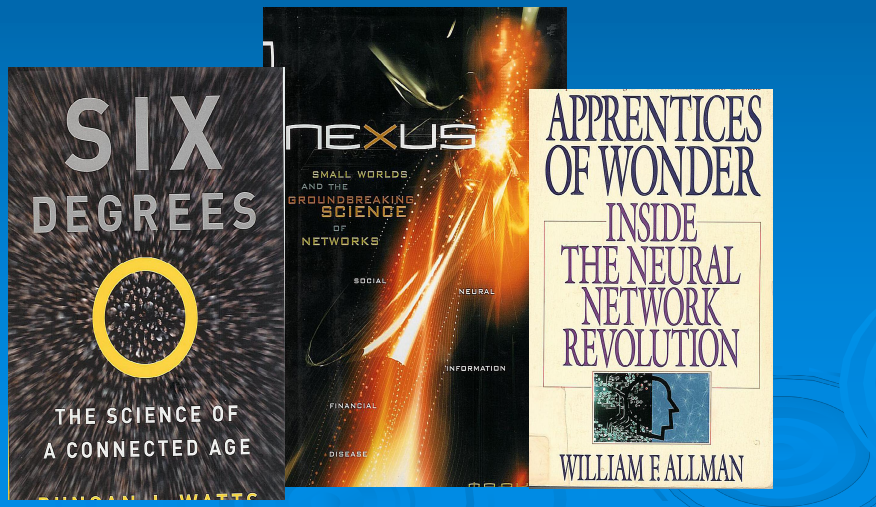
- **Global vs. Local:** "covering an unlimited or limited geographical area. Dictionary of Computing)

- Star (hub & spoke), Directed, Daisy-Chain, Ring Networks: Although topologies for computer networks, the flow of information distinguishing these structures might be useful in studying other net types. Does info flow in one direction, or bidirectional, or thru a central hub, or along a chain?



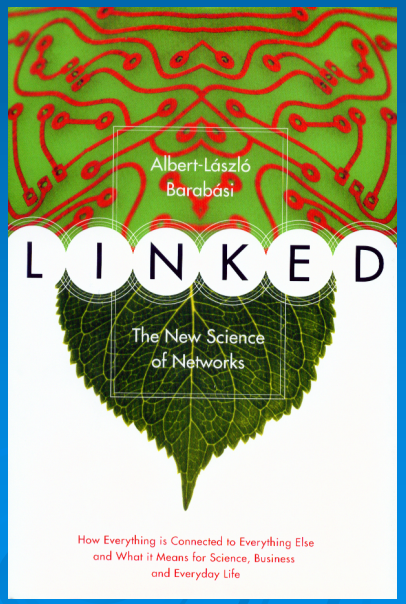
SAMPLE INFO BITS

- **"If one brain region has links to two others, then these two other regions are also likely to share a link". (Whether you are studying knots of neurons or friends). (Vito Latora, Massimo Marchiori)**
- **" Networks of crucial biochemical reaction of networks of 43 difference organism….show almost precisely the same architecture as that of internet and the world wide web". (Barabasi, Hawoong Jeaong et al)**



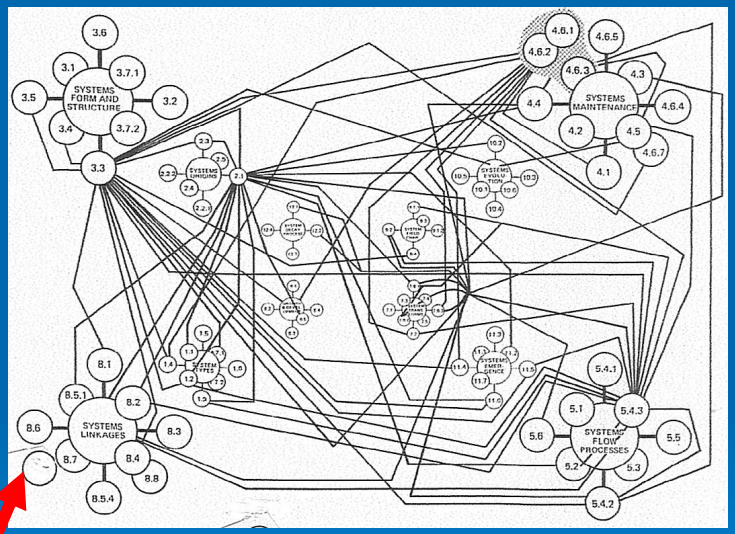
LINKAGE PROPOSITIONS

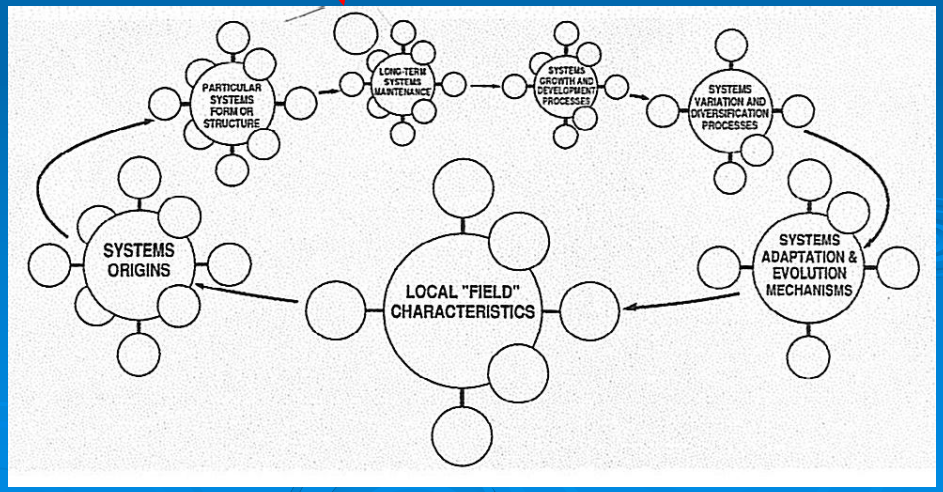
NETWORKS (small world type) are a potential cause of SYNCHRONY



POSITION IN SSP AND GS LYFE CYCLE

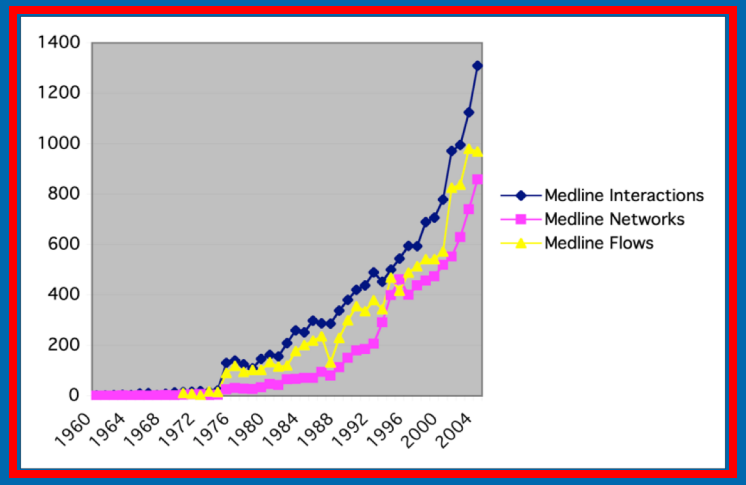
The red arrows mark the position of Networks Flows-Interactions in the SSP and GS Life Cycle.



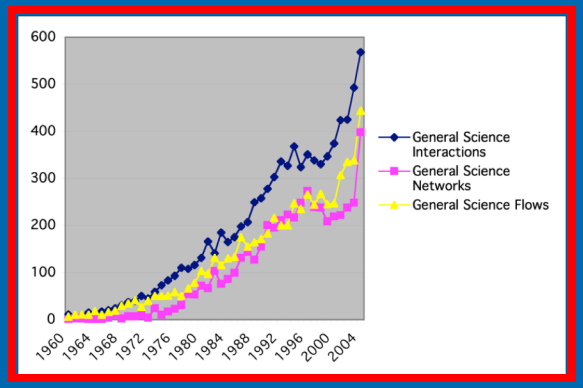


SCOPE AND TRENDS IN LITERATURE

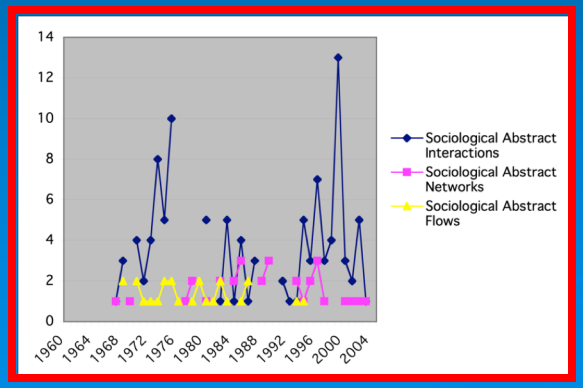
This graphs show the trends in the Medical, General Science and in the Social Science literature in the last 45 years



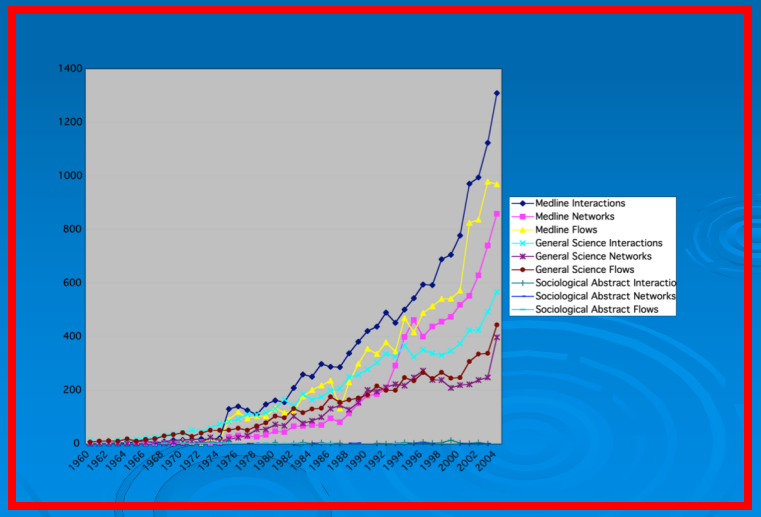
BIOLOGICAL



GENERAL SCIENCE



SOCIAL



BIOLOGICAL, GENERAL SCIENCE, SOCIAL

SAMPLES OF KEY WORKERS AND INSTITUTIONS

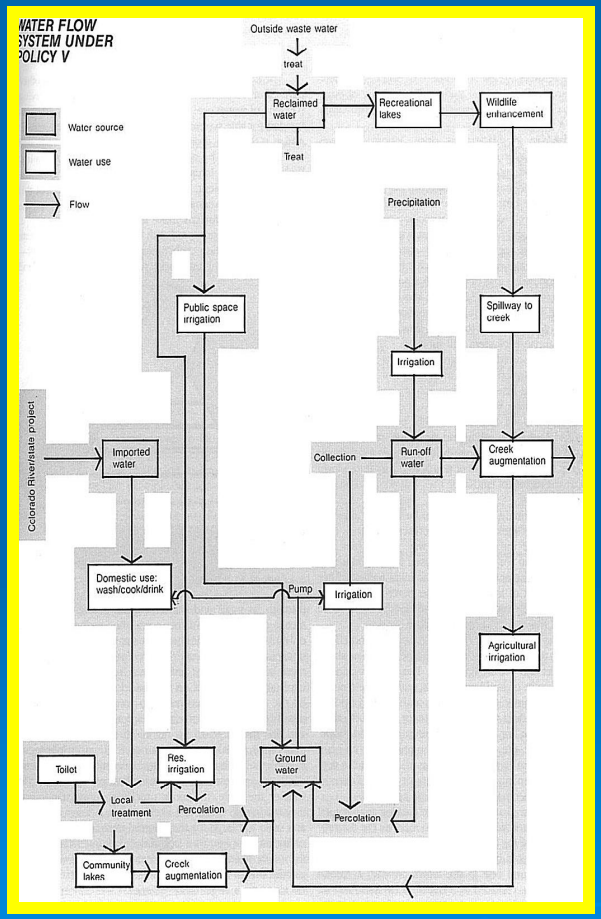
•Orlin J.B., Milgram S., Kochen M., Wasserman S., Freeman L.C,Holland P.W., White H., Boorman C.,

• Barabasi A., Ctr for Study of Complex Networks, Notre Dame

• Watts D.J., Newman M.E., Adamic L.A., Molloy M. Aiello M. Chung F., Reka A., Simon H., Latora V., Marchiori M., Sole R., Ferrer R.,

• NECSI (New England Complex Systems Institute)
• COSI - Center for Complexity in Social Science
• CASOS - Center for computational analysis of Social and
• Organizational Systems
• Academia de Terapia Sistematica
• American Society for Cybernetics
• Santa Fe Institute
• Association Francaise de Science des Systemes
• AIRS - Associazione Italiana per la Ricerca sui Sistemi
• BIRA - Belgian Institute for Automatic Control
• European Society for the study of Cognitive Systems
• ICS - Institut Fuer Kybernetik und Systematheorie
• Istituto di Cibernetica
• Society Swisse De Systematique
• The GAIA Institute
• SMSAC - The society of Management Science and Applied Cybernetics

APPLICATIONS



- General systems theory
- Intent to model, diagnose, improve or design better systems.
- Ecosystems are vital, dynamic networks of connections.
- GENSYSML database

A tool for better understanding and improving ecosystems or building new and more effective ecological models