Brian Meux
Lyle Center for Regenerative Studies
(LCRS) &
Institute for Advanced Systems Studies.
Cal Poly Pomona, CA 91768

L.C.R.S.

Integration of Sources on Cycling in System of Systems Processes (SSP Model) and Application to Environmental Systems: the GENSYSML Tool.

Dr. Len Troncale
Institute for Advanced Systems Studies,
&
Biology Dept.,Cal Poly Pomona, CA 91768

I.A.S.

California State Polytechnic University, Pomona

California State University, National Science Foundation

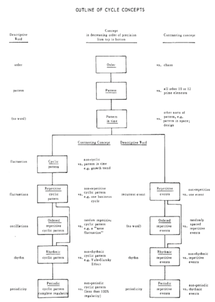
Purpose

In general systems literature to date there has been much work on the elucidation of general system processes, or isomorphies.

- However, past work has ignored some isomorphies and the nature of the relationships between isomorphies.
- The SSP model, with linkage propositions (see L. Troncale-this proceeding's poster) and the GENSYSML tool (see Bowers, T. -this proceeding's poster) attempt to not only use a 'full set' of isomorphies but also provide the linkage propositions between these isomorphies.
- The principal integration of sources into the GENSYSML tool will be a test and elaboration of the tool and this process. Trying to apply the SSP and GENSYSML to improving social systems design will be an added test.
- This integration of information is only a sample of what the GENSYSML tool could contain.
- In the literature to date, this report will show a sample of the working definitions, identifying features and functions, linkage propositions, sample information bytes, types and taxonomies, as well as a listing of institutions and workers involved in general systems research on cycling.
- It will also be shown how a general knowledge of cycles in systems, combined with the GENSYSML tool will be useful in the study of ecosystems.

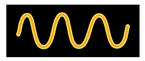
Working Definitions

- The cycling process occurs when the system undergoes transformations from one state to another, ultimately transforming into a previously existing state. (B. Meux)
- Any phenomena repeating after fairly regular time intervals. Generally cycles are found in anything to which numerical measurements may be assigned at intervals in time. (CRI)
- There is a need for a common language, making communication and collaboration easier, to obtain faster progress and more production.
- At right is a taxonomy clarifying how one website dedicated to cycles us its terms.
- Many different researchers may use similar words such as a wave, but the words cycle, fluctuation, loop, oscillation, rhythm, and undulation are also used. How are these unique aspects, or "discinyms" that cause conflation.



Dewey's Cycle Concepts

Identifying Features



Stages - Stages progress through observable relatively stable entities that are dependent on the previous stage and the complete cycle

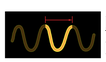
Flow rates- each cycle captures matter, energy, and information and moves it through its pathway. Captured flow makes an entity what it is.

Sequence-stages must follow an obligatory sequence in order for the whole cycle to work. Each stage creates conditions and prerequisites for the next stage.

Recycling - The same materials, energy, or information are used over and over again, for example, enzymes and factors in the cell.

Populations - The existence of very large populations of any type of entity are a prerequisite for cycling to occur.

Entrainment - An external force acting on a system that coordinates the populations of entities to act similarly, in this case cyclical behavior.

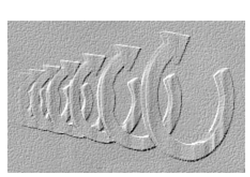


Periodicity - A system may change from state to state in a fixed, or variable period of time.

Initial Conditions - Some initial condition may be necessary to begin the progression from stage to stage. Some cycles may return to this initial condition.

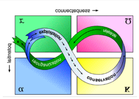
Types & Taxonomies

- **Scale-based taxonomies of Cycles** →
  - Atomic (atomic clock) Organismic (Plant life cycle) Astronomical (Star cycle)
- **Discipline oriented taxonomies**
  - Astronomical cycles - eclipse cycle, full moon cycle, orbital cycles
  - Biological cycles - calvin cycle, cell cycle, menstrual cycle
  - Economic cycles - Kitchin inventory cycle, Kondratiev wave, Juglar fixed investment cycle, Hawtrey pure money cycle
- **Complex system dynamics taxonomies** (Troncale, 1986)
  - Systems Transformation
    - Cyclical Behavior
      - Life cycles
      - Limit cycles
      - Periodic/oscillatory behavior



Sample Information Bytes

Source	Quote
L.H. Gunderson and C.S. Holling, eds. "Panarchy: Understanding Transformations in Human and Natural Systems." 2001 Island Press.	"An adaptive cycle that alternates between long periods of aggregation and transformation of resources and shorter periods that create opportunities for innovation, is proposed as a fundamental unit for understanding complex systems from cells to ecosystems to societies."
Gamarra, Javier G.P.; Sole, Ricard V. "Bifurcations and Chaos in Ecology: Lynx Returns Revisited." technical paper of SFI	"One of the most popular data sets in ecology, that of Lynx fur returns, is analyzed in order to look for evidence for a bifurcation process. This bifurcation seems to be present from the observation of a shift in the amplitude of oscillations of the lynx time series."
MacArthur, R. "Fluctuations of Animal Populations, and a Measure of Community Stability". Yearbook of the Society for General Systems, Vol.3, 1958, pp. 148-151	"Proof: Since…furthermore, if the number of links in a complete cycle of the energy is called the length of the cycle, the greatest common divisor of these lengths is 1 and so the conditions set forth in Shannon and Weaver (1949) for the Markov chain to be "ergodic" are satisfied." (p.148)



C.S. Holling. Adaptive Cycle

Linkage Propositions

The following are examples of linkage propositions relating cycles, cycling and oscillations to other systems concepts and processes (For an explanation of linkage propositions see L. Troncale poster describing the SSP model.):

Temporal boundaries in a system result from selection by its environment for the most optimal cycling time. This means that temporal boundaries and cycling time are types of externally-generated functions of the system.

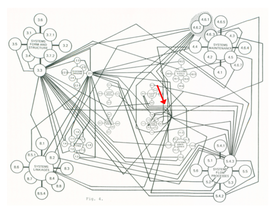
Metastability inhibits recycling of elements/components/entities.

Cycling of a system (Life Cycle type) is the same as temporal boundaries of the system in question.

Recycling of systems components/entities after systems lifecycle decay contributes to equilibrium of the next higher level of hierarchy

Cycling reduces the energy flow necessary to maintain a negentropic deterministic succession of states or modes in a system.
Cycling is a special case of synergy.

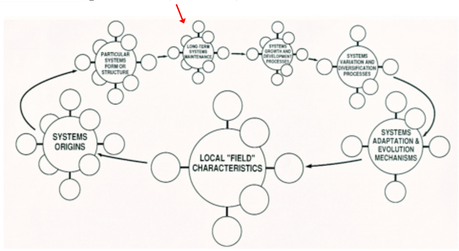
(An Amateur attempt at an L.P. - B. Meux)
An oscillation is a type of cyclic pattern in time.
or
Cyclical behavior is a type of oscillation



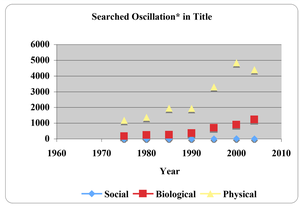
Cartoon of Preliminary SSP Model

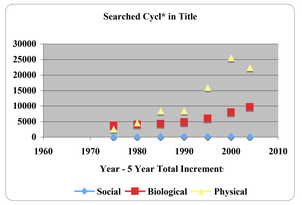
Position in General Systems Life Cycle

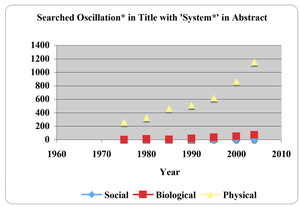
- Red arrow above shows position of cycles in the SSP diagram of 90 LP's on 4 processes.
- The systems life cycle (Troncale, 1986, p.55) itself is a cycle, and in a general classification of systems processes, cycling can be grouped into the categories of systems transformation and systems decay processes.
- In the cycle diagram below, IAS' current thought organizes cyclical behavior into systems maintenance processes (at arrow)

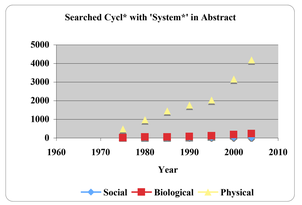


Sources & Systems Literature Trends









- The low number of articles in the 'social' database (sociological abstracts) may show a need in social sciences for a more rigourous systems focus.
- This database search should not be deemed as a conclusive picture of systems science.
- The physical sciences use cycles and oscillations in their research language, but that doesn't necessarily signify a general systems approach.

We found that using the process terms alone did not result in good results (too many); it was better to require the use of the word "system" some where in the title or abstract for good hits. Even then totals of 4,000 to 15,000 hits shows there is a lot of lit to cover for the GENSYSML harvest.

Total oscillation* articles: Social: 13 Biological: 2651 Physical: 14619

With 'system*' in abstract: Social: 3 Biological: 120 Physical: 3063

Total cycl* articles: Social: 1229 Biological: 40831 Physical: 88275

With 'system*' in abstract: Social: 152 Biological: 715 Physical: 14090

Social Article Sample: Oscillation* in title and system* in abstract (sociological abstracts)

Gardner, Peter M, Bicultural Oscillation as a Long-Term Adaptation to Cultural Frontiers: Cases and Questions Human Ecology, 1985, 13, 4, Dec, 411-432.
Abstract: ... the primary decision-making mechanisms within each society, illustrated by four case examples. A general "system type" is formulated to be applied to analysis of other oscillatory systems.

Institutions & Workers

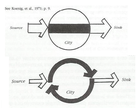
- Santa Fe Institute (SFI)- A multidisciplinary approach to complexity.
- International Institute for Applied Systems Analysis - IIASA. Interdisciplinary scientific studies in variety of areas, especially critical areas of population & ecology.
- New England Complex Systems Institute (NECSI) - An E-conference with references to cycles.
- Principia Cybernetica Web - An E-conference with references to cycles.
- The Cycles Research Institute (CRI) - study cycles and fluctuating phenomena in any and every discipline.
- International Committee for Research and Study of Environmental Factors (ICEF) - scientific investigation of environmental factors responsible for fluctuating phenomena.

C.R.I.

- **Workers**
  - *Edward R. Dewey* (1895-1978). President of the Foundation for the Study of Cycles (FSC) in 1942. A life dedicated to studying cycles.
  - Alexander Chizhevsky (1897-1964) Interdisciplinary cycles researcher
  - C.S. Holling Adaptive Cycles. Dept. of Zoology, University of Florida

E.R. Dewey

Applications to Environmental Systems

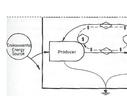


Linear vs. Cyclical Material Flows

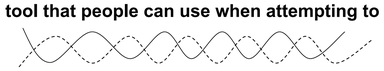
- Most materials in our society are not designed to be RECYCLED. They are created, used and thrown away. Using a general knowledge of CYCLING, manufacturers can apply a CYCLICAL strategy to any materials on any HIERARCHICAL level in our society.
- John Lyle (founder of Cal Poly's Center & campus for Regenerative Studies) attempted to design human ecosystems using an ecosystem approach of structure, function, and locational pattern (from Odum) using natural systems as a model to integrate ecological order into human systems, thus merging human and natural systems.

Lyle's Structure, Function, Locational Pattern

- A general understanding of natural processes (SSP Model) is needed in order to integrate humans into natural processes, such as CYCLES and OSCILLATIONS
- Human and natural cycles (such as known agricultural and ecological cycles and oscillations may be studied to find any preferred SYNERGISTIC (I.e. production) or neutralizing (i.e. pest control) effects between the two systems.
  - This knowledge can be used in design, planning, management, and policy.
  - Especially useful will be the increased detail provided by the SSP Linkage Propositions between CYCLES and 80 other systems processes; we will attempt a much-needed human and natural systems re-integration.
- GENSYSML is tool that people can use when attempting to solve environmental problems



H.T. Odum's System's Ecology as studied at the IAS



Neutralizing effect