Review: Systems Theory

M.K. Lau

November 1, 2012

1 Meadows

- Why systems?
  - Feedbacks
  - Delays
  - Diffusion and Redundancy
  - Blind Men and the Elephant
- System Structure and Behavior
  - Elements, connections and function
  - Emergence, more than the sum of the parts
  - Stocks and Flows
  - Feedbacks (stabilizing and reinforcing)
- Systems and Us
  - Resilience

  - Self-organization = the capacity of a system to make itself more complex
  - Hierarchy = systems with sub-systems

- Creating Change
  - Linear minds in a non-linear world
  - Align goals of stakeholders
  - Tragedy of the commons
  - Escalation
  - Competitive Exclusion
  - Shifting burden to the intervenor
  - Interventions
    * Feedback policies
    * Good of the whole
    * System Wisdom = let the system run itself
    * Locate Responsibility
    * Stay humble and keep learning
    * Celebrate complexity
    * Expand time horizaons
    * Defy disciplines
    * Expand thought horizons
    * Don't erode goodness

2 Ulanowicz

- Ecology the exceptional science
  - Ecology does follow as an extrapolation from other fields of science and is non-Newtonian in nature
  - Ascendency = the developmental status of a community = size + organization
- Causality in the Age of Science
  - Moving toward understanding *how* over *why* things happen
  - Darwinian evolutionary theory is inherently Newtonian, viewing individuals as "atoms" and populations as "bodies."
  - Newtonian at the small scale but non-Newtonian at the large scale (namely, irreversibility)
  - Energy=Information is a unifying concept between physics and biology
  - Newtonian Physics = a few components that are rigidly linked
  - Ecology = many components that are variably linked
  - "There are no irrefutable claims by any discipline to encompass ecological phenomena."
- The emergence of order
  - Popper's world of propensities
  - Autocatalytic loops
  - System boundaries

- Quantifying growth and development
  - The universe is hierarchical
  - Autonomous aspects can arise at any level from irreversibility
  - Ignoring genetics, as the focal level will be viewed only from phenomena at that scale of observation
  - A paradigm is a tacit agreement not to ask certain questions. - TFH Allen
  - AMI = average mutual information = constraint of the actual from the potential
  - TST = total system throughput = the sum of all transfers
  - Ascendency = AMI x TST
  - Rigidity = Fragility, Structure = Decreased Resilience
- Extending ascendency
  -
- Other members of the elephant
  - Limits
    * 3 = connectedness for 1) spontaneaous order in Boolean networks (Kaufmann) 2) corrections per node in ecosystem food webs (Pimm) and 3) bits per emmiter in ecosystems (et al. Sole)
- Practical applications
  -
- The ascendent worldview

–