Systems Theory

What is a System?

- Definition
  - Set of Elements and Relations
  - Elements may be Agents, Components, or Subsystems
  - Algorithms Express Behavior
  - Structure is Defined by its Pattern
  - Inputs are Transformed into Outputs
- Structure
  - Hierarchical
  - Linear
  - Star
  - Mesh
  - Bus
  - Ring
  - Fully Connected
- Categories / Examples
  - Artificial
    - Artificial Life
    - Software
    - Cities
  - Biological
    - Flora
    - Fauna
  - Natural
    - Galaxies
    - Atmosphere
  - Social
    - Corporations
    - Families
    - Government
    - Military
- Dynamical Behavior
  - Feedback Loops
    - Negative Feedback (maintenance)
    - Positive Feedback (growth)
  - Archetypes
    - Limits to Growth / Success
    - Eroding Goals
    - Success to the Successful
    - Tragedy of the Commons
    - Shifting the Burden
    - Fixes That Fail
    - Growth and Underinvestment
    - Escalation (conflict)
  - Other Dynamical Behaviors
    - Finding an Equilibrium Point
    - Oscillations / Periodic Behavior
    - Chaotic / Attractor
    - Bifurcation / Phase Transition
    - Self-Organization
    - Criticality
    - Hysteresis / Path Dependence
    - Network Dynamics (Cascades, Diffusions, Synchronization
    - Other
- Modeling Software
  - Stella
  - iThink
  - Vensim
  - Other
- Types
  - Complicated / Deterministic Examples
    - Airplane
    - Building
  - Complex / Evolutionary
    - Artificial
    - Biological
      - Humankind
      - Biological Species
    - Natural
    - Social
      - Human Organizations
      - Wolf Pack
- Principles
  - Bounded
  - Exhibit a Lifecycle
  - Contain Subsystems
  - Composed of Networks
  - Interact with Other Systems
  - They are Dynamic
  - Complex Systems Evolve
  - Maintained Through Negative Feedback
- Input Categories
  - Material
  - Energy
  - Messages
- Output Categories
  - Material
  - Energy
  - Messages
- Diagramming Techniques
  - Causal Loop Diagrams
  - Stock and Flow Diagrams
  - Other
- Meadows Leverage Points
  - Constants, Parameters, Numbers
  - Buffer Size, Stabilizing Stocks
  - Structure of Material Stocks and Flows
  - Length of Delays
  - Strengths of Negative Feedback
  - Gain Around Positive Feedback
  - Structure of Information Flows
  - System Rules (Incentives, Punishment, Constraints
  - Power to Add, Change, Evolve, Self-Organize
  - Goals of the System
  - System Paradigm
  - Power to Transcend Paradigms

Sources: George Mobus, Gene Bellinger, Donella Meadows, Gemini, and various others