Introduction to Systems Science

A Syllabus

Course Description

This course is an introduction to the basic principles and applications of systems science. Basic contents include complex adaptive systems, systems modeling, feedback loops, networks, systems archetypes, systems dynamics, and evolution. Systems fall into four categories: artificial, biological, natural and social. Students will learn some of the important theoretical frameworks and practical tools to analyze, model, and influence systems.

Course Objectives

- Understand basic concepts in systems science
- Analyze the emergence and evolution of systems
- Apply systems modeling techniques to real-world problems
- Explore strategies for sustainability and resilience in socio-ecological systems

Weekly Topics & Readings

Week	Topic	Key Readings
1	Introduction to Systems Science: History, Definitions, and Scope	Mobus (2014), Reynolds (2007)
2	Systems Thinking and Conceptual Frameworks	Meadows (2008), Sterman (2000)
3	Complexity Theory: Foundations and Implications	Stacey (2007), Mitchell (2009)
4	Systems Archetypes	Senge (2006)
5	Systems Modeling: Causal Loops and Stock-Flow Diagrams	Sterman (2000)
6	Networks	Newman (2010)

7	The Dynamics of Organizational Change and Strategy	Stacey (2007)
8	Sustainability and Resilience in Socio-Ecological Systems	Walker & Salt (2006)
9	Evolutionary Systems	Fichter, L. S., Pyle, E. J., & Whitmeyer, S. J. (2010).
10	Course Review and Future Directions in Systems Science	All readings Mobus (2005) Gould

Assessment Methods

- Participation and Discussion: 20%
- Weekly Reflections/Reading Responses: 20%
- Systems Model Project: 40%
- Final Presentation: 20%

Core Texts

- Fichter, L. S., Pyle, E. J., & Whitmeyer, S. J. (2010). Strategies and rubrics for teaching chaos and complex systems theories as elaborating, self-organizing, and fractioning evolutionary systems. *Journal of Geoscience Education*, *58*(2), p. 65-85. doi:10.5408/1.3534849
- Meadows, D. H. (2008). Thinking in systems: A primer. Chelsea Green.
- Mitchell, M. (2009). Complexity: A guided tour. Oxford University.
- Mobus, G. E., & Kalton, M. C. (2014). Principles of systems science. Springer.
- Reynolds, P. D. (2007). A primer in theory construction.

- Sawyer, R. K. (2005). Social emergence: Societies as complex systems.
- Senge, P. (2006). The fifth discipline. Doubleday.
- Stacey, R. D. (2007). Strategic management and organisational dynamics: The challenge of complexity.
- Sterman, J. D. (2000). Business dynamics: Systems thinking and modeling for a complex world.
- Walker, B., & Salt, D. (2006). Resilience thinking: Sustaining ecosystems and people in a changing world.

Learning Activities

- Asynchronous lectures and seminars
- Final project
- Systems modeling
- Weekly assignments

Final Project

Select a system of your choice—artificial, biological, natural, or social—to analyze using concepts and tools from the course. The project will culminate in paper using the paper “Project: Introduction to Systems Science.” The objective is to analyze a system to understand the “as-is” world and recommend an innovative “to-be” world.

Systems science offers a wealth of applications by providing frameworks and tools to understand and manage complexity within organizations. Organizations can use systems modeling to diagnose inefficiencies, forecast the effects of strategic decisions,

and identify leverage points for positive change. Organizational change initiatives leverage systems science to anticipate unintended consequences and design interventions that align with both short-term objectives and long-term evolvability. Note: sustainability is not an option as sustainability is only short term. All complex systems evolve over the long term.