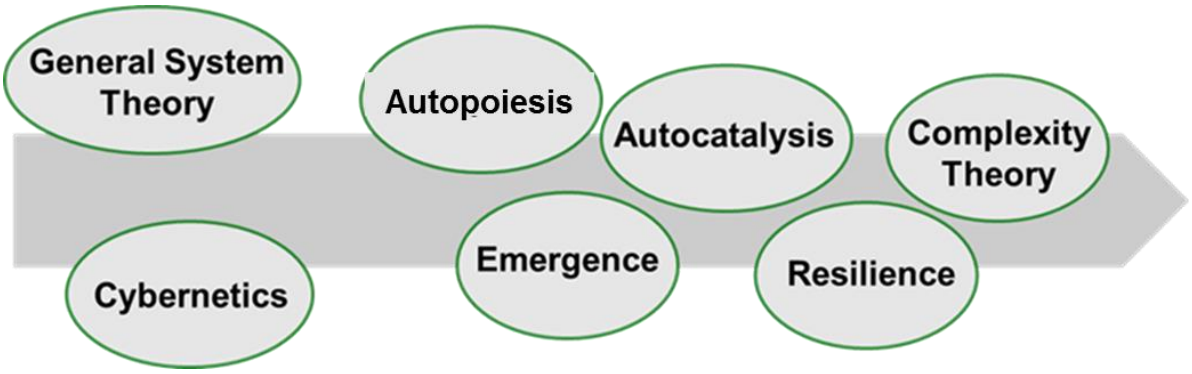
# Seminar – Module
# System Science and Sustainability
# Winter term 2018/19

"System Science and Sustainability" is a Master-level introductory course into the field of system sciences, its development over time, branching of approaches, key terms and concepts. "System science" is used here as an overarching expression for a field to which numerous scholars contributed from very diverse disciplines like anthropology, biology, chemistry, ecology, economics, mathematics, physics, psychology, sociology and others. Developments like cybernetics, chaos theory or network analysis/science can be regarded as part of or at least strongly related to system science. Some branches of system science are even regarded as new fields of science in their own right like synergetics or complexity science.




These developments have opened up new possibilities for improved analysis and decision making in scientific, business and political domains. Nevertheless, we observe daily that in complicated situations, particularly in policymaking and business, simple strait forward decision making still prevails, giving rise to an increase of negative developments when originally intended to curb them. Every unexpected side effect or backlash, that renders useless the measures originally taken, is a clear indication that the actors' basic mental models were incomplete and broader systemic correlations neglected. System thinking is therefore of particular importance in the transition to a more sustainable society.

The aim of this course is to track (parts of) the historic development of system science and study basic concepts and their relevance for a more sustainable society. Students will not set up a specific model (like e.g. in "system dynamics") but develop a deeper understanding of system science and a way of "system thinking" which allows to address sustainability problems more successfully. This we will achieve through reading and discussing scientific papers and book chapters.

Thus, students are expected to participate actively in this course through classroom discussion, presentations, written assignments, and last but not least reading.

## COURSE STRUCTURE

The course will meet weekly, October through January, in a presentation and discussion format. Each week students are required to complete the assigned reading and come to class ready to discuss. After short inputs by the instructor, student(s) designated as discussion leader will be responsible for facilitating the classroom discussion. In preparation of the classes, discussants are to write a short response paper. Thus, each week, students will be expected either to lead or actively participate in the discussion.

For weeks in which you are LEADING discussion, you must

1) Complete readings;

2) Prepare a presentation and present in approx. 20 minutes an oral summary of the particular approaches in readings;

3) Prepare discussion questions; facilitate group discussion for approx. 30 minutes.

For weeks in which you are a DISCUSSANT, you must

1) Complete readings;

2) Write a response paper of approx. 800 words, send per email by midnight the Sunday before the class.

## RESPONSE PAPERS

Each student will write 5 response papers and lead 1 classroom discussion. You do not have to write a response paper if you are leading the discussion that week. Each response paper should have approx. 800 words. The response papers should address the reading material covered in class. In the weekly response papers, students should briefly summarize the main points of the reading and then provide their own input. Student input can take various forms. It can:

- link the respective theoretical aspect of system science to sustainable development at large;
- compare/contrast the author's approach to that of another author and/or to previous class room discussions;
- comment on the field of application at hand.

## COURSE SCHEDULE

| Date and Time | Topic | Required Reading | Written Assignment |
|---|---|---|---|
| 16. Oct. | Introduction: organization, methodology, aim and topic | **Bateson**, Gregory, Ecology and Flexibility in Urban civilization, in: Bateson, Gregory, Steps to an Ecology of Mind, 1972/1987/2000, (pp 499- 511 or 502 – 513) (available on internet) | —— |
| 23. Oct. | General Systems Theory | **Bertalanffy,** Ludwig von, 1950, An outline of General System Theory, The British Journal for the Philosophy of Science, Volume I, Issue 2, 1 August 1950, Pages 134–165, https://doi.org/10.1093/bjps/I.2.134 | |
| 30. Oct. | Autopoiesis | **Maturana**, Humberto,1975, The Organization of the Living: A Theory of the Living Organization, in: Int. J. Man-Machine Studies (1975) 7, 313-332 **/ Mingers**, John,1989, An Introduction to Autopoiesis, Implications and Applications, in: Systems Practice, Vol. 2, No. 2, 1989,<br>**Seidl**, David, 2004 Luhmann's theory of autopoietic social systems, (Section 1 – 3) | |
| 06. Nov**.** | Autocatalyis, Cooperation and Competition | **Ulanowicz,** Robert E., 2009, The dual nature of ecosystem dynamics, in: Ecological Modelling 220 (2009) 1886–1892;<br>**Ulanowicz,** Robert E., 2007, Ecosystems becoming, in: Int. Journal of Ecodynamics .Vol 2, No. 3 (2007)153-164<br><br>**Latour**, Bruno, 1996, On actor-network theory: A few clarifications, in: Soziale Welt, 47. Jahrg., H. 4 (1996), pp. 369-381, http://www.jstor.org/stable/40878163 | |
| 13.Nov. | Resilience | **Holling,** C.S., 2000, Understanding the Complexity of Economic, Ecological, and Social Systems, in: Ecosystems (2001) 4: 390–405<br>**Walker**, Brian, C. S. Holling, Stephen R. Carpenter, and Ann Kinzig,2004, Resilience, Adaptability and Transformability in Social–ecological Systems, in: Ecology and Society 9(2);<br>**Gunderson**, Lance H., 2000, Ecological Resilience–In Theory and Application, in: Annual Review of Ecology and Systematics, Vol. 31 (2000), pp. 425-439<br>**Bengtsson**, Janne, Per Angelstam, Thomas Elmqvist, Urban Emanuelsson, Carl Folke, Margareta Ihse, Fredrik Moberg, and Magnus Nyström,2003, Reserves, Resilience and Dynamic Landscapes, in: AMBIO: A Journal of the Human Environment, 32(6):389-396.<br>**Brand**, Fridolin Simon and Kurt Jax, 2007, Focusing the Meaning(s) of Resilience: Resilience as a Descriptive Concept and a Boundary Object, in: Ecology and Society 12(1): 23; | |
| 20. Nov. | Variety and Diversity | **Boisot,** Max and Bill McKelvey, 2011, Complexity and Organization-Environment Relations: Revisiting Ashby's Law of Requisite Variety, in: Allen, Peter, Steve Maguire and Bill McKelvey (eds.), The Sage Handbook of Complexity and Management, 2011, 279-298;<br>**Ashby** W.R.,1958, Requisite variety and its implications for the control of complex systems, in: Cybernetica 1:2, p. 83-99. (http://pcp.vub.ac.be/Books/AshbyReqVar.pdf) | |
| 27.Nov. | Complexity | **Cilliers,** Paul, 2001, Boundaries, Hierarchies and Networks in Complex Systems, in: International Journal of Innovation Management, Vol. 5, No. 2 (June 2001) pp. 135–147; | |

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| | | **Woermann**, Minka, n.y., What is Complexity Theory? Features and Implications,<br>**Holland**, John H. 2006, Studying Complex Adaptive Systems, in: Jrl Syst Sci & Complexity (2006) 19: 1–8;<br>**Heylighen**, Francis, 2008, Complexity and Self-organization, in: Marcia J. Bates and Mary Niles Maack (eds.), 2008, Encyclopedia of Library and Information Sciences; | |
| 04. Dec. | Applications to Business | **McKelvey**, Bill, 2001, Energising Order-Creating Networks of Distributed Intelligence Improving the Corporate Brain, in: International Journal of Innovation Management, Vol. 5, No. 2 (June 2001) pp. 181–212;<br>**Lichtenstein**, B. and Bill McKelvey, 2011, Four types of emergence: a typology of complexity and its implications for a science of management, in: Int. J. Complexity in Leadership and Management, Vol. 1, No. 4, 2011<br><br>**Noe**, Egon and Hugo Fjelsted Alrøe, 2003, Combining Luhmann and Actor-Network Theory to see Farm Enterprises as Self-organizing Systems, Paper presented at "The Opening of Systems Theory" in Copenhagen May 23-25 2003. | |
| 11. Dec. | Applications in Economics | **Arthur**, Brian, 2013, Complexity Economics: A Different Framework for Economic Thought, SFI WORKING PAPER: 2013-04-012<br>**Kharrazi**, Ali, Elena Rovenskaya, Brian D. Fath, Masaru Yarime, Steven Kraines, 2013, Quantifying the sustainability of economic resource networks: An ecological information-based approach, in: Ecological Economics 90 (2013) 177–186;<br>**Hartmann**, Dominik, Cristian Jara-Figueroa, Miguel Guevara, Alex Simoes and César A. Hidalgo, 2016, The Structural Constraints of Income Inequality in Latin America; in: Integration & Trade Journal, No. 40, June 2016, p.70-85;<br>**Wilson**, David S. 2016, Two Meanings of Complex Adaptive Systems, in: Wilson, David S., Alan Kirman (Eds.) Complexity and Evolution - Toward a New Synthesis in Economics, 31 – 46, Strüngmann Forum Reports, MIT press https://www.esforum.de/publications/sfr19/Complexity%20and%20Evolution.html | |
| 18. Dec. | Applications to societal transitions | **Geels**, Frank W., Johan Schot, 2007, Typology of Sociotechnical Transition Pathways, in: Research Policy 36 (2007) 399–417;<br>**Ostrom**, Elinor, 2009, A General Framework for Analyzing Sustainability of Social-Ecological Systems, in: Science 325, 419 (2009);<br>**Frischmann**, Brett M., 2013, Two Enduring Lessons from Elinor Ostrom, in: Journal of Institutional Economics, 9, pp 387-406 | |
| 08. Jan | Applications to societal transitions | **Anderies**, John M., Marco A. Janssen, and Elinor Ostrom, 2004, Framework to Analyze the Robustness of Social-ecological Systems from an Institutional Perspective, in: Ecology and Society 9(1): 18;<br>**van der Leeuw**, Sander E., 2016, Adaptation and Maladaptation in the Past, in: Wilson, David S., Alan Kirman (Eds.) Complexity and Evolution - Toward a New Synthesis in Economics, 239 - 269, Strüngmann Forum Reports, MIT press https://www.esforum.de/publications/sfr19/Complexity%20and%20Evolution.html<br>**Bednar**, Jenna, 2016, Robust Institutional Design – What Makes Some Institutions More Adaptable and Resilient to Changes in Their Environment Than Others? in: Wilson, David S., Alan Kirman (Eds.) Complexity and Evolution - Toward a New Synthesis in Economics, 167 - 184, Strüngmann Forum Reports, MIT press | |

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| 15. Jan. | Applications to societal transitions | **Fath,** Brian D., 2017, Systems Ecology, Energy Networks, and a Path to Sustainability, in: Int. J. of Design & Nature and Ecodynamics. Vol. 12, No. 1 (2017) 1–15;<br><br>**Gowdy,** John, Mariana Mazzucato, Jeroen C.J.M. van den Bergh, Sander E, van der Leeuw, David S. Wilson, 2016, in: Wilson, David S., Alan Kirman (Eds.) Complexity and Evolution - Toward a New Synthesis in Economics, 327 - 350, Strüngmann Forum Reports, MIT press https://www.esforum.de/publications/sfr19/Complexity%20and%20Evolution.html | |
| 18.Jan. | Wrap up | Systems Thinking (Cabrera & Cabrera, 2015) | Holländer |

## ASSESSMENT

Students will be assessed on their active participation and written work.

50% Presentation/discussion

50% Response papers (5 total)

## Recommendation:
## Additional General Literature on System Sciences (* marks easy reads)

**Ashby**, Ross, An Introduction to Cybernetics, 1956/2015

**Arthur**, W. Brian, The Nature of Technology, 2009*

**Beinhocker, Eric,** The Origin of Wealth: Evolution, Complexity, And the Radical Remaking of Economics, 2006/2007 *

**v. Bertalanffy**, Ludwig, General Systems Theory,1969/2006

**Braitenberg**, Valentino, Vehicles – Experiments in Synthetic Psychology, 1984*

**Colander**, David and Roland Kupers, Complexity and the Art of Public Policy, 2014*

**Erdi**, Peter, Complexity Explained, 2010

**Hausmann** et al., Atlas of Economic Complexity (new version on sale at MIT press, free download of older versions)*

**Kauffman**, Stuart A., Reinventing the Sacred, 2008/2010

**Kauffman**, Stuart A., At Home in the Universe, 1996*

**Kauffman**, Stuart A., The Origins of Order, 1993

**Meadows**, Donella H., Thinking in Systems, 2008*

**Mitchell**, Melanie, Complexity – A Guided Tour, 2009*

**Morin**, Edgar, On Complexity, 2008

**Page**, Scott, Diversity and Complexity, 2011*

**Senge**, Peter M., The Fifth Discipline, 1990/2006*

**Sterman**, John, Business Dynamics: Systems Thinking and Modeling for a Complex World, 2000*

**Ulanowicz**, Robert, A Third Window: Natural Life beyond Newton and Darwin, 2009*

**Wilson,** David S. and Alan Kirman (Editors), Complexity and Evolution: Toward a New Synthesis for Economics (Strüngmann Forum Reports) 2016 *

**Supervisors:**

Prof. Dr. Robert Holländer, hollaender@wifa.uni-leipzig.de,

Consultation hours on appointment: Mondays 15:00 to 16:30 pm

and research associate

Lydie Laforet, laforet@wifa.uni-leipzig.de

Consultation hours on appointment: Mondays 13:00 to 15:00 pm