# Systems Strategy and Dynamics

## Prof. Luigi Geppert (Module 1); Prof. Mauro Bernuzzi (Module 2)

***COURSE AIMS AND INTENDED LEARNING OUTCOMES***

The course aims to develop students' knowledge of systemic tools and models in order to better understand and analyse the dynamic evolution of complex systems, found in every area of human activity.

In an increasingly “dynamic” business context that is difficult to plan, much like the current one, the process of defining managerial decisions appears particularly complex, making it difficult to compare a priori and predict the consequences of the most critical options.

This process requires the support of *analytical methods* and *tools* to represent and measure the dynamic complexity of the reality, which the manager can use to improve and increase his understanding of the phenomena.

The course aims to provide both *analytical methods* and *simulation modelling* methods (or rather *-* in the context of this course - Systems Thinking and System Dynamics) for the conception and creation of analytical or dynamic representation and simulation models, which can be used to explore the effects of long-term strategic decisions, evaluate new strategies, and develop and understand the behaviour of complex systems.

At the end of the course, students will be able to:

– improve the analysis and assessment process of the supply chain structure, the related structuring strategies and potential business policies over time;

– understand the complexity through analytical structures and counter-intuitive dynamics;

– build, at least qualitatively, appropriate dynamic micro-worlds (digital twins) to represent the many situations for which the "right" managerial decision becomes the critical success factor;

– use the methodological paradigms presented to analyse a supply chain.

At the end of the course, the student will have acquired theoretical and applied knowledge of the principal tools and models that describe complex phenomena in the real world.

***COURSE CONTENT***

In the course, two methodologies will be discussed:

– a methodology based on how the constituent elements of a system interact with each other to describe the evolution over time of the quantities concerning them (Module 1) A general class of models known as "System Dynamics" will be explored in detail; these allow the relatively easy modelling of systems that are both very complex and difficult to handle mathematically. In particular, the topics covered in module 1 concern:

* the definition and representation of complex systems: *Policy Resistance*;
* the elementary modes of dynamic behaviour;
* causal circular diagrams;
* diagrams levels and flows;
* the "stock management problem" at 1 and 2 levels;
* dynamic equilibrium in supply chains: amplification, oscillation, delay;
* business case studies.

The course looks at the means for planning and constructing appropriate dynamic simulators (micro spheres) that exemplify recurring decision-making situations within companies, and that deal with issues of applied strategic management applied to Supply Chain business cases.

– a methodology that uses stochastic matrices to describe system behaviour over time (Module 1). A general class of models called "Markov Models".

***READING LIST***

The course material is essentially found in notes and slides prepared by the lecturers. For both modules, a series of articles will be provided for further study, and a range of strategic simulations that exemplify real decision-making situations.

Materials (Module 1):

L. Geppert, *Introduzione alla Dinamica dei Sistemi: concetti generali di modellazione della complessità e applicazioni per la strategia e la gestione aziendale,* dispense del docente pubblicate in Blackboard, 2007.

L. Geppert, *Modelli e applicazioni d’esempio,* modelli software del docente pubblicati in Blackboard, 2011.

For detailed study (not to be studied for the exam)

Sterman, *John Business Dynamics: Systems Thinking and Modeling for a Complex World,* Irwin McGraw-Hill, 2000.

Senge-M. Peter, *The fifth discipline: the art and practice ofthe learning organization,* DoubleDay, 1994.

During the course, to support the concepts presented in module 2, a number of models prepared with appropriate modelling software will be used (for example: *iThink* by iseesystems and Vensim *PLE* by Ventana Systems, which can be respectively downloaded for free from the websites: www.iseesystems.com and [www.vensim.com](http://www.vensim.com)).

Textbooks (Module 2):

M. Bernuzzi, *Sistemi Dinamici Stocastici,* dispense del docente pubblicate in Blackboard, 2018.

R. M. Feldman-C. Valdez-Flores*,* *Applied Probability and Stochastic Processes*, Springer, 2010.

Pishro-Nik Hossein, *Introduction to Probability,* *Statistics and Random Processes*, Kappa Research LLC, 2014.

Privault N., *Understanding Markov Chains, Examples and Applications,* Springer (2013)

Singh K., *Linear Algebra step by step,* 0xford University Press (2014)

***TEACHING METHOD***

The teaching method for both modules is based on lectures on theory and assignments to be completed in class and at home. The course may also include presentations by managers who are using dynamic simulation.

***ASSESSMENT METHOD AND CRITERIA***

The learning process is assessed by way of a final exam involving the following:

1. The examination is based on a written test with exercises entailing open- and closed-ended questions covering topics in Module 1 and Module 2.

2. The overall mark is the average of the marks on the topics tested for Module 1 and Module 2. The average mark must be above 18/30. If the assessment of either of the 2 topics (module 1 and module 2) falls below 15/30, the average is not calculated and the final exam is considered failed.

3. Attending students: should an interim test be administered, the final mark is the sum of the mark earned on the written test and the credit for the interim test.

4. The examination procedures are the same for all examination sessions.

***NOTES AND PREREQUISITES***

Attendance at and active participation in lectures is strongly recommended. On the lecturer's webpage, the time of receipt and the thesis request form are indicated.

In case the current Covid-19 health emergency does not allow frontal teaching, remote teaching will be carried out following procedures that will be promptly notified to students.

Further information can be found on the lecturer's webpage at http://docenti.unicatt.it/web/searchByName.do?language=ENG, or on the Faculty notice board.