



# System Dynamics Advanced

Online Post-graduate University Course

*'As the complexity of our world increases systems thinking is emerging as a critical factor for success, and even survival. How then can people become skilled systems thinkers? The most effective learning experiences combine experience with reflection, theory with practice. Traditionally, theory was taught in school and university, and experience was gained in life outside those walls. But in the world of complex dynamic systems such as a business, society, or ecosystem, everyday experience fails because the time horizon and scope of the systems is so vast-we never experience the majority of the effects of our decisions. And without relevant experience, theory is uninteresting to students. The old ways of learning fail. When experiments in the real world are impossible, simulation becomes the main way we can learn effectively about the dynamics of complex systems.'*

John Sterman

Preface of the book  
System Dynamics - Exercises



## Course Objectives and Contents

### PART I. THEORY

This course allows the student to acquire, in a time-efficient and uncomplicated manner, knowledge in the formation and construction of dynamic models. First, the basic structures of the systems and more common dynamics are presented.

#### **System Dynamics**

- Causal diagrams
- Stable, unstable and oscillating systems
- Medium term dynamics

#### **Construction of a model**

- Diagramming the flows
- Phases in the construction of a model
- Computer simulations

### PART II. BASIC EXERCISES

The phases in the construction of a model are studied using study cases, the student is taught how to model with the software and simulate different alternatives.

#### **Exercise 1. Modeling a basic system**

- Using the software

#### **Exercise 2. Dynamics of a tank**

- Foreseen behavior and behavior in the model

#### **Exercise 3. Production and inventory**

- From the text description to the model
- Using Tables in non-linear relations
- Using Delays in the models

#### **Exercise 4. Project dynamics**

- Building a model in phases
- The measurement units help us
- Using Logical Functions

#### **Exercise 5. Short term vs. long term policies**

- Studies in soft defined environments. To extract the data
- Importance of the horizon of the simulation
- Simulating different management styles

#### **Exercise 6. Commodity cycle**

- To integrate several sub-models in a bigger one
- The cause of the oscillations
- Explanation of the results

## **PART III. ADVANCED EXERCISES**

The modeling exercises guide the learner through the process of building a working simulation; students will not only learn about the issues addressed, and in the use of state of the art simulation software, but will develop skill in the modeling process.

**Exercise 7. The aging chains**

**Exercise 8. Drawing complex diagrams**

**Exercise 9. Using qualitative variables**

**Exercise 10. Import and export data to spreadsheets**

**Exercise 11. Building Games and Learning Labs**

**Exercise 12. Interactive models**

**Exercise 13. Input Output Interface**

**Exercise 14. Monte Carlo Sensitivity Testing**

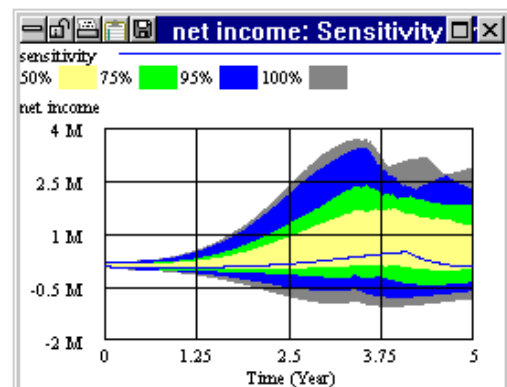
### **Import and export data to spreadsheets (exercise 10)**

Students can use two different ways to interact with data from outside the model. He can use the import and export feature to get or save data to spreadsheets or tabulated text files, or can dynamically link to a spreadsheet to collect data during model simulation. The import feature results in extra files but can improve simulation speed. If the external data file changes, it will be necessary to import the data again. Linking dynamically to a spreadsheet data file allows the simulation to keep up to date with whatever data the spreadsheet file contains. The software opens Excel automatically and reads the data during simulation.



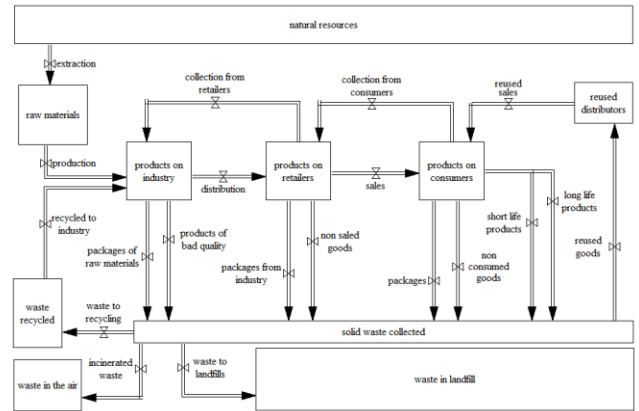
### **Monte Carlo Sensitivity Testing (exercise 14)**

Sensitivity testing involves changing our assumptions about the value of inputs to the model while performing multiple simulations, then examining the uncertainty in selected output variables. Monte Carlo simulations automate sensitivity testing. Distributions for input variables include random uniform, normal, triangular, Poisson and others. Output is displayed as graphs with confidence bounds.



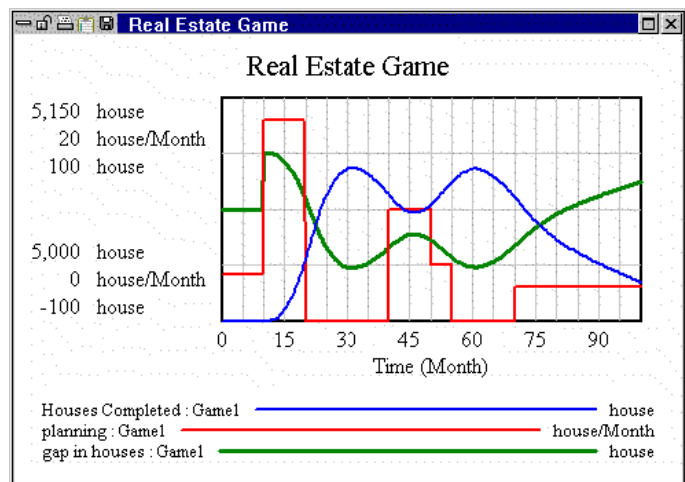
## Drawing complex diagrams (exercise 8)

Multiple Views and Shadow Variables are extremely useful if we are creating moderately-sized or large models. Instead of trying to fit the model diagram onto one page, we can create as many pages (views, or sectors of the model) as we wish. This dramatically clarifies the workings of a model. Model structure is linked among views using Shadow Variables.



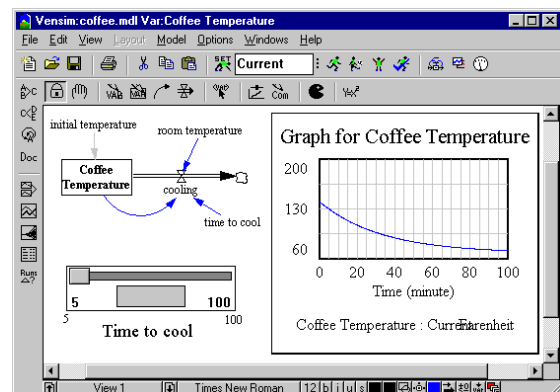
## Building Games and Learning Labs (exercise 11)

Games are a way of actively engaging in the progress of a simulation. Games are examples of the "flight simulator" approach, where the user participates in decisions that affect the simulation outcome for each step in time. A simulation model can be run as a game by stepping through time and making changes to gaming variables along the way. In contrast, a normal simulation model runs through the complete time span based on the initial setup of the model.



## Input and Output Interface (exercise 13)

The students can create flight simulators or learning environments with a simplified user interface. We can insert Slider Input objects, which control the initial value of constants, or the value of gaming variables during a game, and Output objects with custom graphs and reports.



## ✓ Teacher



### **Juan Martin Garcia, Ph.D.**

Ph.D. Industrial Engineer by UPC (Spain). Worldwide recognized expert in System Dynamics, with more than 30 years of experience in this field. Postgraduate studies of System Dynamics at Massachusetts Institute of Technology MIT Sloan School of Management. Director of ATC, a management consulting firm that develops strategic plans for corporate executives. Collaborator of the Sustainable Development Department at Universitat Politecnica de Catalunya in Barcelona, Spain, and several other Spanish and Latin-American universities. Author of books about modeling with System Dynamics, with preface of John Sterman (MIT).

## ✓ Software

The student receives a licensed version of Vensim PLE PLUS.



## ✓ Admission requirements

No statistical or specific mathematical education is required

## ✓ Cost

700 euros, **includes** the cost of a Vensim PLE PLUS license.

## ✓ Dates and deadline

Each student begins the course and **is coached independently**, on his own schedule. Learning effort: 50 hours. The deadline to complete the program is 31 December 2016.



## The students' opinion



*'I really enjoyed your course a lot. I liked how you presented the exercises in a progressive manner that made it really easy to pick up on using system dynamics.'* Ron Van Buskirk. **USA.**



*'It was a pleasure working with you and having you available almost 24 hours a day. For me this was a new experience and it is true that it makes you to start thinking on many details in different way, to observe the problem from completely different point of view, with a new approach in finding a solution for it. There were many questions that were coming in my mind during building models in this course, but most of them were very soon clarified through the modeling work and researching the available literature that was given on the CD.'* Suzana Andonova. **Rep. Macedonia.**



*'1. The course was quite interesting. It built up slowly until the computer software simulation. 2. Excellent email facilities. 3. Excellent availability of tutor.'* M. Mifsud. **Malta.**



*'I am happy that I finished the course successfully but sad that my course is finished. I have to admit that it was the most interesting course I have participate in my life!. I am so excited that in such a little time I have learned how a model works and it's possibilities in life. Everything I did was something new, and as I learned more, the more interesting the course became! I've learned how to think globally and to relate the variables until I will have the result that I want. Malamati Nikolaos Vernadaki.'* **Greece.**



*'Congratulations to you and your team about the SD course. The texts, specially your books, are very well written and the selected exercises progressively allow to understand how to do SD modeling, as well as to know how to work with Vensim software. And your immediate answer to all my emails, some of them late at night or on Sundays!, encouraged me to work more. Thanks!.'* João Ferreira Dias. **Portugal.**



*'I think the main interest of this method is that it leads to consider real problems in a different way (at least for me), to understand the behavior even if we miss some aspects and to be able to draw the key points which are influential. Especially when we come from a scientific activity in the industry, we like to play with obvious and real items, like measurements, statistical data and so on. Most of the time we focus on this and try to find a solution by using classical methods. And sometimes it doesn't work! Because we forgot or we miss something. Now, very often, when I'm thinking about something I find oneself considering it using system dynamics method, and I'm surprised to see how we can handle the problem differently and better understand it, even without building a model.'* Christian Longet. **France.**



*'Now, I feel able to model real world problems within my field of interest (strategic management) on my own. Your course gave me tools and insights at hands to use "System Dynamics" for decision making in a complex and constantly changing environment. As this wasn't my first online course I can say this course ranks under the three best online courses I've taken. The main reasons are the homework in form of exercises which forced me to think deeply about SD and your extraordinary assistance. But what's more important and which shows that a course is really good is when the learned things can be used shortly after the completion of the course. Needless to say I'll use the learned things immediately within the following weeks.'* Joachim Block. **Germany.**



## Certificate

Each exercise completed has a value of 1.5 points. Students can receive the certificate issued by the Universidad Politecnica de Catalunya in Barcelona, Spain.



## Payment

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Sender: Student's name  
Amount: 700 euros  
Concept: Course 515473 Advanced System Dynamics

or by card:



## Registration / information

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<http://www.talent.upc.edu/ing/professionals/presentacio/codi/547300/system-dynamics-advanced/>