Guided Study Program in System Dynamics
System Dynamics in Education Project
System Dynamics Group
MIT Sloan School of Management[1]

Assignment #11

Assigned on: Friday, November 20, 1998

Due by: Monday, December 7, 1998
                 12:00 PM (Noon)[2]
                 WE WILL REVIEW THE RESPONSES ON MONDAY
                 AFTERNOONS, BOSTON TIME.
                 LATE SUBMISSIONS WILL NOT RECEIVE FULL
                 ATTENTION.

Please email assignment solutions, questions, or comments to:
gsp@sysdyn.mit.edu
Save solutions with the filename XYZ-S11.doc
(where XYZ are your initials)

Reading Assignment:

Please read the following:

- *Introduction to Computer Simulation,*[3] by Nancy Roberts et al., Chapter 16

Also read the following:

- *World Dynamics,*[4] by Jay W. Forrester, Chapters 1, 2, and 4

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[2] The deadline is in United States Eastern Time, equivalent to Greenwich Mean Time minus 4 hours during US daylight savings time, and Greenwich Mean Time minus 5 hours for the rest of the year.

[3] Roberts, Nancy, David Andersen, Ralph Deal, Michael Garet, and William Shaffer, 1983. *Introduction to Computer Simulation: A System Dynamics Approach.* Waltham, MA: Pegasus Communications. 562 pp.

[4] Forrester, Jay W., 1971. *World Dynamics,* (1973 second ed.). Waltham, MA: Pegasus Communications. 144 pp.

Exercises:

1. Introduction to Computer Simulation, Chapter 16: Representing More Complex Causal Relations

Chapter 16 of *Introduction to Computer Simulation* builds the same model as chapter 5 of the *Study Notes*, but with a slightly different approach. Please read over chapter 16 up to the end of Exercise 11. In your assignment solutions document, include answers to parts b., c., and d. of Exercise 11: Comparing Gap and Multiplier Formulations for Urban Growth, the model diagram, documented equations, and graphs of model behavior.

2. Independent Modeling Exercise

A. Please do parts a. through e. of Exercise 12: Jobs and Migration from Chapter 16 of *Introduction to Computer Simulation*. In your assignment solutions document, include the model diagram, documented equations, graphs of any lookup functions you might use, and graphs of all simulations that the exercise asks you to run. Also answer all the questions in parts c., d., and e.

B. Please replace part f. of the exercise with the following:

Add the effect of jobs on out-migration. Draw reference modes for the system behavior. Then simulate the model. Does the model generate the behavior you expected? Why or why not? Explain any differences in behavior between this model and the original model from part A. In your assignment solutions document, include the model diagram, documented equations, graphs of any lookup functions you might use, and a graph of the new model behavior.

3. World Dynamics, Chapter 1: Introduction

Please read Chapter 1 and then answer the following questions:

A. Refer to Figure 1-1 on Page 3. What does the growth fraction of population have to be in order to give the results shown in Figure 1-1?

B. Refer to the numbered assertions on pages 11 to 13. Choose one and explain, in feedback terms, why you would intuitively agree or disagree with the assertion.

4. World Dynamics, Chapter 2: Structure of the World System

Please read Chapter 2 and then answer the following questions:

A. Page 19 lists the five levels that were chosen as the most important levels for the structure of the world system. If you were to present a list of SIX levels, which additional level would you choose? If you would like, you can also replace some of the original five levels, but your final list should have six levels. Please give reasons for your choices.

B. Chapter 2 lists four factors that limit the growth of population: crowding, food supply, pollution, and natural resources. Describe some factors that you think represent "crowding" and explain how they might act as a limit to population growth.

5. World Dynamics, Chapter 4: Limits to Growth

Please read Chapter 4 and answer the following questions:

A. Now that you have studied in-depth the way crowding, food supply, pollution, and natural resources hinder population growth, briefly discuss which one of these limitations has had the greatest effect. Relate your discussion to the text as well as personal knowledge and experience.

B. Section 4.2 (page 69) discusses Natural Resources Depletion as a limit to growth. In particular, natural resources fall fastest when usage rate is highest. Is it likely and realistic for natural resources to be completely depleted? If not, what is likely to be the equilibrium value of natural resources, if any? (A qualitative explanation will suffice.)

C. The simulation output on Page 75 in Chapter 4 shows behavior of the stocks from 1900 to 2100 with a pollution crisis. How do you think each of the stocks will behave from 2100 to 2200? Justify your hypotheses.