

**Guided Study Program in System Dynamics**  
System Dynamics in Education Project  
System Dynamics Group  
MIT Sloan School of Management<sup>1</sup>

Assignment #18

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**Reading Assignment:**

Please read the following:

- *Principles of Systems*,<sup>3</sup> by Jay W. Forrester, Chapter 4

Please refer to Road Maps 9: A Guide to Learning System Dynamics (D-4509) and read the following paper from Road Maps 9:

- The Credit Card Model, by Manas Ratha (D-4683)

Please refer to Road Maps 6: A Guide to Learning System Dynamics (D-4506-4) and read the following paper from Road Maps 6:

- Systems thinking: critical thinking skills for the 1990s and beyond, by Barry Richmond (D-4565)

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<sup>3</sup> Forrester, Jay W., 1968. *Principles of Systems*, (2nd. ed.). Waltham, MA: Pegasus Communications. 391 pp.

Please refer to Road Maps 8: A Guide to Learning System Dynamics (D-4508-1) and read the following paper from Road Maps 8:

- Mistakes & Misunderstandings: Use of Generic Structures and Reality of Stocks and Flows, by Lucia Breierova (D-4646)

## **Exercises:**

### 1. Principles of Systems

Please read chapter 4 of *Principles of Systems* and do the workbook exercises for these sections (located at the end of the book). The material in this chapter is very important and you should make sure you understand it. Please let us know if you have any questions. You do not need to submit anything for this reading assignment.

### 2. The Credit Card Model:

A. Build the model as you progress with the paper. Formulate the model and simulate it to make sure it is producing the expected behavior. In your assignment solutions document, please include the model diagram, documented equations, and graphs of model behavior.

B. Perform sensitivity analysis on the model by altering the values of the constants. By varying the constants, can you change the type of behavior the model exhibits? How? In your assignment solutions document, include graphs of interesting model behavior, noting the parameter values used to produce that behavior.

C. The way the model appears in the paper, Joe's balance keeps rising until it reaches the limit, at which point Joe continuously pays off only the interest charges on the "Balance Payable," and the "Balance Payable" itself stays constant. Suppose Joe realizes that by not reducing the balance, he will be paying interest indefinitely. Joe decides that he wants to gradually eliminate his account balance. Think of a reasonable and realistic payment policy to achieve Joe's goal. Model the new policy, simulate the new model, and see if the policy is indeed an effective one at eliminating Joe's account balance. In your assignment solutions document, please include the modified model diagram, documented equations, and graphs of model behavior. Discuss the short- and long-term effects of the policy change on the "quality of life."

### 3. Systems thinking: critical thinking skills for the 1990s and beyond

In the top paragraph on page 114 of this paper, the author poses the following question to his readers: "How can the framework, the process, and the technologies of systems thinking be transferred to the rest of the world in an amount of time that is considerably less than what it currently takes to get a master's or Ph.D. degree in our field?" What is

your opinion on this question? In formulating your answer, you should consider not only the speed and the quantity of the transfer, but also the quality of the material being taught.

4. Mistakes and Misunderstandings, Use of Generic Structures and Reality of Stocks and Flows:

Read this paper carefully. You do not have to answer any questions for this paper but if you can think of an instance when you made the same mistake, feel free to share the lesson gained with us.

5. Understanding Oscillatory Systems

This is the second in a series of exercises designed to help your understanding of oscillatory systems. Use the model from Exercise 2 in Assignment 17 to complete the following exercises.

A. Simulate the model again. In your assignment solutions document, include the graphs of the behavior of the “flow” and of the “stock” in the base run.

B. Create a new dataset and simulate the model with “period” equal to  $\pi$ . In your assignment solutions document, include graphs of the behavior of the “flow” and of the “Stock” in this simulation. You may wish to change the initial value of the “Stock.” Describe the relationship between the two graphs and compare the simulation to that from part A.

C. Repeat part B with “period” equal to  $4\pi$ .

D. What conclusions can you make about the relationship between an oscillating flow and its stock as the period of the flow changes?