Guided Study Program in System Dynamics

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

Assignment #30

Assigned on: Friday, June 25, 1999

Due by: Monday, July 12, 1999
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-S30.doc
(where XYZ are your initials)

Reading Assignment:

Please download and read the following paper from http://sysdyn.mit.edu/gsp98/ :

- Properties of Damped Oscillations Systems, by Helen Zhu (D-4767)

[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.

Exercises:

1. Properties of Damped Oscillations Systems

Please read "Properties of Damped Oscillations Systems" (D-4767). This paper dampens the first model in "Oscillating Systems II: Sustained Oscillations" (D-4602). In this exercise, you study a damped version of the second model in "Oscillating Systems II: Sustained Oscillations" (D-4602).

After reading "Properties of Damped Oscillations Systems" (D-4767) please refer back to "Oscillating Systems II: Sustained Oscillations" (D-4602), and re-read the description of the Cleanliness of a College Dorm Room model.

Kevin's roommate is not the only one who grows sick of seeing all of Kevin's laundry on the floor. Eventually Kevin realizes that he himself is unable to find the papers that he needs for class or the pizza that he had ordered the night before. Kevin can really only tolerate a maximum of eight articles of clothing on the floor before his messiness begins to impede his lifestyle. When Kevin changes his clothes, he either drops them on the floor or, if he feels that his floor is too cluttered, goes to the trouble of putting them away.

A. Change the Cleanliness of a College Dorm Room model to reflect Kevin's reaction to excessive laundry buildup. In your assignment solutions document, include the model diagram, documented equations, and graphs of the model behavior. Explain the behavior of the model in one or two paragraphs, contrasting the behavior of this model and the behavior of the model in the paper.

B. How would the behavior of the model change if Kevin dropped his clothes on the floor more frequently? Why? Justify your answers with graphs of model behavior.

C. How would the behavior of the model change if Kevin's tolerance for laundry on his floor increased? Why? Justify your answers with graphs of model behavior.

2. Independent Modeling Exercise

"Americans have been fighting wildfire full tilt for more than half a century. In those years we've created a powerful system built on brave young firefighters, old bombers, modern trucks, helicopters, and a bear named Smokey. But at the same time foresters and ecologists have been learning that too much fire fighting can be as bad as none. Today many of them agree that if we try to keep fires out of forests completely, dead wood and other fuels build up. Then, instead of low fires that just clear out brush, flames climb into the crowns of monarch trees and kill them. These fires burn so hot they leave total devastation. [...]

"*Density and diversity* A healthy ponderosa forest is made of widely spaced, fire-resistant trees. With overprotection, young trees and competing species make a flammable understory so shaded that ponderosa seedlings can't grow.

"*Forest floor* If burned often, a forest floor is a shallow layer of duff on soil that accepts ponderosa seeds. Overprotected, the floor builds deep layers of debris. Soil germination declines; fires burn hotter.

"*How fires burn* Frequent fires move swiftly across the fire floor, killing few large trees. When fire is rare, accumulated fuels explode into towering crown fires, and the thick floor burns long, hot, and deep, killing roots of grasses and trees.

"*Frequency of fire* Scientists measure frequency by scars on trees or ash layers on the ground. Fire intervals vary: short in ponderosa forests and grasslands, long in coastal Douglas fir forests. Inevitably, this year or next century, fire returns.

"*Recovery from fire* A healthy ponderosa forest recovers within three years, its roots intact, its trees barely scarred. In unfit forest, fire kills big trees; soil no longer absorbs rain and it erodes. Recovery may take centuries."

excerpts from "The Essential Element of Fire" by Michael Parfit
National Geographic, September 1996

Conceptualize and formulate a system dynamics model that addresses the problem of overprotection of forests by demonstrating the long-term costs of fighting forest fires.

We would like to encourage you to begin by reading the above *National Geographic* article in its entirety, if possible. Feel free to also refer to other sources in order to conceptualize and formulate the model. In your assignment solutions document, include the model diagram, documented equations, and graphs of model behavior. In a few paragraphs, explain why the system and the model produce the observed behavior. In the model documentation, make sure to explicitly state where you obtained the data for the parameters in the model. If you estimate the parameters, include proof that your model generates consistent and realistic behavior over the range of realistic parameter values, and explain why that range is, indeed, realistic. Then use the model to propose a cost-minimizing policy for fighting forest fires that takes into account both short-term and long-term effects.