Extra Exercises for Chapter 9. Information Feedback and Causal Loop Diagrams

1. Complete the causal loop diagram for the electric blanket.

Suppose you wish to draw a causal loop diagram to describe temperature control from an electric blanket. This system is similar to the home heating system discussed in Chapter 9. If you look to Figure 9.3 for ideas, you might draw the diagram in Figure 1. The loop on the left acts to control the heat flow to the sleeping space from the electric wires in the blanket. (A high dial setting means more heat production.) The loop on the right controls the heat loss. (Let's ignore heat from the sleeper's body.) Complete this diagram by labeling each arrow as + or - and each loop as (+) or (-).

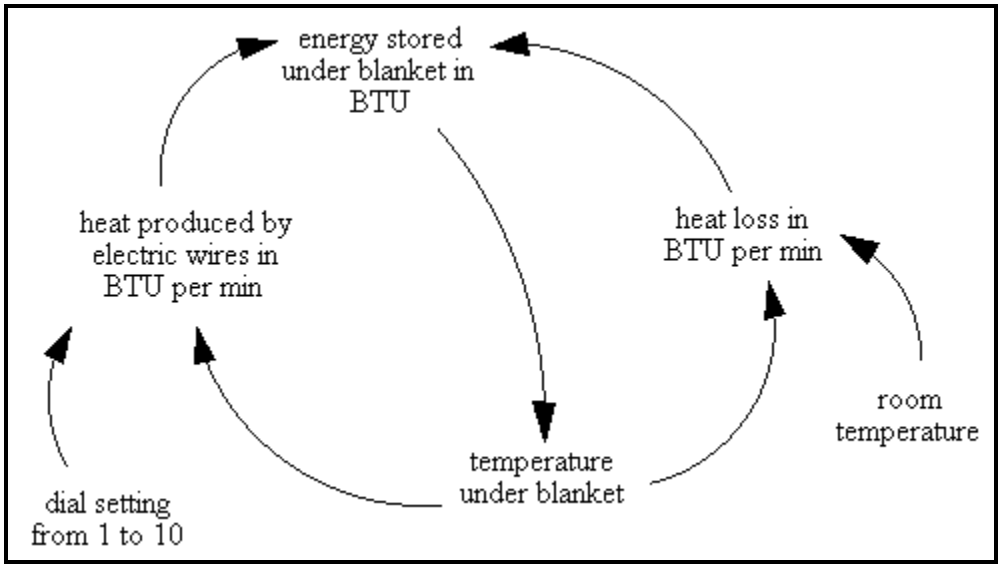

Figure 1. Finish this causal loop diagram for temperature control with an electric blanket.

2. Complete the New Diagram

The heat produced by the wires in the blanket depends on a dial which the sleeper may set between 1 (lowest heat) and 10 (highest heat). The dial setting is shown as an input to the previous exercise. Now, suppose you wish to expand the diagram to allow for changes in the dial position over time. Most people guess a setting when they first go to bed. For example, they might set the dial at "5", midway between the lowest and highest settings available. Then, after allowing some time for the heat flows to equilibrate, they might judge whether the equilibrium temperature is comfortable. If it's too hot under the blanket, they adjust the dial down. If it's too cold, they adjust the dial upward.

Figure 2 expands the previous diagram to represent these adjustments in the dial setting. A new variable (the temperature ratio) is defined as the ratio of the temperature under the blanket to the desired temperature. If the temperature under the blanket is 77 degrees and the desired temperature is 70 degrees, for example, the ratio would be 1.1 indicating that the temperature is 10% hotter than you would like.

Now there may be delays in the person's actions to adjust the dial. (see chapter 14 to read about delays; see chapter 18 to learn about how delays can lead to oscillatory behavior) In Figure 2, we use an observed temperature ratio to account for the delay in observing changes over time. The delay may be relatively short (i.e. you are still awake and are consciously delaying your reactions to allow time for temperatures to equilibrate). Or the delay may be long (i.e. when you are sleeping.) If the observed temperature ratio falls, the dial would be turned up. If it rises, the dial would be turned down.

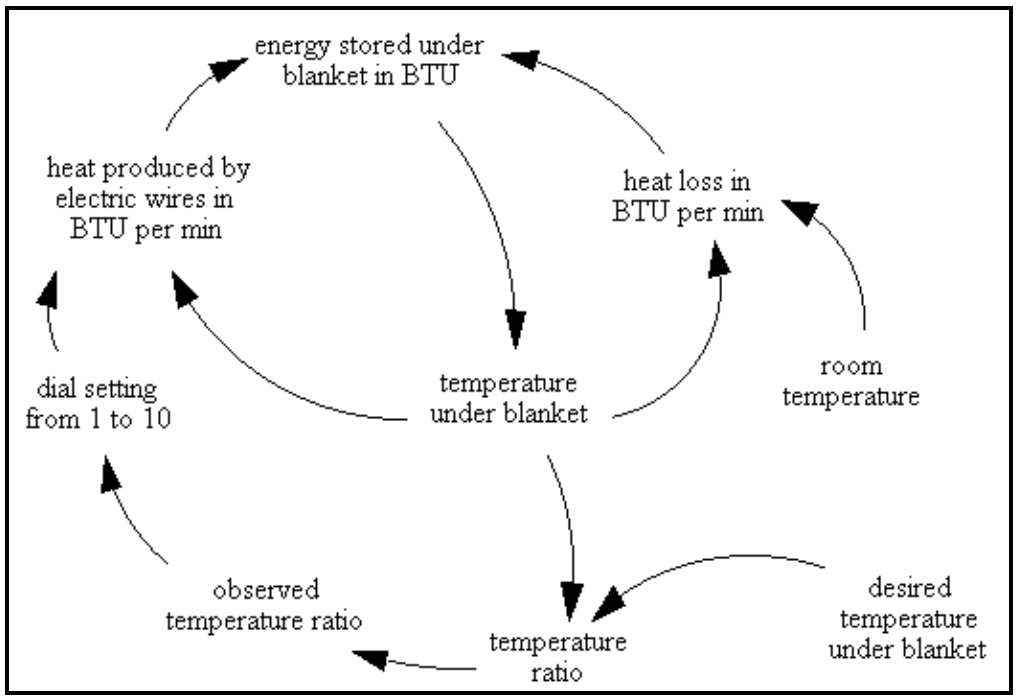

Figure 2. Expanded diagram to allow the dial setting to respond to temperature.

Complete the Figure 2 diagram by labeling each arrow as + or - and each loop as (+) or (-).

3. Two Sleepers and Two Blankets

Expand the previous diagram to include two people sleeping under two separate electric blankets. The sleeper on the left controls a dial on the left side of the bed. The sleeper on the right controls a dial on the right side of the bed. Your diagram should show a system with two sets of feedback loops that operate relatively independently of each other to achieve the separate goals. It should also show that the room temperature influences the heat loss from both blankets.

4. Misplaced Dials and Abnormal Operation

The two blankets system normally functions with the left dial at the foot of the left side of the bed while the right dial is located on the right side of the bed. Now, imagine that the dials become misplaced under the bed. We could be in for trouble -- the sleeper on the left reaches down to a dial, but that dial controls the heat to the right side blanket. And the sleeper on the right reaches down to a dial that controls the heat to the left side blanket. Expand the diagram drawn in exercise #3 to represent the new system. How does your new diagram compare to the previous diagram? Do any of the loops in the previous diagram disappear? Do any new loops appear?

5. Feedback in the College Model

Figure 3 shows the model of S-shaped growth in a private college (see extra exercises from chapter 7). Draw a causal loop diagram to show the feedback loops in this model.

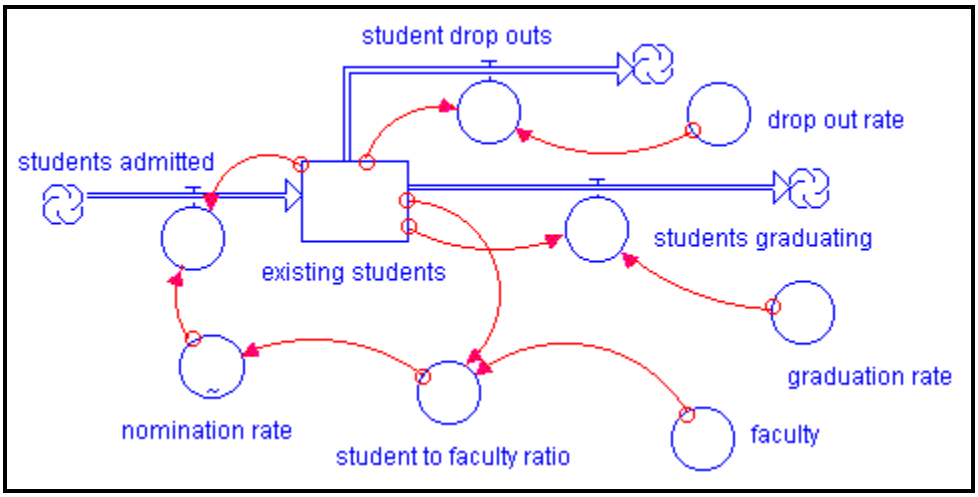

Figure 3. Model of S-Shaped growth in a private college.
(described in extra exercises for chapter 7)

6. Structural Similarity

Find a causal loop diagram in chapter 9 of the book for a model that gives S-Shaped growth. Then explain how the loops in the chapter 9 diagram correspond to the loops you identified in your answer to exercise #5.

7. Four Hikers: Loops in 1st Hiking Model

Download the extra exercise on "Let's Go For A Hike." Then draw a causal loop diagram to shown the feedback loops in the 1st exercise with the four hikers.

8. Four Hikers: Loops in 2nd Hiking Model?

Draw a causal loop diagram to show the feedback loops in model shown in the 2nd hiking exercise. Do you see the same set of loops found in the 1st model? Would you expect to see the same set of loops?