Extra Exercises for Chapter 7. S-Shaped Growth in a College

Figure 1 shows the flow diagram shows a model to simulate growth in a private college. The simulation begins with 200 students and 100 faculty, so the student to faculty ratio is two to one. Students normally require around 4 years to graduate, so the graduation rate is assumed to remain constant at 25%/yr. The dropout rate is constant at 15%/yr. A special feature of this college is that new students may only be admitted if they are nominated by an existing student. Each existing student has the right to propose two nominees per year. The existing students will fully exercise this right if they are impressed with their education. Let's assume the existing students will be impressed with their education when the student to faculty ratio is low. If the ratio should increase, however, the existing students will become less impressed, and they will be less willing to make nominations. The students' nomination rate is given by the nonlinear relationship in Figure 2. At ratios of 10 or less, the nomination rate will be 2 nominees per student per year. At the opposite extreme, the students' nomination rate will fall completely to zero if the student-faculty ratio climbs to 50.

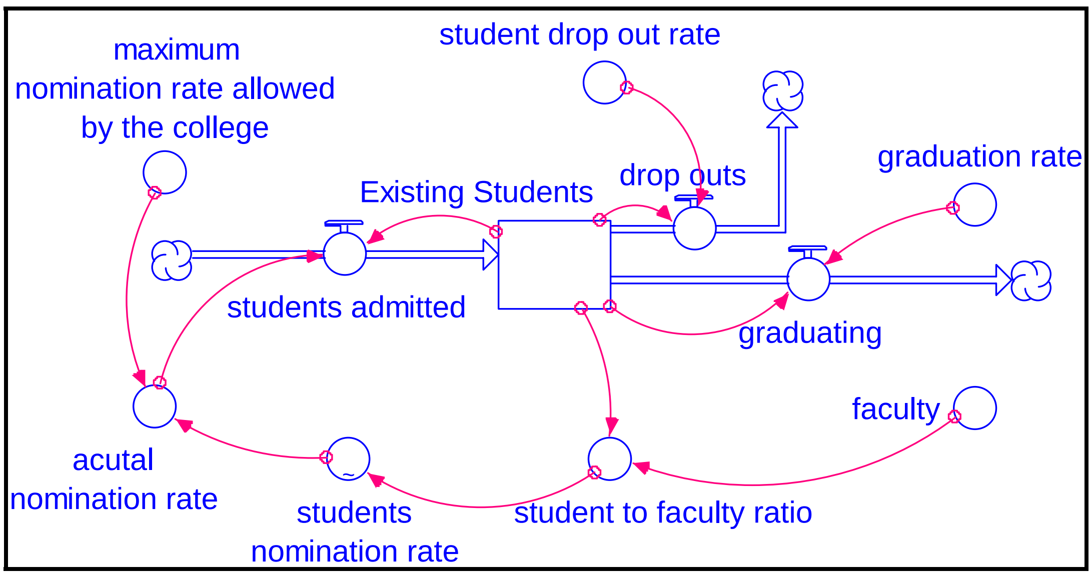

Figure 1. Model of the number of students at a college.

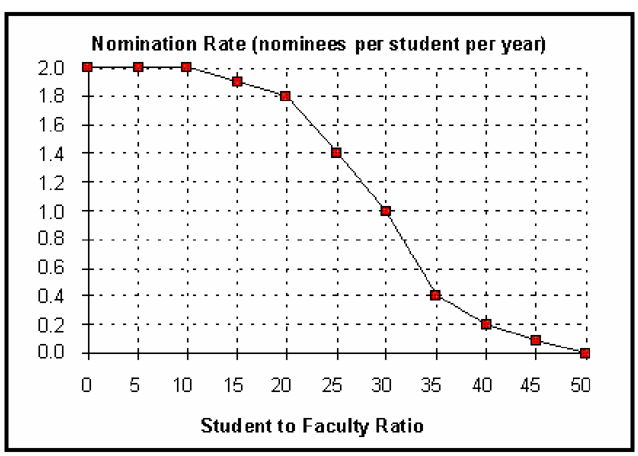

Figure 2. Nonlinear graph for the students' nomination rate (~).

The college may impose a maximum nomination rate. Set the maximum at 4 nominess per student per year. Based on the students' inclinations portrayed in Figure 2, the college's upper limit would not be reached in the exercises listed below. We'll experiment with this administrative limit in the extra exercises for chapter 18.

<u>1. Size of the College</u>

How large will the existing student body become if the number of faculty is fixed at 100? You should be able to derive the ultimate size with pencil and paper, so resist the temptation to run the model to answer this first question.

<u>2. Build and Simulate</u>

Build the model to simulate the growth in the student body over a ten-year time interval with DT, the time step, set to 0.25 years. Turn in a time graph of the number of existing students to document your work. Does the model confirm your answer in the previous exercise?

<u>3. Stable Equilibrium?</u>

If you complete the previous exercise correctly, you should see the student body reach a dynamic equilibrium. Do you believe that the equilibrium is stable, unstable or neutral?

<u>4. Stability Test</u>

Introduce a "disturbance flow" (see Figure 6.8) to remove around 25% of the students in the 10th year of the simulation and allow the simulation to run for 20 years. Turn in a time graph of the number of existing students to document your results. Does the test confirm your answer in the previous exercise?

<u>5. Build a Larger College</u>

The dropout rate of is 15%/yr in the previous exercises. This is relatively high rate -- 60% as large as the graduation rate. Suppose the college wants to build to a larger size, and it goes to work on the drop out problem. How much larger will the college become if the dropout rate were reduced to zero? (You should be able to answer this question without running the model.)

<u>6. Confirm Your Estimate</u>
Set the dropout rate to zero and run the model. Does the new simulation confirm your estimate in the previous exercise?

Note: We'll return to the College Model later in the BWeb Exercises:
Chapter 9 on Causal Loop Diagrams
Chapter 18 on the Introduction to Cyclical Behavior