Lab #2
Instructor: Todd BenDor

System Dynamics Modeling with STELLA

Part I: Feebate Controllability

1. See feebates section of Modeling Process Lecture (Powerpoint #5)

2. Find feebate model at: http://public.wsu.edu/~forda/models.html

    - You can find it directly at: http://www.wsu.edu/~forda/Feebates Fig 16-4.STM
    - If this does not properly appear on the screen, try a different version of the model: http://public.wsu.edu/~forda/fee1.zip
    - Also see the Netsim Version: http://forio.com/service/netsims/Andy.Ford/feebates_2nd_ed/index.html

3. Try to optimize your controllability of the feebate system. How well can you do? How well does the book say you can do?

Part II: Workload Management

We all experience excessive workload at some point in our lives. Urban planning graduate students, faculty seeking tenure and young professionals striving to establish themselves are particularly prone to this condition. A work overload appears when the inflow of tasks exceeds our capacity to complete them. It can rise to a steady manageable state or continue to increase indefinitely until it creates 'burnout.' Work overload is often blamed on the environment generating work rather than on poor management of workload, although it can be created by both factors.

Normally, **tasks** will flow into a **To Do List** at a rate that is exogenously determined (we may have no influence on our workloads!). **Completed tasks** will flow out at a rate determined by the **To Do List** and the **task completion time**. The **task completion time** may, however, change considerably depending on **overload**, which is a ratio of **To Do List** and **To Do Capacity**. Indeed, it will often take longer to complete a task under the physical and psychological fatigue arising from work overload.

Assuming the **To Do Capacity** is constant as long as there is a reasonable amount of overload, we might be able to complete our assignments with harder work. However, when our To Do List greatly exceeds our To Do Capacity, fatigue will build up, which will greatly increase task completion time. This would mean that the To Do List and the work overload will continue to build up.

1) After thinking about the description of how task completion works, draw feedback loops to illustrate your mental model of this system. There should be two feedback loops in the model and you should represent all of the major elements of the system in your causal

loop diagram. **Be sure to note the direction of causal linkage (+ or -) and denote each full loop with a loop symbol**.

2) Build a model using STELLA based on the feedback loops you have drawn and experiment with the model.

Parameter details:

Parameters are numerical constants specified on the basis of experiential and experimental data available for the system. Such data is often obtained through literature, field research and controlled experiments. Following information is provided to you to assert parameters for your model:

Initial to do capacity = 100 tasks
Initial to do list = 50 tasks

Tasks = 10/month

Normal work completion time = 5 months

We know that there is a non-linear effect of overload on the time to complete tasks. Like the last assignment, this relationship can be viewed as a multiplier relationship from a lookup table, which uses **overload** on the x-axis as an input. Here, the causal relationship looks like: **overload** affects **overload effect on completion**, *w*hich affects **task completion time**.

This relationship is given by the following graphical function:
Overload_Effect_on_Completion = GRAPH(Overload)
(0.00, 0.5), (0.25, 0.75), (0.5, 1.00), (0.75, 1.30), (1.00, 1.60), (1.25, 1.98), (1.50, 2.43), (1.75, 2.93), (2.00, 3.43), (2.25, 4.05), (2.50, 5.00)

Details for model building and experimentation

A. List variables in the model. Which of these are endogenously determined and which are exogenous? Which of the variables are stocks, which are flows, and which are converters?

Use connectors to specify causal relationships between various model variables you have listed. Open each variable, except stock, and specify algebraic equivalents for the causal relationships in the description above.

B. If this system is initially at equilibrium, what is the task inflow rate? [Hint: This is not zero, since zero new tasks will cause the **To Do List** to decline (not equilibrium)]. Specify this rate and make an equilibrium simulation run with your model. Try creating a graph of the **To Do List** level and **task inflow** and **completion rates** over time.

C. Now step up the **task** inflow rate by 10 tasks/month at time=10 to represent a sudden increase in your workload. Run the model and compare the simulation results with the patterns you observed in the equilibrium simulation. Explain and graph the results, including the net flow rate, pollutants, relative pollution level multiplier, pollutant assimilation rate, and the pollution inflow rate

   Hint: Use step function: 'STEP(Size, Time of Step)'

Things to think about:

What happens if we made To Do Capacity variable? How could we do this?

Does Capacity to do work accumulate over time? Could we build up a resistance to fatigue? How might we model this?

Part III: Modeling a War on Drugs

Read:

1. Heroin-Crime Model Description (After 1976 Boston Globe Article)
2. Drug Legalization argument (Libertarian Harvard Economist)

In this part of the assignment, you will construct a model of a hypothetical 'war on drugs,' in which **Drug Inventory** is affected by **Supply**, **Consumption**, and **Drug Busts.**

We are going to assume (at least initially) that **Drug Inventory** does not affect **supply** rate directly, nor does it affect **consumption** rate or **drug busts**. Drug consumption suggests a **desired drug inventory**, which, when compared with the available **inventory**, affects the **drug price** (through a **Drug Price Index**).

Drug Consumption is driven by the number of addicts and their per-capita consumption. **Addicts** commit a certain number of **per-capita crimes** to get drugs (creating a total number of crimes; 'Normal crimes'). This crime is influenced by their relative desperation for a drug, which is influenced by **Drug Price**. In low inventory conditions, normal drug price increases (due to the drug price index).

As **Drug price** increases, the **Drug Related Crime Potential** increases, which leads to **Drug Related Crime** (after a **delay**), and influences the rate of new **drugs being supplied** to the system (along with the **average drugs supplied per crime**).

Begin thinking about how this model fits together. What are the variables here?

Sketch out a causal loop diagram and perhaps even generate a stock-flow diagram.