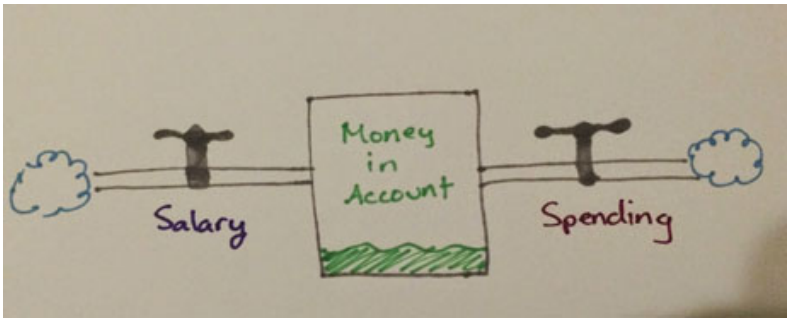
Lesson Week Ten: Working With Simulation Models

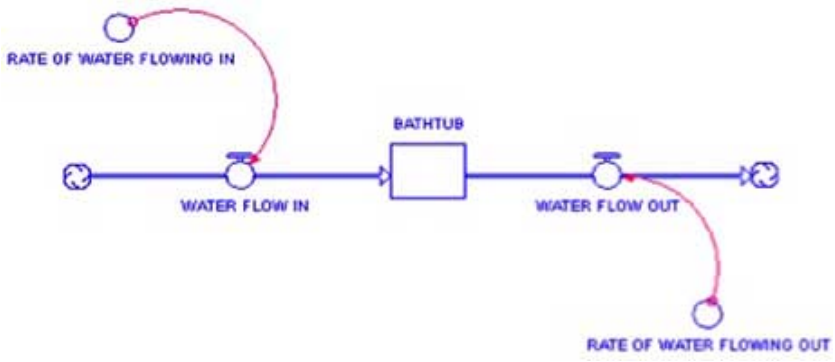
You have learned that a model of causal loop structures is a hypothesis about what causes behaviors that concern us. Models can be constructed in such a way that causal relations are quantified with simple algebraic equations. Modern software exists – Vensim, Stella, Powersim, etc. - that can then simulate the behavior a model generates. Instruction in simulation modeling – a next step in learning to systems think - is beyond the scope of this introductory course. However, by playing with simulation models built by others, which allows you to run simulations of behavior under different scenarios, we can learn much about a complex problem. Increasing opportunities to work with simulation models are appearing on the internet. This lesson will provide an example of a simulation model that can be manipulated, and give you practice in working with and learning from such models.



Stock and Flow Models

In simulation models, variables that measure levels, like gallons of water in a bathtub, are differentiated from other variables and are commonly called stocks. Variables that are measured per unit time, like gallons per minute flowing into or out of a bathtub, are shown as flows into or out of stocks.

Flows are what directly change stocks. All other variables affect stock levels only indirectly by how they affect flows. Stock and flow models permit quantification and simulation of the behavior generated by a model. Stock and flow structure is needed in simulation models to build a more accurate picture of interactions among variables than the causal loop diagrams you learned in this course. However, like CLDs, stock and flow models reveal feedback loops and use much of the same symbolic language.

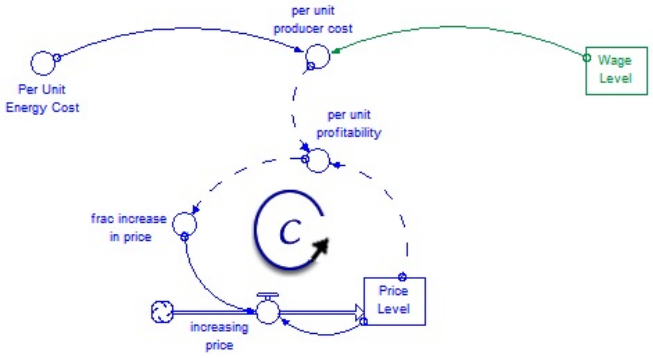


Learning By Simulating Dynamic Complexity

Netsim is a software program that allows us to run and modify a simulation model. Forio is an application that provides for online access to Netsim creations. These applications are used in the following example http://forio.com/simulate/netsim/energy-sotm-2/simulation/ of a model of the problem of increasing energy costs. Netsim explains a model by unfolding/building it in stages and telling the story, as you have learned to do in this course. Then the Netsim program asks you to run the simulation to see the effects of modification of the model. The discussion assignment in this lesson will use this example. You should be able to recognize and read the models you see despite slightly different symbolism and slightly different construction from models used in this course:

1. Dashed arrows are used instead of negative sign (-) and unbroken arrows instead of positive sign (+).
2. Variables are connected in “stock and flow” diagrams.

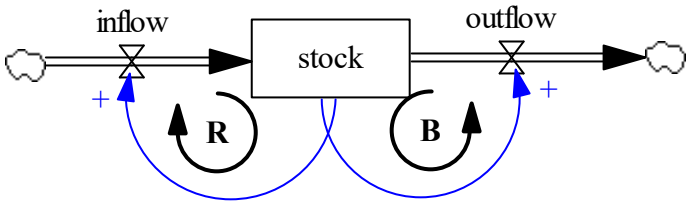
3. While Reinforcing feedback is labeled (R), just as you learned, Balancing feedback is labeled (C), meaning 'counteracting' instead of (B) as you learned.



Discussion Assignment:

Follow the Netsim instructions in this example to study the problem and the model until you understand them. Then manipulate the variables, run the simulation under the two scenarios and learn from the consequent behaviors in the time graphs.

1. Draw the full model in Vensim including the appropriate signs on all the arrows. Share the model for discussion with the class. You will need to use two new Vensim commands: the ones to draw **stocks** and **flows**, which you will find in the row next to other command buttons that you have already learned to use. To draw a stock, click on the button that shows "var" in a rectangle, click where you want to place in the drawing space, type a name for the stock, and hit 'enter'. To draw an inflow, click on the button with a double arrow, click on the drawing space, click on the stock it should flow into, type a name and hit 'enter'. To draw an outflow, click on the stock rectangle, click on the drawing space, type a name for the flow and hit 'enter'. Stocks and flows in Vensim look like this:



2. In the Netsim example, develop a hypothesis for how the dynamics change in the energy situation if wages do not increase when the energy price increases. Write a narrative that tells the story. Revise the model to demonstrate those dynamics. Share your narrative and revised model with the class.

3. Discuss the question: This situation as modeled is an example of what systems archetype?

4. Explore the examples of simulation modeling of problems provided on the Forio site: http://forio.com/simulate/netsim/. Study and work with at least two of them in depth.