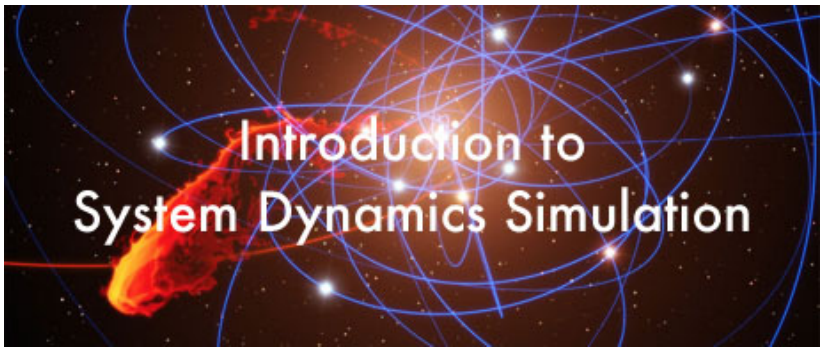
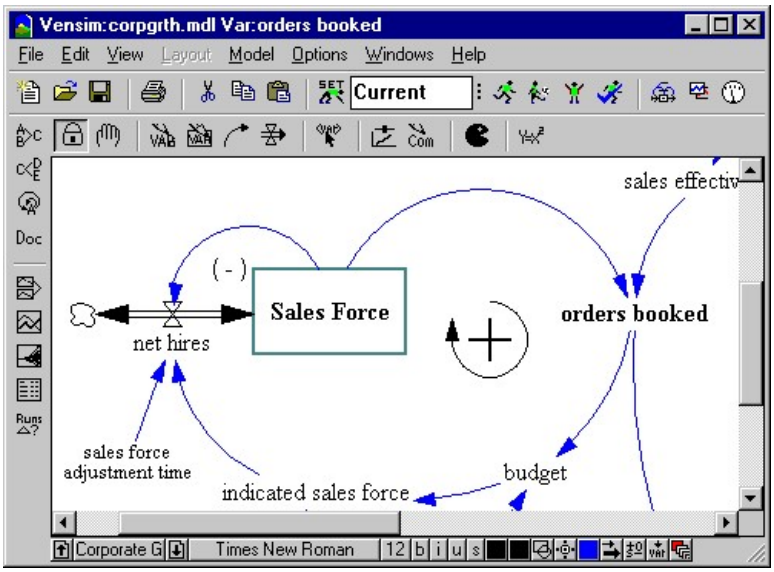
Lesson Week 12 – Introduction to System Dynamics Simulation



The ultimate tool in systems thinking, system dynamics is the professional skill devoted to the creation of models that are quantified so that they can be "run" to show the behavior over time that they generate. Using software such as Vensim, Stella and Powersim, system dynamicists create visual models and describe the causal connections with simple algebraic equations. Then the computer simulates the behavior the model generates by doing the differential calculus of behavior outcomes over many time increments, which used to be almost impossibly difficult before computerization. Simulation models are the next step beyond causal loop diagrams.

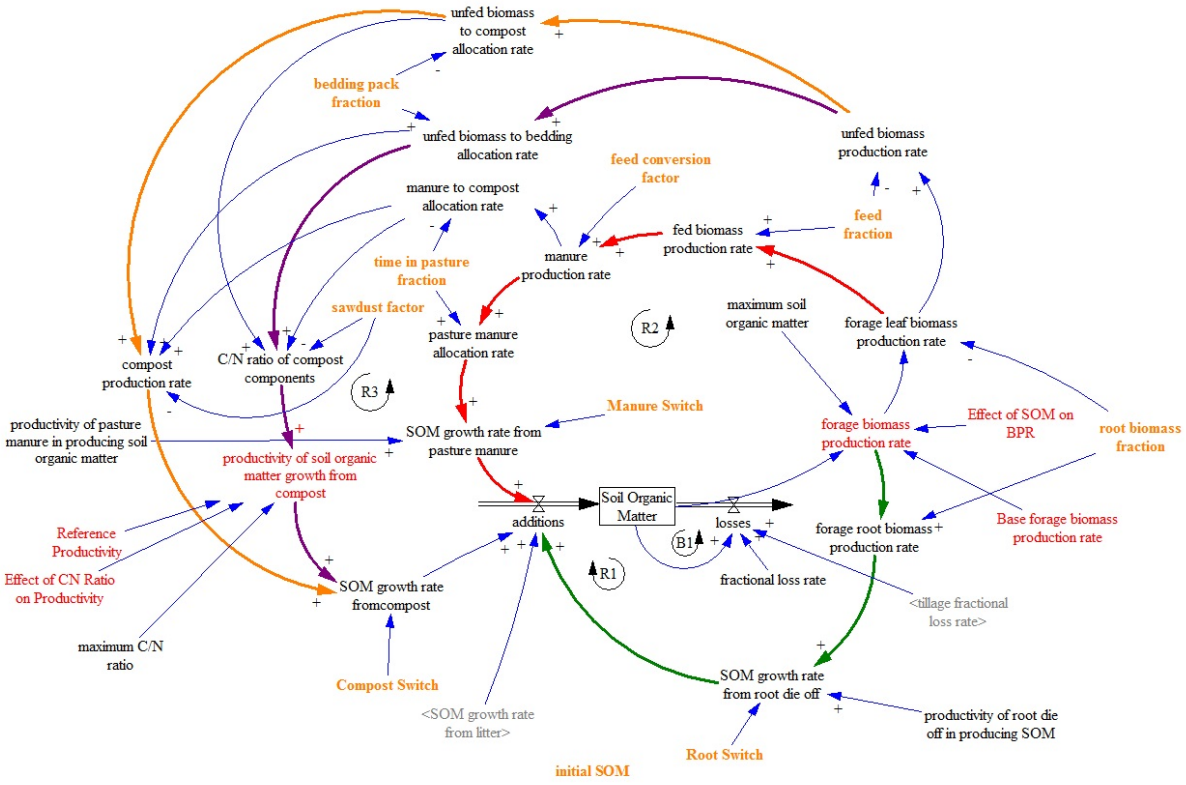


The value of simulation is that one can test hypotheses about what model structures and parameters are causing a problem, and then test alternative solutions. It permits experimentation with different scenarios, develops our understanding of the system of influence, and thus provides insights as to policy choices or decisions in the real world that might solve a problem.

Simulation modeling is now used in an increasing number of fields to address the complexities of problems encountered in those fields because of the variety and number

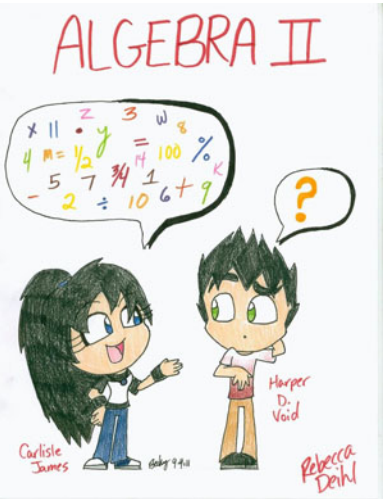
of variables that interact. It is widely used in weather prediction and climate change modeling, medicine and public health, corporate management, environmental science, industrial design and military strategy. For example, public health problems like epidemics are affected by diverse variables – biological, medical technological, social, economic, political and cultural - that require the trans-disciplinary modeling capabilities that systems dynamics offers. An example is Understanding Diabetes Population Dynamics Through Simulation Modeling and Experimentation.

Learning to use simulation software is not difficult, but learning to visualize causal connections algebraically takes practice. The soil organic matter project used as an example in Lesson 9 was one of my first attempts at simulation modeling. Here is how the simulation model for this project looks:



The study of system dynamics simulation modeling is a course in itself, for which this course is a good stepping stone, but which I found more challenging than the CLD modeling you learn in this course. A course in system dynamics was offered in the agricultural school of Cornell University near where I farmed. As a farmer I was allowed to sit in on the course and do all the required work. Most of the graduate students taking the course were training in fields that used a lot of mathematics. Perhaps because my formal training had been in the social sciences, I took the course three times before I began to feel comfortable with the quantification of relationships that other students were used to. I understood the algebra required in the models, but my high school algebra had

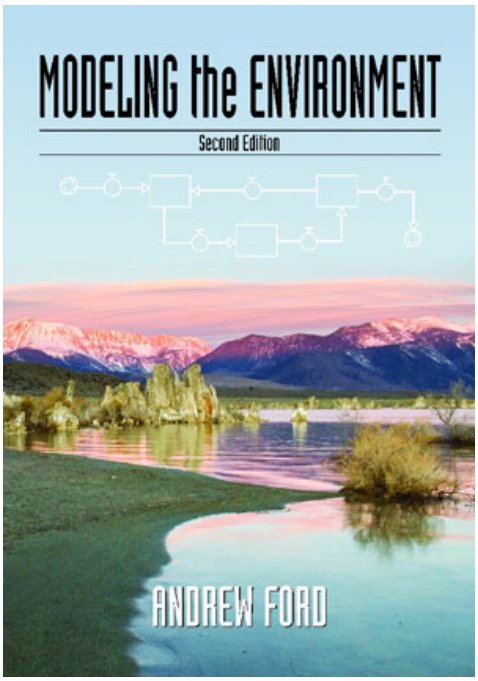
been about solving equations, not devising equations to accurately describe real world relationships.



This week's assigned video lecture, Getting Started with Stella, provides an excellent brief exposure to simulation modeling without getting into teaching the subject. It is a demo on simulation modeling with Stella modeling software, which functions like the Vensim software used in this course. It also exposes you to the other main simulation software besides Vensim, and what it can do.

One version of Stella also offers a story telling 'interface' intended to educate a broader public about the system dynamics of a problem. This interface creates a 'front end' that anyone can manipulate without having to do the actual modeling building. Isee Systems, the creator of Stella, and others have used the interface to create some of the problem presentations that you see in this course. The Netsim presentation of the energy problem in lesson week 10 was an example.

Those who want to develop their systems thinking skills beyond this course have many opportunities in the form of classroom and online courses and books. System dynamics is taught in a number of schools, of which MIT has been the pioneer in the field in this country. Two main textbooks I have used are **Business Dynamics: Systems Thinking and Modeling for a Complex World** **by** John Sterman of MIT, and **Modeling the Environment** by Andrew Ford. Isee Systems, the creator of Stella modeling software, is one example of a source of online and classroom courses.



Assigned Resource

Getting Started with Stella