HPAM 643/843 **System Dynamics Modeling Project**

Key dates:

September 29 — Submit form for Project Topic
October 14 —Project Presentations on Reference Mode and Causal Loop Diagram (CLD) (5%)
November 3 — Project Presentations on initial simulation model (5%)
December 22 — Final presentation (10%)
December 22 — Final paper with model uploaded to blackboard (20%)

The focus of this class is on using system dynamics *models* to *design sustainable solutions* to a public health dynamic problem. A solution requires both an interpretation of the problem and a demonstration using computer simulation that the solution could work. However, given that one of the recurring themes throughout the course has been that we often do not know a priori what solutions will work or how they will work, and key point in searching for a solution is to go through multiple iterations where you develop increasingly deeper insights into the system, problem definition, explanations for what is causing the problem, what the solutions might be, etc. Ultimately, the goal is to use the model to develop insights that lead you to find novel solutions.

To do this, you will need to build a series of system dynamics simulation models. Each model or version of the model should build on what you learned from a previous model. Each version should represent a step in your thinking, something you try out and test by building and running the simulation model. Through this process, you will likely discover that many of your initial ideas or expectations were wrong or counter-intuitive, and you will over time learn what it is that is wrong and how to build a better model. This is an inherent part of the process of building models, and it is through this process that insights into the system and problem definition are developed.

Your final product will consist of a 10-minute presentation with 5 minutes for Q&A and 10-15 page double spaced paper. The final result should be suitable for submission to the International System Dynamics Conference (ISDC) and follow ISDC submission guidelines and formatting requirements. Good formatting, well-drawn diagrams, layout, grammar and spelling, etc. are important aspects of professional presentations. Like the conference papers, feel free to attach supporting appendices (e.g., equation listings).

The paper and final presentation should cover the following content:

- Title of project, your name, and names of anyone who helped you including key informants and agency partners
- Background and orientation to the problem
- Description of the reference mode as you have interpreted the dynamic problem
- Overview of the simulation model structure including major stocks-and-flows, feedback mechanisms, table of main parameters (values, units and possible measures), and key equations
- Computer simulations showing how your model reproduces the reference mode
- Discussion of an intervention of policy solution and demonstration about how it would solve the problem by showing the results from one or more computer simulations with an emphasis on designing sustainable policies or programs
- Conclusion of key system insights developed through the modeling process and next steps for this model

The final submission should be uploaded on blackboard, and include a PDF of the paper, final Vensim simulation model file, and PDF of the final presentation. The grade will be based on the presentations to the class (20%) and final written product (20%).

Here are some things to keep in mind:

- *Always try to have a running model*. It is common to try and collect a lot of information, search for data, interview participants, and so on before starting to formulate a simulation model. Some conceptualization is always necessary, but at some point the benefits of more information are outweighed by the inherent limitations of our conceptual models. To avoid this, build an initial simulation model as soon as possible, even if it involves only one stock and you really don't know how the system works. The exercise of building and testing a simulation model quickly sensitizes you to what kinds of information you need to collect and sharpens the questions you're asking key informants.

- *Keep your models small*. It's common to try and build large models, and we can easily fall into the trap of wanting increasingly more detail complex in the model in an effort to make it more realistic. But remember, the point of modeling is not to build a model that is realistic in all aspects, but just realistic enough on the essential aspects of the problem to find a solution. The best strategy for doing this is to keep your models small starting with one or two stocks and then only gradually building up to larger models. You will also want to prune your models as you discover structures that are no longer essential to the problem.

- *Don't be afraid to start over*. A byproduct of developing deeper insights into the problem and system creating it is often that you realize in retrospect how to represent the problem with a simpler model. Or, you discover that the direction you're going isn't working at all. In both cases, don't be afraid to start over with a blank model. One barrier to this is often that it took you a long time to get to this version, and it will take you as long if not longer to start from scratch. However, what often happens is that with each version you begin to model faster as you become familiar with the structures and why you are making certain modeling decisions. So what might have taken you several weeks now only takes a day or two.

- *Document your insights*. When you have the small and big "ah ha" moments, document them! It is very easy to forget this and think that you'll be able to remember why you modeled some aspect of the problem in a particular way. But then, at the end of the semester, you can't quite remember all the reasons for modeling something one way versus another way. A good strategy here is to document your model as you go using PowerPoint slides where you can copy and paste model structure, simulation runs, and provide concise narratives of key insights.

- *Remember your reference mode*. It is very easy to get caught up modeling the system as opposed to the problem. Remember that your goal is to model a specific problem articulated as your reference mode. Always come back to this and use your reference mode to help guide what feedback loops should be in the model, which mechanisms, which variables to include, and so on.

- *Build and test as you go*. Drawing a diagram of a model is always easier than formulating equations that work, so a common trap in modeling is to draw a large diagram and then try to formulate all the equations. Build small parts of the model and test as you go; don't wait until the end to do an extreme conditions test or check for dimensional consistency.

- *Don't be afraid to reframe the problem*. It is quite possible that as you work on interpreting the design problem and search for a solution, you come to discover something that is fundamentally wrong in how the problem is reframed. Do be afraid to reframe the problem, even if that means starting over with a simpler model. And, remember to document this if it happens!