MBA 645 Special Topics: Strategic Management Science

Spring 2025 (revised 2025-01-09)

Bill Foote

Contents

Course description

This course explores how organizations can use system dynamics as the core analytical technology to achieve mission-critical goals. In this **Basics of System Dynamics** course we build and apply several basic System Dynamics models in the first 5 weeks of the course. In the last two weeks, 6 and 7, we will apply our inventory of skills and models to the problem of simulating a B (Benefits) Corporation in the context of a practical Business Canvas approach. For this portion of our studies we will use paper, pencil, and the VensimPLE platform for all of our work.

Goals

At the end of this course students can expect to demonstrate progress in meeting the following goals, proposed here as actions with verbs in the imperative mood.

1. Pose a researched business question, model the causal influences implicit in the question, simulate potential causal relationships and counterfactual inferences and their sensitivities, and align inferences with decision alternatives and plausible choices for stakeholders.
2. Deploy analyses which produce interactive analytical products using an industry-grade computational platform engineered according to a tradition of design principles.
3. Using endogenous, generative models summarize experience and beliefs about stakeholders, their data, and the processes that the generated data used, to infer potential outcomes to answer business questions.
4. Practice quantitative critical thinking skills through a compound of statistical and normative problem solving.
5. Understand the role of the analyst and the analytics process in the decision-making context of complex organizations and their environments.
6. Communicate analytical decision results to decision makers and other consumers of analytical products effectively using interactive tables and graphs.

Contact

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Office hours (Spring 2025):

- Online on Zoom, Saturdays 10am to 12 noon
- Other times by appointment, text me to arrange a time or just to have a chat

Origins

For my part the course emanates from from about 45 years of learning about, teaching managers system dynamics at Fordham University, Clarkson University, Syracuse University and LeMoyne University. I have used SD techniques and simulations at a variety of financial institutions, high tech, energy, retail, governmental and not-for-profit organizations world-wide while in industry at Ernst & Young, Deloitte, and other organizations.

I have taken liberally materials and ideas (some might say I curated materials) from several extant courses. They all flow from the avowed discoverer of the systems dynamics methodology, Jay W. Forrester, and his decades of work, and students, at the Sloan School of Management, MIT.

- The maths: Harry Hochstadt's *Differential equations : a modern approach (1963-4)* details in the first 84 pages the math behind system dynamics, namely solving systems of simultaneous differential equations.
- The numerics: Joel Ferziger's *\underline{Numerical Methods for Engineering Applications_, 1978.* Yes, FORTRAN. I moved most of these routines to MATLAB and APL2 in the 80's.

- Jay Forrester's 1998 MIT Introduction to System Dynamics self-study course
- George Richardson's 2013 Albany University
- John Sterman's 2013 Introduction to System Dynamics MIT-OCW course
- Craig Kirkwood's ASU System Dynamics Home Page
- Ventana System's VensimPLE tutorials along with Tom Fiddaman's MetaSD model library

Resources

Course **content and weekly schedule** is housed in the System Dynamics 101 website.

These books and models will be referenced throughout the course.

The two primary texts are:

- Daniel H. Kim and Virginia Anderson, System Archetypes Basics from Story to Structure (SysArch reference) outlines with several examples the 8 system archetypes and the problems they can help managers solve. Examples and solutions abound in the book and in this course.
- Juan Martín García's SYSTEM DYNAMICS MODELLING WITH VENSIM (SysDynMod reference), available in paperback and ePub formats, will guide us throughout the course as we build causal loops and their associated stock and flow diagrams.}]

The computational platform is the Vensim P L E (VensimPLE). In the past, conducting meaningful business analysis required computer science and programming skills.

Download VensimPLE here.

With Vensim business analysts and managers with diverse skill sets can use the Vensim self-service analytics platforms to model and simulate realistic decision environments in communities of complex organizations. Groups of decision makers can analyze data, trends, tipping points, and discover the leverage needed for policy intervention.

I rely on the system dynamics body of knowledge contained in Sterman's comprehensive text, and beautifully explicated in Donella Meadows primer, as well as several articles and presentations in the course readings repository.

- Donella Meadows, Thinking in Systems: A Primer, 2008 edition. Either begin the course or end it with this gem.
- John Sterman's Business Dynamics, 2013 is the baseline body of knowledge for system dynamics modeling, especially in social-ecological systems (SES). We will be reading excerpts as we begin to build models.
- Course readings repository will house various articles and other materials we will draw on each week of the course.
- Course Vensim models repository contains all of the Vensim files (*.mdl) and the SynModVensim cases (prefixed with *case* + number.)

Requirements

The course is officially online. However optional live sessions each week (they will be video'd!) will help keep all of us awake to one another's needs throughout the course including advice on solving some of the thornier problems we will face.

Assignments

There are six (6) assignments to be submitted to the course Learning Management System (LMS) site. In addition there is a participation grade.

- Assignments 1 through 5 are each worth 13% of the final grade, that is, for a total of 65% of the final grade. These will be completed during weeks 1 through 5 of the course. They will typically include an upload of a model and a short interpretation of results.
- Assignment 6 is worth 25% of the final grade and will be completed during weeks 6 and 7 of the course. This last assignment is designed to pull course concepts together into a comprehensive system dynamics model replete with interpretation and ready for policy analysis. The final project artifacts will be deposited into an R Package hosted on the student's Github account.
- Final assessment prerequisites: the student presents a 5th week summary of course work to date and a proposal for the final project. Written hand-outs (3-5 pages or slides) and a video will constitute the artifacts for this assessment prerequisite. This is a binary (all or nothing) requirement and will serve to advise the student of gaps in knowledge and skill, all to position the student for a successful completion of the final project.
- Participation is worth 10% of the final grade. This grade will be primarily evidenced through posted comments on the course blog site regarding modeling vignettes and issues.

We will work in teams and submit individual assignments and posts. Individual final grades are A-F (integer ranges): A (>95), A- (90-94), B+ (85-89), B (80-84), C+ (75-79), C (70-74), D (65-69), F (<65).

Rubrics

A student's course work will be assessed using a rubric with themes and a scale.

5 - The student simply commands the subject.

4 - There are smaller calculation, informational, inferential errors, minor misunderstandings or gaps in the student's knowledge

3 - Major misunderstandings or gaps in the student's knowledge, leaps of logic, or the student is sometimes unable to apply basic concepts, or there are some major calculation, informational, inferential errors: nevertheless the average performance is satisfying and remediation is possible.

2 - There are major gaps in the knowledge and skills of the student.

1 - The student can list concepts and results covered but cannot reproduce their essence and correctly use them in practical situations presented during the course.

0 - The student does not really know the subject at all!

Indicative integer thresholds (the instructor reserves the authority to judge the assignment of scores across the breadth and depth of observed coursework): 5 –95 pct, 4 – 85 pct, 3 – 75 pct, 2 – 60 pct, 1 – 55 pct of the maximum assessment score. These will be mapped to letter grades at the end of the course.

This general rubric guides assessment of coursework.

- **Words:** The text is laid out cleanly, with clear divisions and transitions between sections and subsections. The writing itself is well-organized, free of grammatical and other mechanical errors, divided into complete sentences, logically grouped into paragraphs and sections, and easy to follow from the presumed level of knowledge.

- **Numbers:** All numerical results or summaries are reported to suitable precision, and with appropriate measures of volatility and uncertainty attached when applicable.
- **Pictures:** All figures and tables shown are relevant to the argument for ultimate conclusions. Figures and tables are easy to read, with informative captions, titles, axis labels and legends, and are placed near the relevant pieces of text.
- **Code:** The code is formatted and organized so that it is easy for others to read and understand. It is indented, commented, and uses meaningful names. It only includes computations which are actually needed to answer the analytical questions, and avoids redundancy. Code borrowed from the notes, from books, or from resources found online is explicitly acknowledged and sourced in the comments. Functions or procedures not directly taken from the notes have accompanying tests which check whether the code does what it is supposed to. All code runs, and the `R Markdown` file `knits` to `html_document` output, or other output agreed with the instructor.
- **Modeling:** Model specifications are described clearly and in appropriate detail. There are clear explanations of how estimating the model helps to answer the analytical questions, and rationales for all modeling choices. If multiple models are compared, they are all clearly described, along with the rationale for considering multiple models, and the reasons for selecting one model over another, or for using multiple models simultaneously.
- **Inference:** The actual estimation and simulation of model parameters or estimated functions is technically correct. All calculations based on estimates are clearly explained, and also technically correct. All estimates or derived quantities are accompanied with appropriate measures of uncertainty. Information criteria are described and used to explain outcomes in terms of predictive power including volatility and uncertainty (e.g., over- and underfitting). Exceptions are noted, assumptions are challenged, recommendations for ongoing work are stated.
- **Conclusions:** The substantive, analytical questions are all answered as precisely as the data and the model allow. The chain of reasoning from estimation results about the model, or derived quantities, to substantive conclusions is both clear and convincing. Contingent answers (for example, "if X, then Y, but if A, then B, else C") are likewise described as warranted by the model and data. If uncertainties in the data and model mean the answers to some questions must be imprecise, this too is reflected in the conclusions.
- **Sources:** All sources used, whether in conversation, print, online, or otherwise, are listed and acknowledged where they used in code, words, pictures, and any other components of the analysis.

Assignment Formatting

All assignments must be turned in electronically, through the learning management system, by each student. All assignments will involve writing a combination of code and actual prose. You must submit your assignment in a format which allows for the combination of the two, and the automatic execution of all your code. The easiest way to do this is to use `R Markdown`. `R Markdown` also allows the use of interactive modeling through `Shiny` applications.

Work submitted as Word files, unformatted plain text, etc., are not acceptable at any time during the course. Each assignment will require the submission of at least one `R Markdown` script file and the `html` file that the `R Markdown` script generates. When using data sets, this course will only use `csv` (comma separated variable files generated by Excel or in text files or calls to data using APIs. If the submission uses a `csv` file, that file must also be submitted with the `R Markdown` script and generated `html` output files. The student may also submit a supplemental `R` script file, suitably commented, that represents the `R` code chunks in the `R Markdown` script.

Managing the data base of submitted assignments throughout the course will be aided by standards including file name construction for assignment submission. To this end, every file submitted must have a file name

which includes the student's name, course identifier, and clearly indicates the type of assignment (project) and its number (week). Here is the format we will use: `yourName_courseidentifier_Assignment#.ext`, where # is the week number and ext is the file name extension.

For example W.G. Foote would submit **RMarkdown** file with this filename:

- `wgfoote_MBAC611_Assignment1.Rmd`, where the file extension `Rmd` is the extension that `RStudio` uses for `R Markdown` documents.
- File extensions `R`, `html`, and `csv` are the other three admissible file types.

Other matters

Course Specific Policies

Students are expected to behave in a professional and courteous manner at all times when interacting with all members of the course learning community. Respect for others is demonstrated through attendance, meaningful participation, and punctuality. Every effort should be made to be present for each session, if not feasible, view the recording of each session, especially since weekly assignments will be made conditional on content in live sessions.

All projects must be completed and submitted by the due dates and times set out. This will allow the entire class to review and revise submissions in a timely fashion. Submissions to `lms.manhattan.edu` are based on Eastern Time (UTC +5).

- Late submissions will result in student inability to accumulate the knowledge needed to advance to the next week's coverage of course topics.
- Late submission will also delay necessary instructor feedback to the student in a timely fashion.
- As the course continues to layer on more skills and capabilities, a late submission with inaccurate or incorrect implementations of financial applications will only deprecate the student's ability to successfully complete future assignments, let alone the final project.

So, don't be late. Due dates are posted in the LMS (Learning Management System) to help you pace your progress through the very quickly rolling out of the 7 weeks of the course term. Due dates are not deadlines. However, there is one deadline from the Registrar: all grades (including Incompletes) must be posted within 48 hours of the end of the course term.

Academic integrity

The Manhattan College Academic Integrity Policy holds students accountable for the integrity of the work they submit. Students should be familiar with the Policy and know that it is their responsibility to learn about instructor and general academic expectations with regard to proper collection, usage, and citation of sources in written work. The policy also governs the integrity of work submitted in exams and assignments as well as the veracity of signatures on attendance sheets and other verifications of participation in class activities. For more information and the complete policy, see the Manhattan College Catalog.

Students with disabilities

If you need academic accommodations due to a disability, then you should immediately register with the Director of the Specialized Resource Center (SRC). The SRC at Manhattan College authorizes special accommodations for students with disabilities. If you have a documented disability and you wish to discuss academic accommodations, please contact me within the first week of class. ## Academic integrity

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