Computer Simulation

Module 1: Intro + Course Tour

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Getting to Know You

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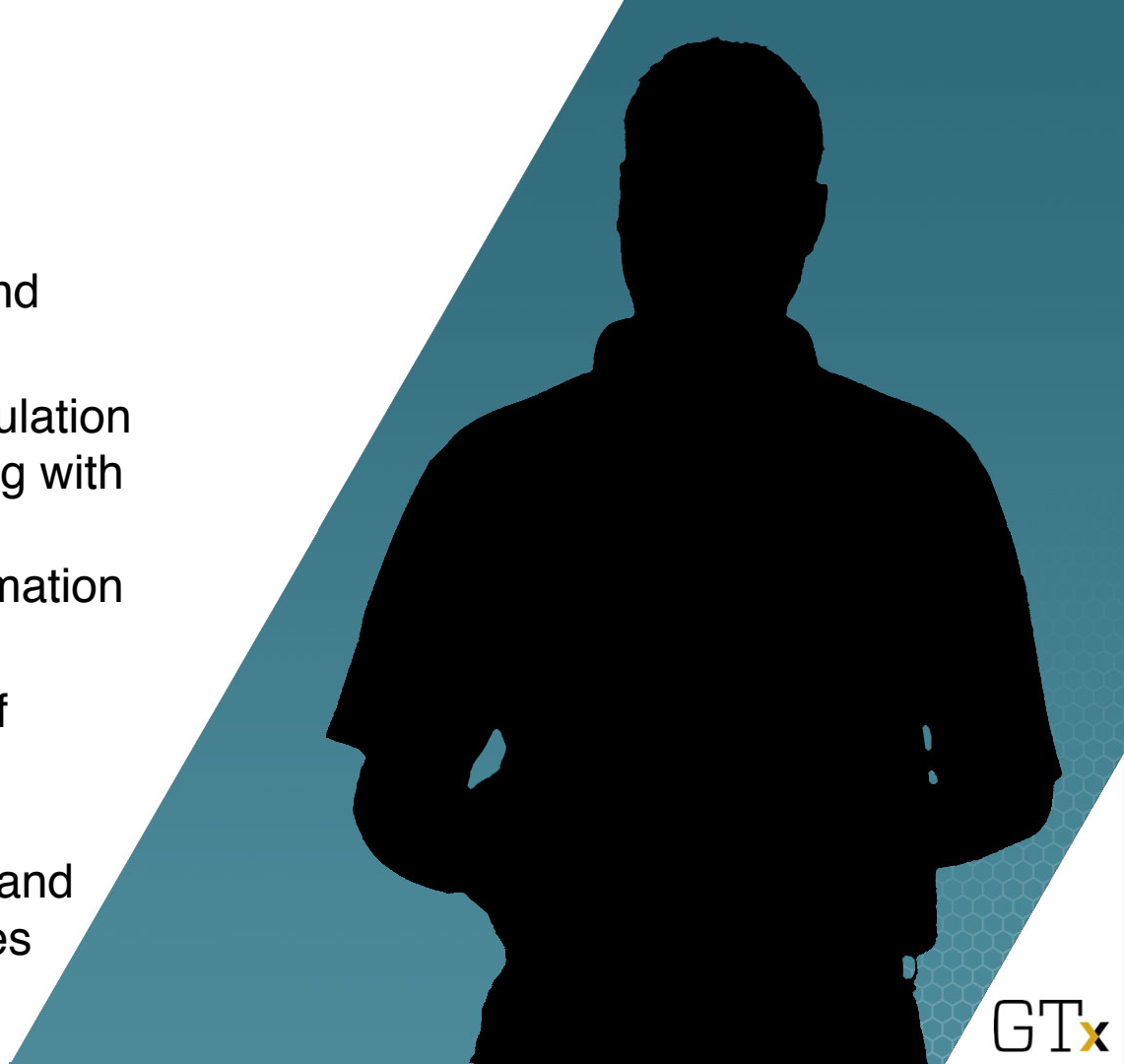
Course Info

Course Objectives:

- Identify simulation models and recognize simulation studies
- Illustrate organization of simulation languages including Modeling with Arena, a comprehensive simulation package with animation capabilities
- Analyze statistical aspects of simulations including input analysis, random variate generation, output analysis, and variance reduction techniques



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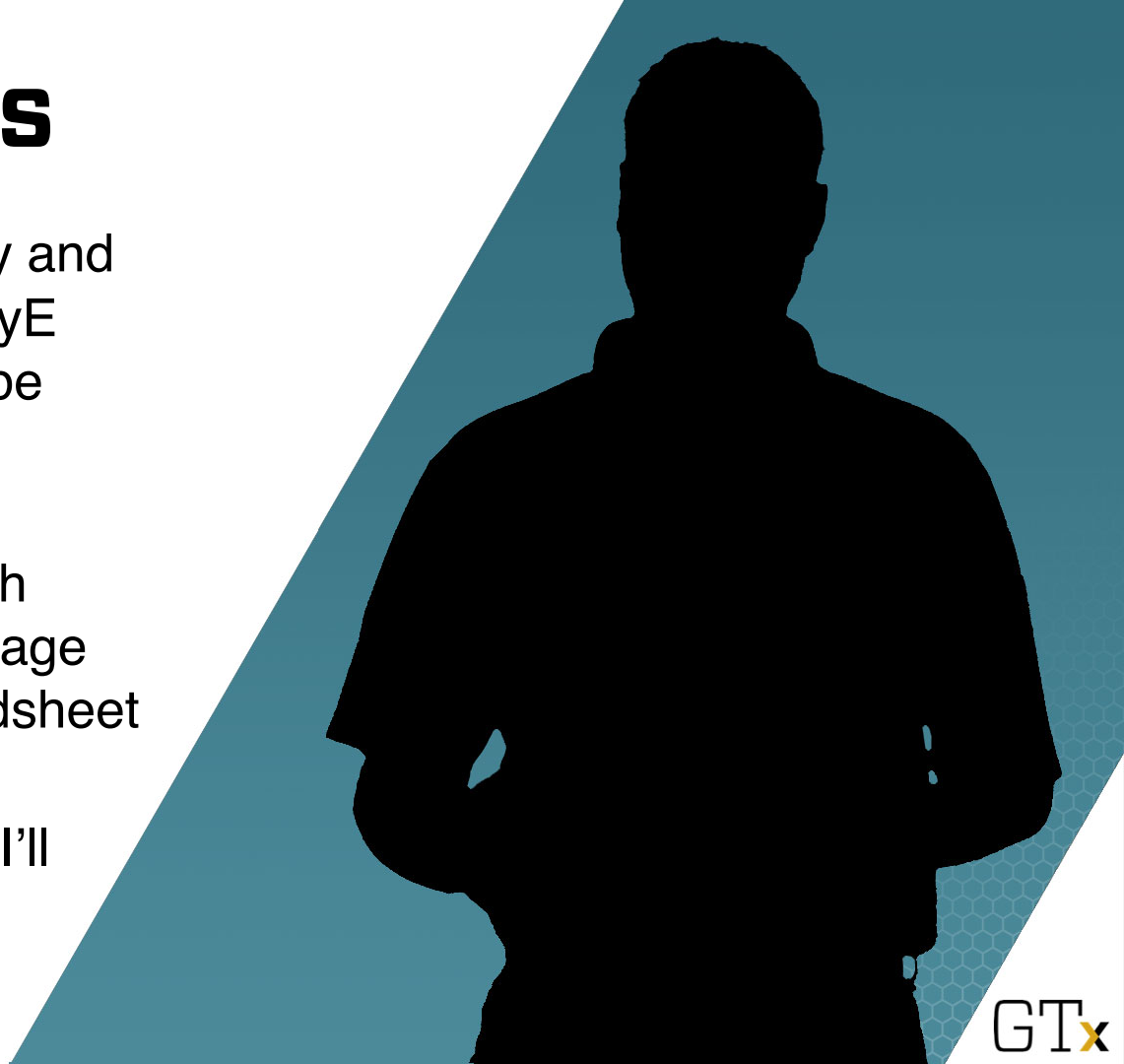
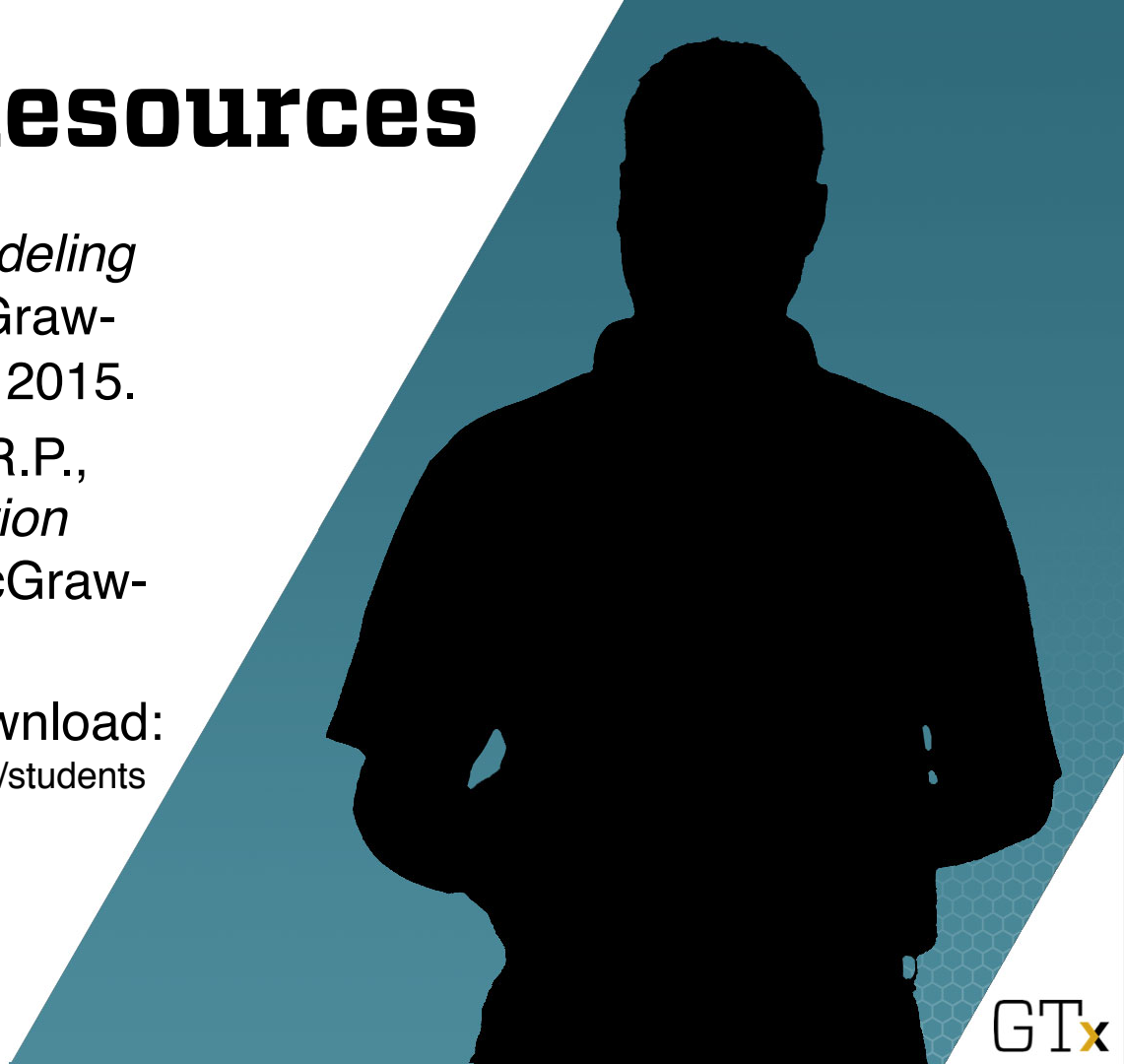
Prerequisites

- You *must* know probability and statistics at the level of ISyE 2027 and 2028, and maybe even a little stochastic processes.
- You should be familiar with some programming language and maybe even a spreadsheet package.
- Good News: Don't panic! I'll make the course as self-contained as possible!



Suggested Resources

- Law, A.M., *Simulation Modeling and Analysis*, 5th ed., McGraw-Hill Education, New York, 2015.
- Kelton, W.D., Sadowski, R.P., and Zupick, N.B., *Simulation with Arena*, 6th edition, McGraw-Hill, New York, 2015.
- **FREE** Arena software download:
  www.arenasimulation.com/academic/students



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Grading

Test 1 (30%)

Test 2 (30%)

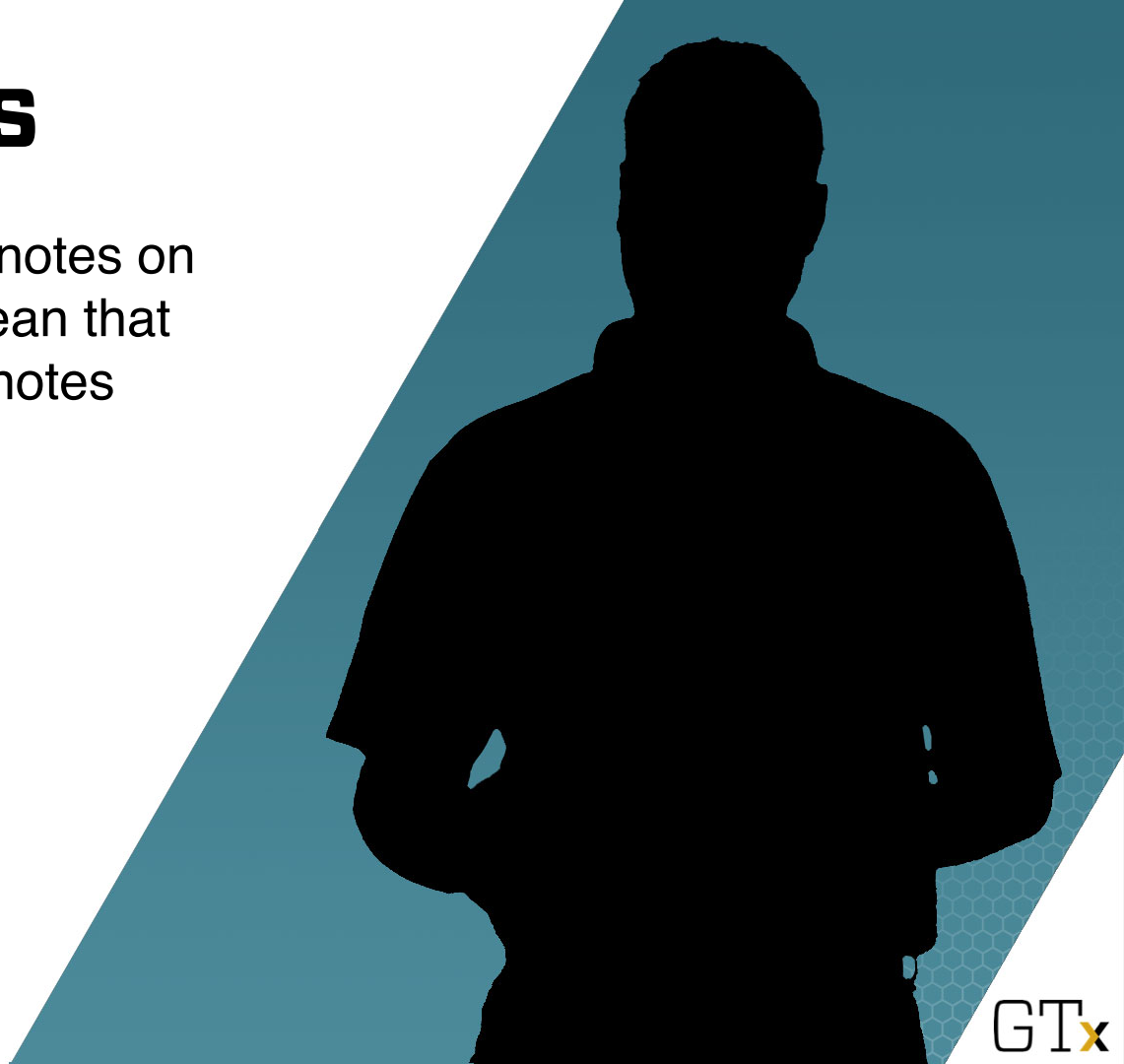
Test 3 (30%)

HW + Project + if I like you (10%)

HW will be assigned after every module.

Course Notes

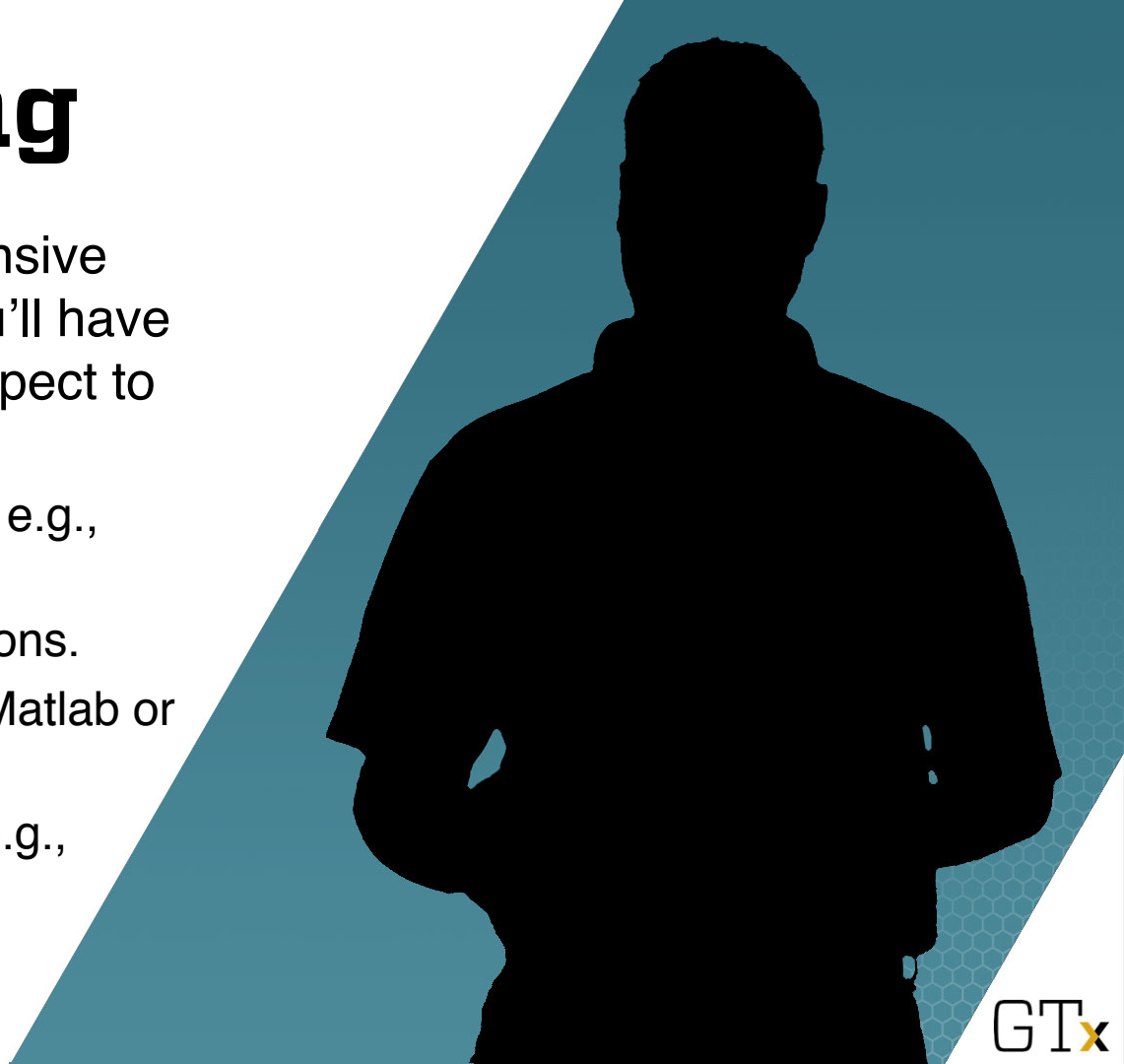
We provide pretty extensive notes on the website. This doesn't mean that you can simply print out the notes and skip class!



Programming

This course will involve extensive computer programming. You'll have some choice, but you can expect to use:

- A spreadsheet package, e.g., Excel.
- Some spreadsheet add-ons.
- A "real" language, e.g., Matlab or Python.
- A simulation language, e.g., Arena.



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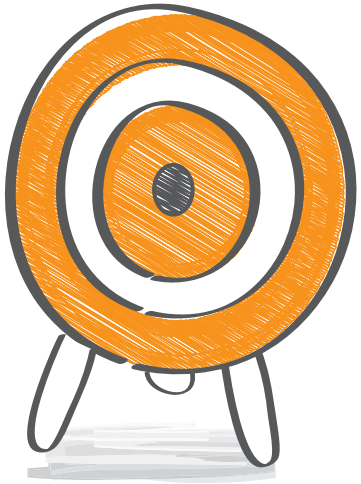
Summary

- Hi Everyone!
- Just gave some high-level course info.
- Next Time: Give some details on the course syllabus.



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Syllabus

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Lesson Goals

Last Time: Gave some high-level course info.

This Time: Now some details on the course syllabus.

Generally speaking, the course will have lessons that emphasize math/stats issues, and lessons that are mostly modeling and programming of a variety of systems.

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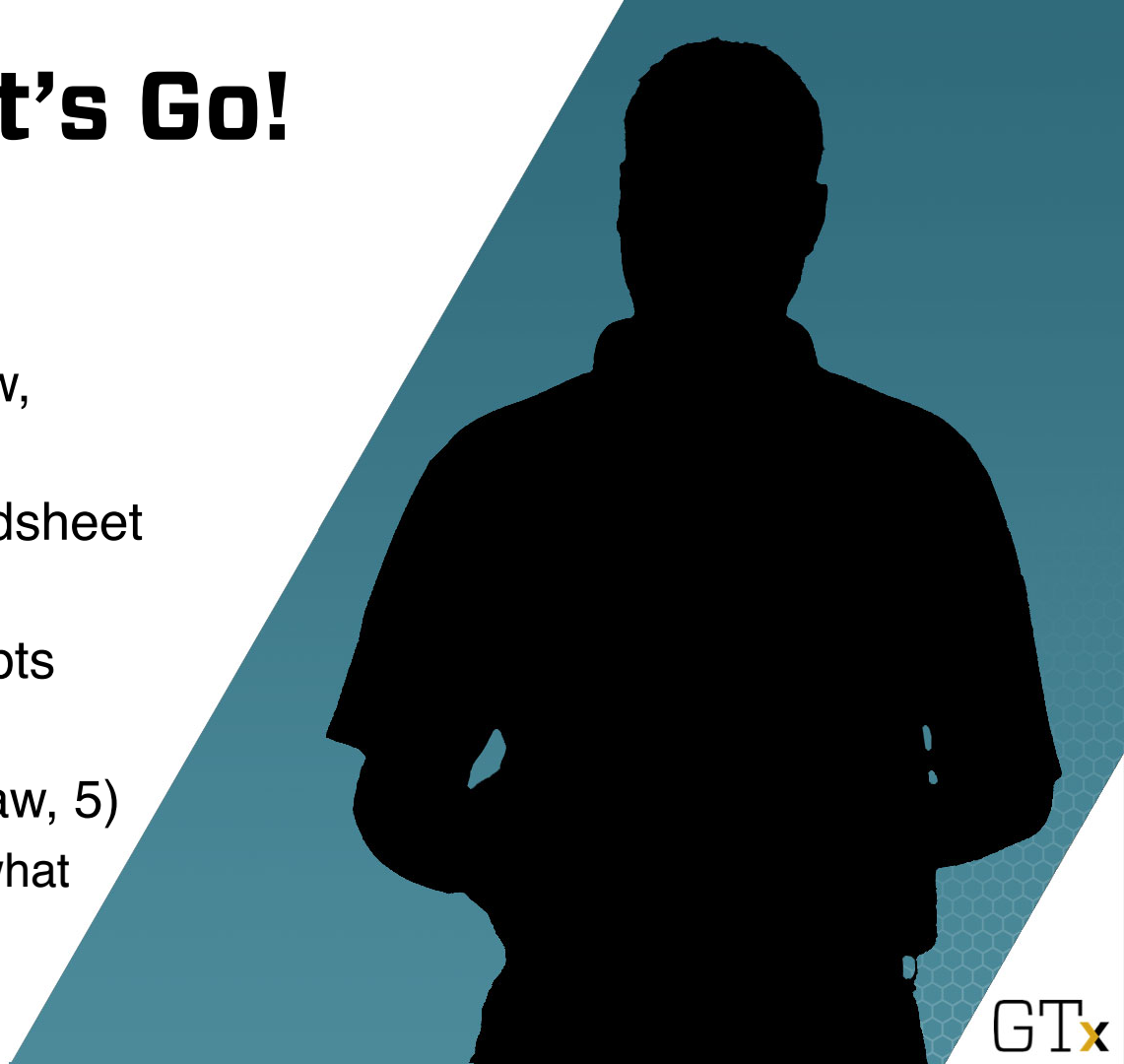
Syllabus – Let's Go!

- Introduction
- Calculus, Probability, and Statistics Boot Camp (Law, Chapter 4)
- Hand Simulations; Spreadsheet Simulations
- General Modeling Concepts (Law, 1&2)
- Verification+Validation (Law, 5)
  - Is the simulation doing what you think?



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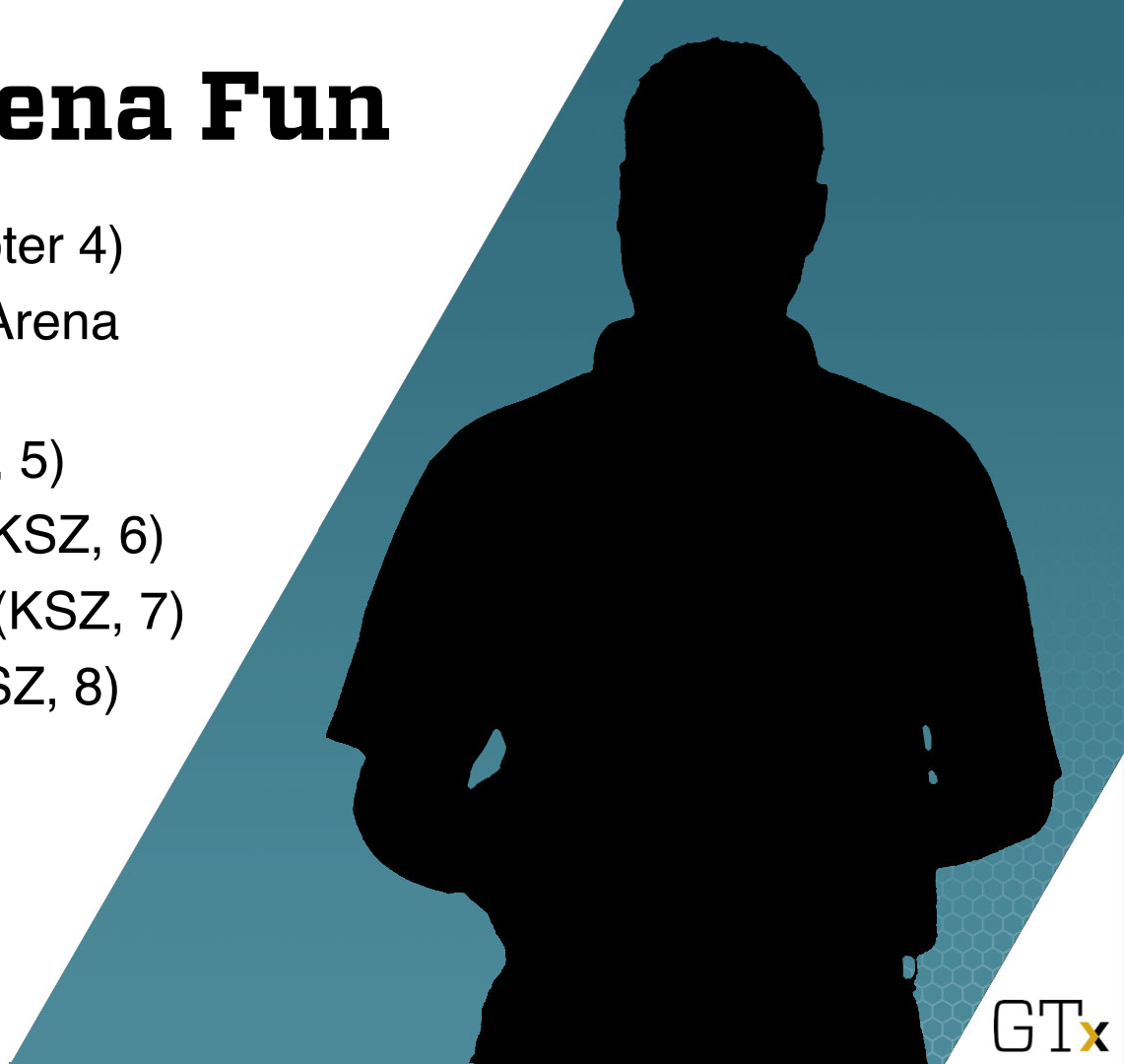
Syllabus – Arena Fun

- Arena Basics (KSZ, Chapter 4)
- A Generic Call Center in Arena (KSZ, 5)
- An Inventory Model (KSZ, 5)
- A Manufacturing Center (KSZ, 6)
- Entity Transfers in Arena (KSZ, 7)
- Advanced Arena Stuff (KSZ, 8)



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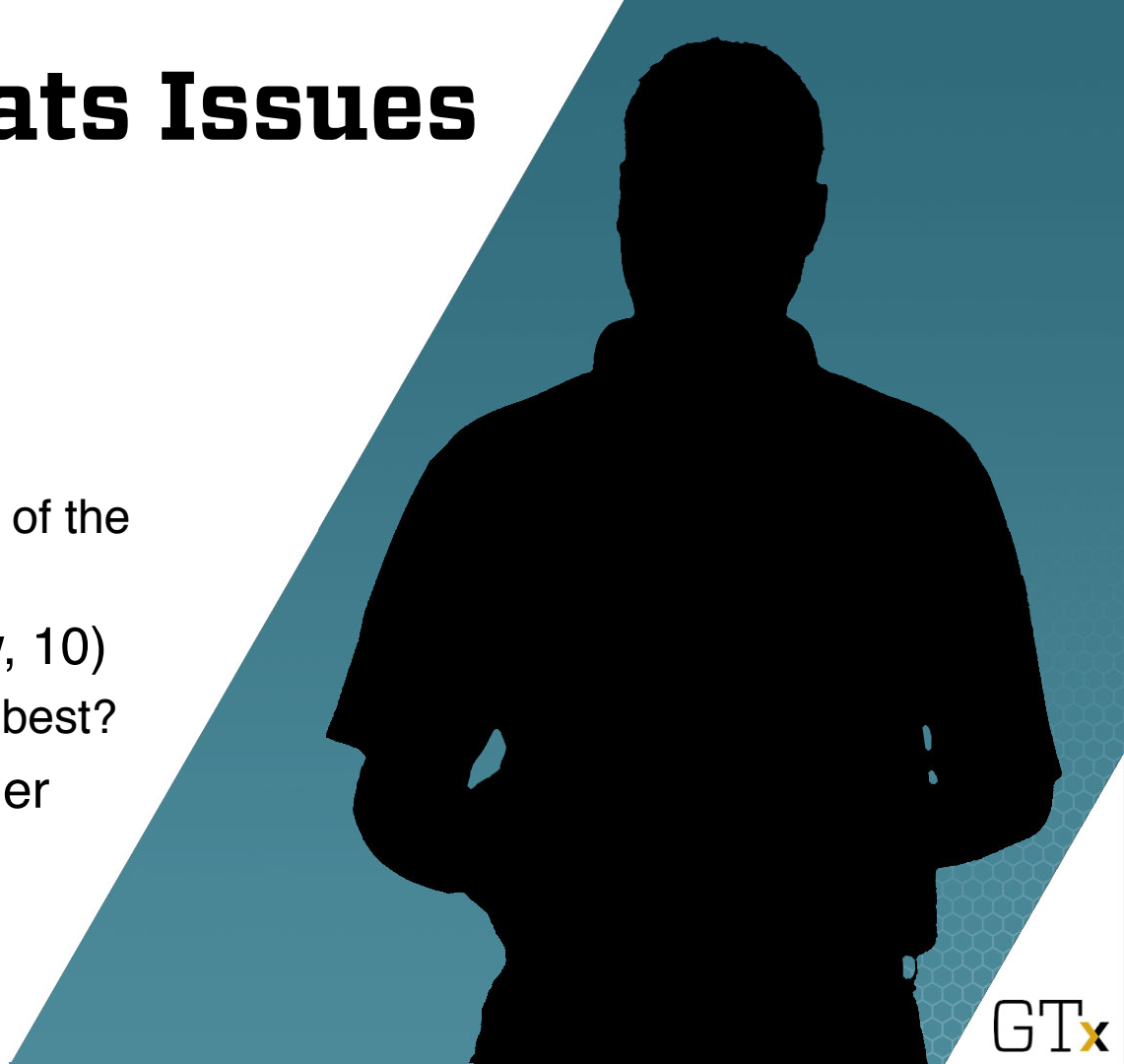
Syllabus – Randomness

- Random Number Generation (Law, 7)
  - generate “randomness” on a computer
- Random Variate Generation (Law, 8)
  - single random variables
  - multivariate random variables
  - random processes
  - financial models

Syllabus – Stats Issues

- Input Analysis (Law, 6)
  - What should drive the simulation?
- Output Analysis (Law, 9)
  - Analyze what comes out of the simulation
- Comparing Systems (Law, 10)
  - Which system is better / best?
- Variance Reduction + Other Cool Stuff



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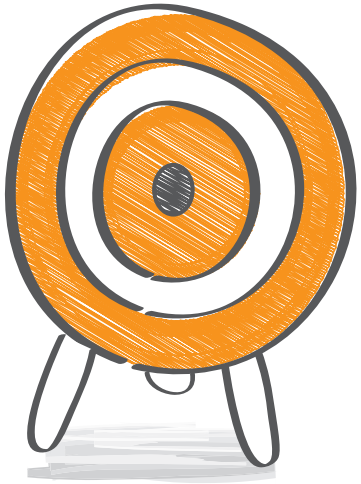
Summary

- Chatted about the syllabus.
- Next Time: Let's finally get into simulation with a Whirlwind Tour!



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Whirlwind Tour

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Lesson Goals

Last Time: Chatted about the syllabus.

This Time: Let's finally get into simulation!

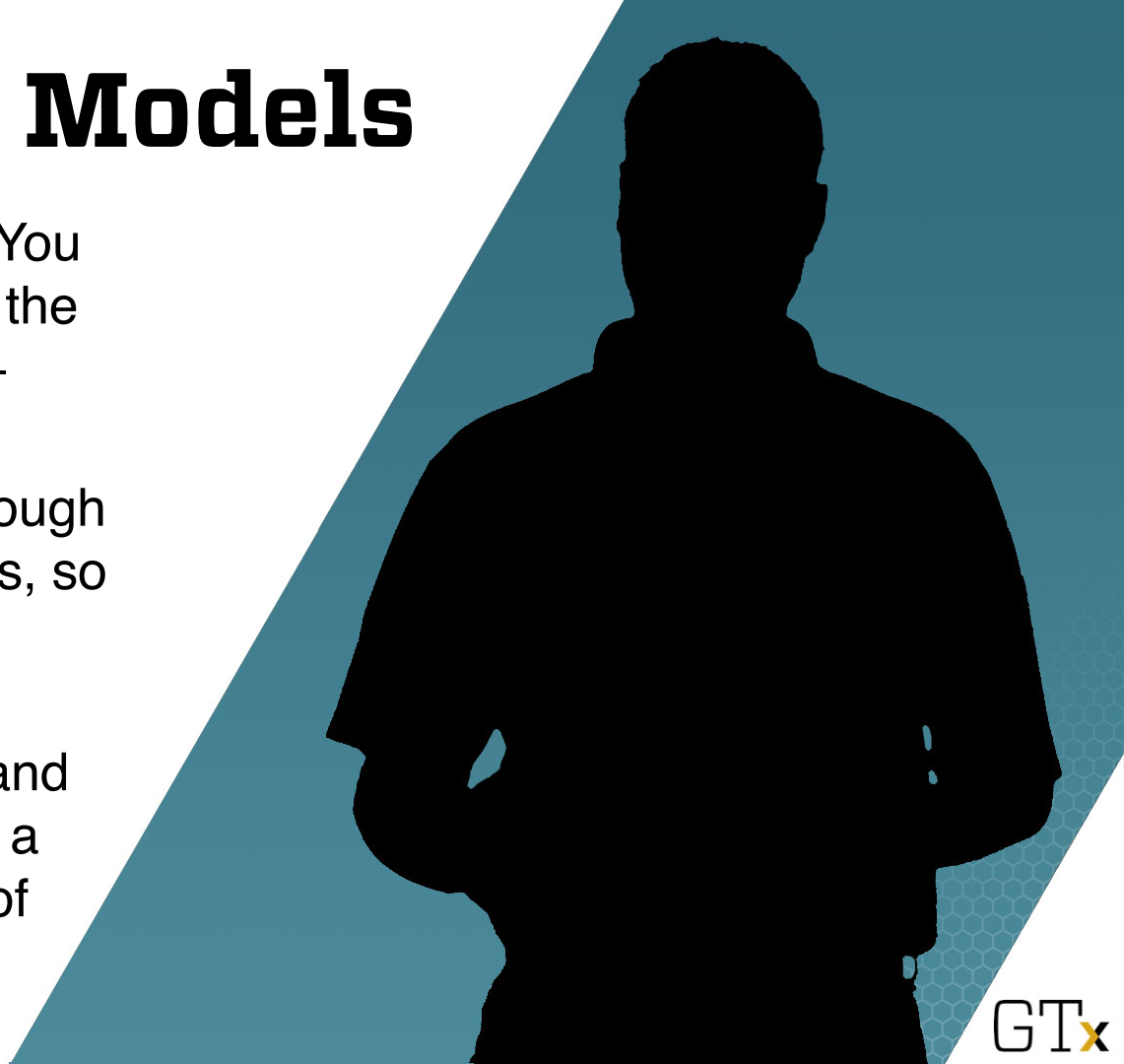
We'll first talk about general modeling issues, and why we would even consider using simulation.

Models

- Models are high-level representations of the operation of a real-world process or system.
- Our concern will be with models that are:
  - Discrete (vs. continuous)
  - Stochastic (vs. deterministic)
  - Dynamic (vs. static)
- How can you “solve” a model?
  - Analytic methods
  - Numerical methods
  - Simulation methods

Examples of Models

- Toss a stone off of a cliff. You can model its position via the usual physics equations – analytical models.
- Model the weather. Too tough for exact analytical models, so you might use numerical methods.
- Add a little randomness, and you may have to resort to a simulation model (plenty of examples coming up).



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What is Simulation?

- Simulation is the imitation of a real-world process or system over time.
- Simulation involves the generation of an artificial history to draw inferences concerning the operating characteristics of the real system that is represented.

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Simulation is...

- One of the top three industrial engineering / operations research / management science technologies.
- Used by academics and practitioners on a wide array of theoretical and applied problems.
- An indispensable problem-solving methodology.

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What is It Good for?

- Describe / analyze real or conceptual system behavior.
- Ask “what if” questions.
- Aid in system design and optimization.
- Can simulate almost anything.
  - Customer-based systems like Manufacturing Processes, Supply Chains, Health Systems.
  - Systems with no “customers”, e.g., stock option prices.

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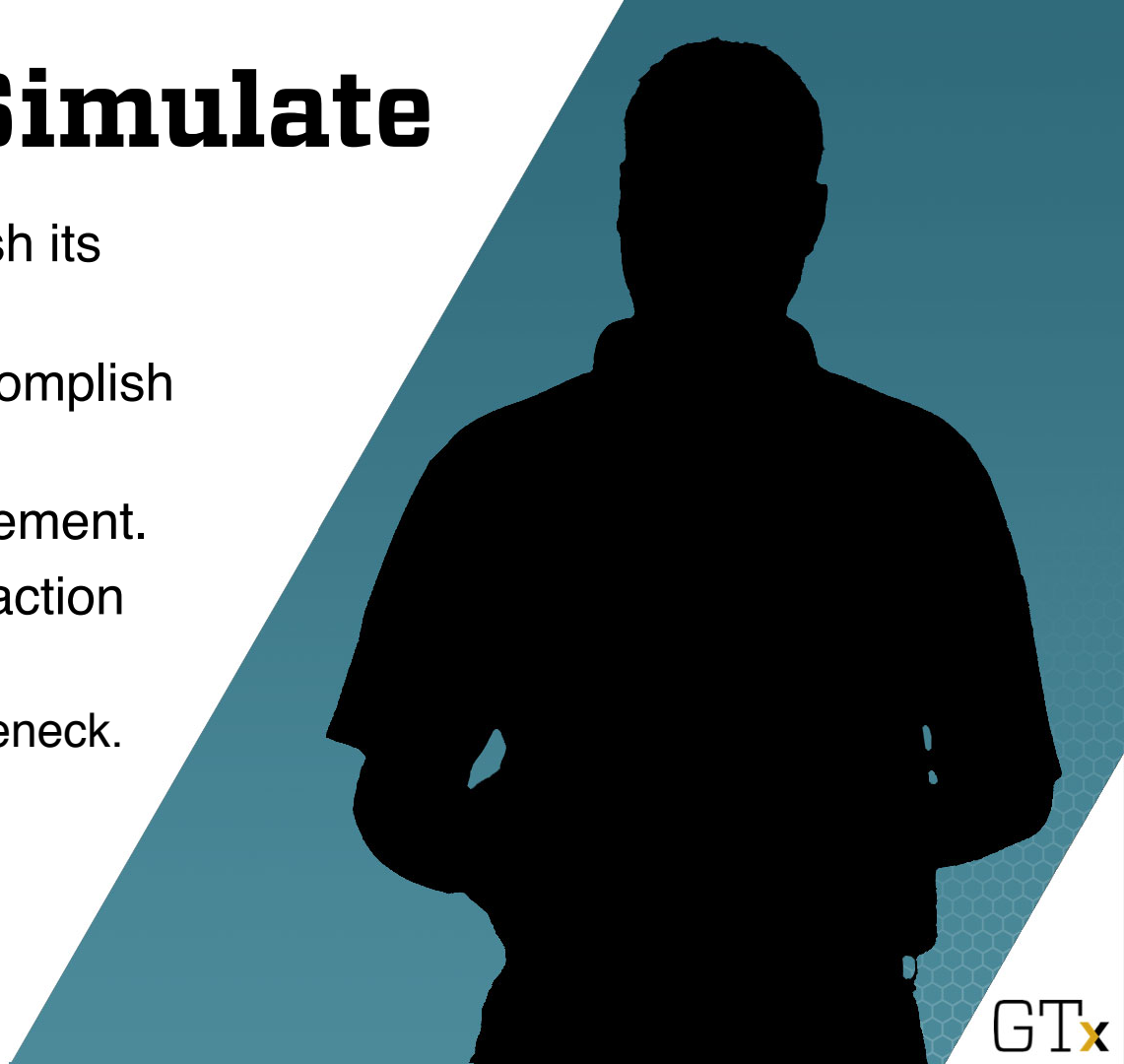
Reasons to Simulate

- Will the system accomplish its goals?
- Current system won't accomplish its goals. Now what?
- Need incremental improvement.
- Create a specification or action plan.
- Solve a problem, like a bottleneck.
- Resolve disputes.
- Sell an idea.



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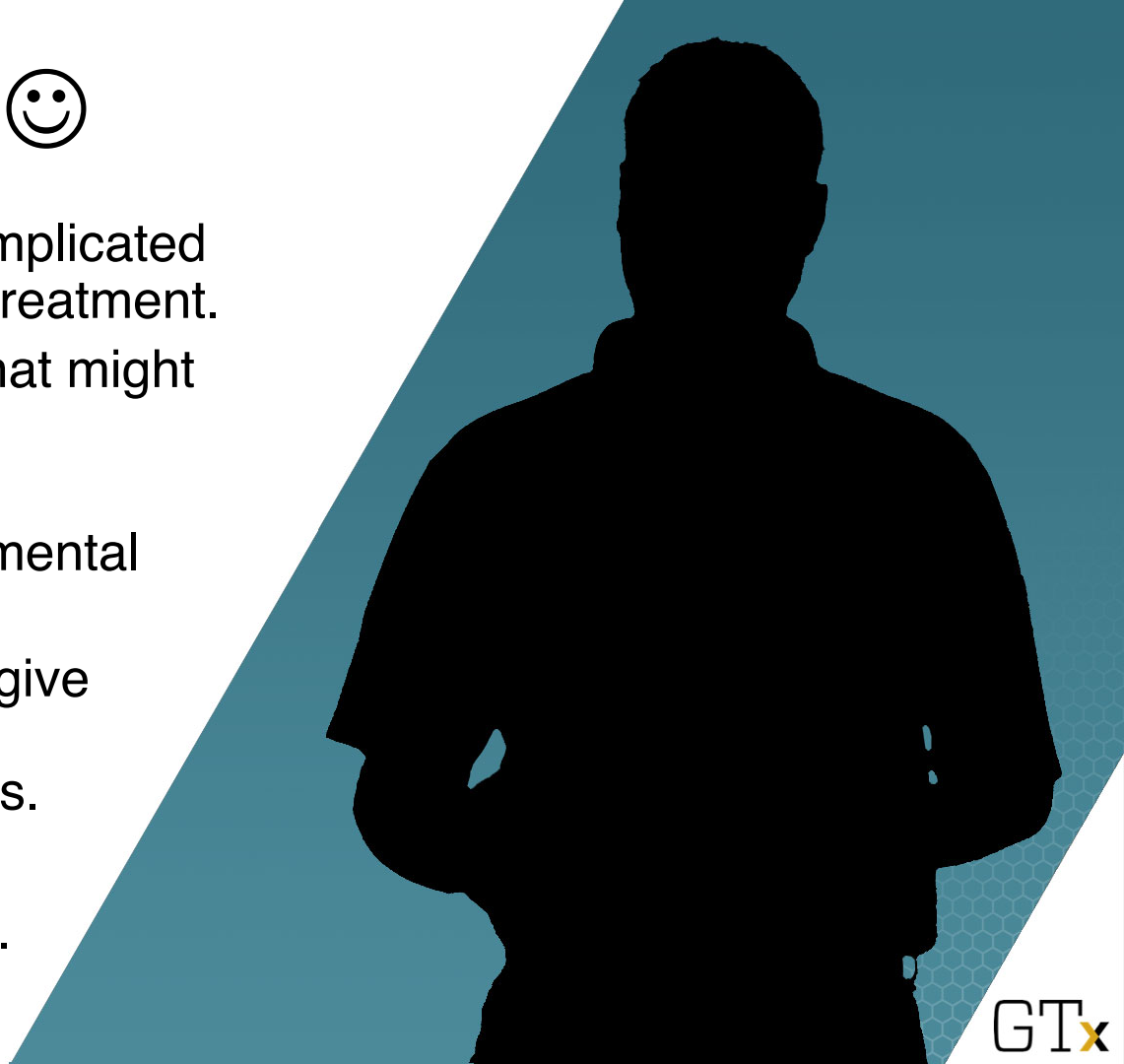
Advantages ☺

- Can study models too complicated for analytical / numerical treatment.
- Study detailed relations that might be lost in the analytical or numerical treatment.
- Use as a basis for experimental studies of systems.
- Use to check results and give credibility to conclusions obtained by other methods.
- Reduce design blunders.
- Really nice demo method.
- (Sometimes) very easy.



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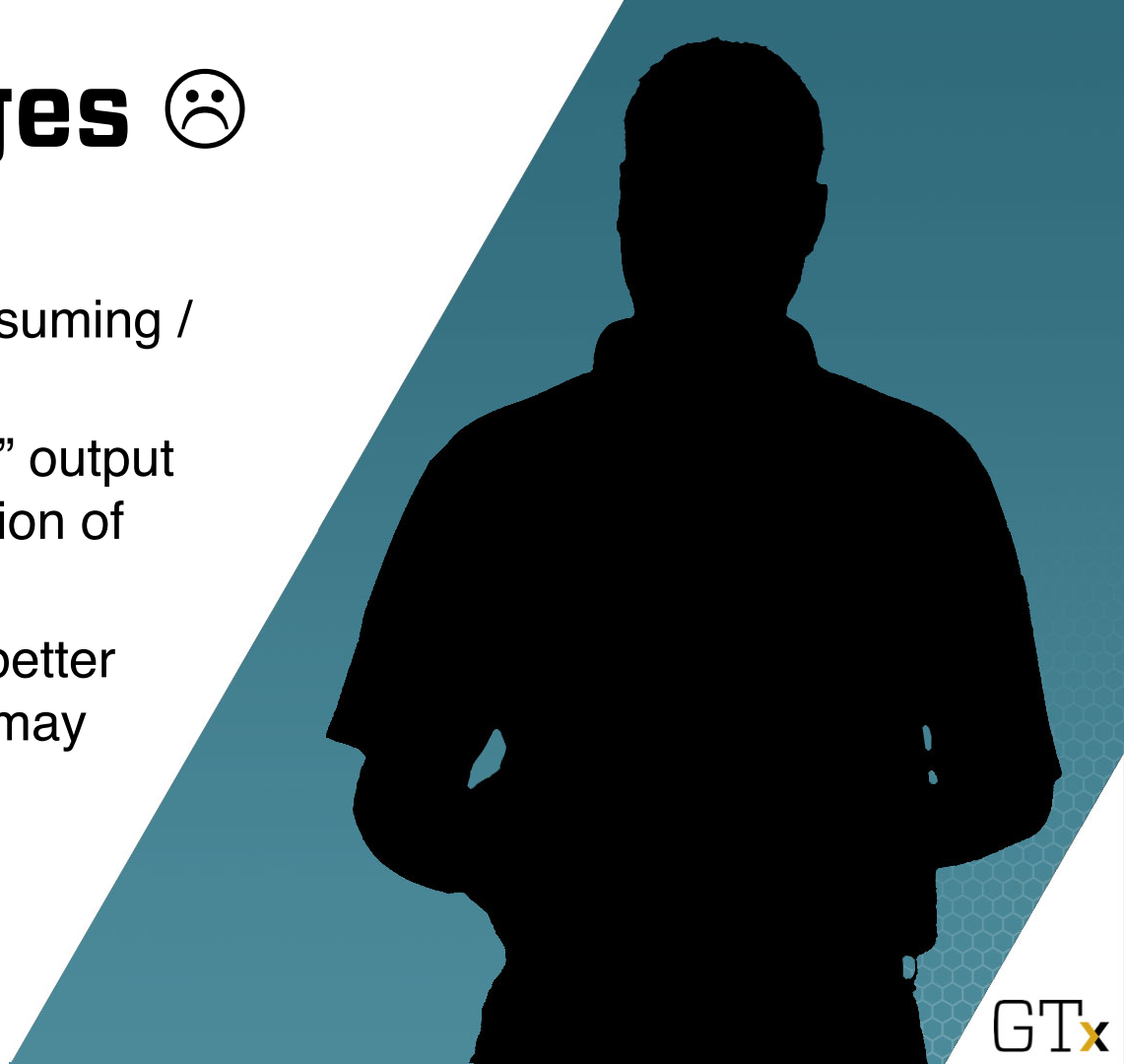
Disadvantages ☹

- Sometimes not so easy.
- Sometimes very time consuming / costly.
- Simulations give “random” output (and lots of misinterpretation of results is possible).
- To do a certain problem, better methods than simulation may exist.
- …



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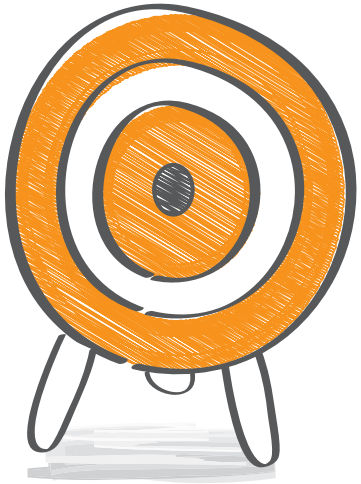
Summary

- Finally started our Whirlwind Tour with a discussion on the nature of simulation models.
- Next Time: A historical (hysterical?) presentation.



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