University of Cincinnati
Department of Operations, Business Analytics, and Information Systems
BANA 7030 Simulation Modeling and Methods
Fall Semester 2017 (this syllabus covers both sections)**:**
   Section 001: Thursdays 6:00pm-8:50pm, 3220 Rec Center
   Section 002: Tuesdays & Thursdays 11:00am-12:20pm, 110 Lindner Hall

THE MANDATORY FINAL EXAM FOR BOTH SECTIONS WILL BE TOGETHER AS A JOINT "BLOCK EXAM" AT A TIME/DATE DURING FINAL-EXAM WEEK, DEC. 4-9, TO BE DETERMINED CENTRALLY BY UC, AND WILL BE ANNOUNCED BY MID-OCTOBER; ROOM TO BE ANNOUNCED LATER. SO PLAN UP FRONT FOR THIS.

Syllabus

Instructor:
- Dr. W. David Kelton, Professor
- david.kelton@uc.edu, ++1-513-556-6834, http://www.cba.uc.edu/faculty/keltonwd/
- Office: 18B Clifton Court Pavilion North (but office hours will NOT be held in my office ... see the next item)
- Office hours and location: Thursdays 3:00-5:00pm in room 010N in the SAP lab (Suite 10 in the basement of Lindner Hall near the elevators), by appointment, and ongoing by e-mail (please set your e-mail account or client to copy back all prior messages when replying or forwarding).

Webste: https://canopy.uc.edu, log in to Blackboard with your UC login/password, then under My Courses select something like "meta_keltonwd_949: (Meta 2178) SIMUL MODELING & METHODS (001, 002)" … do not select your particular section number of BANA7030 (001 or 002) if you see it, as there's nothing there … all the information, materials, and assignment-upload modules are on this combined Blackboard "metacourse" covering both sections. Check it frequently for announcements, material, and updates.

Catalog description: 3 graduate credits. Building and using simulation models of complex static and dynamic, stochastic systems using both spreadsheets and high-level simulation software. Topics include generating random numbers, random variates, and random processes, modeling systems, simulating static models in spreadsheets, modeling complex dynamic stochastic systems with high-level commercial simulation software, basic input modeling and statistical analysis of terminating and steady-state simulation output, and managing simulation projects. Applications in complex queueing and inventory models representing real systems such as manufacturing, supply chains, healthcare, and service operations.

Objectives: Techniques and application of computer simulation of existing or proposed real-world facilities and processes. Models of such facilities or processes are often complex, precluding traditional analytical techniques. Students will learn to build simulation models and do simulations with full-strength commercial simulation software, analyze and interpret the results, as well as to plan simulation studies. Additional topics include selecting input probability distributions and statistical analysis of simulation output.

Prerequisites:

- Calculus, both differential and integral.
- Basic courses in both probability and statistics, using calculus.
- Basic operations-research overview courses.
- Experience using the Windows operating system.
- Experience using Excel, including programming your own formulas, finding and using built-in functions, and absolute/relative cell references (the "$" thing).
- Section 001: Thursdays 6:00pm-8:50pm, 3220 Rec Center
  Section 002: Tuesdays & Thursdays 11:00am-12:20pm, 110 Lindner Hall
- However, there will be no formal class meetings on:
  - Tues. Oct. 10: Due to UC Reading Days Oct. 9-10 (pertains to Sec. 002 only).
  - Thurs. Oct. 12: No lectures due to Reading Days earlier this week and the need to keep the sections together on coverage, but open office hours in the regular classrooms for the whole class periods (pertains to both sections).
  - Tues. Nov. 21: No lecture in advance of Thanksgiving holiday on Thursday of that week and the need to keep the sections together on coverage, but open office hours in the regular classroom for the whole class period (pertains to Sec. 002 only).
  - Thurs. Nov. 23: Due to UC closure for Thanksgiving (pertains to both sections).
- THE MANDATORY FINAL EXAM FOR BOTH SECTIONS WILL BE TOGETHER AS A JOINT "BLOCK EXAM" AT A TIME/DATE DURING FINAL-EXAM WEEK, DEC. 4-9, TO BE DETERMINED CENTRALLY BY UC, AND WILL BE ANNOUNCED BY MID-OCTOBER; ROOM TO BE ANNOUNCED LATER. SO PLAN UP FRONT FOR THIS.
- Laptop use will be allowed in class, but *only* for taking notes and following along in the class notes and software – *please*, **_no_** web surfing, e-mailing, instant-messaging, social-networking, etc., as such is very distracting to those around you, to me (trust me, I *know* when you're doing it), and (obviously) to you. *If I receive information or complaints that this policy is being violated I regret that I will be forced to ban laptops from class.* Please respect this policy.
- Obviously, turn *off* all cell phones in class and do not use them at all for anything other than class-related activities (e.g., calculator, looking up words in a dictionary).
- The class lectures will be recorded and made available to you after each class, so that you can re-watch/listen to things that you might like to hear/see again. To view the recordings, on the Blackboard website for the class, in the left navigation click "Echo360 ALP," and then select the lecture date/time you want to review (after having attended that class in person); note that both sections 001 and 002 are listed chronologically by class time. These are NOT in any way a substitute for attending each and every class ... the quality of the recordings may vary, the system might go down, but more importantly you miss the opportunity to interact with me and with other students. Please do not abuse the availability of these recordings as a lame excuse to cut class ... if I feel that class attendance is becoming a problem, I will have to discontinue these recordings and take down prior classes' recordings.

Materials:

- Kelton/Sadowski/Zupick, *Simulation with Arena*, 6th edition, McGraw-Hill, copyright 2015 but published on 1/1/2014 (ISBN-13 = 9780073401317, ISBN-10 = 0073401315). *Be sure you get your own hardcopy of the 6th edition*; earlier editions will not work. You will need your own hardcopy, as the Final Exam will be open-book (but closed-notes and closed-computer), and obviously sharing books during the Final Exam will not be permitted. International versions and used/rented books are fine as long as it's your own hardcopy of the 6th edition (there's no CD/DVD with the book, even new copies). The book has been ordered through the UC bookstore but you're free to get it anywhere ... (relatively) inexpensive used copies are readily available online, and just doing a web search on the ISBN number usually works.
- The website for the *book* is http://www.mhhe.com/kelton (then select 6th edition on left) and you should visit it to check the Errata and update your copy of the book accordingly. However, DO NOT download the Arena software from this site, and DO NOT follow the installation instructions in Appendix D of the textbook. Rather, you should download the Arena 14.50.00002 software via instructions under Course Documents on the class Blackboard website (if you want to run Arena on your own machine).
- Lecture slides as PDF files (two slides per page, color) are on the website under Course Documents. No hardcopy will be handed out so it's up to you to download and (if you wish) print; it will be helpful for you to have this hardcopy in class, on which to take notes, but these will not be allowed in the Final Exam.
- Access to the special-purpose simulation software @RISK and Arena (see **Computing** below).
- Additional material will be handed out in class or posted on the website as we progress.

Grading:

- **30%**: Approximately seven *Individual* Assignments, each weighted equally. Solutions will be posted on Blackboard immediately after the due date/time, so late assignments cannot be accepted (the upload site will be closed at the due date/time). To reiterate, these are *individual* assignments to be done by yourself, *not* in groups, and you cannot consult with anyone other than the instructor (see "Academic integrity" below).
- **30%**: *Individual* project and paper. A complete simulation study of a system of your choosing (more information on the project is below). Like the Individual Assignments, the Individual Project is indeed to be *individual*. Due *Sun. Dec. 3, 9:00pm* via upload to Blackboard.
- **40%**: Final Exam. THE MANDATORY FINAL EXAM FOR BOTH SECTIONS WILL BE TOGETHER AS A JOINT "BLOCK EXAM" AT A TIME/DATE DURING FINAL-EXAM WEEK, DEC. 4-9, TO BE DETERMINED CENTRALLY BY UC, AND WILL BE ANNOUNCED BY MID-OCTOBER; ROOM TO BE ANNOUNCED LATER. SO PLAN UP FRONT FOR THIS. Open-hardcopy-book, but closed everything else (in particular, the class lecture slides are not allowed). Calculators required (an actual dedicated physical calculator, not a cell-phone or tablet calculator app as neither cell phones nor tablets will be allowed in the exam), but no computers or tablets allowed. No sharing of books or calculators allowed. Comprehensive.

Computing: This course involves a lot of computing with two special-purpose software packages: Palisade's DecisionTools-suite Excel add-in @RISK 7.5.1, and Rockwell's Arena 14.50.00002. For more detail on how you can access these two packages, on the Blackboard website under Course Documents on the left, see the topics "Accessing the Palisade DecisionTools Suite (including @RISK)" and "Accessing the student version of Arena 14.50.00002 (14.5 for short)." In terms of hardware, you can use the MS Windows machines in the computer labs on the 2nd floor of Lindner Hall, or you can use your own computer, or you can remotely access the Lindner Hall labs via UCIT's UCVLabs:

- **If using the Lindner Hall labs**, you should already have an account by virtue of being registered for this course, regardless of whether you are in a program in the college of business. In either case, log in to these machines with your usual UC credentials that you use for everything else. Consultants in the 211 Lindner Hall lab (++1-513-556-7159) can help with login problems and with accessing Arena and @RISK (but not with the content of them).

- **If using your own computer**, you will need to install the software on your machine. On the Blackboard website, under Course Documents on the left, see the topics "Accessing the Palisade DecisionTools Suite (including @RISK)" and "Accessing the student version of Arena 14.50.00002 (14.5 for short)." This is advanced commercial-grade software so you need to follow the installation instructions carefully. Unfortunately, Arena and @RISK run only under MS Windows, not natively on the Mac OS, but you can still use your Mac via a Windows emulator ... see the two Blackboard course website topics just mentioned for complete instructions and how to get and install the extra software you'll need.

- **If remotely accessing the Lindner Hall labs via UCIT Virtual Labs**, you can use your own computer (either MS Windows or Mac OS) but you first need to install the UCIT Virtual Labs software on your machine (see the link "UCIT Virtual Labs" on the left navigation of the Blackboard website for installation and usage instructions for both Windows and Mac machines); in UCIT Virtual Labs, be sure to select the Lindner College of Business instance, and be extra-sure to save your own files on your local system or somewhere else under your control (e.g., a USB thumb drive or your networked filespace provided by UC) rather than on the "virtual machine" since such files disappear when your UCVLabs session ends. If you have any questions, please see the help desk in 211 Lindner Hall or call 513-556-7159.

Individual*-project information:** The ***Individual Project is to be a complete simulation study of a real system of your choosing. Typically, the steps in your project will include:

- Defining the system to be simulated and stating the purpose of the study.
- Collecting data on the system (primary or secondary) and use to determine input probability distributions and other parameters. Experience indicates that data collection can be a very difficult and time-consuming part of a study; for the purposes of this project, don't be concerned about getting a large sample size, but just collect a small amount of data to get a model defined, with the knowledge that if you were being paid to do this (rather than paying to do it) you would collect more data.
- Coding and verifying the model.
- Exercising the model to evaluate the system as it is, and at least one alternate configuration or operating policy, with an eye toward improvement. Pay attention to concerns about the statistical validity of your results, i.e., do an appropriate statistical analysis of the simulation output, including statistical comparison or selection or optimum-seeking (see Chapters 6 and 7).
- Writing a brief final report describing what you did and what your results and recommendations are. Include output as an appendix, and submit your model(s) electronically as you'll do for the Individual Assignments. Write the report for someone who is familiar with the system, and who knows basic probability and statistics, but who does not know (or care) anything about how simulations are done. In other words, you must summarize and interpret your results, rather than present page after page of output data. There are no minimum or maximum page limits or format; say everything you need to say and don't say anything more.
- Milestones:
  - *Sun. Oct. 1, 9:00pm*: Submit a brief proposal of what you plan to simulate, how you'll observe the systems and get data to which to fit input probability distributions, and what questions you'll address with your model. Be sure to get permission from whoever is responsible for operating the real system. An upload area for this will be set up in Blackboard.
  - *Sun. Nov. 12, 9:00pm*: Submit a brief progress report, again via upload to Blackboard in an area that will be set up for this.
  - *Sun. Dec. 3, 9:00pm*: File(s) and written report due (all files via upload through the Individual Project item under Assignments in the Blackboard class website). You must submit a written report, with appendices/supplements as you see fit with your results, and also your Arena files, plus any other files (e.g., Excel) that you used in your project. Do not submit "intermediate" files that Arena creates with filename extensions .mdb, .opw, .out, .p, etc. – generally just your Arena .doe model files.

List of topics by chapter in the book (and the order we'll follow … depending on time, we may not get to all the topics toward the end of this list):

- What is Simulation? (Chapter 1)
- A Refresher on Probability and Statistics (Appendix B)
- Fundamental Simulation Concepts (Chapter 2)
  - Additional material on static spreadsheet simulation with @RISK (not in book)
- Random-Number Generator and Generating Random Variates (Chapter 12, Sections 12.1-12.2)
- A Guided Tour Through Arena (Chapter 3)
- Modeling Basic Operations and Inputs (Chapter 4)
- Modeling Detailed Operations (Chapter 5)
- Statistical Analysis of Output from Terminating Simulations (Chapter 6)
- Intermediate Modeling and Steady-State Statistical Analysis (Chapter 7)
- Entity Transfer (Chapter 8)
- Continuous and Combined Discrete/Continuous Models (Chapter 11)
  - Additional material on Lanchester combat differential equations (not in book)
- Further Statistical Issues (Chapter 12, Sections 12.3-12.6)

Simulation links:
- INFORMS Simulation Society (http://www.informs.org/community/Simulation-Society/)
- Winter Simulation Conference (http://www.wintersim.org)
- EUROSIM, the Federation of European Simulation Societies (http://www.eurosim.info/)
- DoD Modeling and Simulation Coordination Office (M&S CO) (https://www.msco.mil/)
- Rockwell Automation, the vendor of Arena (http://www.arenasimulation.com)
- Simio, another vendor of competing software (http://www.simio.com/)
- ExtendSimulation, yet another competing software product (http://www.extendsim.com/)
- ProModel, yet yet another competing simulation product (http://www.promodel.com/)
- Palisade Corporate, the vendor of @RISK (http://www.palisade.com/)

Academic integrity: I take this very seriously, and you should too as it affects the value of your program and degree. On each project and exam you will be required to state and sign, in writing, "*On my honor, I have neither given nor received unauthorized aid in completing this academic work.*" Academic dishonesty in any form will absolutely not be tolerated, and will be dealt with firmly.

Official statement on this from the college of business (from http://business.uc.edu/resources/academic-resources/advising/resources.html): "*All academic programs at the Lindner College of Business will apply a "Two Strikes Policy" regarding Academic Integrity. Any student who has been found responsible for two cases of academic misconduct may be dismissed from the College. The "Two Strikes Policy" supplements the UC Student Code of Conduct (http://www.uc.edu/conduct/Code_of_Conduct.html). All cases of academic misconduct (e.g., cheating, plagiarism, falsification) will be formally reported by faculty. Students will be afforded due process for allegations, as outlined in the policy.*"

UC statement on special needs and accommodations: "*If you have any special needs related to your participation in the course, including identified visual impairment, hearing impairment, physical impairment, communication disorder, and/or specific learning disability that may influence your performance in this course, you should meet with the instructor to arrange for reasonable provisions to ensure an equitable opportunity to meet all the requirements of this course. At the discretion of the instructor, some accommodations may require prior approval by Disability Services.*" For more information and detail, see http://www.uc.edu/aess/disability.html.

UC statement on counseling services, Clifton campus: "*Counseling Services, Clifton Campus Students have access to counseling and mental health care through the University Health Services (UHS), which can provide both psychotherapy and psychiatric services. In addition, Counseling and Psychological Services (CAPS) can provide professional counseling upon request; students may receive five free counseling sessions through CAPS without insurance. Students are encouraged to seek assistance for anxiety, depression, trauma/assault, adjustment to college life, interpersonal/relational difficulty, sexuality, family conflict, grief and loss, disordered eating and body image, alcohol and substance abuse, anger management, identity development and issues related to diversity, concerns associated with sexual orientation and spirituality concerns, as well as any other issue of concerns. After hours, students may call UHS at 513-556-2564 or CAPS Cares at 513-556-0648. For urgent physician consultation after-hours students may call 513-584-7777.*"