IEMS 305 – Statistical Methods for Quality Improvement
Fall, 2010

Instructor: Prof. Daniel Apley; Rm. C150; 491-2397; apley@northwestern.edu; office hours: W 11:00-12:30 or by appointment or drop in (if I am free)

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Lecture: MWF 10:00—10:50, TECH LG68

Lab: W 4:00 – 4:50 TECH C135. We will have ~ 4-5 labs over the quarter, but we will probably not meet at all at the scheduled time. Lab teams will generally meet to conduct the labs outside of the W 4:00 – 4:50 time, at a time convenient for the team. I really want students to understand the lab material well. I plan to give introductions, overviews, recaps, etc of each lab during lecture. If this turns out to be ineffective at conveying the lab material, then we will begin meetings at the regularly scheduled W 4:00 – 4:50 lab time. Otherwise, we will not be meeting at W 4:00 – 4:50.

Required Text: *Introduction to Statistical Quality Control, 6th ed.*, by D. C. Montgomery, Wiley, 2009.

Reference Text: An introductory statistics text such as *Probability and Statistics for Engineering and the Sciences, 7th ed.*, by Jay L. Devore, Thomson, 2008.

Blackboard: Handouts, homework assignments, data sets, announcements, etc. will be posted regularly

Prerequisite: A previous course in statistics at the level of IEMS 303 or 201.

Software: MINITAB (primarily) and Excel (possibly), both available in C135. Enrollment in class should allow you access to the lab; if not, contact Johnathan Gaetz (arioch@iems.northwestern.edu). You can download a six-month academic rental of Minitab from http://www.minitab.com/education/semesterrental/ for ~$30.

Grading:			
	Midterm	25%	(Mon, Oct 25, In Class)
	Final	30%	(Fri, Dec 10, 12:00-2:00)
	Lab	35%	
	Homework	10%	
	Class Participation Bonus	see below	

Course Objective: Introduce basic statistical techniques for improving quality and consistency in products and "processes". The emphasis will be on product design and manufacturing process improvement, although many of the techniques may be applied to other types of processes, e.g. financial services or health care. Six-sigma programs, the focus of which is reducing variability in processes, are becoming firmly ingrained in many industries. This is essentially a course in the statistical methods used in six-sigma, with the material covered at a level consistent with the strong analytical skills of Northwestern students. A broader objective of this course is to reinforce the ability to think statistically and analyze data effectively.

Course Outline:

History and Overview of Quality Improvement (Ch. 1 & 2, ~ 0.5 weeks)
Review of Background Statistics (Ch. 3 & 4, ~ 0.5 weeks)
Basic Statistical Process Control (SPC) Methods (Ch. 5, ~ 1 week)
Variables Control Charts (Ch. 6, ~ 1 week)

Attributes Control Charts (Ch. 7, ~ 1 week)
Process and Gage Capability Analysis and ANOVA (Ch. 8, ~ 2 weeks)
Intro to Designed Experiments: 2 Level Factorials (Ch. 13, ~ 1 week)
Fractional Factorial Experiments (Ch. 13, ~ 0.5 weeks)
Process Optimization and Robust Design (Ch. 14, ~ 1 week)
Other Useful Six Sigma topics (~ 1 week)
Feedback Control (Ch. 12, ~ 0.5 week)

Exams: The midterm and final exams will be closed book and closed notes, except for the following. You are allowed one page of "cheat sheet" notes (8-1/2" by 11", front and back) for the midterm and two pages for the final exam. In addition, you are allowed to bring a printout of the pdf handout of distribution tables from the textbook appendices (no notes written on the back/margins/etc. of these, though). The pdf handout will be posted on Blackboard. If you are unable to take the midterm and/or final at the scheduled time due to travel or other plans, then you should not take this course at this time.

HW/Lab Policies: Labs should be conducted in teams of 3 or 4 students, and each Lab will have a group lab report due. HW is to be turned in individually. No credit will be given for late HWs or Labs, but you are allowed to drop your single lowest HW score. HW and Lab assignments and HW solutions will be posted on Blackboard, so HW assignments will not be graded in detail.

Labs: Together, the labs will constitute your six-sigma project for the course. Teams of 3 or 4 students will focus on the Statapult as their "process" for the entire quarter. Teams will build knowledge of their process through experimentation and statistical analysis over the duration of the quarter, as they apply various quality improvement tools. Through a series of 4—5 labs, students will systematically apply the statistical quality improvement and variation reduction tools covered in lecture, including basic descriptive and inferential statistics, control charting and other SPC tools, gauge capability analysis, ANOVA, basic design of experiments, and robust process design. **The labs are an important component of this course, and students are expected to demonstrate a solid command of the material in the lab reports.** Aspects upon which the lab reports will be graded include:

- Demonstration of a clear understanding of the purpose of the labs and their relation to six-sigma variation reduction.
- Proper and thorough application of the variation reduction tools covered in class.
- Overall success in reducing variability in the process.
- Additional experimentation and data analysis not explicitly asked for in the lab assignments (but relevant to reducing variation in your process) will earn bonus points. Any such experiment should be designed to answer a specific question, and students should put careful thought into the experiment and the question it is designed to answer. Make sure the question is relevant to helping you understand important sources of variability.
- Clear, concise technical writing, with effective use of graphical displays of statistical information.
- **Thorough, insightful discussions interpreting the experiment, the results, and their meaning and significance are the most important part of the lab reports.**

Class Participation Bonus: This is purely an opportunity to raise your grade and will in no way lower your grade. The most important part of analyzing data is interpreting the result, both quantitative and visual displays, and drawing conclusions. Although the science (i.e., the formulae and mechanics) of numerical calculations are usually covered adequately in textbooks, the art of interpretation is usually not. This is something that is much easier to cover in lecture, with the aid of interactive software and visual displays of information. I try to emphasize this as much as possible on the exams and projects, and I have noticed in the past a very strong correlation between exam/project performance and the extent to which students attend lecture, pay attention, and participate in discussion. **The purpose of this bonus is to encourage students to do this, helping to ensure that you get the most out of the class.**

The bonus is as follows. If you have good participation, and your final grade is close to the border between two letter grades, then you will be bumped up to the higher of the two grades. The lower boundary of the bump-up margin will be extended for exceptional class participation (e.g., down to the midpoint of the range for the lower grade). Inadequate class participation will not affect your grade. Participation means coming to class on time, asking questions, and volunteering answers. I will occasionally collect in-class feedback on how well students are absorbing the material via short written answers to a question. Being present and writing a reasonable answer will count towards your participation.

Other Notes:

- There will be no class Friday, November 5 and Monday, November 8 (because of INFORMS).