George Mason University
SYST 508– Spring 2014
Complex Systems Engineering Management
Thursdays, 7:20-10:00pm
Robinson Hall A243

Professor: Dr. Larrie D. Ferreiro
Email: **lferreir@gmu.edu**
Office hours: By appointment
Daytime Phone: 703-805-5423 primary
Cell Phone: 703-965-6419 secondary

Course Syllabus

This syllabus is the agreement between you, the student, and me, the professor. Please read it carefully.

Course Goals and Objectives: This course is aimed at Master's-level students in Applied Information Technology. It develops and broadens their understanding and appreciation of both technical and non-technical aspects of systems engineering. In particular, the course introduces the students to the organizational, economic, technological and societal factors (POETS) that apply to the development of large-scale, complex mega-systems, and shows the students that "one size does not fit all" when it comes to the project management of mega-systems. At the conclusion of this course, students should be able to exhibit leadership thinking about systems (not just how but why systems are built), account for circumstances that warrant different approaches to mega-system development, be able to recognize which processes need to be tailored, and be able to explain how to do so.

Methodology: This course uses a combination of lecture, individual readings of chapters, articles and books, student-led class discussions and team projects. A typical class will require the students to have read a textbook chapter and/or a relevant article prior to the class, and be prepared to discuss a list of questions. The class itself will generally include a lecture by me, but most of the time will be devoted to student-led discussions of cases presented by textbook chapters and articles. The student-led case-study method is particularly effective for analyzing and synthesizing complex subjects.

Students will read and review one book on complex systems from a list provided below, or choose another book, subject to my approval.

Students will form into small teams (3-5 members) at the beginning of the course, and select a system that they will examine in four separate but linked project assignments carried through the semester. A key aspect of this course is teamwork. It is the norm not only within a project team but between the team and its external stakeholders. The students should view this as an additional opportunity to build teamwork skills.

As with almost all university-level courses, you should expect to spend a considerable amount of time on your homework assignments. The general rule of thumb for university courses has traditionally been at least two hours of homework per week for every class hour. You should therefore not be surprised to spend at least six hours per week outside class on your SYST 508 assignments.

Prerequisites: None

Grading *(Note that there are* ***no*** *quizzes, midterm or final):*

Homework:	20%	Book Review and Presentation:	20%
Class Participation:	20%	(5% preview, 10% final report, 5% presentation)	
		Team Projects (10% per project):	40%

Letter Grade	Grade Point	Remark
A+	4.00	Excellent
A	4.00	Excellent
A-	3.67	Excellent
B+	3.33	Good
B	3.00	Good
B-	2.67	Good
C+	2.33	Competent
C	2.00	Competent
C-	1.67	Unsatisfactory
D	1.00	Unsatisfactory
F	0.00	Failing

Class Participation and Attendance: You are expected to attend classes in order to effectively participate in the discussions and presentations. At the university level, it is a generally-recognized tenet that you will learn as much from your fellow students as you will from any individual professor. In this course, much of your learning will occur through the group discussions of readings, presentations by your fellow students, and through the interactions in your team project. This cannot happen if you are not in class. Therefore, both your attendance and how active you are in discussions will be taken into account for grading.

All students experience events that may prevent them from attending class – personal circumstances, religious holidays, etc. If you can't attend a class, or if you must arrive late or leave early, let me know as far ahead of time as possible. If you are assigned to make a presentation and you have to miss class, you MUST tell me well ahead of time, in order that I can make adjustments. If you fail to do so, I may not be able to make adjustments and you may not receive credit.

Textbook and Course Materials**:** The course textbook is *Engineering Mega-Systems: The Challenge of Systems Engineering in the Information Age* by Renee Stevens (Boca Raton: CRC Press, 2011: ISBN: 978-1-4200-7666-0). Please have this book by Class 4.

I will provide other readings for class assignments on GMU's BlackBoard system. Students will use the GMU Library or other library resources for books to review, and for performing group research and presentations. You will need access to the GMU BlackBoard system on a continual basis, and I will be communicating with you via GMU e-mail. Your devices (computer, laptop, tablet, etc.) need to be configured to the latest versions of these systems, so check with GMU's Computing and Technology resource page for those requirements.

Class Schedule and Assignments

Class	Topics	HW to be completed	Class Activities
1	**Course Introduction**	None	Lecture: Introduction and course objectives Setting the context
2	**Systems and Mega-Systems**	Johnson , "Three Approaches to Big Technology" Sato, "Local Engineering and Systems Engineering" **Select book for review**	Lecture: Systems engineering; POETS; mega-systems; tame versus wicked Discussion: HW readings **Form teams and select case system**
3	**Stakeholder Requirements and System Concepts**	Ibsen, "Boeing vs. Airbus"	Lecture: Stakeholder requirements. System concepts. **Team project assignment 1: Identify key stakeholder expectations, create system concepts, downselect to one concept. Due Class 5** Discussion: HW reading
4	**System Requirements and Tradeoff Studies**	Balbi, "Italian Broadcasting" **Book review preview**	Lecture: System requirements. Tradeoff studies Discussion: HW reading **Individual book review previews**
5	**System Architecture and Use Schematics; Team Presentation 1**	Fletcher, "Minitel" **Team Project Presentation 1**	Lecture: Systems architecture; Concept of operations and use schematics **Team project presentation 1: Stakeholder requirements and system downselect** **Team project assignment 2: Develop graphics-based use schematic of selected system. Due Class 7** Discussion: HW reading
6	**Technical Reviews, Test and Evaluation**	Light, "When Computers were Women"	Lecture: Technical Reviews. Test and Evaluation Discussion: HW reading
7	**Mega-System Concepts; Team Presentation 2**	Stevens *Mega-Systems*: - Ch 3. Mega-System Concepts - Ch. 4. Framework **Team Project Presentation 2**	Lecture: Mega-system concepts **Team project presentation 2: Graphics-based use schematic**
8	**The System Profiler in Context**	Stevens *Mega-Systems*: -Ch. 5 Engineering Mega-Systems	Class exercise: Developing a system profile (electronic health record)
9	**The System Profiler in Action**	Stevens *Mega-Systems*: - Chs. 7 & 8 Case Studies: Single Integrated Air Picture Electronic Product Code	Discussion: Using the system profiler in the SIAP and EPC case studies **Team project assignment 3: Build "tame' and 'wicked" system profiles of selected system and use scenario. Due Class 12**
10	**Observations from Case Studies; Student Book Review Presentations**	Stevens *Mega-Systems*: -Ch 9 Observations from case studies **Submit individual book review**	Lecture: Observations from case studies **Book review presentations**
11	**Systems Thinking; Student Book Review Presentations**		Lecture: Systems Thinking **Book review presentations**

Class	Topics	HW to be completed	Class Activities
12	**Mega-System Challenges; Team Presentation 3**	Stevens *Mega-Systems*: -Ch 10 The Way Ahead **Team Project Presentation 3**	Lecture: Mega-System Challenges **Team project presentation 3: "Tame" and "wicked" system profiles** **Team project assignment 4: Re-visit team assignments 1 and 2 (revised stakeholder requirements, system downselect and use schematic) based on "wicked" system profile results. Due Class 14**
13	**Decision-Making Under Uncertainty**	Hansson, "Safe Design" *Challenger* Case Study *Columbia* Case Study	Discussion: HW readings
14	**Team Presentation 4**	**Team Project Presentation 4**	**Team project presentation 4: Stakeholder requirements, system downselect and use schematic after analysis of system profiler**
15	**Final Presentations (if required)**	Final corrected presentations (if required)	Final corrected presentations (if required) **Engineering: Lone or social activity?**

***Homework and Class Discussions**:* We use the Harvard Business School case study method to analyze the homework readings (articles and book chapters) using critical, open-ended questions. This involves three steps: (1) Homework -- individual analysis of the reading by answering the questions in writing; (2) In-Class Small-Group Discussion – 3-5 individuals who discuss the questions and compare notes, and (3) In-Class Large-Group Discussion, where the whole class discusses the questions. Where the class size is small enough, we will dispense with the Small-Group and go straight to the Large-Group.

Each reading selection will be accompanied by a list of reading questions in a separate Word document. You are to complete SHORT BUT COMPLETE (2-3 paragraphs each) answers to each of these questions and submit them to before the class using BlackBoard. You will be graded on: critical thinking in answering the questions; your use of SPECIFIC examples from the readings and from other sources (which I strongly encourage you to use) in order to support your arguments; and the clarity of your writing, which includes proper spelling, punctuation and grammar. Please bring in a hard copy of your answers to class to use as a reference during group discussions.

You will submit all your homework on BlackBoard using any supported format (MS Word, PDF, etc.). Please label the file with YOUR last name and class number, as follows: LASTNAME-CLASS X. And PLEASE use the spell-check and grammar check before submitting the work – good engineering requires good writing skills (I encourage you to visit GMU's Writing Center**:** **writingcenter.gmu.edu**). I will review the document, add my comments and grade, and then post it back to you via BlackBoard.

Students will be required to participate in the large-group class discussions. You will be assessed on how well you develop your answers and how well you engage with your fellow students in eliciting their ideas and points of view.

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You should turn in your homework on time (i.e., by the day of the class). If you cannot, please let me know the reason and we will work out a schedule. Otherwise, I will reduce your homework score by half a grade (for example, from an A to a B+) if it is one week late, a full grade (A to B) for more than a week, and I will mark "incomplete" (equivalent to a 0) for more than two weeks late.

Independent Book Review: Students will read a book from the class reading list (below), or another, relevant book subject to my approval. You will write a review of the book and present the main points to the class. You will make selection by Class 2, present a short (2-minute) preview in Class 4, and submit the review in Class 10. Book reviews will be presented during Classes 10 and 11.

In order to make certain that the entire class benefits from the wide selection of books (that is, to make sure that we don't get two or three people reading and presenting the same book), I ask the students to provide me a rank-order list of their preferred books, from 1st to 4th place. I will make every attempt to assign you your top choice. Once again, you may choose another, relevant book subject to my approval.

You may choose to purchase the book, check the book out from the GMU Library or use GMU's Interlibrary Loan (ILL) system. If you are a resident of one of the local counties (e.g., Fairfax, Loudon, etc.), you may also use your local county library (including ILL).

Your 2-minute preview in Class 4 will follow the single-slide template provided.

You will complete a 3-5 page (single-spaced) review of the book, with the following: a) summary of book; b) theses and main points; c) specific lessons regarding engineering systems and complexity related to politics, organization and economics and society. You will also submit and present in class a 10-15 minute presentation (template is provided).

BOOK REVIEW – CLASS READING LIST

1. Janet Abbate, *Inventing the Internet*. Cambridge, Mass: MIT Press, 1999. ISBN: 0585077975. 272pp.
2. William Aspray and Martin Campbell-Kelly, *Computer: A History of the Information Machine*. Boulder, Co: Westview Press, 2008. ISBN: 0813342643. 360pp.
3. Andrew Blum, *Tubes: A Journey to the Center of the Internet*. New York: Ecco, 2012. ISBN: 0061994936. 304pp.
4. Paul Ceruzzi, *Internet Alley: High Technology in Tysons Corner, 1945-2005*. Cambridge, Mass: MIT Press, 2008. ISBN: 0262033749. 256pp.
5. B. Jack Copeland. *Colossus: The Secrets of Bletchley Park's Code-Breaking Computers*. Oxford: Oxford University Press, 2010. ISBN: 0199578141. 480pp.
6. Paul Dyson, *Turing's Cathedral: The Origins of the Digital Universe*. New York; Pantheon, 2012. ISBN: 0375422773. 432pp.
7. Paul Edwards, *A Vast Machine: Computer Models, Climate Data and the Politics of Global Warming*. Cambridge, Mass.: MIT Press, 2010. ISBN: 0262013925. 552pp.
8. Kweku Ewusi-Mensah, *Software development failures: anatomy of abandoned projects*. Cambridge, Mass.: MIT Press, 2003. ISBN: 0262256087. 290pp.
9. Jon Gertner, *The Idea Factory: Bell Labs and the Great Age of American Innovation*; New York: Penguin Press, 2012. ISBN: 1594203288. 432pp.
10. James Gleick, *The Information: A History, a Theory, a Flood*. New York: Pantheon, 2011. ISBN: 0375423729. 544pp.
11. Katie Hafner, *Where Wizards Stay Up Late: The Origins of the Internet*. New York: Simon & Schuster, 1998. ISBN: 0684832674. 304pp.

12. Thomas Hughes and Agatha Hughes (eds.). *Systems, experts, and computers: the systems approach in management and engineering, World War II and after*. Cambridge, Mass.: MIT Press, 2000. ISBN: 0262082853. 520pp.
13. William Langewiesche, *Fly by Wire: The Geese, the Glide, the Miracle on the Hudson*, New York: Farrar, Straus and Giroux, 2009. ISBN: 0374157189. 208pp.
14. Jennifer S. Light, *From warfare to welfare: defense intellectuals and urban problems in Cold War America*. Baltimore: Johns Hopkins Univ. Press, 2005. ISBN: 0801882737. 287pp.
15. Tom McNichol, *AC/DC: the Savage Tale of the First Standards War*. Hoboken: Wiley, 2010. ISBN: 0787982679. 208pp.
16. Charles Perrow, *Normal accidents: living with high-risk technologies*. New York: Basic Books, 1984. ISBN: 0465051448. 386pp.
17. Peter Singer, *Wired for War: The Robotics Revolution and Conflict in the 21st Century*. New York: Penguin, 2009. ISBN: 1594201986. 512pp.
18. Tom Standage, *The Victorian Internet: The Remarkable Story of the Telegraph and the Nineteenth Century's On-line Pioneers*. New York: Walker & Company, 2007. ISBN: 0802716040. 256pp.
19. David L. Stearns, *Electronic Value Exchange: Origins of the VISA Electronic Payment System*. London: Springer, 2011. ISBN: 1849961387. 268pp.
20. Jonathan Sterne, *MP3: The Meaning of a Format*. Durham NC: Duke University Press, 2012. ISBN: 0822352877. 360pp.
21. Doron Swade, *The Difference Engine: Charles Babbage and the Quest to Build the First Computer*. New York: Viking, 2001. ISBN: 0670910201. 352pp.
22. Yuri Takhteyev, *Coding Places: Software Practice in a South American City*, Cambridge, MA: MIT Press, 2012. ISBN: 0262018071. 256pp.

***Team Projects*:** Students will form into small teams (3-5 members) at the beginning of the course, and select a system that they will examine in four separate but linked project assignments carried through the semester. The project assignments will build one upon the other to create different products required during the early part of a systems design.

Student teams will first select a system from one of the cases outlined below, either from the Harvard Case portfolio, a case system from a selected book, or a real-world example chosen by the student team. I encourage your teams to use examples from actual projects the members are working on (or have worked on) to give context to the systems engineering concepts in the class. (Note: Where the case system descriptions lack sufficient detail, student teams are expected to "fill in the blanks" with outside research and reasonable assumptions based on professional experience.) Each team will then use their selected system to carry out the four team projects, as follows:

- Team project assignment 1 (start Class 3, due Class 5): Identify key stakeholder expectations, create system concepts, downselect to one concept. Student teams will begin with selected case system, and identify the following: the primary stakeholder community; the primary user community; the principal mission or purpose of the system; and the initial set of technologies which will form the basis of the system. In other words, project assignment 1 assumes a tightly-constrained ("tame") system environment. The team will first develop the key stakeholder requirements based on the stakeholder and user communities (for this assignment, keep it to less than a dozen

requirements). The team will then develop and define several (3-5 preferable) concepts for carrying out the principal mission of the system using the initial set of identified technologies. These concepts may differ operationally, in use of technology, or both. Finally, the team will use a selection process such as a Pugh Concept Selection matrix to downselect to a single concept for further development. Examples of the Pugh matrix and of system downselect are provided. The team presentation will explain the process of determining stakeholder requirements and how the system downselect was made.

- Team project assignment 2 (start Class 5, due Class 7): Develop graphics-based use schematic of selected system. Student teams will begin with the selected system concept, and develop a use schematic that portrays in graphical form how the system will be employed in normal operation. The form of the use schematic is entirely up to the team's discretion. It may be in the form of a single picture that portrays a concept of operations; a use case; a short graphic novel (i.e., comic strip); a video; or any other visual depiction of how the system will work. IMPORTANT: each team member will first (individually and separately) develop a rough use schematic, displaying how they visualize the system in operation; the team will then create a final use schematic. The team presentation will compare and contrast each team member's initial visualization of a use schematic, describe how they converged to a single idea, and show the final team vision.

- Team project assignment 3 (start Class 9, due Class 12): Build "tame" and "wicked" system profiles of selected system and use schematic. Student teams will start with the systems profiler to plot the initial "tame" system assumption developed in project assignment 1. The team will then re-examine the selected case system, expanding their initial analysis to identify the following: the diverse stakeholder communities; the complete set of user communities; the multiple set of missions of the system; and the wider set of system technologies which will be used as the of the system evolves. It will then use the systems profiler to develop the outlines of the "wicked" system environment. The teams will then compare and contrast the two profiles and draw preliminary observations.

- Team project assignment 4 (start Class 12, due Class 14): Re-visit team assignments 1 and 2 (revised stakeholder requirements, system downselect and use schematic) based on "wicked" system profile results. Student teams will re-examine the stakeholder and user communities using the results from the "wicked" profile, and develop a revised list of stakeholder requirements (no limit for this assignment). Based on the revised mission context and system context, the team will decide whether to re-examine the initial concepts, choose new ones, or a mixture of both. The team will then build a new use schematic based on the selected concept. As with project assignments 1 and 2, these concepts may differ operationally, in use of technology, or both. The team will use the same processes as in project assignments 1 and 2 to downselect to a single concept for further development and to develop a use schematic (but you do not need to develop individual concepts first, only the team's final use schematic). The team presentation will explain if, how and why the "wicked" system downselect and use schematic differed from those of the "tame" system.

Teams may choose cases from the following:
Harvard Case systems (see Team project assignment 1 folder in BlackBoard):

- IT at Mercedes Benz India
- IT transformation at Accenture
- RFID at Hong Kong University (HKU) library
- ERP at Bombardier
- IT management at ALCAN
- Zhejiang China Telecom
- IT Innovation at Shinsei Bank
- Pharmacy Service Improvement at CVS
- Partners Healthcare System
- IT at STARS Air Ambulance
- University Health Network
- Binnj on the Apple iPad

Case systems from books and articles:

- BankAmericard Authorization System Experimental (BASE), or another system described in David L. Stearns, *Electronic Value Exchange: Origins of the VISA Electronic Payment System*. London: Springer, 2011. ISBN: 1849961387.
- Semi-Automatic Ground Environment (SAGE) or ARPANET, described in Thomas Hughes, *Rescuing Prometheus*. New York: Vintage Books, 1998. ISBN: 0679739386.
- Minitel, as described in Amy L. Fletcher, "France Enters the Information Age: A Political History of Minitel" *History of Technology* 18/2 pp. 103-117, 2002.
- Other systems described in books and articles, as chosen by teams and approved by me.

Other case systems:

- As chosen by student teams and approved by me, preferably based upon current or previous real-world projects of team member(s).

Team project schedule:

- Class 2: Form project teams and select case system
- Class 3: Team project assignment 1: Identify key stakeholder expectations, create system concepts, downselect to one concept. Due Class 5.
- Class 5: Team project presentation 1: Stakeholder requirements and system downselect. Team project assignment 2: Develop graphics-based use schematic of selected system. Due Class 7.
- Class 7: Team project presentation 2: Graphics-based use schematic.
- Class 9: Team project assignment 3: take selected system and use schematic, build "tame" and "wicked" system profile. Due Class 12.
- Class 12: Team project presentation 3: "Tame and "wicked" system profiles. Team project assignment 4: Based on system profile results, go back and re-consider Team Assignments 1 and 2 (revised stakeholder requirements/system downselect/use schematic). Due Class 14.
- Class 14: Team project presentation 4: Stakeholder requirements, system downselect and use schematic after analysis of system profiler.
- Class 15: Final corrected presentations (if required).

Class Schedule – Spring 2014

Date	Class Number	Topics
Jan 23	1	Course Introduction
Jan 30	2	Systems and Mega-Systems
Feb 6	3	Stakeholder Requirements and System Concepts
Feb 13	4	System Requirements and Tradeoff Studies ; Student Book Review Preview
Feb 20	5	System Architecture and Use Schematics; Team Presentation 1
Feb 27	6	Technical Reviews, Test and Evaluation
Mar 6	7	Mega-System Concepts; Team Presentation 2
Mar 13	**NO CLASS - GMU SPRING BREAK**	
Mar 20	8	The System Profiler in Context
Mar 27	9	The System Profiler in Action
Apr 3	10	Observations from Case Studies; Student Book Review Presentations
Apr 10	11	Systems Thinking; Student Book Review Presentations
Apr 17	**NO CLASS**	
Apr 24	12	Mega-System Challenges; Team Presentation 3
May 1	13	Decision-Making Under Uncertainty
May 8	14	Team Presentation 4 (Final)

Administrative Notes:

Closings and cancellations: In the event of inclement weather or another major event, the university announces class cancellation, delay of classes and changes to administrative office hours through the university switchboard, 703-993-1000; the George Mason home page, www.gmu.edu; GMU-TV; and local radio and television stations. If there is any doubt as to the status of the class, contact me. If I need to cancel a particular class, I will contact the students at the earliest possible opportunity.

Emergency Preparedness: In the event of an emergency, we will follow GMU procedures. You may want to register with Mason Alert: https://alert.gmu.edu/index.php?CCheck=1

Privacy: Students must use their MasonLIVE email account to receive important University information, including messages related to this class. See ***http://masonlive.gmu.edu*** for more information.

Academic Integrity (not just about cheating!): GMU has an ***Honor Code*** with clear guidelines regarding academic integrity: "*Student members of the George Mason University community pledge not to cheat, plagiarize, steal, or lie in matters related to academic work*".

Three fundamental and rather simple principles to follow at all times are:

(1) Do not plagiarize: all work submitted must be your own (in other words, never cut and paste whole phrases from a book or from the web);
(2) Give credit when you use someone else's words: when using the work or ideas of others, including fellow students, give full credit through accurate citations; and
(3) Ask if you don't know what to do: if you are uncertain about the ground rules on a particular assignment, ask me for clarification.

Plagiarism is generally thought of as a moral issue – it is dishonest to use someone else's words as your own, without properly crediting the source.

However: an equally important issue is that, when you copy someone else's words, you are not learning. You are (or someone else is) investing valuable time and resources for you to attend university and learn stuff so you can have a bright future. If you copy and don't learn, you are wasting your time and that person's significant contribution to your future. Don't do it.

Accommodating students with specific needs: If you have a documented learning disability or other condition that may affect you academic performance you should: 1) make sure this documentation is on file with ***Office for Disability Services*** (http://ods.gmu.edu) to determine the accommodations you need; and 2) speak with me to discuss your accommodation needs.

Computers and other electronic devices in class: You are expected to pay attention to and be engaged with what is happening in class, both when your fellow students are making presentations or discussing readings, as well as when I am giving a lecture. You can't do that while surfing or texting or tweeting. It becomes very obvious to both me and to your classmates that you aren't engaged and it distracts everyone. More importantly, you are not learning! **Close your laptops and put your tablets and smartphones away**.

Common courtesy and common sense prevails. Use your phones only during breaks, and please do so outside class. Leave your phones on beep or buzz if you need to be available for emergency calls, and take the calls outside of class.

NOTE: This information is subject to change with advance notification to the class.