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**SCHOOL OF
ENGINEERING
& APPLIED SCIENCE**



*DEPARTMENT OF SYSTEMS and
INFORMATION ENGINEERING
University of Virginia
Thornton Hall
Charlottesville, VA 22903*

**SYS 6001: Introduction to Systems Engineering
Opening of Course Memo
Version 4.0**

Instructor: William T. Scherer
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Office Hours: Tuesday, 3:15-4:15 PM, Olsson 228 Lobby (If you don't have a key to Olsson 228 (are not a graduate in the SIE department), email or notify in class that you are coming.)

Class Time/Location: Tuesday/Thursday, 2:00- 3:15 Olsson 011

Course Prerequisites: Graduate Standing or Permission of Instructor

Catalog Description: An integrated introduction to systems methodology, design, and management. An overview of systems engineering as a professional and intellectual discipline, and its relation to other disciplines such as operations research, management science, and economics. An introduction to selected techniques in systems and decision sciences, including graphical techniques, decision analysis, and simulation. Elements of systems management, including decision styles, human information processing, organizational decision processes, and information system design for planning and decision support. Emphasis is placed on relating theory to practice via written analyses and oral presentations of individual and group case studies.

Course Philosophy: The primary goal of this course is to challenge the way in which the student thinks; the way in which students approach problem solving. Secondary goals are to familiarize the student with systems engineering methodologies (the "systems approach"), systems engineering science tools (e.g., decision analysis, graphical tools, etc.), systems management concepts (e.g., TQM, team building), and systems modeling.

Students are encouraged to proactively participate throughout the semester. This includes classroom interactions and outside the classroom activities, such as group meetings. The nature of this material is not the kind that can be "spoon-fed" to students - the material requires active engagement of the material by the student. Reading assignments cannot be briefly scanned -- the student must read the material and reflect on the nature of what the author is trying to communicate.

If any student has any problems with the material, the instructor, the Teaching Assistant, homework assignments, etc., I encourage them to see me or phone as soon as possible. Don't wait for a small problem to escalate into a serious problem. I also encourage feedback from the students throughout the semester. You can leave a note in my mailbox (signed or unsigned), stop-by my office, or telephone.

Texts:

Required:

NOTE: New book, published 1 August 2016. This is not a new edition:

- *How to Do Systems Analysis: Primer and Casebook* (Wiley Series in Systems Engineering and Management) by Gibson, Scherer, Gibson and Smith (1 Aug 2016)
- [Innumeracy: Mathematical Illiteracy and Its Consequences](#) by [John Allen Paulos](#) (Aug 18, 2001)
- *TBD -- @Risk Software*

Reference – not required but recommended

- *The Engineering Design of Systems, D. Buede [latest edition]*

Computer Requirements:

Every student will be required to use Excel, @Risk/Crystal Ball (Excel add-ins), Solver (an Excel add-in – not provided or ordered -- typically comes with Excel), and prepare Powerpoint presentations.

Grading:	<i>(Tentative)</i>	Midterm Exam	25%
		Final Exam	30%
		Class Participation	10%
		Cases and Projects	<u>35%</u>
			100%

Course Goals: The goals of SYS 6001 are:

1. To present the basic principles of systems engineering.
2. To present:
 - the history of SE,
 - the methodologies of SE,
 - the tools and techniques SE, and
 - the modeling of systems for SE.
3. To present the applications and practice of Systems Engineering across a broad spectrum of disciplines
4. To give class members the understanding of the methodology and the applications of SE as a foundation for the UVa SE graduate Program.

Detailed Topics – Tentative

PART 1: Systems Methodologies

Top-down, goal-driven problem solving (and its relation to bottom-up problem solving)
History of operations research, systems engineering, and systems analysis
Overview of systems methodologies
Comparison and Contrasting of Systems Methodologies (i.e., NASA SE, DOD Standards, industry standards -- EIA, IEEE, CMM, CMMI, etc.)
Phases of systems engineering life cycle:
 Systems definition phase
 Systems design and development phase (included requirements, trade studies, etc.)
 Systems implementation & maintenance phase (includes test and evaluation, etc.)
Systems management issues
Comparison of systems methodologies to contemporary/historical management approaches including:
 Business Process Reengineering (BPR)
 Total Quality Engineering (TQM), ISO-9000
 Concurrent Engineering (CI)
 Systems Integration (SI)

PART 2: Decision Making for Systems Engineering

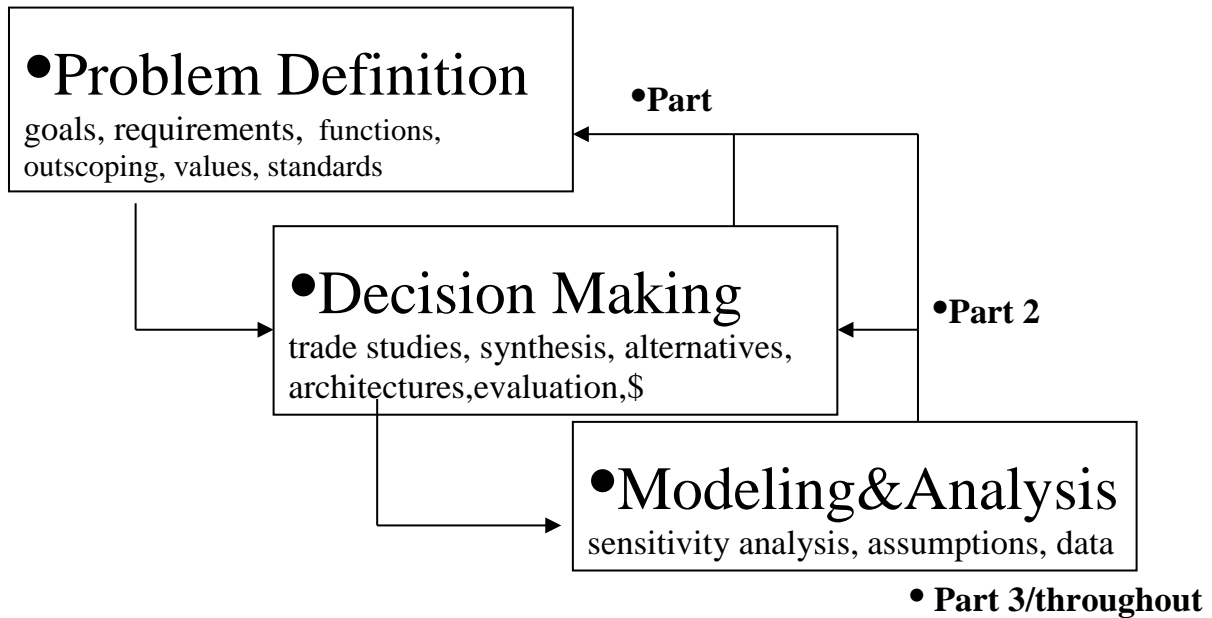
Introduction to critical issues and problems, basic decision analysis concepts
Overview of decision making pitfalls and common errors
Introduction to decision concepts:
 Measurement concepts
 Pareto optimality/dominance
 Rate and Weight
 Analytic Hierarchy Process (AHP)
 Decision Theory (Value and Utility Theory)
 Decision trees
 Software for decision making
Economic issues, including NPV, cost/benefit, project management (PERT, CPM)
Misc. Issues: Stochastic dominance, sensitivity analysis (tornado charts, single/multi-variable, graphical, etc.)

PART 3: Modeling for Systems Engineering and Tools of Systems Engineering

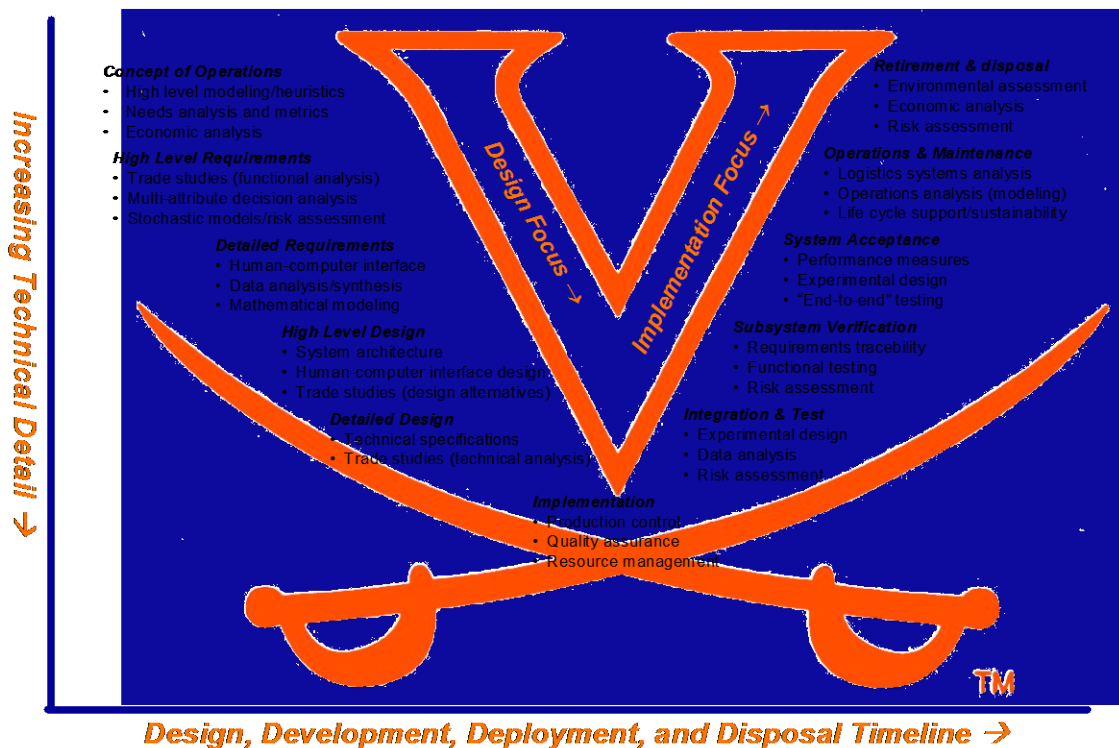
Introduction to systems modeling/problem formulation
Making the ‘business case’
Basics of system models, introduced via cases:
 Optimization concepts (Solver, OPTQuest)
 Reliability/Maintainability Concepts (Excel, Crystal Ball)
 Basic simulation modeling and dynamic systems (Crystal Ball, Excel)
 Stochastic and optimization concepts for systems engineering
Software/Graphical Tools
Other modeling tools (e.g.: Crystal Ball, optimization, etc.)

Throughout: Discussion of real world problems via systems engineering and analysis case studies

SYS 6001 - Another View



Systems Engineering Methodology with illustrative analytical tools and techniques



SYS 6001: Introduction to Systems Engineering
WT Scherer
A Partial Reference List

1. Blanchard, B.S., and Fabrycky, W.J., *Systems Engineering and Analysis, 4th Edition*, Prentice-Hall, Englewood Cliffs, New Jersey, 2006.
2. Blanchard, Benjamin, *Systems Engineering Management*, Wiley, 2004.
3. Buede, Dennis, *The Engineering Design of Systems: Models and Methods*, Wiley, 2000.
4. Chapman, W., Bahill, A.T., and Wymore, W., *Engineering Modeling and Design*, CRC Press, New York, 1992.
5. Chen, G., Jamieson, J.M., Schkade, L.L., and Smith, C.H., eds, *The General Theory of Systems Applied to Management and Organization*, The Systems Inquiry Series, Intersystems Publications, Seaside California, 1980.
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9. Daellenbach, Hans, *Systems and Decision Making: A Management Science Approach*, Wiley, 1994.
10. Deming, W.E., *Out of the Crisis*, MIT Press, Cambridge MA, 1986.
11. Eisner, Howard, *Computer-Aided Systems Engineering*, Prentice-Hall, Englewood Cliffs, New Jersey, 1988.
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14. Flood, Robert L., *Creative Problem Solving: Total Systems Intervention*, Wiley, New York, 1991.
15. Gohagan, John K., *Quantitative Analysis for Public Policy*, McGraw-Hill, New York, 1980.
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21. Majone, G., and Quade, E., editors, *Pitfalls of Analysis*, Wiley-Interscience, New York, 1980.
22. Martin, James, *Systems Engineering Guidebook: A Process for Developing Systems and Products*, CRC Press, New York, 1997.
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24. Quade, E.S., *Analysis for Public Decisions*, North-Holland, New York, New York, 1989.
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26. Saaty, Thomas L., and Alexander, J.M., *Thinking With Models: Mathematical Models in the Physical, Biological and Social Sciences*, Pergamon Press, New York, 1981.
27. Sage, Andrew P., *Methodology For Large-Scale Systems*, McGraw-Hill, New York, 1977.
28. Sage, Andrew P., *Systems Engineering: Methodology & Applications*, IEEE Press, New York, 1977.
29. Sage, Andrew P., *Systems Engineering*, New York: John Wiley & Sons, Inc., 1992.
30. Sage, Andrew, and Armstrong, Jim, *Introduction to Systems Engineering*, Wiley, 2000.
31. Weinberg, Gerald M., *An Introduction to General Systems Thinking*, Wiley, New York, 1975.
32. Weinberg, Gerald M., *Rethinking Systems Analysis and Design*, Little, Brown, and Company, Boston, 1982.