

SYLLABUS

SAE 549: Systems Architecting

Fall 2018

Class Session: Mondays, 3:30 pm – 6:10 pm, OHE 120

Class Section: 32319D (DEN/Off-campus) and 32349D (On Campus)

Contact Information:

Instructor: Mr. Kenneth Cureton
Office hours: Mondays, 1:30 – 3:00 PM
Office location: RAN 215 & Virtual
Office phone: 213-740-1713
E-mail: cureton@usc.edu

Teaching Assistant: None

Course Learning Objectives:

- To improve students' ability to think critically, ask the right questions, and apply the right methods when architecting various types of systems.
- To improve students' understanding of the role of system architects and their relationship to systems engineers and transdisciplinary systems engineering.
- To introduce the students to new, advanced multidisciplinary topics (e.g., systems thinking, systems modeling, psychological principles in systems architecting, biologically-inspired architectures, agent-based modeling, human capabilities and limitations) relevant to complex systems architecting.
- To introduce the students to key concepts in performing trade-off analysis which is important to both systems architecting and engineering.

Readings and Notes:

- Weekly lecture notes will be posted on the Desire to Learn (<http://courses.uscdcn.net>)
- Required Reader:
 - Rechtin, E. (1991), *Systems architecting: Creating and building complex systems*. Englewood Cliffs, NJ: Prentice Hall. ISBN: 0-13-880345-5. *Note: This text is out of print, but is available in the USC Bookstore as the "Course Reader" for SAE 549.*
- Required Texts: *Note: you can download these books through USC Libraries for free.*
 - Madni, A.M., "Transdisciplinary Systems Engineering: Exploiting Convergence in a Hyper-Connected World," Springer 2018 (*also available for purchase in the USC Bookstore*)
 - Bahill, T. A., Madni, A.M., "Trade-off Decisions in Systems Design" Springer, 2017.
 - Maier, M., & Rechtin, E. (2000). *The Art of Systems Architecting, Second Edition*. Boca Raton, FL: CRC Press e-book ISBN: 978-1-4200-5852-9

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- Required Readings: *Note: you can download these papers via the DEN/D2L or Google Scholar or USC Libraries for free.*
 - Madni, A.M. “Generating Novel Options During Systems Architecting: Psychological Principles, Systems Thinking, and Computer-Based Aiding,” pages 1-9, Systems Engineering, Volume 16, Number 4 2013
 - Ordoukhanian, E, Madni, A.M., “System Trade-offs in Multi-UAV Network”, AIAA Space 2015, August 31-Sep 2, 2015, Pasadena, CA
 - Madni, A.M., Madni, C.C. and Sievers, M. “Adaptive Cyber-Physical-Human Systems,” 2018 INCOSE International Symposium, July 7-12, 2018.
 - Madni, A.M. “Integrating Humans With and Within Complex Systems: Challenges and Opportunities,” (Invited Paper) CrossTalk, The Journal of Defense Software Engineering, May/June 2011, “People Solutions.”
 - Madni, A. M. 2010. “Integrating Humans With Systems and Software: Technical Challenges and Research Agenda,” Systems Engineering, 13(3): 21.
 - Madni, A.M. and Sievers, M. “Systems Integration: Key Perspectives, Experiences, and Challenges,” 2013
 - Madni, A.M., and Sievers, M. "System of Systems Integration: Key Considerations and Challenges." Systems Engineering (2013).
 - Madni, A.M., Ross, A. “Exploring Concept Trade-offs,” Chapter 10 in “Trade-off Analytics,” Eds Parnell G., Wiley 2016

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Grade

Your grade will be based on:

- Homework assignments (total of 4 assignments) = 20%
- Midterm exam = 30%
- Final term paper = 50%

Homework

- Each homework assignment will consist of a few questions that ask students to briefly apply that week's learning to analysis of a hypothetical new system. The homework will be assigned at the end of Lectures #2, #3, #5, and #6 and will be **due before start of class** the following week. Late submissions will receive a maximum of half-credit after the due date/time. Answers to all homework assignments will be reviewed in Lecture #13.
- **Collaboration on the homework assignments is forbidden.** Violators will receive an automatic score of zero for that assignment.

Exam

- The exam will consist of multiple questions that will test students' knowledge about the fundamentals of systems architecting, complex systems, and systems thinking. The exam will be on all the subjects covered in Lectures #1 through #6 and related assigned readings. This will be a timed exam (2 hours and 40 minutes). The exam will be available on D2L at any time between **Thursday October 11, 2018 at 6:00 AM Pacific Time** and **Sunday October 14, 2018 at Midnight Pacific Time**. Answers to the exam will be reviewed in Lecture #13.
- **Collaboration on the exam is forbidden.** Violators will receive an automatic F for the course.

Term Paper:

The term paper should address the following problem:

Describe and analyze the architecture of a selected vehicle or phone/tablet (see below). Your analysis should discuss how the architecting process led to the architecture. The architecting process should address the heuristics used, key tradeoffs, questions posed, people involved, options generated, and decisions made.

***Submit a maximum 1-page abstract for approval by
September 24, 2018 3:30 PM Pacific Time on your chosen vehicle or phone/tablet.***

Student must write on a **specific** system from one of the following categories.

- Automated (Self-Driving) Cars
- Smart Phones or Smart Tablet Computers
- Space Telescopes
- Robotic Systems (including Unmanned Space Exploration)
- Manned Space Transport
- Passenger Aircraft
- Airborne Platforms (Fighter / Bomber Aircraft / Helicopter / Unmanned Aerial Vehicles)

Students should **not** propose an individual component or subsystem or process, but an entire vehicle (or phone/tablet) from one of the above categories in the above list.

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LENGTH: The term paper should be approximately 8 pages (excluding references, appendices, and cover page), single-spaced, single column, standard (1" top and bottom, 1.25" left and right) margins, 12-point Times New Roman type.

DELIVERY: The term paper *must* be submitted through the Desire to Learn (D2L) system. Links for submitting the final paper will be available on D2L (<http://courses.uscdcn.net>).

DEADLINE: Term papers are due on **December 10, 2018 at Midnight Pacific Time.** *No late papers will be accepted after the due date and time, and the student will receive an automatic F grade for the final paper.*

Collaboration or plagiarism in the term paper is forbidden. Violators will receive an automatic F grade for the final paper.

UNIVERSITY LEVEL ISSUES

■ **Statement for Students with Disabilities:**

Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me (or to TA) as early in the semester as possible. DSP is located in GFS 120 and is open 8:30 a.m.–5:00 p.m., Monday through Friday. The phone number for DSP is (213) 740-0776.

■ **Statement on Academic Integrity:**

USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own. All students are expected to understand and abide by these principles. *Scampus*, the Student Guidebook, contains the Student Conduct Code in Section 13.00, while the recommended sanctions are located in Appendix A: <https://scampus.usc.edu/university-student-conduct-code/>. Students will be referred to the Office of Student Judicial Affairs and Community Standards for further review, should there be any suspicion of academic dishonesty. The Review process can be found at: <http://www.usc.edu/student-affairs/SJACS/>.

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Schedule of Class Sessions: Any changes will be announced.

2018	Lecture Topics	Readings
Aug 20	1. Intro to SAE Program, the course, the instructor, and systems architecting	<ol style="list-style-type: none"> 1. "Preface" from Rehtin, 1991 2. Chapter 1,2, and 3 from Rehtin, 1991 3. Chapter 1 from Madni 2018
Aug 27	2. System Architecture and Architectural Frameworks	<ol style="list-style-type: none"> 1. Chapter 6 from Madni 2018 2. Chapter 15 from Rehtin 1991 <p><i>Submit student bio by 3:30 PM Monday Aug 27, 2018 Pacific Time Homework #1 Assigned</i></p>
Sep 3	Labor Day Holiday	(no lecture this day)
Sep 10	3. Architecture Trade-off Analysis	<ol style="list-style-type: none"> 1. Madni, A.M., Ross, A. "Exploring Concept Trade-offs," Chapter 10 in "Trade-off Analytics," Eds Parnell G., Wiley 2016 2. Ordoukhanian, E, Madni, A.M., "System Trade-offs in Multi-UAV Network", AIAA Space 2015, August 31-Sep 2, 2015, Pasadena, CA 3. Section 2.3 from Bahill & Madni 2017 4. Chapter 5 from Bahill & Madni 2017 5. Chapter 6 from Madni 2018 <p><i>Homework #1 Due by 3:30 PM Monday Sept 10, 2018 Pacific Time Homework #2 Assigned</i></p>
Sep 17	4. Systems Thinking	<ol style="list-style-type: none"> 1. Madni, A.M. "Generating Novel Options During Systems Architecting: Psychological Principles, Systems Thinking, and Computer-Based Aiding," pages 1-9, <i>Systems Engineering</i>, Volume 16, Number 4 2013. 2. Chapter 2 from Madni 2018 <p><i>Homework #2 Due by 3:30 PM Monday Sep 17, 2018 Pacific Time</i></p>
Sep 24	5. Heuristics	<ol style="list-style-type: none"> 1. Appendix A from Rehtin 1991 2. Section 2.4 from Bahill & Madni 2017 <p><i>Submit abstract by 3:30 PM Monday Sep 24, 2018 Pacific Time Homework #3 Assigned</i></p>
Oct 1	6. Human-System Integration: Implications for Systems Architecting	<ol style="list-style-type: none"> 1. Madni, A.M. "Integrating Humans With and Within Complex Systems: Challenges and Opportunities," (Invited Paper) <i>CrossTalk, The Journal of Defense Software Engineering</i>, May/June 2011, "People Solutions." 2. Madni, A. M. 2010. "Integrating Humans With Systems and Software: Technical Challenges and Research Agenda," <i>Systems Engineering</i>, 13(3): 21. 3. Chapter 11 from Rehtin 1991 4. Chapter 7, Human Performance Enhancement, from Madni 2018 <p><i>Homework #3 Due by 3:30 PM Monday Oct 1, 2018 Pacific Time Homework #4 Assigned</i></p>
Oct 8	7. Modeling, Simulation, and Prototyping	<ol style="list-style-type: none"> 1. Chapter 3 from Rehtin 1991 2. Chapter 5 from Madni 2018 <p><i>Homework #4 Due by 3:30 PM Monday Oct 8, 2018 Pacific Time</i></p>
Oct 11-14	Midterm Exam	<i>2 hour 40 minute timed exam at any time of your choice between October 11 at 6 AM and October 14 Midnight (Pacific Times)</i>
Oct 15	8. Cyber-Physical Systems	<ol style="list-style-type: none"> 1. Madni, A.M., Madni, C.C. and Sievers, M. "Adaptive Cyber-Physical-Human Systems," 2018 INCOSE International Symposium, July 7-12, 2018.
Oct 22	9. Systems Architecting and Political Process	<ol style="list-style-type: none"> 1. Chapter 12 from "Art of Systems Architecting" by Maier, M., & Rehtin, E, SECOND Edition.

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2018	Lecture Topics	Readings
Oct 29	10. Systems Architecting, Complexity and Complex Systems	1. Section 2.2.7 from Madni 2018
Nov 5	11. Special Topics - Guest Lecture	(none)
Nov 12	12. Special Topics - Guest Lecture	(none)
Nov 19	13. Case Study and Homework Review	(none)
Nov 26	14. Course Review	<ol style="list-style-type: none"> 1. Madni, A.M. and Sievers, M. "Systems Integration: Key Perspectives, Experiences, and Challenges," 2013 2. Madni, A.M., and Sievers, M. "System of Systems Integration: Key Considerations and Challenges." <i>Systems Engineering</i> (2013). 3. Chapter 16 from Rechtin 1991 4. Chapter 11 from Madni 2018
Dec 3	Study Days	(no lecture this day)
Dec 10	Final Exam Week (no exam)	(no lecture this day) <i>Final Term Paper Due by Midnight December 10, 2018 Pacific Time</i>