

## SYLLABUS

SAE 549: Systems Architecting

Spring 2018

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

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

### **Contact Information:**

Instructor: Kenneth Cureton  
Office hours: Monday 1:00 PM – 3:00 PM  
Office location: RAN 215  
Office phone: 213-740-1713  
E-mail: [cureton@usc.edu](mailto:cureton@usc.edu)

Teaching Assistant: Edwin Ordoukhanian  
Office hours: Wednesday 12:00 – 2:00 PM  
Office location: RRB 227 & Virtual  
Office phone: 213-740-1713  
E-mail: [Ordoukha@usc.edu](mailto:Ordoukha@usc.edu)

*\* The office hour will be online as well as in-person. BlueJeans log in information will be posted on D2L. Both on campus and off-campus students are encouraged to call in during office hours if they have questions.*

Kindly use office hours and/or use online discussion boards (available on D2L) if you have any questions on the course materials, mid-term, or final paper. The turnaround time to answer questions on discussion board is 24 hours. The use of email (to the TA and instructor) should be limited to emergency situations. The TA will consult with the instructor before responding.

### **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://www.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 Text:
  - Madni, A.M., "Transdisciplinary Systems Engineering: Exploiting Convergence in a Hyper-Connected World," Springer 2018 *Note: you can download this book through USC Libraries for free.*

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- Bahill, T. A., Madni, A.M., “Trade-off Decisions in Systems Design” Springer, 2017. *Note: you can download this book through USC Libraries for free.*
- Recommended Reading:
  - Maier, M., & Rechtin, E. (2009). The art of systems architecting (3rd ed.). Boca Raton, FL: CRC Press ISBN: 978-1-4200-7913-5
  - Nadler, G., & Chandon, W. (2004). Smart questions: Learn to ask the right questions for powerful results (1st ed.). San Francisco, CA:Josey-Bass ISBN: 978-0787971373

### Grade

Your grade will be based on:

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

### 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 previous lectures and assigned readings. This will be a timed exam (2 hours and 40 minutes). The exam will be available on D2L between **Thursday March 8, 2018** and **Saturday March 10, 2018**.
- **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 system (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  
February 12, 2018 3:30 PM on your chosen system.***

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

- Automated (Self-Driving) Cars
- Smart phones or smart tablet computers
- Passenger Aircraft
- Space Telescopes
- Robotic Systems
- Manned Space Transport
- Airborne Platforms (Fighter /Bomber aircraft/helicopter/Unmanned Aerial Vehicles)

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

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

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**DEADLINE:** Term papers are due on **April 27, 2018 at 11:59 PM**. *No late papers will be accepted after the due date and time, and the student will receive an automatic F grade for 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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**SAE 549: Systems Architecting**

**Spring 2018**

**Schedule of Class Sessions:** Any changes will be announced.

2018	Lecture Topics	Readings
Jan 8	1. Intro to SAE Program, the course, the instructor, and systems architecting	<ol style="list-style-type: none"> <li>1. "Preface" from Rechtin, 1991</li> <li>2. Chapter 1,2, and 3 from Rechtin, 1991</li> <li>3. Chapter 1 from Madni 2018</li> </ol>
Jan 15	University Holiday	
Jan 22	2. System Architecture and Architectural Frameworks	<ol style="list-style-type: none"> <li>1. Chapter 6 from Madni 2018</li> <li>2. Chapter 15 from Rechtin 1991</li> </ol> <p><b><i>Submit student bio by 12:00 noon Monday Jan 22 2018</i></b>  <b><i>Homework #1 Assigned</i></b></p>
Jan 29	3. Architecture Trade-off Analysis	<ol style="list-style-type: none"> <li>1. Madni, A.M., Ross, A. "Exploring Concept Trade-offs," Chapter 10 in "Trade-off Analytics," Eds Parnell G., Wiley 2016</li> <li>2. Ordoukhanian, E, Madni, A.M., "System Trade-offs in Multi-UAV Network", AIAA Space 2015, August 31-Sep 2, 2015, Pasadena, CA (<i>Google Scholar</i>)</li> <li>3. Section 2.3 from Bahill &amp; Madni 2017</li> <li>4. Chapter 5 from Bahill &amp; Madni 2017</li> <li>5. Chapter 6 from Madni 2018</li> </ol> <p><b><i>Homework #1 Due by 3:30 PM Monday Jan 29, 2018</i></b>  <b><i>Homework #2 Assigned</i></b></p>
Feb 5	4. Systems Thinking	<ol style="list-style-type: none"> <li>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. (<i>Google Scholar</i>)</li> <li>2. Chapter 2 from Madni 2018</li> </ol> <p><b><i>Homework #2 Due by 3:30 PM Monday Feb 5, 2018</i></b></p>
Feb 12	5. Heuristics	<ol style="list-style-type: none"> <li>1. Appendix A from Rechtin 1991</li> <li>2. Section 2.4 from Bahill &amp; Madni 2017</li> </ol> <p><b><i>Submit abstract by 3:30 PM Monday Feb 12, 2018</i></b>  <b><i>Homework #3 Assigned</i></b></p>
Feb 19	University Holiday	
Feb 26	6. Human-System Integration: Implications for Systems Architecting	<ol style="list-style-type: none"> <li>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." (<i>Google Scholar</i>)</li> <li>2. Madni, A. M. 2010. Integrating Humans With Systems and Software: Technical Challenges and Research Agenda. <i>Systems Engineering</i>, 13(3): 21.</li> <li>3. Chapter 11 from Rechtin 1991</li> <li>4. Chapter 7, Human Performance Enhancement, from Madni 2018</li> </ol> <p><b><i>Homework #3 Due by 3:30 PM Monday Feb 26, 2018</i></b>  <b><i>Homework #4 Assigned</i></b></p>
Mar 5	7. Modeling, Simulation, and Prototyping	<ol style="list-style-type: none"> <li>1. Chapter 3 from Rechtin 1991</li> <li>2. Chapter 5 from Madni 2018</li> </ol> <p><b><i>Homework #4 Due by 3:30 PM Monday March 5, 2018</i></b></p>
Mar 12	Spring Break	
Mar 19	8. Systems Architecting and Political Process	<ol style="list-style-type: none"> <li>1. Chapter 12 from Art of Systems Architecting by Maier, M., &amp; Rechtin, E, SECOND Edition. Available for free download through USC libraries.</li> </ol>

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Mar 26	9. Systems Architecting, Complexity and Complex Systems	1. Section 2.2.7 from Madni 2018
Apr 2	10. Special Topics - Guest Lecture	
Apr 9	11. Special Topics - Guest Lecture	
Apr 16	12. Case Study and Homework Review	
Apr 23	13. Course Review	<ol style="list-style-type: none"> <li>1. Madni, A.M. and Sievers, M. Systems Integration: Key Perspectives, Experiences, and Challenges, 2013</li> <li>2. Madni, A.M., and Sievers, M. "System of Systems Integration: Key Considerations and Challenges." <i>Systems Engineering</i> (2013).</li> <li>3. Chapter 16 from Rehtin 1991</li> <li>4. Chapter 11 from Madni 2018</li> </ol> <p style="color: red; margin-top: 0;"><b>Final Term Paper Due by 11:59 PM April 27, 2018</b></p>

### Assigned Readings List

You can download these papers from 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
- Simon, H. A. 1976. How Complex are Complex Systems? PSA: Proceedings of the Biennial Meeting of the Philosophy of Science Association, 1976: 507-522.
- 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, Azad M. "Elegant systems design: Creative fusion of simplicity and power." *Systems Engineering* 15.3 (2012): 347-354.
- Madni, Azad M., et al. "Toward an Experiential Design Language: Augmenting Model-based Systems Engineering with Technical Storytelling in Virtual Worlds." *Procedia Computer Science* 28 (2014): 848-856.
- Madni, Azad M. "Expanding Stakeholder Participation in Up-front System Engineering through Storytelling in Virtual Worlds." *Systems Engineering* 18.1 (2015): 16-27.
- 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).
- Simon, H. A. 1962. *The Architecture of Complexity*. Proceedings of the American Philosophical Society, 106(6): 467-482.
- Madni, A.M., Ross, A. "Exploring Concept Trade-offs," Chapter 10 in "Trade-off Analytics," Eds Parnell G., Wiley 2016