

## SYLLABUS

**SAE 549: Systems Architecting**

**Summer 2017**

**Class Session:** Tuesday, 6:00 PM – 9:10 PM PDT, OHE 120

**Class Section:** 32322D (DEN/Off-campus) and 32349R (On Campus)

### **Contact Information:**

Instructor: Mr. Kenneth L. Cureton

Office hours: Tuesday, 3-to-5 PM PDT, virtually\*

Office location: RAN 215

Cell phone: (714)-342-7818

E-mail: Cureton@usc.edu

Teaching Assistant: Edwin Ordoukhanian

Office hours: Tuesday, 3-to-5 PM PDT, virtually\*

Office location: RAN 215

Cell phone: (818)-720-2682

E-mail: Ordoukha@usc.edu

We encourage you to e-mail us if you have any questions or difficulties in understanding course materials. The turnaround time for emails is typically 24 hours. If you don't hear from us within that timeframe, please send us a reminder. Always include the TA in any email sent to the instructor.

\* Virtual office hours via Bluejeans on-line conferencing system.

### **Course Learning Objectives:**

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

### **Readings and Notes:**

- Weekly lecture notes will be posted on the Desire to Learn (<http://www.courses.uscden.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:
  - 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 Readings:
  - 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

### **Class Grade:**

Your grade will be based on two exams and one final research paper. All exams will be administered via Desire 2 learn on the USC Distance Education Network. Each exam will account for 30% of your final grade. The final research paper will account for 40% of your final grade.

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### Exams:

- The exams will consist of multiple questions that will test students' knowledge about the fundamentals of systems architecting, complex systems, and systems thinking. These exams will cover the three lectures and assigned readings prior to the exam. These will be open book, take-home exams over a four-day period. The first midterm can be downloaded, completed, and submitted to Desire2Learn anytime between **Friday June 16, 2017 6:00 AM and Monday June 19, 2017 11:59 PM**. The second midterm can be downloaded, completed, and submitted to Desire2Learn anytime between **Friday July 14, 2017 6:00 AM and Monday July 17, 2017 11:59 PM**.
- You *are not allowed* to collaborate on the exams. You *are not allowed* to copy-and-paste from the readings, publications, any other Internet sources, or the course materials-- all exam answers must be in your own words. The default punishment for unauthorized collaboration, cheating, and plagiarism on the exams is a grade of 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 for selection choices) in terms of any or all of the class concepts presented in lectures. Your analysis should discuss how the architecting process led to the architecture. The architecting process should address the key tradeoffs, the steps taken, the questions asked, the people involved, the options generated, the decisions made, and any heuristics used.*

The student can choose any ONE of the following systems, with focus on the Architecture:

- Automated (Self-Driving) Cars (recommend Google Car or BOSS)
- Electric Cars (recommend GM EV1 or Tesla S, or Hybrid such as Toyota Prius)
- Residential or Commercial Alternative Electric Power Generation (recommend Solar)
- Dam Projects (recommend Hoover/USA or 3 Gorges/China or Sardar Sarovar/India)
- iPhone or iPad or iPod
- High-Speed Rail System (recommend California)
- Large Passenger Aircraft (recommend Boeing 787, 777, 747, or Airbus A380, A350)
- Concorde Supersonic Passenger Jet
- Hubble Space Telescope or James Webb Space Telescope
- Mars Rover (recommend Curiosity)
- Apollo Manned Space or Space Shuttle System
- International Space Station
- F-117, F-15, F-16, F-18, F-22 or F-35 Aircraft (any ONE configuration)
- Global Hawk Drone
- GPS Navigation Satellite System
- B-2 or B-52 Bomber
- SR-71 Blackbird Aircraft
- V-22 Tiltrotor
- Apache AH-64 Helicopter
- Future Combat System (FCS)
- Zumwalt-class destroyer or DD-21 or DD(X)

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**LENGTH:** The term paper should be between 6-8 pages (excluding references and appendices, and cover page), single-spaced, in 12-point type. The term paper is due on or before **August 8 2017 at 11:59 PM.**

**DELIVERY:** The term paper must be submitted through the Desire to Learn (D2L) system. Links for submitting the assignments will be available under the “Assignment” section of D2L (<http://courses.uscden.net>).

**GRADING:** Each term paper will be graded on the letter scale: A, A-, B+, B, B-, etc. Your paper grade will require writing a paper that would be instructive or of general interest to systems architects, including those who may not be necessarily interested in the particular system you analyze.

**LATENESS:** Term papers are due on **August 8 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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**Schedule of Class Sessions:** The exact schedule is subject to change. Dates of readings may change to align with other schedule adjustments. Changes will be announced.

2017	Lecture Topics	Readings
<b>May 23</b>	1. Intro to SAE Program, the course, the instructor, and systems architecting	<ol style="list-style-type: none"> <li>1. “Preface” of Rechtin, 1991</li> <li>2. Chapter 1,2, and 3 of Rechtin, 1991</li> </ol>
<b>May 30</b>	2. System Architecture: Key Perspectives and Concepts	<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. (Google Scholar)</li> <li>2. Chapter 15 from Rechtin 1991</li> </ol> <p style="color: red; margin-top: 0;"><b><i>Submit student biography before class starts</i></b></p>
<b>Jun 6</b>	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 of Bahill &amp; Madni 2017</li> <li>4. Chapter 5 of Bahill &amp; Madni 2017</li> </ol>
<b>Jun 13</b>	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. (Google Scholar)</li> </ol>
<b>Jun 16 Jun 19</b>	<i>First Midterm</i>	<b><i>Take-home exam covering Lecture topics 2, 3, and 4-- Friday June 16 at 6:00 AM PDT through Monday June 19 at 11:59 PM PDT</i></b>
<b>Jun 20</b>	5: Heuristics	<ol style="list-style-type: none"> <li>1. Appendix A of Rechtin 1991</li> <li>2. Section 2.4 of Bahill &amp; Madni 2017</li> </ol>
<b>Jun 27</b>	6: Systems Architect and Complex Systems	<ol style="list-style-type: none"> <li>1. Ch 1, 2, and 14 from Rechtin, 1991.</li> <li>2. Simon, H. A. 1962. The Architecture of Complexity. <i>Proceedings of the American Philosophical Society</i>, 106(6): 467-482.</li> <li>3. Simon, H. A. 1976. How Complex are Complex Systems? PSA: <i>Proceedings of the Biennial Meeting of the Philosophy of Science Association</i>, 1976: 507-522.</li> </ol>
<b>Jul 4</b>	University Holiday	
<b>Jul 11</b>	7. 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.” (Google Scholar)</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> </ol>
<b>Jul 14 Jul 17</b>	<i>Second Midterm</i>	<b><i>Take-home exam covering Lecture topics 5, 6, and 7—Friday July 14 at 6:00 AM PDT through Monday July 17 at 11:59 PM PDT</i></b>

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<b>Jul 18</b>	8. Impact of Political Processes on System Architecture	To Be Announced (from www.skit.com SAE 550 links)
<b>Jul 25</b>	9. System Architecting Leadership & Risk Management	To Be Announced
<b>Aug 1</b>	10. System Architecting in Different Industries & Domains	To Be Announced: Architecting examples/differences/commonalities of different domains (e.g. Healthcare, Automotive, Aerospace, Energy Grid)
<b>Aug 8</b>	11. Course Review	<ol style="list-style-type: none"> <li>1. Madni, A.M. and Sievers, M. <i>Systems Integration: Key Perspectives, Experiences, and Challenges</i>, 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 Rechtin 1991</li> </ol> <p style="color: red; margin-top: 5px;"><b><i>Submit Research Paper by 11:59 PM PDT</i></b></p>

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### 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