

SYLLABUS

SAE 549: Systems Architecting

Spring 2024

Class Session: Monday, 4:00 pm – 6:40 pm

Class Section: 32319D (DEN/Off-campus) and 32349D (On Campus OHE100D)

Contact Information:

Instructor: Dr. Robert Joseph Minnichelli
Office hours: Virtual, By Appointment Only
E-mail: minniche@usc.edu

Special Guest Lectures by Prof. Ellen
Pawlikowski

Teaching Assistant: Shatad Purohit
Office hours: Virtual, By Appointment Only
Office location: OHE 500
Office phone: 213-421-4860
E-mail: shatadkp@usc.edu

Kindly use online discussion boards (available on D2L) if you have any questions on course materials, mid-term, or final paper. The turnaround time for TA to answer questions is 24 hours.

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 using TRASEE™ education paradigm
- 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, human behavior modeling) relevant to complex systems architecting.
- To introduce the students to key concepts associated with trade-off analysis which are 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 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.*
 - Madni, A.M. *Transdisciplinary Systems Engineering: Exploiting Convergence in a Hyper-connected World*, Springer, 2018
 - Maier, M., & Rechtin, E. (2009). *The art of systems architecting* (3rd ed.). Boca Raton, FL: CRC Press ISBN: 978-1-4200-7913-5
- Recommended Reading:
 - Madni, A.M. and Augustine, N(Eds.) *Handbook of Model Based Systems Engineering*, Springer, 2023

Grade

Your grade will be based on one exam (will account for 40% of your final grade) *and* a final term paper

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(which will account for the remaining 60% of your final grade). The exam will be administered online through Desire 2 learn.

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 administered on **Monday April 01, 2024**.
- **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 as a case study. 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, the outcomes and implications for the future.

Submit a maximum 1-page draft abstract by March 04, 2023, 3:30 PM on your chosen topic.

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

- Autonomous Systems
- 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 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 **April 26, 2023, 3:30 PM**.

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>).

LATENESS: Term papers are due on **April 26, 2023, 3:30 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

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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 likely to change, based on availability of guest lecturers. Dates of readings may change to align with other schedule adjustments. Changes will be announced.

2024	Lecture Topics	Readings
Jan 08 Week 1	SAE Program, Course Overview, and Intro to Systems Architecting Part 1	<i>Submit student bio by Sunday Jan 14, 2024 11:59 PM</i> -Preface, Introduction, Chapters 1-4, and Case Study 1: DC-3 from Maier and Rechtin 2009
Jan 15 Week 2	University Holiday – No Class	
Jan 22 Week 3	Intro to Systems Architecting Part 2	-Chapter 1 from Madni 2018 - Madni, A.M. Generating Novel Options During Systems Architecting: Psychological Principles, Systems Thinking, and Computer-Based Aiding,” Systems Engineering, Volume 17, Number 1, pp. 1-9, 2014.
Jan 29 Week 4	Architecture Tradeoff Analysis and Ontology Enabled Systems Architecting	-Madni, A.M., and Ross, A. “Exploring Concept Trade-offs,” Chapter 10 in “Trade-off Analytics,” Eds Parnell G., Wiley 2016 -Chapter 5 of Bahill and Madni 2017
Feb 5 Week 5	Role of Heuristics in Systems Architecting	-Chapter 2 (review) and Appendix A from Maier and Rechtin 2009 -Section 2.4 from Bahill and Madni 2017 -Section 8.6 from Madni 2018
Feb 12 Week 6	Human-System Integration: Implications for Systems Architecting	- Chapter 7 from Madni 2018 - A. M. Madni, M. Sievers, and C. C. Madni, “Adaptive Cyber-Physical-Human Systems: Exploiting Cognitive Modeling and Machine Learning in the Control Loop,” Insight (International Council on Systems Engineering), vol. 21, no. 3, pp. 87–93, 2018, doi: 10.1002/inst.12216.
Feb 19 Week 7	University Holiday – No Class	
Feb 26 Week 8	Guest Lecture – Ontology-Enabled Hardware-Software Testbed for Engineering Adaptive Systems <i>Dr. Edwin Ordoukhanian</i>	-E. Ordoukhanian,, A.M. Madni; (2022). Ontology-Enabled Hardware-Software Testbed for Engineering Adaptive Systems. In: Madni, A.M., Boehm, B., Erwin, D., Moghaddam, M., Sievers, M., Wheaton, M. (eds) Recent Trends and Advances in Model Based Systems Engineering. Springer, Cham. https://doi.org/10.1007/978-3-030-82083-1_16
March 04 Week 9	Guest Lecture: Case Study – TBD <i>Prof. Ellen Pawlikowski</i>	<i>Submit drafty abstract by 3:30 PM Friday March 8, 2024</i> -Chapter 3 (review), Chapter 7, and Case Study 5: The Global Positioning System, and Chapter 13 from Maier and Rechtin 2009
March 11	University Holiday – No Class	Spring Recess
March 18 Week 10	Guest Lecture: Case Study – TBD <i>Prof. Ellen Pawlikowski</i>	-Chapter 5, Chapter 6, Chapter 12, and Case Study 3: Intelligent Transportation Systems from Maier and Rechtin 2009

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<p>March 25 Week 11</p>	<p>Guest Lecture: Model-Based Systems Architecture using Dependency Structure Matrix <i>Shatad Purohit</i></p>	<p><i>Submit outline of paper by 3:30 PM Monday March 25, 2024</i></p> <ul style="list-style-type: none"> - Part III Introduction, Chapter 8 from Maier and Rechtin 2009 - A. M. Madni and M. Sievers, "Model-based systems engineering: Motivation, current status, and research opportunities," Systems engineering, vol. 21, no. 3, pp. 172–190, 2018, doi: 10.1002/sys.21438. - S. Purohit and A. M. Madni, "A Model-Based Systems Architecting and Integration Approach Using Interlevel and Intralevel Dependency Matrix," IEEE systems journal, vol. 16, no. 1, pp. 747–754, 2022, doi: 10.1109/JSYST.2021.3077351.
<p>April 1 Week 12</p>	<p>Midterm</p>	
<p>April 8 Week 13</p>	<p>Architecting Resilient Systems and System-of-Systems</p>	<p>Chapter 9 from Madni 2018</p>
<p>April 15 Week 14</p>	<p>Transdisciplinary Systems Engineering</p>	<ul style="list-style-type: none"> - A. M. Madni, "Transdisciplinary Systems Engineering: Exploiting Disciplinary Convergence to Address Grand Challenges," in IEEE Systems, Man, and Cybernetics Magazine, vol. 5, no. 2, pp. 6-11, April 2019, doi: 10.1109/MSMC.2019.2899957. - Chapter 5 of Madni, A.M. Transdisciplinary Systems Engineering: Exploiting Convergence in a Hyperconnected World, Springer 2018
<p>April 22 Week 15</p>	<p>Course Review</p>	
<p>April 26</p>	<p>Final Papers Due at 3:30 PM</p>	