PROGRAM ASSESSMENT COLUMN REPORT

Program - Systems Engineering (MS)

Program Information

Program General Information

Mission Statement

The mission of the MS program in Systems Engineering is to equip students to design, produce, deploy, operate, maintain, refine, and retire systems, considering multiple objectives and constraints from diverse stakeholder groups. Graduating students are expected to apply a combination of theories and tools, carried out through a suitable methodology and a set of system management procedures, to address real world problems that are often of large scale and scope. The program emphasizes both analytical and practical aspects of engineering complex systems. Students are expected to demonstrate proficiency in several quantitative modeling disciplines. Graduates will contribute to the engineering of large-scale systems (transportation, energy, health, etc.), considering diverse stakeholder needs, in support of Mason's mission of creating a more just, free, and prosperous world. Stakeholders of the program include students, alumni, employers, and faculty.

College/School

College of Engineering and Computing

Department/Division

Systems Engineering and Operations Research

Graduates of the MS-SE will be able to: model and analyze real life systems, by formulating the analysis questions of interest, selecting suitable analysis methods, and employing state-of-the-art software tools to carry out the tasks.

Student Learning Outcome Label: SLO1 Modeling and Analysis
Outcome Status: Active
Assessment Period(s): 2022 - 2023
Is this Student Learning Outcome tied to an external accreditation standard?: No

Assessment Method	Findings and Improvements
Assessment Measure: Direct Measure	**Findings Date**: 09/30/2023

Description of Assessment Measure: SYST 621 has the following learning objectives: " ability to apply Model-Based & Architecture-Based Systems Engineering (MBSE/ABSE) concepts in support of an architecture design problem " working knowledge of architecture design methodologies " employing simulation support for architecture design " ability to evaluate and analyze design solutions via simulations and engineering analyses Student evaluation criterion is given as: Midterm 40%, Project 60% The midterm is a written, open-book examination at a scheduled date/time. The examination does not require proctoring. The midterm exam questions cover the material presented in class lectures, test student understanding of MBSE concepts, and their skills in employing a software tool to design a solution architecture. As for the project component of the evaluation, students are required to form teams for a design project. A team can have a maximum of two (2) members. A list of example design problems is also provided for them to make a selection. Students may propose their own problem(s) to solve. During the first few weeks of the course, each team is required to present their selected design problem by providing the following: " A unique title to the project " A brief problem statement of the Purpose of the proposed architecture design; specific problem that will be solved or set of questions that will be answered, and analyses that would be carried " The Vision statement for the chosen problem " The Point of View that will be used to represent the architecture " The high-level Operational Concept graphic	**Findings**: Fourteen students (i.e., 7 in Fall 2021 and 7 in Fall 2022) were assessed. Thirteen students were competent or higher (~93%). The following is the feedback received from the invited judges in addition to the project evaluations performed by them: “Maybe it’s a bias from being in the class last year, but the models seemed much more in depth this year, especially the simulations. Not sure if it was a change in your instruction, the students, or both&but I was honestly impressed. That&and the simulations all worked too, which was the most frustrating part for me.” --Tim Lockhart "That was an impressive showing. Your course material is definitely setting these students up for success. I have come across few modelers who know these skills. I think this shows the usefulness of your coursework over just watching youtube like we learned. Thanks for the invite!" --Greg Mowles “Thanks very much for the invitation. Today is the first time I have seen a very powerful implementation with CSM for SE analysis. We really need to promote this more as I think it is very valuable in the SE community. I suspect many MS students from other universities do not get this experience. I wanted to discuss a couple of items with you: " Are all the models built from scratch in this course or they are carrying over from previous courses. Reason I ask is some models (e.g., drone SAR) had a lot of detail in it. " Is the Drone SAR mode shareable. I would like to show this our Navy sponsor as example of what analysis can be done with a systems architecture. I occasionally get a push back from someone in the audience that SysML is for diagraming.” --Ali Raz **Reporting Period**: 2022 - 2023 **Conclusion**: Target Met **Individual(s) Responsible for Assessment**: Each student is responsible for taking the midterm exam, submitting the required project files, and presenting the results to the class. The instructor is responsible for assessing the student's deliverables in meeting the assessment **Number of Students Assessed**: 14 **ACTIONS & IMPROVEMENT PLANS** **Past Improvements**: None **Future Improvements**: The instructor will continue to highlight the requirements of the design project and provide past example architectures for students to use as a reference. The instructor will continue to work with the project teams throughout the term. The expectations and rubrics

with narrative A couple of weeks after finalizing the teams and the design projects, students are required to develop two to four Main Success Scenarios that cover some aspects of the problem. They are specifically asked not to increase the number of Use Cases or make them too detailed/complicated. A developed Use Case should go from the beginning to the end of a process. At this point, students start implementing their project models using industrial-strength MBSE software tools, e.g., Magic System of Systems Architect (formerly known as Cameo System Modeler). Their initial design consists of the following views: " Use Case diagram(s) " High-level Activity diagrams elaborating Use Cases. Students are required to simulate the Activity diagrams to validate the scenarios " A structural view (i.e., BDD) with the structural elements that (at some level of abstraction) would support the activities or actions in the activity view(s). Students present the above material in an in-class presentation session where instructor and the other student members provide their feedback and ask questions if any. This session is followed by one more in-class progress presentation by the project teams to report progress made and to discuss any issues/difficulties encountered. The team projects are finally evaluated in an in-class presentation session scheduled on final exam date/time. The evaluations are done collectively by instructor and by other teams. For Fall 2022 session, a group of external evaluators were also invited and provided with evaluation forms to fill out. The following were the judges with their affiliations: " Tim Lockhart, Defense Advanced Research Projects Agency " Greg Mowles, The Aerospace Corporation	used to grade the project work will be provided to students at the beginning of the course. The instructor will also continue to invite experts/professionals from industry and academia to get their useful feedback on the course contents and student performance

" Dr. Ali Raz, SEOR Department, GMU Each project team is required to develop a solution architecture using the software application and present their results using the architectural views (PowerPoint presentation are not encouraged.) Students are provided with the following list of items to be emphasized in their project presentations. The judges are also provided with this list. " Architectural views/diagrams: requirements (if developed), structural, and behavioral " Integration of views: project team should be able to demonstrate how model elements (including relationships) connect structural and behavioral aspects. For example, operations defined in a block are used as actions or effects in behavioral diagrams " A Content diagram (a UML diagram) to represent the architecture views and their relationships. This may also include details of scenarios, notes on the simulations performed to obtain the values of items needed to calculate MoPs, and some discussion on the feasibility of results obtained " Analysis views containing both models and results of the analysis/simulations " In case of requirements, use of satisfy, verify, etc. relationships to model elements. Project teams may include dependency and requirement matrices to present this information " Descriptive notes on diagrams with details on design elements and the relationships. Project work is evaluated on a 100-point scale. Points are awarded given the following distribution: " Model/Architecture Description – 30 points This should include: o A clear description of the system being modeled o A clear operational concept with system boundary o An overall view of the structure and	

behavior with the help of model elements/diagrams (e.g., a content diagram) o Clear, adequate and integrated views and their organization. " Analysis & Simulation Results – 50 points This should include: o A clear definition of analysis problem/questions o Suitability of the model for the analysis problem o Clear and adequate analysis views o Demonstration of analysis views yielding desired results o Some discussion on lessons (both positive and/or negative) learned in terms of validity of results, effectiveness of the approach/tool used, etc. " Presentation– 20 points In addition, the following rubric is used to evaluate student performance in one of the following three categories: " Excellent: Student project proposal, report, and presentation address all pertinent issues in a coherent, cogent, persuasive, professional way. " Competent: Student project proposal, report, and presentation address all pertinent issues but the model, analysis performed, and/or presentation can be further improved to be more coherent, cogent, persuasive, or professional. " Needs work: Student project proposal, report, and presentation lack professionalism. The presentation is incoherent, grammatically challenged, or not cogent The assessment takes place in the course SYST 621 Systems Architecture Design, which is offered in the fall and spring semesters. The course covers approaches based on system engineering constructs such as object orientation and service oriented architectures and how they are used to design architectures and then represent them in	

Assessment Method	Findings and Improvements
conformance with an architecture framework such as DoDAF. The outcome is measured from a combination of written exam and a development of a solution architecture using an industry-standard software design tool. Approximately 5-15 students enroll in this class per semester **Assessment Status:** Active **Achievement Target:** We expect that at least 85% of students enrolled in SYST 621 will be competent or highly competent in the specified rubric	

Graduates of the MS-SE will be able to: design a system, component or process to meet the needs of its users and all stakeholders.

Student Learning Outcome Label: SLO2 Design
Outcome Status: Active

Graduates of the MS-SE will be able to communicate effectively in professional presentations.

Student Learning Outcome Label: SLO3: Oral Communication
Outcome Status: Active

Graduates of the MS-SE will be able to communicate effectively in written professional reports.

Student Learning Outcome Label: SLO-4 Written Communication
Outcome Status: Active

Graduates of the MS-OR Program will be able to solve a real-life, unstructured, complex, interdisciplinary problem within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability, by interacting with the stakeholders, defining the problem, collecting data, providing alternative solutions , performing analysis, validating their results and making well-justified recommendations.

Student Learning Outcome Label: SLO-5 Completion of Complex Projects
Outcome Status: Active