– Systems Engineering & Technical Management –
2019-2020 Assessment Report

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Contents

1 Introduction

1.1 Program Goals and Design

The Systems Engineering & Technical Management (SEM) program is designed as both a dual major option for students with an ABET accredited primary major in an engineering discipline offered at Oregon Tech and as a MS Engineering focus specialty. Students first choose a primary ABET accredited major (e.g., Electrical Engineering, Renewable Energy Engineering, Mechanical Engineering), and complete additional specialized coursework to earn a second major in Systems Engineering & Technology Management. The program is designed so that both majors in the degree can be completed in 4 years by taking summer courses. ABET ETAC degree students may also pursue the dual major with departmental approval.

The purpose of the SEM program is to prepare graduates who can address complex problems in areas such as electrical and electronic systems, information systems, renewable energy systems, economic and financial systems, telecommunications, transportation, project management, and manufacturing. Systems engineering is not about specific technologies, but how to put heterogeneous technologies together to formulate system solutions to complex problems. As such, systems engineering is a multidisciplinary engineering discipline concerned with the design, modeling, analysis, and management of technological systems that employ a combination of devices, software, hardware, firmware, materials, and humans for such diverse purposes as communications, energy engineering, health care, transportation or manufacturing. The dual major and MS specialty curriculums provide engineering students with design viewpoints and methodologies that emphasize system integration, and with subject matter and tools for modeling and analysis especially appropriate for large complex systems, including system theory, simulation, computational data analysis and statistics, and engineering management

Graduates of the dual degree program and MS SEM specialty are technically competent in an engineering discipline, but also have formal education, training and skills in systems engineering, project management, product development, strategy and innovation, as well as engineering management. This combined training makes them ideal candidates to assume functional managerial positions, such as project managers and technical team leaders.

The dual major in Systems Engineering & Technical Management and MS SEM specialty are both offered fully online.

1.2 Program Brief History

The DMSEM program was developed in response to requests from local industry. The Industry Advisory Boards of the EERE Department had recommended adding Systems Engineering coursework since 2008, based on the emerging need for systems engineers. At the time this program was initially developed (2013), there were 19 Systems Engineering BS degree programs in the US. None of these degrees were available in the State of Oregon. Due to the lack on systems engineering education in the state and the need for this skillset, the Engineering and Technology Industry Council (ETIC) committed $195,000 for Oregon Tech to develop and launch a dual major in this technical field. The program was approved by the Curriculum Planning Commission in February 2014, and was launched in Fall 2014. The MS Eng SEM specialty was offered starting 2017, with courses cross-listed between the two programs (i.e. DS SEM and MS Eng. specialty).

2 Program Mission, Educational Objectives, and Outcomes

2.1 Program Mission

The mission of the DMSEM and MS Eng. SEM specialty is to equip graduates with the knowledge and skills to address complex multidisciplinary problems involving the design, modeling, analysis, and management of technological systems that employ a combination of devices, software, hardware, firmware, materials, and humans for such diverse purposes as communications, energy engineering, health care, transportation or manufacturing. The dual major and graduate curriculum provides engineering students with design viewpoints and methodologies that emphasize system integration, and with subject matter and tools for modeling and analysis especially appropriate for large complex systems including system theory, simulation, computational data analysis and statistics, and engineering management.

2.2 Program Educational Objectives for DMSEM

The SEM dual major requires students to complete an ABET-accredited engineering major as a primary major (e.g., BSEE, BSREE, etc.). In addition to the Program Educational Objectives of the primary major, the additional Program Educational Objectives for the SEM program are:

- PEO1: Graduates of the program will excel as professionals in the various fields of engineering.
- PEO2: Graduates of the program will demonstrate an ability to apply systems thinking and systems engineering methods to the solution of complex problems involving one or more engineering disciplines.
- PEO3: Graduates of the program will demonstrate an ability to manage technical projects in multidisciplinary teams, and will excel in problem solving, and effective communication.

2.3 Relationship Between Program Educational Objectives and Institutional Objectives

The SEM dual major and MS Eng. SEM specialty is closely aligned with the university's mission of providing "innovative and rigorous degree programs" in technically-related fields "with an emphasis on application of theory to practice." It also supports the mission of the college of ETM to "educate leaders in the fields of engineering, technology, and management."

2.4 Student Outcomes

The SEM dual major requires students to complete an ABET-accredited engineering major (e.g., BSEE, BSREE, etc.). In addition to the ABET-EAC (a) through (k) Student Outcomes (assessed in the primary major), students pursuing the dual major in SEM must meet an additional SEM specific Student Outcome:

a an ability to apply systems engineering methods to practical problems involving one or more engineering disciplines

b knowledge and understanding of project management techniques and frameworks

3 Cycle of Assessment for Program Outcomes

3.1 Introduction and Methodology

The SEM specific Student Outcomes are covered in the three courses listed below, included as degree requirements in the SEM dual major program. The courses where assessment is performed are indicated with an asterisk (*). Outcome (a) is assessed in SEM421, and outcome (b) is assessed in SEM422. For the purposes of assessment metrics, SEM 521 and SEM 522 students are included in the numbers as the courses are cross-listed and specific deliverables related to this assessment are identical.

- SEM421 Systems Engineering, SEM521 Systems Engineering *
- SEM422 Advanced Systems Engineering, SEM522 Advanced Systems Engineering *
- SEM425 Advanced Management for Engineers, SEM525 Advanced Management for Engineers

3.2 Assessment Cycle

Given that the SEM program is structured as a dual major only, the overall assessment cycle for any program involving a primary engineering major with dual major in SEM would correspond to the combination of the assessment cycle for the primary engineering major and the assessment cycle for the SEM dual major.

Table 1 outlines how the SEM specific student outcomes are integrated into the typical assessment cycle for the other engineering disciplines at Oregon Tech. For each cycle of the particular primary major discipline, please refer to the corresponding Assessment report for that particular discipline.

Table 1: SEM dual major outcome assessment cycle

Outcome	Year 1	Year 2	Year 3
ABET (a) – (k)	As determined by cycle of primary engineering major		
a. Systems Engineering	✓	✓	✓
b. Project Management	✓	✓	✓

3.3 Summary of Assessment Activities & Evidence of Student Learning

3.3.1 Introduction

Formal assessment of the two SEM student outcomes was conducted during the 2019-2020 academic year using direct measures such as course projects and assignments.

In addition to direct assessment measures, the student outcomes (a) and (b) were indirectly assessed through a senior exit survey. Senior exit surveys are conducted every year in the spring term. The indirect assessment data used in the 2019–2020 report was collected after the end of the corresponding assessment year.

3.3.2 Methodology for Assessment of Program Outcomes

At the beginning of the assessment cycle, an assessment plan was generated by the Assessment Coordinator in consultation with the Assessment Handbook. The plan includes the outcomes to be assessed during the particular assessment cycle, as well as the courses and terms in which these outcomes are to be assessed.

The SEM assessment process uses assignments and projects in SEM courses specifically to assess programmatic student outcomes. These assignments are assessed based on rubrics created by Oregon Tech SEM faculty. A systematic, rubric-based process is used to assess the level of attainment of a given program outcome, based on a set of performance criteria. The work produced by each student is evaluated according to the different performance criteria, and assigned a level of 1-developing, 2-accomplished, or 3-exemplary. The results for each outcome are then summarized in a table and reviewed by the faculty at the annual Closing-the-Loop meeting. The acceptable performance level is to have at least 80% of the students obtain a level of accomplished or exemplary in each of the performance criteria for any given program outcome. If any of the direct assessment methods reflects a performance below the established level, that triggers the continuous improvement process, where all the direct and indirect assessment measures associated with that outcome are evaluated by the faculty, and based on the evidence, the faculty decides the adequate course of action. The possible courses of action are:

- Collect more data (if there is insufficient data to reach a conclusion as to whether the outcome is being attained or not); this may be the appropriate course of action when assessment was conducted on a class with low enrollment, and it is recommendable to re-assess the outcome on the following year, even if it is out-of-cycle, in order to obtain more data.

- Make changes to the assessment methodology (if the faculty believe that missing the performance target on a specific outcome may be a result of the way the assessment is being conducted, and a more proper assessment methodology may lead to more accurate numbers); for example, this could be the suggested course of action if an outcome was assessed in a lower-level course, and the faculty decide that the outcome should be assessed in a higher-level course before determining whether curriculum changes are truly needed.

- Implement changes to the curriculum (if the faculty conclude that a curriculum change is needed to improve attainment of a particular outcome). A curriculum change will be the course of action taken when the performance on a given outcome is below the target level, and the evidence indicates that there is sufficient data and an adequate assessment methodology already in place, and therefore there is no reason to question the results obtained.

If the faculty decide to take this last course of action and implement curriculum changes, the data from the direct assessments is analyzed and the faculty come up with a plan for continuous improvement, which specifies what changes will be implemented to the curriculum to improve outcome performance.

In addition to direct assessment measures, indirect assessment of the student outcomes is performed on an annual basis through a senior exit survey.

The results of the direct and indirect assessment, as well as the conclusions of the faculty discussion at the Closing-the-Loop meeting are included in the annual SEM Assessment Report, which is reviewed by the Department Chair and the Director of Assessment for the university. The suggested changes to the curriculum are presented and discussed with all the department faculty at the annual Convocation meeting in Fall, as well as with the EERE Industry Advisory Boards. If approved, these changes are implemented in the curriculum and submitted to the University Curriculum Planning Commission (if catalog changes are required) for the following academic year.

The sections below describe the 2019–20 targeted assessment activities and detail the performance of students for each of the assessed outcomes. The tables report the number of students performing at a developing level, accomplished level, and exemplary level for each performance criteria, as well as the percentage of students performing at an accomplished level or above.

3.3.3 2019-2020 Targeted Assessment Activities

The sections below describe the 2019-2020 targeted assessment activities and detail the performance of students for each of the assessed outcomes. The Tables report the number of students performing at a (1) developing level, (2) accomplished level, and (3) exemplary level for each performance criteria, as well as the percentage of students performing at an accomplished level or above (i.e., 2 or 3).

3.3.4 Targeted Assessment for Outcome a: an ability to apply systems engineering methods to practical problems involving one or more engineering disciplines.

This outcome was assessed in SEM421/521 – Systems Engineering in Fall 2019 by means of a substantial final project which consisted of a presentation and a paper.

For the final project (paper and presentation), students selected a recent article or industry case involving a serious issue related to a product or service pertaining to the course (e.g. defect, technical issue, reliability problem, supply chain problem, etc.). Students analyzed the issue, explored how the problem could have happened, and developed a set of recommendations based on course learning. The project contained a quantitative component (e.g. data analysis, modeling, survey, interviews).

15 students were assessed in Fall 2019 using the performance criteria listed in the table below. The minimum acceptable performance level was to have above 80% of the students performing at the accomplished or exemplary level in all performance criteria.

Table (a)1 summarizes the results of this targeted assessment. Table (a)1 summarizes the results of this targeted assessment. The results indicate that the minimum acceptable performance level of 80% was met on all performance criteria for this program outcome, that is, 80% of students were able to apply systems engineering methods to practical problems involving one or more engineering disciplines.

Table (a)1: Targeted Assessment for Outcome (a)

Outcome (a): an ability to apply systems engineering methods to practical problems involving one or more engineering disciplines				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	%Students >= 2
1 - Knowledge	1	3	11	93%
2 - Application	1	3	11	93%

3.3.5 Targeted Assessment for Outcome b: knowledge and understanding of project management techniques and frameworks

This outcome was assessed in SEM422/522 – Advanced Systems Engineering in Winter 2020 by means of:

Homework #7 involved demonstration of project management knowledge and tools. Students demonstrated knowledge of the following topics: precedence relations, network diagram, critical path analysis, work breakdown structure, resource analysis, project costing, and project scheduling. Students used MS-Project to create project schedules (Gantt chart), resource charts, and analyze precedence relations and critical path.

9 students were assessed in Winter 2020 using the performance criteria listed in the table below. The minimum acceptable performance level was to have above 80% of the students performing at the accomplished or exemplary level in all performance criteria.

Table (b)1 summarizes the results of this targeted assessment. The results indicate that the minimum acceptable performance level of 80% was met on all performance criteria for this program outcome, this is, over 80% of students demonstrated knowledge and understanding of project management techniques and frameworks.

Table (b)1: Targeted Assessment for Outcome (b)

Outcome (b): knowledge and understanding of project management techniques and frameworks				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	%Students >= 2
1 - Knowledge	0	3	6	100%
2 - Application	0	3	6	100%

3.3.6 Indirect Assessment

Indirect assessment of the SEM program specific outcomes is typically conducted via a Senior Exit Survey. Student Exit Survey results for 2019-2020 were published by the Office of Academic Excellence. The Systems Engineering and Technical Management Dual Major scored 100%, “high proficiency” or “very much”, in all ELSOs (Essential Student Learning Outcomes).

4 Changes Resulting From Assessment

This section describes the changes resulting from the assessment activities carried out during the assessment year 2019-2020. It includes any changes that have been implemented based on assessment in previous assessment cycles, from this or last year, as well as considerations for the next assessment cycle.

The SEM faculty reviewed the assessment results to determine whether any changes are needed to the SEM curriculum or assessment methodology based on the results presented in this document. The objective set by the SEM faculty is to have at least 80% of the students perform at the level of accomplished or exemplary in all performance criteria of the assessed outcomes. Table 4 provides a summary of the 2019-2020 assessment results for the outcomes which were directly assessed.

Table 4: Summary of SEM direct assessment for AY2019-2020

	Total Students	Students ≥2	% Students ≥ 2
a - Systems Engineering			
1 - Knowledge	15	14	93.0%
2 - Application	15	14	93.0%
b - Project Management			
1 - Techniques	9	9	100%
2 - Frameworks	9	9	100%

The results show that the threshold of attainment of this outcome was met for outcome (a) and for outcome (b). No changes were suggested by the faculty based on these results.

Appendix A:

SEM422/522 Course Project Rubric

Date Presented: Term: ____________________

Instructor:James Eastham

	1-Developing	2-Competent	3-Exemplary	Score
Organization:	[ ] Missing outline [ ] Missing summary [ ] Does not follow organized pattern	[ ] Well organized [ ] Easy to follow [ ] Contains outline [ ] Contains summary [ ] Follows clear logical pattern	[ ] Competent plus additional organization methods	
Problem Statement	[ ] Poor / Unclear problem statement [ ] Poor / Unclear why problem is important	[ ] Good / Clear Problem Statement OR Why problem is important	[ ] Good / Clear problem statement AND [ ] Good / Clear why problem is important	
Hypothesis & Method	[ ] Poor hypothesis AND [ ] Poor method	[ ] Sound hypothesis OR clear method	[ ] Sound hypothesis AND [ ] Clear method followed to analyze problem	
Problem Summary & Analysis	[ ] Attempts to discuss issues, but fails to recognize any of the key problems of the case.	[ ] Identifies one or more key problems. Provides only a superficial discussion of the problems with no discussion of relevant importance.	[ ] Identifies and thoroughly describes multiple problems; indicates relevant importance among the	
Decision Model Criteria & Formation	[ ] Limited research and documented links to model development	[ ] Good research and links to course learning in model development	[ ] Excellent research into the issues with clearly documented links to model development	
Data Driven Approach:	[ ] Lacks clear methods for data acquisiation, criteria,	[ ] Some examples of how data was acquired for criteria, analysis, model	[ ] Clear use of how data used to drive criteria, analysis, model	
Connections: Theory and Practice:	[ ] Makes little or vague connection between the issue/problem and the theory.	[ ] Makes appropriate and insightful connections between the issue/ problem and the theory.	[ ] Makes appropriate, insightful and powerful connections between the issue/problem and the theory.	
Presentation:	[ ] Graphs are difficult to read [ ] Fonts are too small/large [ ] Scales are not optimized [ ] Data is not well presented [ ] Grammatical errors [ ] Missing labels	[ ] Good use of color and font sizes [ ] Figures are well placed [ ] Scales are fitted to the dataset [ ] No grammatical errors [ ] All appropriate labels included	[ ] Competent plus excellent use of figures, visual choices are most appropriate	
Use of Time:	[ ] Presentation ran way over or way over time limit	[ ] Presentation ran very close to time schedule	[ ] Presentation duration 12 minutes with 3 minutes for questions	
Communication:	[ ] Delivery: Hard to follow the flow of ideas [ ] Visuals: No use of visuals [ ] Involvement of the class: Little or no attempt to engage the class in learning [ ] Response to Class Queries: Limited response to questions and discussion with no reference to theory/research	[ ] Delivery: Most ideas flow but focus is lost at times [ ] Visuals: Limited use of visuals loosely related to the material [ ] Involvement of the class: Limited use of activities to clarify understanding [ ] Response to Class Queries: Satisfactory response to class questions and discussion with limited reference to theory and research	[ ] Delivery: Very clear and concise flow of ideas [ ] Visuals: Visuals augmented and extended comprehension of the issues in unique ways [ ] Involvement of the class: Excellent discussion points [ ] Response to Class Queries: Excellent response to comments and discussion with appropriate content	
			Total:	

Appendix B:

SEM421/521 Project Management HW Rubric

Date Presented: Term: ____________________

Instructor:James Eastham

	1-Developing	2-Competent	3-Exemplary	Score
Organization:	[ ] Does not follow organized pattern	[ ] Well organized [ ] Easy to follow [ ] Contains summary [ ] Follow s clear logical pattern	[ ] Competent plus additional organization methods	
Project Schedule	[ ] Poor / Unclear Precedents or Dependents	[ ] Good / Clear schedule, precedents or dependents	[ ] Good / Clear problem schedule AND precedents AND dependents	
Work Breakdown Structure	[ ] Poor / Unclear WBS	[ ] Good implementation of WBS	[ ] Good implementation of WBS AND [ ] Clear WBS numbering and organization	
Resource Allocation	[ ] Missing, incomplete, or incorrect resource allocation or charts	[ ] Good assignment of resources [ ] Good resource allocation charts	[ ] Good assignment of resources AND reports/charts AND additional resource insight	
Cost Estimation	[ ] Missing, incomplete, or incorrect cost analysis	[ ] Correct break-even analysis [ ] Correct IRR [ ] Correct IRR Month [ ] Good answ er to part d	[ ] Competent plus additional graphs or insights	
Additional Analysis	[ ] Limited implementation of additional learning	[ ] Some implementation of additional learning	[ ] Many additional examples (e.g. costs, dashboards, critical tasks, % complete, mini-reports	
			Total:	