Oregon Institute of Technology
Computer Systems Engineering Technology Department
Embedded Systems Engineering Technology Program Assessment
2010-11

I. Introduction

The Embedded Systems Engineering Technology (ESET) program was proposed to OUS in spring of 2006 and approved in August, 2006. The curriculum for the ESET program is common with the hardware and software programs for the freshman year. The sophomore year of the ESET program has been constructed to mirror the track through both the Computer Engineering Technology (CET) and Software Engineering Technology (SET) programs, called the Dual Degree program. The ESET program junior year is when ESET students get instruction specific to topics of embedded systems engineering. These courses were taught for the first time in fall, 2008.

II. Mission, Objectives and Program Student Learning Outcomes

The mission of the Embedded Systems Engineering Technology (ESET) Degree program within the Computer Systems Engineering Technology (CSET) Department at Oregon Institute of Technology is to prepare our students for productive careers in industry and government by providing an excellent education incorporating industry-relevant, applied laboratory based instruction in both the theory and application of embedded systems engineering. Our focus is educating students to meet the growing workforce demand in Oregon and elsewhere for graduates prepared in both hardware and software aspects of embedded systems. Major components of the ESET program's mission in the CSET Department are:

I. To educate a new generation of Embedded Systems Engineering Technology students to meet current and future industrial challenges and emerging embedded systems engineering trends.

II. To promote a sense of scholarship, leadership, and professional service among our graduates.

III. To enable our students to create, develop, apply, and disseminate knowledge within the embedded systems development environment.

IV. To expose our students to cross-disciplinary educational programs.

V. To provide government and high tech industry employers with graduates in embedded systems engineering and related professions.

Program Educational Objectives

The Program Educational Objectives reflect those attributes a student of the ESET program will practice in professional endeavors.

A. Graduates of the embedded program are expected to understand societal impact of embedded systems and technological solutions.

B. Graduates of embedded degree program are expected to do hardware/software co-design for embedded systems. Graduates will continue to develop skills in analysis, approach, optimization, and implementation of embedded systems.

C. Graduates of the embedded program are expected to obtain the knowledge, skills and capabilities necessary for immediate employment in embedded systems. Embedded Systems is a profession increasingly driven by advances in technology, therefore graduates are expected to obtain the necessary life-long learning skills to enable them to be able to adapt to a changing environment.

D. Graduates of the embedded program are expected to develop a broad base of skills. These skills will prepare them for professional practice: 1) as embedded engineers, 2) participants in embedded development teams, and 3) effective communicators within a multidisciplinary team.

E. Graduates of the embedded program are expected to acquire knowledge of management and marketing of embedded projects and products and to prepare for series production.

Program Student Learning Outcomes

Embedded Systems Engineering Technology baccalaureate graduates will be engaged in:

1. Application of mathematics including differential and integral calculus, probability, and discrete mathematics to hardware and software problems (Objectives C, D, E).

2. Application of project management techniques to embedded systems projects (Objectives C and D).

3. Application of knowledge of embedded systems engineering technology, along with some specialization in at least one area of computer systems engineering technology. (Objective D)

4. A broad education and knowledge of contemporary issues necessary to reason about the impact of embedded system based solutions to situations arising in society. (Objective A)

5. Identification and synthesis of solutions for embedded systems problems. (Objective B, C)

6. Design, execution and evaluation of experiments on embedded platforms. (Objective C, D)

7. Analysis, design and testing of systems that include both hardware and software. (Objective B, D)

8. Documenting the experimental processes and writing of satisfactory technical reports/papers. (Objective D, E)

9. Delivery of technical oral presentations and interacting with a presentation audience. (Objective D, E)

10. Recognition for and the motivation to further develop their knowledge and skills as embedded engineering advances occur in industry. (Objective C)

11. Working effectively, independently, and in multi-person teams. (Objective D)

12. Professional and ethical execution of responsibilities. (Objective A, D)

III. Three-Year Cycle for Assessment of Student Learning Outcomes

Assessment activities for the ESET program began Fall, 2008. Table 1 presents planned learning outcome assessment on a three year cycle. The number in the cells of the table corresponds to the ISLO defined for the OIT assessment cycle:

- ISLO 1: OIT students will demonstrate effective oral, written and visual communication.
- ISLO 2: OIT students will demonstrate the ability to work effectively in teams and/or groups.
- ISLO 3: OIT students will demonstrate an understanding of professionalism and ethical practice.
- ISLO 4: OIT students will demonstrate critical thinking and problem solving.
- ISLO 5: OIT students will demonstrate knowledge and understanding of career development and lifelong learning.
- ISLO 6: OIT students will demonstrate mathematical knowledge and skills.
- ISLO 7: OIT students will demonstrate scientific knowledge and skills in scientific reasoning.
- ISLO 8: OIT students will demonstrate cultural awareness.

Table 1: Baccalaureate Outcome Assessment Timeline

#	**Learning Outcomes**	**08-09**	**09-10**	**10-11**	**11-12**	**12-13**	**13-14**
1	The ability to apply mathematics including differential and integral calculus, probability, and discrete mathematics to hardware and software problems.	**6**			**6**		
2	An ability to apply project management techniques to embedded systems projects.		**2, 3**			**2, 3**	

#	Learning Outcomes	08-09	09-10	10-11	11-12	12-13	13-14
3	Knowledge of embedded systems engineering technology, along with some specialization in at least one area of computer systems engineering technology.			**4**			**4**
4	A broad education and knowledge of contemporary issues necessary to reason about the impact of embedded system based solutions to situations arising in society.		**3, 8**			**3, 8**	
5	The ability to identify and synthesize solutions for embedded system problems.			**4**			**4**
6	The ability to design, conduct and evaluate the results of experiments on embedded platforms.	**7**			**7**		
7	The ability to analyze, design and test systems that include both hardware and software.	**7**			**7**		
8	The ability to document experimental processes and to write satisfactory technical reports/papers.			**1**			**1**
9	The ability to make technical oral presentations and interact with an audience.			**1**			**1**
10	The recognition for and the motivation to further develop their knowledge and skills as embedded engineering advances occur in industry.			**5**			**5**
11	The ability to work effectively independently and in multi-person teams.		**2**			**2**	
12	An understanding of professional and ethical responsibility.		**3, 8**			**3, 8**	

To summarize, Table 2 shows the program learning outcomes (identified by number only) that will be assessed for each of the next three years.

Table 2: Summary of Assessment Timeline

Academic Year	Outcomes
2008-09	1, 6, 7
2009-10	2, 4, 11, 12
2010-11	3, 5, 8, 9, 10

Outcomes to be assessed are listed below:

3. Knowledge of embedded systems engineering technology, along with some specialization in at least one area of computer systems engineering technology.
5. The ability to identify and synthesize solutions for embedded system problems.
8. The ability to document experimental processes and to write satisfactory technical reports/papers.
9. The ability to make technical oral presentations and interact with an audience.
10. The recognition for and the motivation to further develop their knowledge and skills as embedded engineering advances occur in industry.

Target courses where the assessment tools were to be applied for the 2010-11 academic year are summarized in Table 3.

Table 3: 2010 – 2011 Summary Courses of Assessment Application

Outcome	Courses	Term
3	CST 415 – Computer Networks CST 204 – Microprocessors	Fall Winter
5	CST 162 – Digital Logic CST 466 - Cryptography	Fall Spring
8	CST 415 – Computer Networks CST 204 – Microprocessors	Fall Winter
9	CST 412 – Senior Development Project I CST 371 – Embedded Systems Development I	Fall Fall
10	CST 415 – Computer Networks CST 204 – Microprocessors	Fall Winter

IV. Summary of 2010-11 Assessment Activities

The following are the direct assessment activities that were accomplished during 2010 - 2011 academic year. Each activity is introduced with a description of the activity followed by a table

that summarizes the rubric criteria along with the rubric application results. Where available, the rubric used for assessment is shown in Appendix A.

PSLO #3

Knowledge of embedded systems engineering technology, along with some specialization in at least one area of computer systems engineering technology.

CST 415 – Computer Networks: Fall 2010

Computer networks is a course on network theory and implementation through the TCP/IP protocol suite.

Data Collection Date: 10/18/2010 Coordinator: James N. Long

Assessment Method: Students were given a standard assignment for writing an essay on the field of embedded systems engineering and expectations related to the professional field. The Embedded Systems Engineering Technology Embedded Systems Knowledge Rubric was used to evaluate the essays (see Appendix). Results are shown in Table 4.

Performance Criteria	Assessment Method	Measurement Scale	Minimum Acceptable Performance	Results
Field Description	Written Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	1 of 2 50%
Expectations	Written Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	1 of 2 50%
Target Products	Written Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	1 of 2 50%
Skill Definition	Written Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	1 of 2 50%
Target Companies	Written Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	1 of 2 50%

Table 4 – Assessment outcome results for CST 415 – *Computer Networks*

Evaluation of results: The number of students in this assessment makes the results of no statistical relevance. Given the sample size of two, we cannot draw any conclusions related to the effectiveness of the program for this PSLO.

Actions: This will be re-assessed in the next assessment cycle involving this PSLO. The program is growing so we will have more involved students at that time.

CST 204 – Microprocessors: Winter 2011

Microprocessors focuses on details of microprocessor based digital systems. Students in this course are sophomore level and have just chosen the ESET program and their major program of study.

Data Collection Date: 3/18/2011 Coordinator: Claude Kansaku

Assessment Method: Students were given a standard assignment for writing an essay on the importance of lifelong learning in the field of embedded systems. The Embedded Systems Engineering Technology Embedded Systems Knowledge Rubric was used to evaluate the essays (see Appendix). Results are shown in Table 5.

Performance Criteria	Assessment Method	Measurement Scale	Minimum Acceptable Performance	Results
Field Description	Written Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	0 of 2 0%
Expectations	Written Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	0 of 2 0%
Target Products	Written Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	0 of 2 0%
Skill Definition	Written Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	0 of 2 0%
Target Companies	Written Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	0 of 2 0%

Table 5 – Assessment outcome results for CST 204 – *Microprocessors*

Evaluation of results: There were several problems with this assessment. The assignment, as defined for the lifelong learning and writing, was not specific enough to bring about the results

described in the Embedded Systems Engineering Technology Embedded Systems Knowledge Rubric. This was suspected going into the assessment cycle, but given time limitations, the assessment was performed to gauge how the assignment could be modified to better fill the institutional and program goals in a single assignment. The level of students at the time of assessment administration is also such that there have been no courses taken specific to embedded systems subjects, so it is difficult for students to differentiate between software engineering, hardware engineering, and embedded systems engineering. The number of students assessed also has problems related to statistical significance.

Actions: The assessment method and placement will be reviewed and run in the next assessment cycle for this PSLO.

PSLO #5

The ability to identify and synthesize solutions for embedded systems problems.

CST 162 – Digital Logic: Fall 2010

Digital Logic is a first course introduction to digital logic and related computer components. This assessment focuses on the design of a solution to a problem.

Data Collection Date: 11/10/10 Coordinator: Phong Nguyen

Assessment Method: Students in CST 162 were given a set of specifications to a digital logic design problem. They are next required to follow a specific method to come up with a design which they are to implement using gates. At the end, the students are asked to put in one set of test vector to partially check functionality of the design. Student work was assessed in each of the performance criteria shown in Table 6 as defined in the rubric shown in Appendix A.

Performance Criteria	Assessment Method	Measurement Scale	Minimum Acceptable Performance	Results
Understanding	Problem Assignment	Poor (1)/ Fair(2)/ Good(3)/ Excellent (4)	Good(3)	74.3% (26 / 35)
Plan to Solve	Problem Assignment	Poor (1)/ Fair(2)/ Good(3)/ Excellent (4)	Good(3)	74.3% (26 / 35)
Carrying out the Plan	Problem Assignment	Poor (1)/ Fair(2)/ Good(3)/ Excellent (4)	Good(3)	71.4% (25 / 35)
Evaluating	Problem Assignment	Poor (1)/ Fair(2)/ Good(3)/ Excellent (4)	Good(3)	82.9% (29 / 35)
Solution	Problem Assignment	Poor (1)/ Fair(2)/ Good(3)/ Excellent (4)	Good(3)	82.9% (29 / 35)

Table 6 – Assessment outcome results for CST 162 – Digital Logic

Evaluation of results: The performance passed standard.

Actions: No Action Required

CST 466 – Embedded Systems Security: Spring 2011

Embedded Systems Security focuses on topics related specifically to security in embedded systems.

This assessment focuses on the design of a solution to a problem.

Data Collection Date: 5/20/2011 Coordinator: Phong Nguyen

Assessment Method: Students in CST 466 were given a set of specifications to program an RSA implementation method. They are next required to generate private and public RSA keys and use these keys to encrypt and decrypt plaintext/ciphertext files. Student work was assessed in each of the following performance criteria, shown in Table 7, as defined in the rubric as shown in Appendix A.

Performance Criteria	Assessment Method	Measurement Scale	Minimum Acceptable Performance	Results
Understanding	Problem Assignment	Poor (1)/ Fair(2)/ Good(3)/ Excellent (4)	Good(3)	100% (2/2)
Plan to Solve	Problem Assignment	Poor (1)/ Fair(2)/ Good(3)/ Excellent (4)	Good(3)	100% (2/2)
Carrying out the Plan	Problem Assignment	Poor (1)/ Fair(2)/ Good(3)/ Excellent (4)	Good(3)	100% (2/2)
Evaluating	Problem Assignment	Poor (1)/ Fair(2)/ Good(3)/ Excellent (4)	Good(3)	100% (2/2)
Solution	Problem Assignment	Poor (1)/ Fair(2)/ Good(3)/ Excellent (4)	Good(3)	100% (2/2)

Table 7 – Assessment outcome results for CST 466 – Embedded Systems Security

Evaluation of results: The performance passed standard.

Actions: No Action Required

PSLO #8

The ability to document experimental processes and to write satisfactory technical reports/papers.

CST 415 – Computer Networks: Fall 2010

Computer networks is a course on network theory and implementation through the TCP/IP protocol suite.

Data Collection Date: 10/18/2010 Coordinator: James N. Long

Assessment Method: Students were given a standard assignment for writing an essay on the importance of lifelong learning in the field of embedded systems. The OIT Writing rubric was used to assess these essays. Each of the performance criteria listed below in Table 8 were judged for understanding of importance and application in the field of Embedded Systems Engineering. The rubric used is given in Appendix A.

Performance Criteria	Assessment Method	Measurement Scale	Minimum Acceptable Performance	Results
Purpose and Ideas	Writing Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	2 of 2 100%
Organization	Writing Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	2 of 2 100%
Support	Writing Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	2 of 2 100%
Style	Writing Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	1 of 2 50%
Conventions	Writing Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	2 of 2 100%
Documentation	Writing Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	1 of 2 50%

Table 8 – Assessment outcome results for CST 415 – *Computer Networks*

Evaluation of results: The sample size for this assessment was small enough such that the results have no real statistical significance. Areas where one of the two students did not show Proficiency were writing style and writing documentation.

Actions: This will be re-assessed in the next assessment cycle involving this PSLO. The program is growing so we will have more involved students at that time.

CST 204 – Microprocessors: Winter 2011

Microprocessors focuses on details of microprocessor based digital systems. Students in this course are sophomore level and have just chosen the ESET program as their major program of study.

Data Collection Date: 3/18/2011 Coordinator: Claude Kansaku

Assessment Method: Students were given a standard assignment for writing an essay on the importance of lifelong learning in the field of embedded systems. The OIT Writing Rubric was used to assess these essays. Results are summarized in Table 9.

Performance Criteria	Assessment Method	Measurement Scale	Minimum Acceptable Performance	Results
Purpose and Ideas	Writing Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	3 of 3 100%
Organization	Writing Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	3 of 3 100%
Support	Writing Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	3 of 3 100%
Style	Writing Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	0 of 3 0%
Conventions	Writing Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	2 of 3 66%
Documentation	Writing Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	0 of 3 0%

Table 9 – Assessment outcome results for CST 204 – *Microprocessors*

Evaluation of results: The weakness here in the areas of Style and Documentation correlates with the assessment done in CST 415 – Computer Networks for this PSLO. The shared weakness is in writing style and writing documentation.

Actions: Style and Documentation are also areas of concern handled in the general education courses taken by the ESET students. The university has assessed writing in the 2010-2011 academic year. Actions related to the style and documentation weakness will depend on university wide actions.

PSLO #9

The ability to make technical oral presentations and interact with an audience.

CST 412 – Sr. Project Development I: Fall 2010

Students in CST 412 are in the first term of their Sr. year. Students are expected to have a good level of proficiency in technical public speaking. Each student in the course is required to give at least a five minute speech explaining some technical aspect of their project. These speeches must be supported with professional facts and visuals.

Data Collection Date: 10/18/2010 Coordinator: Calvin Caldwell

Assessment Method: The speeches were given during lecture and lab sections. Assessment was done during the course of the speech based on the OIT public speaking rubric. Results are summarized in Table 10.

Performance Criteria	Assessment Method	Measurement Scale	Minimum Acceptable Performance	Results
Content	Speech Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	2 of 2 100%
Organization	Speech Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	2 of 2 100%
Style	Speech Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	2 of 2 100%
Delivery	Speech Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	2 of 2 100%
Visuals	Speech Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	2 of 2 100%

Table 10 – Assessment outcome results for CST 431 – Sr. Project Development I

Evaluation of results: The number of students involved in this assessment makes the results of no statistical relevance; however, the students passed the assessment benchmark.

Actions: No action is required.

CST 317 – Embedded Systems Development I: Fall 2010

Students in CST 317 are in the first term of their Jr. year. Students are expected to be at a developing level of proficiency in technical public speaking. Each student in the course is required to give at least a five minute speech explaining some technical aspect of their project. These speeches must be supported with professional facts and visuals.

Data Collection Date: 10/29/2011 Coordinator: Phong Nguyen

Assessment Method: The speeches were given during lecture and lab sections. Assessment was done during the course of the speech based on the OIT public speaking rubric. Results are shown in Table 11.

Performance Criteria	Assessment Method	Measurement Scale	Minimum Acceptable Performance	Results
Content	Speech Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	10 of 10 100%
Organization	Speech Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	10 of 10 100%
Style	Speech Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	6 of 10 60%
Delivery	Speech Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	8 of 10 80%
Visuals	Speech Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	7 of 10 70%

Table 11 – Assessment outcome results for CST 317 – Embedded Systems Development I

Evaluation of results: For all performance criteria, more than 50% of students met the minimum requirements.

Actions: No action is required.

PSLO #10

The recognition for and the motivation to further develop their knowledge and skills as embedded engineering advances occur in industry.

CST 415 – Computer Networks: Fall 2010

Computer networks is a course on network theory and implementation through the TCP/IP protocol suite.

Data Collection Date: 10/18/2010 Coordinator: James N. Long

Assessment Method: Students were given a standard assignment for writing an essay on the importance of lifelong learning in the field of embedded systems. The OIT Lifelong Learning rubric was used to assess these essays. Table 12 shows the results of this assessment.

Performance Criteria	Assessment Method	Measurement Scale	Minimum Acceptable Performance	Results
Lifelong learning	Writing Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	2 of 2 100%
Professional societies and organizations	Writing Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	1 of 2 50%
Credentials	Writing Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	0 of 2 0%
Continuing education	Writing Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	0 of 2 0%
Short- and long-term career plans	Writing Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	0 of 2 0%

Table 12 – Assessment outcome results for CST 415 – *Computer Networks*

Evaluation of results: The sample size for this assessment was small enough such that the results have no real statistical significance. Results of the assignment are poor; however, after the assignment was collected, both students were interviewed about industry developments and their plans for staying current in a technically volatile field. Both students were well informed and had plans to continue learning about embedded systems after graduation.

Actions: This will be re-assessed in the next assessment cycle involving this PSLO. The program is growing so we will have more involved students at that time.

CST 204 – Microprocessors: Winter 2011

Microprocessors focuses on details of microprocessor based digital systems. Students in this course are sophomore level and have just chosen the ESET program and their major program of study.

Data Collection Date: 3/18/2011 Coordinator: Claude Kansaku

Assessment Method: Students were given a standard assignment for writing an essay on the importance of lifelong learning in the field of embedded systems. The OIT Lifelong Learning Rubric was used to evaluate the essays (see Appendix). Results are shown in Table 13.

Performance Criteria	Assessment Method	Measurement Scale	Minimum Acceptable Performance	Results
Lifelong learning	Writing Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	2 of 2 100%
Professional societies and organizations	Writing Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	1 of 2 50%
Credentials	Writing Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	0 of 2 0%
Continuing education	Writing Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	0 of 2 0%
Short- and long-term career plans	Writing Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	0 of 2 0%

Table 13 – Assessment outcome results for CST 204 – *Microprocessors*

Evaluation of results: The outcome of this assessment showed substandard results. At this point in the students career, they have not yet fully committed to the embedded systems program and have had no instruction specific to the field of embedded system engineering. It is no surprise that they do not have a good grasp on knowledge and skills required of an embedded systems engineer.

Actions: The assessment method and placement will be reviewed and run in the next assessment cycle for this PSLO.

V. Summary of Student Learning

3. Knowledge of embedded systems engineering technology, along with some specialization in at least one area of computer systems engineering technology.
5. The ability to identify and synthesize solutions for embedded system problems.
8. The ability to document experimental processes and to write satisfactory technical reports/papers.
9. The ability to make technical oral presentations and interact with an audience.
10. The recognition for and the motivation to further develop their knowledge and skills as embedded engineering advances occur in industry.

PSLO #3 - Knowledge of embedded systems engineering technology, along with some specialization in at least one area of computer systems engineering technology.

Actions: Assessments in this area provided inconclusive evidence of issues. This is due to the low number of students in the upper division ESET courses and the course in which the lower division assessment was performed. The placement and relevance of the lower division assessment will be reviewed.

PSLO #5 - The ability to identify and synthesize solutions for embedded system problems.

Actions: Both the upper and lower division assessments passed the standard. No actions are recommended.

PSLO #8 – The ability to document experimental processes and to write satisfactory technical reports/papers.

Actions: Both upper and lower division assessments showed weakness in writing style and documentation. Given the small sample set of the upper division assessment, this assessment will be re-evaluated during the next assessment cycle for this PSLO.

PSLO #9 – The ability to make technical oral presentations and interact with an audience.

Actions: Both the upper and lower division assessments passed the standard. No actions are recommended.

PSLO #10 – The recognition for and the motivation to further develop their knowledge and skills as embedded engineering advances occur in industry.

Actions: The placement of this assessment in the course sequencing will be re-evaluated and the assessment will be then run during the next planned assessment cycle for this PSLO.

VI. Changes Resulting from Assessment

THE FOLLOWING ACTION ITEMS WERE CITED IN THE 2009 – 2010 ASSESSMENT REPORT:

PSLO #2 - Application of project management techniques to embedded systems projects.

Evaluation of results: Students are good at project decomposition; however, there was a weakness in sequencing of task dependencies.

Actions: Early in the junior project sequence, task breakdown, sequencing, and dependencies needs to be emphasized. This should be revisited at least once a term as students work in their project throughout the year.

2010 – 2011 Report: This has been implemented and will be re-assessed in the next assessment cycle for this PSLO.

PSLO #4 - A broad education and knowledge of contemporary issues necessary to reason about the impact of embedded system based solutions to situations arising in society.

Evaluation of results: Students have a good grasp of direct users of their systems; however, they have trouble extrapolating beyond this direct end-user experience.

Actions: Students need to be instructed on creation of a business case for the systems they construct in the junior and senior project sequences. In the business, they should consider larger impacts of their system.

2010 – 2011 Report: This has been implemented and will be assessed in the next assessment cycle for this PSLO.

PSLO #11 – Working effectively, independently, and in multi-person teams.

Evaluation of results: The results were inconclusive due to the small sample space being applied to a team.

Actions: More data must be collected as the program gains more students.

2010 – 2011 Report: The ESET class remains small. This PSLO will be assessed in the next standard assessment cycle for this PSLO.

PSLO #12 – Professional and ethical execution of responsibilities.

Evaluation of results: Assessment shows a lack of understanding of ethics related to professional activities when students are not engaged in a 300 level course on ethics.

Actions: The ESET curriculum needs to be modified so a 300 level ethics related course is required. One of the humanities electives will be made a directed elective so that students will take PHIL 331 – Ethics in the Professions.

2010 – 2011 Report: Due to clerical issues and lost paperwork, this change has not been implemented. The curriculum must be modified to enact this change. This will be done in the 2011 – 2012 academic year and assessed in the next standard cycle for this PSLO.

THE FOLLOWING ACTION ITEMS WERE CITED IN THE 2008 – 2009 ASSESSMENT REPORT:

PSLO #1 - The ability to apply mathematics including differential and integral calculus, probability, and discrete mathematics to hardware and software problems.

Action Items: We need to emphasize the use of graphical representations of data for use in solving engineering problems. This should be done in both CST 162 and CST 315. This will be re-assessed in CST 315, Fall 2009.

2010-2011 Report: This has been implemented; however, the large number of PSLOs for this assessment cycle caused the program faculty to put off re-assessment of this PSLO until the following standard assessment cycle for this PSLO.

PSLO #7 – The ability to analyze, design and test systems that include both hardware and software.

Action Items: Instructor will develop additional lectures on test bench code and code coverage, and will develop demonstrations on how execution of test bench code produces valid simulation test with appropriate coverage. This the first time the course has been offered. Assessment on modifications will be performed in the next assessment cycle.

2010-2011 Report: The Embedded Systems Testing was offered for the first time in Winter, 2011 with an enrollment of three students. The Hardware/Software Co-Design has also been further worked on to cover analysis and design of hardware-software hybrid systems. This PSLO will be assessed in the next standard assessment cycle for this PSLO.

Appendix A – Assessment Rubrics

PSLO #3

Knowledge of embedded systems engineering technology, along with some specialization in at least one area of computer systems engineering technology.

ESET Embedded Systems Knowledge Rubric				
Performance Criteria	**Limited Proficiency (1)**	**Some Proficiency (2)**	**Proficient (3)**	**High Proficiency (4)**
Field Description	Shows no relevant understanding of the field of work.	Gives vague description of the desired field of work.	Has an accurate description of at least part of the field in the desired field of work.	Has a full description of work that will be performed in the desired field of work and areas of application.
Expectations	Has erroneous or no knowledge of what to expect in their target field of work.	Shows knowledge of what to expect in the chosen field of work. Descriptions are vague.	Expectations are accurately described yet does not form a rounded set.	Shows a complete understanding of the types of work environment and job duties to expect in their desired field of work.
Target Products	There is no understanding of the types of products the target work field will entail.	Gives a general idea of products but no specific information.	Gives a general idea of products with specifics on at least one project of interest.	Gives a relatively complete set of products and related products in the desired field of work.
Skill Definition	Skills required are either improperly defined or in error.	Required skills are understood in general with no idea of specifics.	Gives specifics on at least three sets of skills required.	Gives a good description of many skills required in the desired field of work along with specifics.
Target Companies	Companies mentioned are not relevant or incorrect.	A broad list of company types is given with no specific examples.	A list of companies is given with little or no additional information.	Gives a good set of relevant companies and describes areas in which these companies operate.

PSLO #5

The ability to identify and synthesize solutions for embedded system problems.

Problem Solving Rubric for CST 162 – Introduction to Digital Logic and CST 466 – Embedded Systems Security

	Poor - 1	Fair - 2	Good - 3	Excellent - 4
Understanding	Student needs a complete explanation of the problem.	Student needs some clarification from others to understand the problem.	Student understands (can explain) the problem and proceeds to the next step.	Student understands the problem and relates it to other situations.
Plan to Solve	Designs only one strategy, required assistance to evaluate strategy.	Come up with a few strategies and requires assistance to select an appropriate strategy.	Come up with several strategies, decides on an appropriate solution.	Come up with many strategies, decides on appropriate solution to each strategy.
Carrying out the Plan	Attempts to solve problem with an inadequate strategy.	Solves problem without making modifications.	Solves problem using design, makes appropriate modifications.	Tries new methods to solve problem.
Evaluating	Student Requires assistance to evaluate solutions.	Student has Limited evaluation of solution without assistance.	Student compares actual and expected results.	Student suggests other modifications or applications of the results.
Solution	Student has no solution or wrong solution.	Student has partial answer for problem.	Student has the correct solution.	Student has correct solution of problem and provided results extending the solution.

PSLO #8

The ability to document experimental processes and to write satisfactory technical reports/papers.

Rubric created by the OIT Communication Department and approved by the OIT Assessment Commission, February 2009, revised June 2010.

OIT Essay Rubric				
Performance Criteria	**Limited Proficiency (1)**	**Some Proficiency (2)**	**Proficiency (3)**	**High Proficiency (4)**
Purpose and Ideas	Writing has limited or no focus. Purpose and main ideas are unclear and require inference from reader.	Reader can discern the purpose and main ideas although they may be overly broad or simplistic.	Writing is clear and focused. Reader can easily understand the purpose and main ideas.	Purpose and main ideas are exceptionally focused, clear, and interesting.
Organization	Order and structure are unclear. Introduction and conclusion are underdeveloped or missing.	Order and structure are overly formulaic. Introduction and conclusion may be underdeveloped or too obvious.	Order and structure are clear and easy to follow. Introduction draws in the reader and conclusion brings satisfying closure.	Order and structure are compelling and move the reader through the text easily. Introduction draws in the reader and conclusion brings satisfying closure.
Support	Development is minimal. Some supporting details may be irrelevant or repetitious.	Supporting details are relevant, but are limited or rather general. Support may be based on clichés, stereotypes, or questionable sources or evidence.	The main ideas are well developed by supporting details. When appropriate, use of outside sources provides credible support.	Main ideas are well developed by strong support and rich details. When appropriate, use of outside sources provides strong, credible support.
Style	Voice is inappropriate for topic, purpose, or audience. Wording is incorrect or monotonous, detracting from impact. Sentences tend to be choppy, rambling, and awkward.	Voice is inconsistent for topic, purpose, and audience. Wording is quite ordinary, lacking interest, precision, and variety, and may rely on clichés. Sentences tend to be mechanical rather than fluid with an overuse of simple sentence structures.	Voice is generally appropriate for topic, purpose, and audience. Generally, wording conveys message in an interesting, precise, and natural way. Sentences are carefully crafted with variations in structure.	Voice is appropriate for topic, purpose, and audience. Wording is fresh and specific, with a striking and varied vocabulary. Sentences are highly crafted, with varied structure that makes reading easy and enjoyable.
Conventions	Numerous errors in usage, spelling, punctuation, and/or grammar. Errors sometime impede readability. Substantial editing needed.	Writing contains punctuation, spelling, and/or grammar errors, but they do not impede readability and are not extensive. Moderate need for editing.	Writing demonstrates control of standard writing conventions and uses them effectively to enhance communication. Few errors.	Writing demonstrates strong control of standard writing conventions and uses them well to enhance communication. Very few or no errors.
Documentation	Documentation has major errors or is not present.	Documentation has frequent errors.	Documentation is correct except for a few errors.	Documentation is meticulous.

PSLO #9

The ability to make technical oral presentations and interact with an audience.

Rubric created by the OIT Communication Department and approved by the OIT Assessment Commission, February 2009.

OIT Public Speaking Rubric				
Performance Criteria	**No/Limited Proficiency (1)**	**Some Proficiency (2)**	**Proficiency (3)**	**High Proficiency (4)**
Content	Few or no attributed sources. Supporting materials lack credibility and/or don't relate to thesis. Limited or no attempt to inform or persuade.	Some attributed sources used. Supporting materials are somewhat credible and/or don't clearly relate to thesis. Attempt to inform or persuade.	Adequate number of credible and appropriately attributed sources used. Supporting materials relate to thesis. Informs or persuades.	A variety of credible and appropriate sources used. Supporting materials relate in an exceptional way to a focused thesis. Informs or persuades.
Organization	Lacks organizational structure. Introduction and/or conclusion missing. No transitions used.	Organizational structure present but unclear with underdeveloped introduction and conclusion. Transitions are awkward.	Appropriate organizational pattern used and easy to follow with developed introduction and satisfying conclusion. Main points are smoothly connected with transitions.	Organizational pattern is compelling and moves audience through speech with ease. Introduction draws in the audience and conclusion is satisfying. Main points are smoothly connected with transitions.
Style	No understanding of audience regarding topic or purpose of speech. Little enthusiasm and passion for topic. No regard for time constraints.	Some understanding of audience regarding topic or purpose of speech. Some enthusiasm and passion for topic. Some regard for time constraints.	Competent understanding of audience regarding topic and purpose. Enthusiasm and passion for topic. Speech given within time constraints.	Thorough understanding of audience regarding topic and purpose. Clear enthusiasm and passion for topic. Speech given within time constraints.
Delivery	No gestures or eye contact. Monotone voice or insufficient volume. Little poise. Reading of notes only. Abundant oral fillers and nonverbal distractions.	Some gestures and eye contact. Ineffective use of language and voice. Little poise. Heavy reliance on notes. Multiple oral fillers and nonverbal distractions.	Adequate use of gestures, eye contact, language, and voice. Poised with minor reliance on notes. Limited oral fillers and nonverbal distractions.	Effective use of gestures, eye contact, vivid language, and voice to add interest to speech. Poised with use of notes for reference only. No oral fillers and nonverbal distractions.
Visuals	No visuals or poorly-designed and documented visuals that distract from speech or do not create interest. Limited reference to visuals or so much reference delivery is hindered.	Visuals present, but simply designed with limited use of documentation. Visuals are referred to but do not create interest. Visuals may interfere with delivery.	Well-designed and documented visuals that clarify speech and create interest. Visuals are referred to and sufficiently discussed, while not interfering with delivery.	Well-designed and documented visuals that clarify speech, create interest, and hold attention of the audience. Visuals are sufficiently discussed and effectively integrated into speech.

PSLO #10

The recognition for and the motivation to further develop their knowledge and skills as embedded engineering advances occur in industry.

OIT Lifelong Learning Rubric

Performance Criteria	Limited or No Proficiency (1)	Some Proficiency (2)	Proficiency (3)	High Proficiency (4)
1. Lifelong learning	Fails to identify the need for "lifelong learning" and/or omits discussion of their own learning and relevant examples.	Misses important elements in discussing "lifelong learning," applying concepts to their own learning or providing a relevant example.	Defines and discusses at least one concept of "lifelong learning" and the need for it. Applies concept and gives an example related to their own learning.	Defines and discusses various concepts of "lifelong learning" and the need for it. Applies these concepts to their own learning now and in the future. Demonstrates self-awareness by accurately identifying strengths/ weaknesses in their own ability to learn independently. Gives relevant example(s).
2. Professional societies and organizations	Fails to discuss an appropriate professional society, advantages of joining or disadvantages of not joining, and/or possible involvement/participation.	Misses important elements in identifying appropriate professional societies or organizations, the advantages of joining and disadvantages of not joining, and/or possible involvement/participation.	Identifies and discusses appropriate professional societies or organizations, the advantages of joining and disadvantages of not joining, and possible involvement/ participation.	Identifies and thoroughly discusses appropriate professional societies or organizations, the advantages of joining and disadvantages of not joining, and possible involvement/participation. Demonstrates detailed understanding of relevant requirements.
3a. Credentials	Fails to recognize the need for credentials or further degrees and/or omits information on how to obtain/maintain them.	Identifies available credentials or further degrees, but important elements or details on how to obtain/maintain them are missing.	Identifies and discusses the different types of credentials or further degrees that are available and how to obtain/maintain them.	Identifies and thoroughly discusses the different types of credentials or further degrees that are available and how to obtain/maintain them. Demonstrates detailed understanding of relevant requirements.
3b. Continuing education	Fails to recognize the need for continuing education (formal or informal) or omits information on how to obtain it.	Misses important elements in identifying appropriate continuing education (formal or informal), how to obtain it, and the need for it.	Identifies and discusses appropriate continuing education (formal or informal), how to obtain it, and the need for it.	Identifies and thoroughly discusses appropriate continuing education (formal or informal), how to obtain it, and the need for it. Demonstrates detailed understanding of relevant requirements.
4. Short- and long-term career plans	Vaguely describes career goals and/or includes no realistic plan to meet them.	Career goals after graduation do not include both long and short term plans and/or the plan to meet these goals is missing important details or is unrealistic.	Describes realistic career goals after graduation and long-term career aspirations. Includes a plan to meet these goals and aspirations.	Describes realistic career goals after graduation and long-term career aspirations. Includes a thorough and thoughtful plan to meet these goals and aspirations.