Expected Outcome 1: Breadth
By the time of graduation from the program, graduates of the Wireless Engineering Program will have achieved and demonstrated an ability to apply knowledge of mathematics, basic science, and engineering to solve problems encompassing the seven fundamental areas of wireless communications, with greatest emphasis by option as follows:

WIRE: electrical engineering key to the practice of wireless engineering (circuits and systems, electronics, digital systems, electromagnetics, and communication systems.)

WIRS: software-oriented wireless engineering (digital systems, systems software, communication systems, communication networks, wireless applications, and human-computer interaction.)

Assessment Method 1: Course data collection
Assessment Method Description
Data is collected typically from final exam questions in junior and senior level courses taught in fall semesters. Particular courses are assessed every other year. A rubric is employed that features three performance indicators to determine how well the student understands the problem (“PI1: Understands Problem”), if the correct solution approach is chosen (“PI2: approach”), and if student is able to implement the solution approach (“PI3: execution”). A 4 point scale is used for each performance indicator on the rubric where scores of 1, 2, 3, 4 correspond to unsatisfactory, developing, meets expectations, and exceeds expectations, respectively. The preliminary assessment is carried out by the course instructor. The data is evaluated by the department’s Curriculum and Assessment Committee.

Primary success metric: at least 70% of students rate scores of at least a 3 on each PI.
Secondary success metric: no more than 10% of students rate below a 2 on each PI.
The Fall 2012 assessment for the breadth outcome was carried out for wireless engineering students in the courses ELEC 3320 (3 students) and ELEC 3400 (2 students).

Findings

The primary success metric was met on all performance indicators for wireless engineering students in courses ELEC 3320 and ELEC 3400. As expected, most students had a good understanding of the problem but sometimes used the wrong solution approach or had difficulty executing the approach.

How did you use findings for improvement?

Even though the success metrics were met, there is room for improvement. Most of the problems students had involved choosing the proper approach to solve the problem and then successfully carrying out the solution approach. Mostly these problems are course specific, and instructors are informed of the results so they can improve how the material is taught.

It has been noted, however, that a better grasp of material in one of the earlier courses, ELEC 2120 Linear Signals and Systems, would enhance our students’ ability to solve problems. The ECE Department and Wireless Curriculum and Assessment Committees are recommending that a one-hour lab be added to the ELEC 2120 course.

Additional Comments

The department’s Curriculum and Assessment Committee is revising how the assessment results are reported in an effort to provide more meaningful information and improve consistency across all courses and academic majors. The secondary success metric is seen to be of little use and will be discontinued. A better form for collecting performance indicator data for each assessed student in each assessed class has been prepared for future assessments so that data can be compared across courses and compared year by year.

Assessment Method 2: Senior Exit Survey

Assessment Method Description

Survey of graduating seniors; Provides quantifiable data with respect to student satisfaction with their preparation to attain outcomes. Students
were asked how well they believed they achieved the Breadth Outcome, stated above. The rating scale was 5 (excellent), 4 (very good), 3 (good), 2 (fair), and 1 (poor).

Findings
Combining the Fall 2012, Spring 2013, and Summer 2013 surveys, there were responses from a total of 47 graduating seniors. Of these 47, 31 were in the Electrical Engineering program, 9 were in the Electrical Engineering (with Computer Option) program, 3 were in the Wireless Engineering program, and 4 were in dual major or degree programs. The aggregate scores for the Breadth Outcome question from these 47 students are as follows:

- 5 (excellent): 17 students (36%)
- 4 (very good): 21 students (45%)
- 3 (good): 8 students (17%)
- 2 (fair): 1 student (2%)
- 1 (poor): 0 students (0%)

The overwhelming majority of our graduates believe they have achieved the breadth outcome.

How did you use findings for improvement?

The department’s Curriculum and Assessment Committee reviewed the survey results for the Breadth outcome and determined that the outcome has been successfully met.

Additional Comments

Presently, the survey instrument combines results for the various undergraduate programs in the Department of Electrical & Computer Engineering. The committee believes that the survey is most effective as a “flag” for poor performance and that the present aggregate data from our closely related programs is both useful and adequate. However, we will modify the survey instrument to allow breaking out results by program.
Expected Outcome 2: Communication

By the time of graduation from the program, graduates of the Wireless Engineering Program will have achieved and demonstrated proficiency in communicating ideas and information orally and in writing.

Assessment Method 1: Course Data Collection

Assessment Method Description
Communication exercises have been integrated into a number of key in-major courses in the curriculum. All core laboratory courses have technical writing components, leading up to the final lab course, ELEC 3060, and the senior design courses ELEC 4000/COMP 4710, in which written and oral communications are significant components of the design experience. Students receive feedback and recommendations for improvements from the faculty at all stages of these activities. Many upper level courses also have term projects that require written and/or oral reports.

A writing rubric is employed which features 6 performance indicators (PI): PI1 - Content, PI2 - Organization, PI3 - Style, PI4 - Grammar, PI5 - Figures/Tables, PI6 - Use of sources.

An oral presentation rubric is employed which features 5 performance indicators: PI1 - elocution, PI2 - enthusiasm, PI3 - eye contact, PI4 - visual aids, PI5 - content.

A 4 point scale is used for each performance indicator on the rubric where scores of 1, 2, 3, 4 correspond to unsatisfactory, developing, meets expectations, and exceeds expectations, respectively. The preliminary assessment is carried out by the course instructor. The data is evaluated by the department’s Curriculum and Assessment Committee.

Primary success metric: at least 70% of students rate scores of at least a 3 on each PI.
Secondary success metric: no more than 10% of students rate below a 2 on each PI.

The Fall 2012 assessment of communication ability was assessed in one section of ELEC 4000, with 4 WIRE students.
Findings

Writing Rubric Data Summary: 4 Students

<table>
<thead>
<tr>
<th>Metric</th>
<th>≥ 3</th>
<th>&lt; 2</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>PI1: Content</td>
<td>50%</td>
<td>0</td>
<td>Primary metric not met</td>
</tr>
<tr>
<td>PI2: Organization</td>
<td>75%</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>PI3: Style</td>
<td>100%</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>PI4: Grammar</td>
<td>100%</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>PI5: Figures/Tables</td>
<td>75%</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>PI6: Use of Sources</td>
<td>0%</td>
<td>100%</td>
<td>Primary and secondary metrics unmet</td>
</tr>
</tbody>
</table>

For PI6: Use of sources. The worst offenders left out references entirely or failed to refer to references in the report.

Oral Rubric Data Summary: 4 Students

<table>
<thead>
<tr>
<th>Metric</th>
<th>≥ 3</th>
<th>&lt; 2</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>PI1: Elocution</td>
<td>100%</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>PI2: Enthusiasm</td>
<td>100%</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>PI3: Eye Contact</td>
<td>100%</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>PI4: Visual Aids</td>
<td>100%</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>PI5: Content</td>
<td>100%</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

All primary and secondary success metrics were met for oral presentations.

How did you use findings for improvement?

The department’s Curriculum and Assessment Committee has reviewed the assessment and notes the following:

The amount of writing our students do is significant, and the quality is generally quite good. The relatively poor performance on use of references is being fed back to all electrical & computer engineering instructors who require written reports.

Presentation skills are generally very good, perhaps owing to the experience our students gained in making presentations in the junior level labs. No action is recommended.

Additional Comments

The department’s Curriculum and Assessment Committee is revising how the assessment results are reported in an effort to provide more meaningful information and improve consistency across all courses and academic majors. The secondary success metric is seen to be of little use and will be
discontinued. A better form for collecting performance indicator data for each assessed student in each assessed class has been prepared for future assessments so that data can be compared across courses and compared year by year.

**Assessment Method 2: Senior Exit Survey**

**Assessment Method Description**
Survey of graduating seniors; Provides quantifiable data with respect to student satisfaction with their preparation to attain outcomes. Students were asked how well they believed they achieved the Communications Outcome, stated above. The rating scale was 5 (excellent), 4 (very good), 3 (good), 2 (fair), and 1 (poor).

**Findings**
Communication exercises have been integrated into a number of key ELEC courses in the curriculum. All core laboratory courses have technical writing components, leading up to the final lab course, ELEC 3060, and the senior design courses ELEC 4000/COMP 4710, in which written and oral communications are significant components of the design experience. Students receive feedback and recommendations for improvements from the faculty at all stages of these activities. Many upper level courses also have term projects that require written and/or oral reports.

Combining the Fall 2012, Spring 2013, and Summer 2013 surveys, there were responses from a total of 46 graduating seniors. Of these 46, 30 were in the Electrical Engineering program, 9 were in the Electrical Engineering (with Computer Option) program, 3 were in the Wireless Engineering program, and 4 were in dual major or degree programs, of which one program was Wireless Engineering. The aggregate scores for the Communications Outcome question from these 46 students are as follows:
- 5 (excellent): 15 students (33%)
- 4 (very good): 20 students (43%)
- 3 (good): 10 students (22%)
- 2 (fair): 1 students (2%)
- 1 (poor): 0 students (0%)

**How did you use findings for improvement?**
The department provides its students with many opportunities to practice their oral and written communications skills. Almost all (98%) of the students believe they have been taught good or better skills. At this time the department’s Curriculum and Assessment Committee feels no action need be taken.
**Additional Comments**
Presently, the survey instrument combines results for the various undergraduate programs in the Department of Electrical & Computer Engineering. The committee believes that the survey is most effective as a “flag” for poor performance and that the present aggregate data from our closely related programs is both useful and adequate. However, we will modify the survey instrument to allow breaking out results by program.

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**Expected Outcome 4: Design**
By the time of graduation from the program, graduates of the Wireless Engineering Program will have achieved and demonstrated an ability to design and analyze a component or system to meet desired needs within the field of wireless engineering.

**Assessment Method 1: Course Data Collection**

**Assessment Method Description**
We assessed design on the final project report for the Fall 2012 offering of ELEC 4000 (senior design projects). A rubric is employed that features five performance indicators (PI): PI1 - Use knowledge, methods, processes and tools to create a design that meets stated requirements. PI2 - Evaluate if a design meets desired needs. PI3 - Consider realistic constraints in the design. PI4 - Testing of the final design. PI5 - Constructing a prototype of the design. A 4 point scale is used for each performance indicator on the rubric where scores of 1, 2, 3, 4 correspond to unsatisfactory, developing, meets expectations, and exceeds expectations, respectively. The preliminary assessment is carried out by the course instructor. The data is evaluated by the department’s Curriculum and Assessment Committee.

Primary success metric: at least 70% of students rate scores of at least a 3.
Secondary success metric: no more than 10% of students rate below a 2.

**Findings**
Reports for three design teams, a total of 12 students, were evaluated.
Team 1 majors: 3 ELEC, 1 ECPE
Team 2 majors: 2 ELEC, 1 ECPE, 1 WIRE
Team 3 majors: 1 ECPE, 3 WIRE

Scores on the performance indicators (PIs), by team:
<table>
<thead>
<tr>
<th>Team 1</th>
<th>Team 2</th>
<th>Team 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>PI1 4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>PI2 3</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>PI3 3</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>PI4 3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>PI5 3</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

All teams met the primary success metric on all performance indicators, except for one team that scored 2 on PI2 (evaluate if design meets needs).

**How did you use findings for improvement?**
Adherence to engineering standards and multiple constraints was difficult to assess from the provided reports. More emphasis will be placed on this in future semesters, including a specific requirement to address these in the project proposal and in the design report.

The lowest scores occurred for PI2 (evaluate if a design meets desired needs.) This appears to be due to students emphasizing “getting it to work” toward the end of the semester, with less time available for formal evaluation of the project. More attention will be paid to the development of test plans in future semesters.

Presently, students in wireless engineering practice design in the lab ELEC 3060. This lab serves as the prerequisite for a more rigorous design experience in ELEC 4000/COMP 4710 Senior Design Project. At present, the Wireless Curriculum and Assessment Committee assesses the lab 3060 in the fall of even numbered years, and assesses ELEC 4000 in the fall of odd numbered years.

**Additional Comments**
The department’s Curriculum and Assessment Committee is revising how the assessment results are reported in an effort to provide more meaningful information and improve consistency across all courses and academic majors. The secondary success metric is seen to be of little use and will be discontinued. A better form for collecting performance indicator data for each assessed student in each assessed class has been prepared for future assessments so that data can be compared across courses and compared year by year.
**Assessment Method 2: Senior Exit Survey**

**Assessment Method Description**
Survey of graduating seniors; Provides quantifiable data with respect to student satisfaction with their preparation to attain outcomes. Students were asked how well they believed they achieved the Design Outcome, stated above. The rating scale was 5 (excellent), 4 (very good), 3 (good), 2 (fair), and 1 (poor).

**Findings**
Combining the Fall 2012, Spring 2013, and Summer 2013 surveys, there were responses from a total of 47 graduating seniors. Of these 47, 31 were in the Electrical Engineering program, 9 were in the Electrical Engineering (with Computer Option) program, 3 were in the Wireless program, and 4 were in dual major or degree programs, with one of the majors being WIRE. The aggregate scores for the Design Outcome question from these 47 students are as follows:
- 5 (excellent): 14 students (30%)
- 4 (very good): 17 students (36%)
- 3 (good): 11 students (23.4%)
- 2 (fair): 2 students (4.3%)
- 1 (poor): 2 students (4.3%)

**How did you use findings for improvement?**
Students tend to rate their abilities fairly high. However, for this Design Outcome assessment the scoring is lower relative to some of the other items assessed. This indicates a degree of unease in the students’ perceived ability to perform design tasks.

The department’s Curriculum and Assessment Committee provides these assessment results to the faculty and encourages them to craft better design opportunities for our students wherever possible.

**Additional Comments**
Presently, the survey instrument combines results for the various undergraduate programs in the Department of Electrical & Computer Engineering. The committee believes that the survey is most effective as a “flag” for poor performance and that the present aggregate data from our closely related programs is both useful and adequate. However, we will modify the survey instrument to allow breaking out results by program.
Expected Outcome 5: Teamwork

By the time of graduation from the program, graduates of the Wireless Engineering Program will have achieved and demonstrated an ability to function as a member of a multidisciplinary team in the solution of engineering problems.

Assessment Method 1: Course Data Collection

Assessment Method Description
Teamwork is introduced in the freshman year, and then emphasized throughout the curriculum by requiring team projects in several courses, building up to a significant multidisciplinary teamwork experience in the senior projects course. Thus, the primary collection of assessment data for teamwork comes from senior design projects.

A teamwork rubric is employed which features 8 performance indicators (PI): PI1 - Research and gather information, PI2 - Fulfill team role’s duties, PI3 - Share in the work of the team, PI4 - Listen to other teammates, PI5 - Cooperate with teammates, PI6 - Make fair decisions, PI7 - Receptive to feedback, PI8 - Express alternate points of view. A 4 point scale is used for each performance indicator on the rubric where scores of 1, 2, 3, 4 correspond to unsatisfactory, developing, meets expectations, and exceeds expectations, respectively. The preliminary assessment is carried out by the course instructor. The data is evaluated by the department’s Curriculum and Assessment Committee.

Primary success metric: at least 70% of students rate scores of at least a 3 on each PI.
Secondary success metric: no more than 10% of students rate below a 2 on each PI.

The Fall 2012 assessment for the teamwork outcome was carried out for 12 students in the Senior Design Projects course, ELEC 4000. Assessment results were not broken out by major, since it was clear that the primary success metric was met by all majors, with very few low scores. Students for each program were 5 ELEC, 3 ECPE, 3 WIRE and 1 dual major (ELEC/WIRE).

Findings
93% of the scores were 3’s and 4’s, with more 4’s than 3’s, and only a few isolated cases of 1 and 2 scores. Overall, there were only 7 instances of 1
scores, with most of these between two students, indicating a possible personality conflict. There were only 18 total instances of 2 scores (less than 5% of all scores), mostly for PI8 (expresses alternate viewpoints), and PI7 (receptive to feedback.) All success metrics were met for all performance indicators.

In general, good teamwork was observed for these three teams this semester, more so than for some teams observed in previous semesters. It appeared that all team members made significant contributions to each project.

**How did you use findings for improvement?**
The department makes a strong effort to develop teamwork skills for our students. Based on this and other assessment activities, the department’s Curriculum and Assessment Committee sees no need for action on this outcome at this time.

**Additional Comments**
The department’s Curriculum and Assessment Committee is revising how the assessment results are reported in an effort to provide more meaningful information and improve consistency across all courses and academic majors. The secondary success metric is seen to be of little use and will be discontinued. A better form for collecting performance indicator data for each assessed student in each assessed class has been prepared for future assessments so that data can be compared across courses and compared year by year.

**Assessment Method 2: Senior Exit Survey**

**Assessment Method Description**
Survey of graduating seniors. Provides quantifiable data with respect to student satisfaction with their preparation to attain outcomes. Students were asked how well they believed they achieved the Teamwork Outcome, stated above. The rating scale was 5 (excellent), 4 (very good), 3 (good), 2 (fair), and 1 (poor).

**Findings**
Teamwork is introduced in the freshman year, and then emphasized throughout the curriculum by requiring team projects in several courses, building up to a significant multidisciplinary teamwork experience in the senior projects course.

Combining the Fall 2012, Spring 2013, and Summer 2013 surveys, there
were responses from a total of 46 graduating seniors. Of these 46, 30 were in the Electrical Engineering program, 9 were in the Electrical Engineering (with Computer Option) program, 3 were in the Wireless program, and 4 were in dual major or degree programs, with one of the majors being WIRE. The aggregate scores for the Teamwork Outcome question from these 46 students are as follows:
5 (excellent): 24 students (52%)
4 (very good): 16 students (35%)
3 (good): 3 students (6.4%)
2 (fair): 2 students (4.3%)
1 (poor): 2 students (4.3%)

How did you use findings for improvement?
The department’s Curriculum and Assessment Committee believes the department provides many teaming opportunities for its students. The students appear to agree, with 87% ranking their abilities as good or excellent. At this time the committee feels no action need be taken.

Additional Comments
Presently, the survey instrument combines results for the various undergraduate programs in the Department of Electrical & Computer Engineering. The committee believes that the survey is most effective as a “flag” for poor performance and that the present aggregate data from our closely related programs is both useful and adequate. However, we will modify the survey instrument to allow breaking out results by program.