AC 2008-2086: PROGRESS IN ASSESSMENT OF GRADUATE ELECTRICAL AND COMPUTER ENGINEERING DEGREE PROGRAMS AT THE UNIVERSITY OF OKLAHOMA

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PROGRESS IN ASSESSMENT OF GRADUATE ELECTRICAL AND COMPUTER ENGINEERING DEGREE PROGRAMS AT THE UNIVERSITY OF OKLAHOMA

By G E Crain, James J Sluss, Jr, Monte P Tull, and Sam C Lee

Abstract

A new requirement for assessment of graduate programs at the University of Oklahoma was established in 2003. Program Goals and Program Objectives were established and reported in our earlier work. Outcomes of the Program Objectives can be measured with students active in the program. The tactical plan to assess the effectiveness of meeting the Objectives of Advanced Degree programs in Electrical and Computer Engineering is discussed in this paper. Key elements of the plan include1) identifying strategic opportunities for measurement,2) developing the instruments and processes to collect this data, 3) collection and review of the data and then reacting to those findings. This Work-in-Progress paper describes findings and indications from three years of data gathered with the procedure. Particular emphasis is placed here on assessing the effectiveness of the data-gathering instruments and taking corrective actions. This paper examines the data for consistency in indicating positive and negative qualities of the desired Outcomes. We also examine the methods of collecting the data and suggest means for improvement. Metrics discussed relate to Thesis and Dissertation producing student performances. This provides limited measurement of our non-thesis program. This paper will document suggested changes to the Assessment Plan respondent to the three years of experience to date.

1. Introduction:

Graduate Program Assessment is a fairly new academic process. Objectives and desired outcomes for the Electrical and Computer Engineering (ECE) program at the University of Oklahoma (OU) are well established and were published earlier [1]. Strategic and tactical action plans have been put in place to affect assessment of the Program. Instruments are in place for gathering 'Outcomes' data while students remain on this campus. Quantifiable interpretation of data from these instruments as strong, independent metrics of the program's success has yet to be accomplished. To date, primary focus has been on assessing progress of Thesis- and Dissertation-producing students. Positive trends on quantitative data are impacted by the significant productivity growth the program has undergone during the three years of data collection. Nonetheless, strong correlations among data from Students, Faculty and Administration are seen. Some changes to the program have been instituted as a result of this program assessment process.

2. Objectives, Outcomes and Strategic Actions

Three fundamental Objectives have been established and documented [1] by which we intend to assess the Graduate programs in Electrical and Computer Engineering at the University of Oklahoma. The specific Objectives listed in **Table 1** are considered to be strong indicators that the program is academically productive and that our students are being provided with the tools to successfully pursue their careers [2,3]. Specific strategies have been put in place to enable the Program to produce the desired outcomes to these objectives [4]. Administrative, faculty-provided, and student-provided assessment instruments have been established with which to measure the success of the outcomes listed in **Table 1**.

In support of the first Objective, Strategic Administrative guidelines have been established to assure that students are admitted with the appropriate credentials to succeed, that the program

offers graduate level coursework in the areas of research focus, and that the instructors offering these classes are productive and contributing to advancement of the focus technology.

Table 1 Program Objectives and Desired Outcomes for the OU ECE Graduate Program

Program Objectives: "Students will …	Desired Outcome Criteria: "Students will …
1) Demonstrate evidence of **Advanced Study"**	a) demonstrate appropriate undergraduate training"
	b) perform at advanced levels over undergraduates"
	c) posses skills and knowledge of current best practices in the field"
	d) be instructed by faculty actively engaged in advancing knowledge in the discipline"
2) Demonstrate evidence of **Focused Study"**	a) accumulate a core of factual, theoretical and historical knowledge"
	b) learn core problem solving strategies"
	c) learn to communicate with the public and other scholars regarding knowledge, outcomes, standards, products, ethics and behaviors"
3) Demonstrate evidence of **Scholarly Study"**	a) learn to engage in intellectual discourse with others in the discipline
	b) learn to identify and to acquire specialized knowledge needed for particular applications"
	c) learn to organize core knowledge, strategies, collegial associations and intellectual processes to solve problems"

The faculty and the program administration combine to strategically implement the second Objective. The Director, the Graduate Committee and faculty collaborate to assure that contemporary courses are offered in a manner sufficiently timely to enable students to contribute to research in their selected area of focused study. Core graduate courses that contribute broadly to the areas of research focus (i.e., Digital Signal Processing contributes broadly to Communications, Radar, Bio-Engineering and other technologies) will be offered on a more frequent basis. Faculty members are encouraged to include projects for deeper learning and opportunities for students to present their work orally to their classmates and their peers.

Students are given opportunities to and are strongly encouraged to publish and present their work in Scholarly fora. Students who engage in developing peer reviewed publications are given the greatest opportunity to focus their attention on contemporary problems in the discipline, to organize their work into clear and logical contributions, and to communicate their accomplishments to those accomplished. University, Departmental and Faculty resources must be made available to support these opportunities. Student publication records give evidence of the program's success in implementation of the third Program Objective.

3. Processes and Assessment Instruments
An annual assessment report of the Electrical and Computer Engineering (ECE) Graduate Program is submitted to the Oklahoma State Regents for Higher Education (OSRHE). The purpose of this report is to quantitatively assess the progress made toward meeting the Objectives of the program by using data from performance during the Academic Year. ECE offers four

advanced degrees. The Master of Science in Electrical and Computer Engineering (MSECE) is available with and without thesis as an option. The MSECE is offered as an accelerated program to top undergraduates in a way that allows them to complete both the BS in Computer Engineering and the MSECE in five-years. The Master of Science in Telecommunications Systems includes a comprehensive project, usually industry sponsored.   The MS T-Com is principally taught by faculty at OU-Tulsa, but many of the courses are shared between the two campuses via video conferencing. Students from both the Norman and Tulsa campuses can pursue the PhD in Electrical Engineering.

Assessment of the ECE graduate program is carried out at both campuses. Student admissions are overseen by a single Graduate Committee consisting of faculty and students from both campuses. Student and faculty inputs to assessment protocols are equally solicited at both sites. Metrics for success are independent of campus or degree sought.

Faculty input is sought in assessing all graduate students' annual progress toward the degree. Summary assessment of research students' ability to produce focused and scholarly study is solicited with questions listed in **Table 2**. These results have been gathered for three years and the results are discussed in **Section 4**.

Table 2. ECE Graduate Advisory Committee Survey solicited at completion of each Thesis and Dissertation defense.

Please briefly deliberate and answer the following questions and rate progress as 1-thru-10	
Regarding Demonstrating Evidence of **Focused Study**	Has the student accumulated a core of factual, theoretical and historical knowledge?
	Has the student learned core problem solving strategies?
Regarding Demonstrating Evidence of **Scholarly Study**	Has the student learned how to identify and acquire specialized knowledge needed for particular applications?
	Has the student learned how to organize core knowledge, strategies, colleagues, and intellectual processes to solve problems?

Each Thesis and Dissertation producing student completes a comprehensive Exit Interview (ExI) survey. Specific questions solicit quantitative assessment of opportunities and successes in the areas of Advanced, Focused, and Scholarly Study. They are asked to provide bibliographic information of papers and proceedings written and presented during their tenure in the program. Optional questions solicit the student's assessment of facilities, career preparation, and Professional activities in the program. Questions specific to the ECE Program Objectives are listed in **Table 3**.

Data from these Exit Interviews have been gathered for three academic years. Student responses have been both comprehensive and considered. Quantitative and qualitative data from these solicitations are discussed in **Section 4**.

4. Assessment Data and Early Trend Observations

Assessment is a continuing process with semester-by-semester involvement of the Faculty, the Administrative staff and the Students of the program. The vehicles mentioned above give explicit feedback of in-progress and at-completion accomplishments of these three groups as it affects the measurable outcomes of our Program. Much of the assessment material is made with significant involvement and effort by members of the Graduate Committee and by the Advisory

Committees for individual students. Roles and information provided are described in **Tables 4, 5 and 6** with regard to each program Outcome. At the end of the second year of data collection, we can see some qualitative capabilities and trends regarding the effectiveness of our process. These are highlighted in the following paragraphs

Table 3. Exit Interview questions directly related to ECE Program Objectives

Student: On a scale of 1-10, please respond to the following questions	
Regarding **Advanced Study**	Do you think your undergraduate degree program adequately prepared you for graduate studies in ECE?
	Do you think the skills and knowledge imparted to you throughout graduate-level coursework represent the current best practice and knowledge in the field?
	Are you satisfied with the intellectual environment promoted in the classroom by faculty?
Regarding **Focused Study**	Do you think you succeeded in gaining a solid factual, theoretical and historical knowledge base in a core area of study? Why or why not?
	Do you think you succeeded in learning core problem solving strategies? Why or why not?
	What were the most useful opportunities/experiences for you to improve your technical communication skills?
Regarding **Scholarly Study**	Please provide the bibliographic information for any conference papers you presented
	Please provide the bibliographic information for any journal and/or conference papers you authored or co-authored.

Evidence of students' Advanced Study accomplishments is gained from the activities described in **Table 4**. Outcomes from this objective are heavily impacted by recruitment of excellent students, by timely offering of core and contemporary courses, and by engagement of our faculty in research. Procedures are in place for evaluating applicant qualifications and scheduling course offerings. Administration's role in this is to monitor the factual data and make this information available to the Graduate Committee and the ECE faculty. Faculty have the responsibility of sponsoring research and bringing their research into the classroom.

Table 4: Assessment methods for *Evidence of Advanced Study*

Outcome: Students will:	**Source**	**Method**
a) Demonstrate appropriate undergraduate training	Admin	Track entering GRE and GPA levels
	Faculty	Identify supplementary course requirements
	Students	Exit Interview
b) Performance assessed at advanced levels	Faculty	Additional requirements for 4/5xxx courses
	Admin	Corrective action for GPA less than 3.0
c) Be versed in current best practices	Admin	Monitor student performance across curriculum
	Students	Comment on effective elements of curriculum
d) Be instructed by active researchers	Admin	All instructors are members of Graduate Faculty
		Monitor Faculty Publications and Research rates

Maintaining a qualified set of instructors for offering our graduate courses has been accomplished even with rather large changes in faculty count and composition. These changes do provide great opportunity for offering new contemporary courses. Integrating these into degree plans required development and communication of a multi-year class offering plan. Although student quality and faculty research productivity have both improved steadily over the past decade, quantifiable assessment of outcomes (especially **a** and **d**) in **Table 4** would be greatly enhanced by benchmarking peer institutions in equivalent performance.

Accomplishment of successful **Focused Study** outcomes includes, but extends beyond, solid curriculum development in combination with a comprehensive plan of study. Administration can facilitate the coursework and gather data. However, it is faculty involvement and student initiative that truly determines success of outcomes in this area. Three years of gathering data also provides qualitative feedback to the processes now in place, as described below.

Table 5: Assessment methods for *Evidence of Focused Study*

Outcome: Students will:	Source	Method
a) gain core of factual, theoretical and historical knowledge	Admin	Assure timely course offerings
	Faculty	Evaluate advisee's breadth of knowledge
	Students	Exit Interview (ExI) assessment of core curriculum
b) learn core problem solving strategies	Faculty	Evaluate advisee's problem solving skills
	Students	ExI comment: effective Problem Solving Experiences
c) learn to communicate with public and scholars	Admin	Track Research Seminar Agendae
	Faculty	Identify comm. events in syllabi and seminars
	Students	ExI comments: Bibliographical list of contributions

Key outcomes of the focused study objective are the student's ability to solve significant problems and their having opportunity to effectively communicate the results. OU ECE Programs involve a number of research sub-groups such as Telecommunications, Solid State, and Signal/Image Processing, etc. We also have number of multi-disciplinary faculty (Bio-Engineering, Radar, Advanced Controls, and Energy) who collaborate heavily with schools inside and outside the College of Engineering. The majority of these sub-groups have established specialized seminar series that provide regularly scheduled opportunities for faculty and students to present and discuss their research. Students report that having opportunity to hear speakers in their specific area of interest and to present their own work to them contributes heavily to successful experiences in outcomes b and c, above. Faculty Advisory Committee assessment of thesis/dissertation students corroborate the effectively learned capabilities of these students.

Accomplishment of successful **Scholarly Study** outcomes requires students to publish and to become engaged in scholarly dialogue. They must do research then organize, report, and defend their findings. The Administration's role in assessing outcomes in this area is one of facilitating faculty/student exchanges and then monitoring and reporting the results. Faculty are given direct opportunity to advise and guide students through these process and to assess their progress each semester and summarily on completion of the degree.

Research students (not non-thesis MS) very strongly report that their research experience contributed heavily to their ability (or confidence in that ability) to solve problems. Being given responsibility for producing results is an effective means for their learning and gaining an

appreciation for this skill. Faculty research productivity has a heavy impact on establishing opportunities for students to do research and to participate in publication of their work. Faculty research expenditures and publication rates have been an area of continuous improvement. The growing research program has had a significant impact on the number of research assistantships available. Student involvement in publications continues to trend upward. Faculty summary assessment of student problem solving and communications abilities tends to be lower for research students than they assess their core learning accomplishments.

Table 6: Assessment methods for *Evidence of Scholarly Study*

Outcome: Students will:	Source	Method
a) learn to engage in intellectual discourse	Admin	Monitor Faculty/Student Publications Records
	Faculty	Provide research opportunities and set expectations
	Students	ExI evidence
b) acquire specialized knowledge	Admin	Administer Assessments and report problems
	Faculty	Progress toward Degree Assessments
	Students	Progress toward Degree Assessments
c) learn to organize and solve problems	Admin	Facilitate exams, record and evaluate
	Faculty	Assess(Qual/Comprehensive Exams, Defense)
	Students	ExI Commentary

5. Trends, Observations and Changes Data collected from the above described process has been taken for the past three years. To date, all trends have been positive. This is in part due to the significant growth in degree, research expenditure and publications productivity over the same period.

5.1 Evidence of Advanced Study: Demonstrations of students' being capable of Advanced Study continues to show good controls on selection of students and in their being offered courses in contemporary areas. Statistical values for entry level Grade Point Averages and GRE Scores for both MS and PhD applicants who have accepted and entered into the program have not varied significantly over the past three years. Faculty have continued to modernize and offer new advanced courses. Four new graduate level courses were added to the catalogue in AY07: all in the areas of faculty research strengths.

Production of refereed Journal Publications and Conference Papers has improved by 50% in the last four years. This increase is due in large part to the increased participation by our students. Students' roles in research are fostered by a similarly significant growth in research expenditures of the faculty. Increased sponsorship of our students has also increased the percentage of Thesis vs Non-Thesis students in the MS program.

5.2 Evidence of Focused Study: Faculty assessments of graduating students' abilities to accumulate core knowledge, and to demonstrate problem solving skills have both trended up significantly over the past three years (7.8 to 8.7 and 7.9 to 8.9, respectively). These improvements are influenced by the student participation in sponsored activities in the research labs, and by the availability of more courses that relate to faculty research areas. Data for these assessment criteria are only gathered from MS and PhD candidates at the time of completion of their Thesis or Dissertation. However, the number of Non-Thesis MS students has decreased significantly (below 25% in AY07) so this data represents a substantial percentage of our graduate students.

5.3 Evidence of Scholarly Study: Students report satisfaction with research experience in gaining knowledge and in solving problems. Faculty perception of students depth of knowledge in their research areas and ability to solve contemporary problems have both trended up strongly in the past three years (8.3 to 9.5 and 8.1 to 8.8, respectively)

Exiting candidates in AY07 self reported twelve Journal Publications and nine conference publications with ten of the fourteen graduates producing at least one of these. Faculty in major research areas such as Solid State, Telecommunications, BioEngineering and Radar have developed seminar series' at which our students at all levels present their research work to their peers each semester. This has also been a major factor in encouraging the students to publish and participate in national conferences.

The ECE Faculty has recently voted to add a requirement for each PhD candidate to submit a publication for national peer review prior to their General Examination.

6. Conclusions and Recommendations

Assessment activities to date have heavily focused on outcomes from performance of Thesis- and Dissertation-producing students. This group is perceived to have the largest impact on the success of the OU ECE graduate program. Thesis/Dissertation producing students currently represent the significant majority of students. The assessment process will be extended to better assess the effectiveness of the coursework-only segment of the program.

Development of quantitative assessment factors remains a cumbersome process. Positive trends in quantitative data to date have served as a valuable indication of growth of the productivity of our scholastic program. Quantities now in place will clearly level off in the near future, and boundaries must be determined to serve as thresholds for statistical indication of decrease in quality. Responses to qualitative questions continue to be important as indicators of needs for change.

Data gathered from the first three years of survey materials and their correlation with meeting the established Objectives of the program – as measurable only with graduated students - has yet to be accomplished. Assessment of Objectives requires significant feedback from students who have been in practice away from the program for several years. Plans to comprehensively gather alumni data and to correlate Outcome measures to Objective are in progress.

Setting numerical objectives for a number of key measurement parameters would be greatly enhanced by comparing them to benchmarked performance by peer institutions. Graduate Program assessment is a fairly new endeavor at this university, and we find little external evidence with which to compare our work. We look forward to dialogue with those who are engaged in this area at other institutions and to working with others to establish a basis for meaningful benchmarks.

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