New Mexico State University
Engineering Physics External Advisory Board
2017 Report

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Engineering Physics External Advisory Board (EPEAB) 2017 Membership

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Executive Summary

2018 EP External Advisory Board Meeting, Charter, and Membership

The Engineering Physics External Advisory Board (EPEAB) convened for its ninth meeting on Friday and Saturday, April 28th and 29th, 2017. The meeting was hosted by the Physics Department, and held in Gardiner Hall on the main campus of New Mexico State University (NMSU) in Las Cruces, New Mexico. Additionally, the EPEAB reviewed the EP Program Committee's responses to the 2016 recommendations.

The standing charter of the EPEAB is to:

1. Review the current policies and procedures within the program and within the university administration in order to identify strengths and weaknesses.
2. Identify issues of concern within the program, the department and the university that directly affect the EP Program, and make recommendations for improvement.
3. Identify potential opportunities and threats to future of the EP Program.
4. Evaluate whether the EP Program achieves its stated Program Educational Objectives.
5. Prepare a report to be presented to the EP Program Committee and for distribution to the deans, and Provost.

The 2017 EPEAB is additionally requested to comment on the program's preparations and readiness for the upcoming re-accreditation audit of the EP program by ABET[1].

The EPEAB represents the various constituencies served by the EP Program, with representatives from academia, federal science laboratories, industry, and program alumni. Additionally, the EPEAB has both in-state, and out-of-state representation, with both continuous long-term and new membership.

The NMSU Engineering Physics Program was inaugurated in 2001, produced its first graduate in 2004, and gained ABET accreditation in 2007. To date, the program has produced 46 graduates and currently has 38 enrolled (down from a program high of 45 in April of 2016). With the exception of 2016-2017, the program has demonstrated an approximately 10% annual growth rate. EP is a very difficult degree program, and each year a number of students choose to convert to either a focused engineering degree, or physics; a few leave to other departments. However, the most recent year under review reflected a greater loss of 20 students (combined with enrollment gains yielding a net enrollment loss of seven). This appears to be the result of more students being lured towards engineering programs offering greater scholarship opportunities, which generally do not support EP students. While disappointing, this was not interpreted as a weakness in the EP Program's curricula or outcomes.

[1] Accreditation Board for Engineering and Technology, Inc.

The NMSU Physics faculty and EP Program Committee should be commended for maintaining a program of high educational and scientific content for the benefit of NMSU students, and for that matter, the State of New Mexico. This in spite of many challenges.

Program Strengths

Achieving Program Educational Objectives

The data and metrics reviewed point to a very successful EP program. The NMSU EP Program Committee continues to demonstrate good stewardship of the Program through its efforts. Of particular importance is the Program's proactive assessment of student feedback and attention to the details of changing curricula in connected departments, making course content adjustments as necessary. The EPEAB was presented with many good examples of student academic successes and students' ability to find employment in scientific or technical organizations. Recent graduates are engaged in advanced degree programs at very respectable scientific or engineering schools, or employed in industry, academic, or research lab positions.

The EP Program has three educational Objectives:

***EP Objective 1*: Competitiveness.** *Graduates are competitive in internationally recognized academic, government, and industrial environments.*

The EP Program continues to attract top students into its challenging curriculum, with approximately one-quarter each of EP Program graduates engaged in graduate-level academic programs, government-related careers, and industrial or business environments (others are teaching or unknown). Unemployment in science and engineering fields is generally low. EP Program graduation rates have been trending with enrollment, indicating good retention (with the exception of 2017, noted above), with career choices for graduating EP students more diverse than for either physics or engineering graduates[2].

***EP Objective 2*: Adaptability.** *Graduates exhibit success in solving complex technical problems in a broad range of disciplines subject to quality engineering processes.*

EP Program graduates are entering advanced courses of study, and being hired into a diverse selection of high-tech jobs in industry and government laboratories, with some engaged in entrepreneurship. The employment rates and diversity of opportunities not only demonstrate that the goals of the program are being met, but this also addresses the goals of NMSU. Engineering Physics graduates demonstrate ongoing contributions to New Mexico and the nation with greater economic impact. More than 10% of the employed (i.e., not continuing in a program of study) EP graduates report Systems Engineer as their current job title, indicating an interdisciplinary career; the remainder report 16 additional job titles, highlighting the diversity of professional opportunity open to EP graduates.

[2] EP Program reported graduation and post-graduate employment statistics

***EP Objective 3*: Teamwork and Leadership.** *Graduates have a proven ability to function as part of and/or lead interdisciplinary teams.*

In this area, students with EP preparation excel. Preparation for leadership of interdisciplinary teams is a generally neglected element of university preparation for engineering and science careers. Simultaneously, the ability to lead interdisciplinary teams and perform complex system integration functions are among the most necessary skills for the success of large engineering and science development projects. EP Program graduates are well-prepared to address this gap. Recent Program statistics record that more than 20% of program graduates list supervisory duties and greater than 90% report working in team environments.

In addition to the program-specific educational objectives discussed above, The EP Program contributes towards the broader land-grant institutional objectives of NMSU.

As stated by the EP Program:

> *"The Mission of Engineering Physics at New Mexico State University is to offer an accredited degree that combines high-quality engineering and physics programs to best prepare our graduating students for careers in state-of-the-art industry or to move to advanced study in engineering or physics"*

Continued faculty and College commitment to EP Program

EP is a small program compared with major initiatives in the College of Engineering or College of Arts and Sciences. During discussions with University Management (Deans from both the Engineering College and College of Arts and Sciences), and Engineering and Physics Department Faculty, it was clear that that the value of EP to the University is recognized.

The Chair of the EP Program Committee is leading an effort to develop a multi-disciplinary capstone course option. While capstone courses generally address the importance of project management, they often fail to address the necessity of integrating disciplines. The EPEAB supports this effort which would help address the growing need for interdisciplinary development projects and complex systems integration.

Student Satisfaction

The EP Program has better than average retention rates: close to 50% of incoming freshmen remain and graduate in EP, outperforming other departments at NMSU. Typically, program graduates move on to advanced study in either physics or engineering graduate programs, or to careers in industry. Job placement and graduate school admission rates are both above 90%. Both committee interviews and senior exit interviews indicate student satisfaction with the program supported by the following statistics: 70% of graduates are employed immediately upon graduation (80% within 3 months, and 100%

within 6 months), with $70k average salary, and 90% currently employed in a science or engineering field.

Threats and Recommendations for Improvement

While the EP Program demonstrates the characteristics of a strong functional program, the EPEAB highlights several threats to continued success, and offers its recommendations for improvement.

Budgets, lean-overheads, student internships, and other support

Issue 1 (general budget erosion): As discussed at last year's EPEAB, budget pressures at NMSU continue to be a major impediment to EP Program growth. The faculty is now performing most administrative support functions within the Department of Physics. In last-year's recommendations, EP coordination funding by University administration was explicitly called out as important to the EP Program's future. Nevertheless, this support does not seem likely in the near future. The status of student internships is also unchanged from last year. Internships, where students gain research experience in areas of relevance to their professional interests, are definitely correlated with employment potential and performance. This is a key element of experiential learning, and is important to ABET accreditation. The impetus here clearly rests with the faculty through professional contacts, their research grants, etc. This ties back to major points of discussion at last year's EPEAB and the discussion this year on Responses to the 2016 EPEAB recommendations. Specifically, enhancing research revenues in support of faculty and students.

Recommendations: As discussed last year, there are several avenues available to increase research revenue: **First**, increasing success at competing for government or private industry research grants. **Second**, forming strategic partnerships with New Mexico government and industrial research institutions. **Third**, increasing competitiveness among EP students for nationally sponsored scholarships and fellowships. These avenues have a higher probability of success when the effort is shared with an engaged administration. With respect to the former, professors in Physics, as in the Engineering Departments, are putting significant effort into grant writing with demonstrated successes. How the "success rate" for grant proposals could be increased should be a strategic discussion among the Department Faculty. The "hit-rate" for success can always be improved by coordinated red-teaming reviews, for example. For the second point, regarding the government sector, the two largest National Laboratories in the US are in New Mexico. While there presently exists several examples of collaboration between Los Alamos and Sandia research staff and NMSU faculty, continued effort must be devoted to developing additional strategic alliances. Both Los Alamos and Sandia face staff demographics where approximately 25% of the work force will have to be replaced over the next 5 years (e.g. 2000 employees at Los Alamos). Significant hiring across all Laboratory functionalities (technical staff, support staff, etc.) will require significant recruiting. As noted last year, NMSU, specifically the EP Program, should position itself as an important skilled labor source for this purpose. This effort must be initiated at all levels of NMSU leadership – at the Department level, the College level, and especially from the Vice President for Research.

Regarding the third point, most of the National Laboratories, military research laboratories, and NASA centers sponsor scholarships and fellowships, some of which lead to co-op opportunities and/or permanent employment with the sponsoring agency. EP faculty would be well served to become fully aware of these opportunities and coordinate with one another and with stellar EP students for timely and well written application packages, recommendation letters, etc.

Issue 2 (strategic partnerships): There was notable disappointment on the waning of previous partnerships at Los Alamos and Sandia. These partnerships offer valuable student research opportunities, but are very "personality driven" and success in future partnerships will depend strongly on individual professors developing collaborations with scientific staff and groups within the National Laboratories. This can start as an application for research time at a NM-based National user facility like the Los Alamos Neutron Science Center (LANSCE) or the Center for Integrated Nanotechnologies (CINT) and then evolve from there.

Recommendation 1: A second avenue for an NMSU Strategic Alliance with Los Alamos is through the contract re-competition process slated to begin in 2018. Here, the NMSU administration should seek a strategic partnership with Los Alamos by exploring opportunities with the National Nuclear Security Administration (NNSA), and with New Mexico's congressional delegation towards National Laboratory support of New Mexico institutions of higher education through research and teaching partnerships. These, or similar institutional activities, are somewhat beyond EP Program or departmental responsibility, needing advocacy at the Vice President for Research level. Additionally, the department chairs can advocate for this within their colleges and at broader faculty forums.

As reported by the EP Program, student participation in research does appear to be recovering from its low ebb of 2015-2017. However, the survey response rate was not ideal. The EPEAB continues to stress the important role undergraduate research opportunities play in experiential learning, and future employability for students looking to enter the workforce upon graduation. Metrics of participation and opportunity would help to focus future efforts to improve student opportunities.

Recommendation 2: Identify ways to improve the tracking and reporting of student research opportunities offered and taken.

Finally, one response from last-year's EPEAB report stood out: "The [National] labs tend to hire from institutions that have a stronger research infrastructure … our students and faculty have a difficult time competing with prestigious out-of-state universities." It would be worthwhile for future EPEAB committees or Department of Physics advisory committees to consider this issue. From the EPEAB members own experiences at Los Alamos, Sandia, AFRL and NASA, there were many research venues where NMSU faculty or students provided a level of competence and value that was unsurpassed.

Issue 3 (administrative support burden): In 2016, the EPEAB Committee highlighted the increasing need for funding administrative support to the growing EP Program. Due to university budget cuts and other realignments, the Physics Department reported that

additional cuts are likely, and even maintaining the lean status quo, may not be achievable. The EPEAB sees this as the most significant emergent threat to continued program accreditation.

EP is a complex program. While this comes with high overhead demands, as previously demonstrated, it also produces greater positive impacts economically, and technologically. EP is integrated across two colleges, and multiple disciplines, and is accredited. Maintaining accreditation represents a significant overhead which is currently borne by faculty who also teach, perform complex research, and mentor. These challenges, along with the need to maintain outside relationships and foster student opportunities, can be burdensome and ultimately damaging to the success of the program and the university mission.

Recommendation: The EPEAB again recommends that the University administration recognize the return on investment afforded by the EP Program and find additional resources to improve EP Program coordination.

Academic advising: course scheduling, credit requirements and pre-requisites

Issue 1: Engineering Physics is a small program compared with major initiatives in the College of Engineering or in the College of Arts and Sciences. As noted in previous EPEAB reports, University Management (Deans, Administrators, Department Faculty) understand the value of EP to the students, department of physics, and NMSU. Nevertheless, small operational issues do affect small programs and EP students have expressed concerns about class availability, pre-requisite requirements, and course phasing. These concerns should be on the radar of the administration. Specifically, the availability of core courses and associated pre-requisites directly affects the time required to complete the EP degree. In most EP focus areas, there is virtually no way to accommodate a semester slip of a "critical path course" (e.g. for an internship opportunity), without delaying the degree by one year. The physics department is working hard to help students navigate the required EP course schedules. However, continued communication with the College of Engineering - Deans and Faculty - remains important, particularly as departments re-rack course schedules to best accommodate curriculum or credit requirement changes.

Issue 2: A possible change to centralized campus-wide advising is underway at NMSU. While there are identified benefits for this centralization, the downside for the complex Engineering Physics curriculum is concerning, specifically regarding the issues discussed above, including course scheduling, satisfying pre-requisites, and meeting credit requirements by negotiating "equivalent" courses. The college Deans seem to understand the importance of expert counseling in complex programs like EP. Efforts are underway to define faculty points of contact (POC) between students and centralized advisement. The Physics faculty report that 10% of EP students come to them with a good plan, where the remaining 90% need help negotiating the complex pathway through the degree track.

Student feedback on this proposed change indicated strong apprehension. Because of the complexity of the EP degree, EP Students are concerned that general advisors won't

understand what individual students need in terms of preparation to pursue the technical focus that is of special interest to them. Another student comment was that some courses appear the same, but really are not for the purpose of a specialized career path.

Recommendation: These POC positions will retain important perspectives for student course scheduling, and their role should be *formally* recognized and defined as part of the University's centralized advisement rollout. A key aspect of this is for in-department academic advisors to retain the ability to place academic registrations holds on students to ensure they are on the right track. The best solution may be to retain academic advising for EP students within the EP Program Faculty. In short, while the EPEAB is not opposed to centralized academic advising for EP students, it should not be seen as a substitute for in-department advising.

Positive Observation

During EP committee presentations, some laudable curricula modification successes were presented that derive from the important capstone program, where students benefit from cross-disciplinary teaming with other engineering departments to solve problems. In several EP focus areas, there now appears to be flexibility in meeting Capstone pre-requisites within College of Engineering Departments. This "Engineering-wide Capstone" initiative should be applauded.

University-wide effort to reduce credit hours necessary for degree completion (continued from 2016)

Issue: A proposal is under consideration requiring reduction in the minimum number of credit hours required for graduation for all programs at NMSU (and other NM Universities). The current EP requirement is 128 credits, which is proposed to be reduced to 120. This one-size-fits-all proposition is purportedly directed toward making any degree achievable in four years.

This potential threat to the EP Program was addressed in 2016, and again in 2017, as many university departments sought ways to reduce course requirements. Significant discussion took place in 2017 between the faculty and EPEAB, and between the EPEAB and University Management.

Engineering Physics is among the most challenging disciplines in which to achieve a degree, and attracts the brightest and most self-motivated students. The success of program graduates and their contributions to constituencies is evidenced by the breath of high-tech positions held by graduates, as well as the high salaries they command.

EPEAB conversations with Faculty and Deans indicated a disconnection between the perceived "mandate" of this proposal. As made clear in the 2016 report of the EPEAB, any reduction to core engineering or physics content would risk material damage to student preparation, and place the program's ABET accreditation at risk. The EPEAB was reassured by our 2017 conversation with the Deans that the Engineering College and the College of Arts and Sciences will not force the EP program to meet the 120-hour goal for

graduation, but rather that a good faith effort to examine the curriculum to reduce content where appropriate was expected. This was a major issue at the 2016 EPEAB meeting, and appears to be a positive step forward in 2017. The EPEAB feels that the EP Program has applied due diligence to this request. It should be noted that in the case of EP, the ABET requirements for course feedback combined with the proactive faculty attention to Program curricula in light of changes to engineering and physics courses uncover redundancies which are quickly eliminated.

2016 EP Program statistics show that the average number of credits earned by a BSEP graduate is 168, with only one student graduating with fewer than 130 credits. A primary reason for this, cited by students, is self-election to acquire additional minors, particularly in math, which only requires two additional courses, or professional interest in technical areas. Other students opt for double majors.

The EPEAB discussed the likelihood of reducing General Education/ Viewing the Wider World (GenEd/VWW) credits. It was explained to the EPEAB that changes to GenEd/VWW were still under consideration by a university-wide task force, which has yet to complete its work.

Recommendation: As this situation continues to work itself out, the EPEAB continues to strongly recommend against deleting any core engineering or science requirements from the curricula for the various Engineering Physics disciplines.

Upcoming ABET re-accreditation

Issue: The EP Program will be audited for regular re-accreditation in the Fall of 2018.

The NMSU EP Program stands out as both a university asset and as a national asset. A particular strength observed by the EPEAB is the high-quality involvement of the Physics Department and the several Engineering Departments. The diversity of departments offering EP tracks, and the extensive coordination among the faculty add to this strength. Of particular note are the department heads and those who play special roles to make EP a model program. The Board's interactions with EP students during the review left the strong impression that these students are dedicated, bright, and have well-developed technical problem-solving skills.

Overall, the EPEAB feels that the NMSU EP Program is well positioned for success in the upcoming re-accreditation audit. In addition to addressing the specific threats and opportunities highlighted above, the EPEAB offers the following minor observations that will help with the upcoming re-accreditation effort.

1. Course designations: Ensure that for all EP tracks, that course designations are clear to ABET prior to the audit. In some cases, it is not always clear when a specific course is a physics course or an engineering course. One example of this is the accounting of PHYS 451 (which employs a classic physics textbook) as an engineering course.
2. Experiential Learning: Experiential Learning is a strategic focus at NMSU. ABET

outcomes are strongly linked to elements of experiential learning. An especially effective component of undergraduate experiential learning that is valued by prospective employers is student participation in internships. Ensure that this element is highlighted with examples in the ABET self-study report. Also, continue to find means to expand, support, enable, and track EP student internship opportunities.

3. Readiness for change to ABET outcomes: In 2019, ABET will change its outcomes assessment process, moving from the list of 11 items (a. through k.) to seven focus areas. Careful attention will be paid to outcomes definitions. Ensure that the current crosswalk of how each element is currently met is consistent with the new focus areas, and that records are kept to demonstrate those outcomes.