Student Recruitment, Retention and Employment Placement at New Mexico State University for the Future Power Systems Workforce.

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Abstract: **The Electric Utility Management Program (EUMP) at the New Mexico State University (NMSU) is in its 51st year of operation. Its mission is to educate power system engineers who understand the engineering aspects of Electric Power Systems, as well as its complexities related to the economics, management, and societal aspects of Power Engineering. This paper discusses current recruitment, retention and employment placement strategies and results of this program.**

I. Introduction

Growing world population places growing demands on electricity and energy supply. In order to meet this growing demand, electrical systems continue to undergo dramatic changes, which provide unparalleled opportunities for improved economy, efficiency and durability, but which can also create significant challenges. This, in turn, requires a diverse and multi-cultural workforce educated in traditional power systems, as well as prepared to engineer, finance and regulate power systems with ever-growing deployment of renewable energy sources, electrification of non-traditional sectors such as transportation, and 'smart' utilization of energy.

Teaching and advising students are of paramount importance and should be a key part of being an academic teacher. Instructors can have a major impact on the development of future engineers with undergraduate courses. The nature of the curriculum of undergraduate courses, as well as the presentation approach, can attract (or turn away) students in current and future learning. Likewise, it is of key importance to recruit and retain a diverse student population.

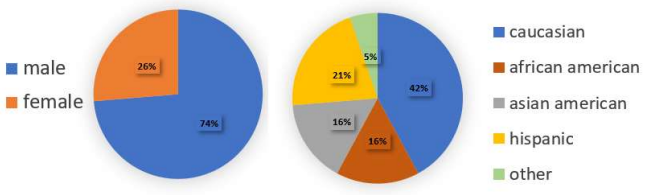

Fig. 1. Students demographics of the Power Systems Track students at NMSU (Fall 2019 data)

II. Recruitment and Retention Approach

NMSU is a Hispanic-Serving Institution (HSI) and, as such, already has a solid basis for minority student outreach and recruitment. Both NMSU and the College of Engineering at NMSU engage in a broad recruitment activities with professional societies such as the National Society of Black Engineers (NSBE), Society of Hispanic Professional Engineers (SHIP), and the Society of Women Engineers (SWE).

Other recruitment activities extend to participation in local and nation-wide competitions with specific goal of brining awareness to power and energy skills. For example, NMSU hosted this year's Boosting Engineering Science and Technology (BEST) STEM competition challenge. Specifically, this year's challenge was focused on the electric grid. HS and MS students had to design and built robots to restore and/or replace damaged conductor following a natural disaster. Photos from this competition are shown in Figure 2.

Fig. 2. NMSU BEST STEM competition challenge participants

A. Electric Utility Management Program.

The Electric Utility Management Program (EUMP) was created by Electric Utilities and Prof. Kersting in 1968 with the mission to educate power system engineers who understand the engineering aspects of Electric Power Systems, as well as the complexities related to the economics, management, and societal aspects of Power Engineering. Prof. Kersting credits the founding of EUMP to two major events. The 1967 blackout;

and a prescient speech by Tom Fort, a General Electric VP, titled ”Who will fill Johnny’s Chair?”. Fort challenged the academic community and industry to find innovative approaches to (power) engineering education. Kersting, along with the leaders of several power companies created a program in which industry funding allowed students to receive financial support towards the MSEE degree. EUMP is currently in its 51st year of teaching and training students. In all these 51 years, sponsors have given generously of their time and resources. The program has graduated 340 students. Roughly 67% of those receiving fellowships and 53% of all power area graduate students started their professional careers with a sponsoring company.

The vision of our Energy Systems area is to provide programs in Electric Energy Systems-related education, research and outreach that provide the highest value to our stakeholders. The principal purpose of EUMP is to train a diverse workforce for the members in particular and the power industry in general. Success is measured objectively: - Are the members able to find suitable graduates for their needs? Can members participate as partners in attracting and training these students? Do our graduates succeed?

B. Traditional Power and Renewable Energy.

Traditional power applications have long been signaling an alarm that currently employed workforce is ageing [1,2] and that hiring of younger workers is problematic. The problem is not unique to the US, and is echoed in other countries around the world [2,3]. Therefore, it is extremely important to graduate students who have a solid foundation in traditional power systems.

Energy and the environment attract tremendous amount of attention from young scholars and activists, from K-12 through graduate school. It is clear that additional renewable and alternative energy education will attract additional sector of students interested in sustainable and renewable energy technologies.

In order to meet both requirements above, EUMP has developed a rigorous and broad educational curriculum described in the next section.

D. Teaching Power Systems, Power Electronics and Renewable Energy classes.

The MSEE degree requires 30 Credit Hours and can be completed in 3 semesters. It is not uncommon for students to take an additional class in economics to complete a minor in regulatory economics within the three semester time frame. Depending on the student’s background additional credits may be required. However, each student has considerable liberty in selecting classes of interest to her or him. We continue to graduate students who ‘can hit the ground running’ as engineers, but have a broad exposure to grow into leadership positions.

The following classes are available to students:

EE391. Introduction to Electric Power Engineering 4 cr.
EE531: Power System Modeling and Computational Methods.
EE 532: Dynamics of Power Systems, 3 cr.
EE 533: Power System Operation, 3 cr.
EE 534: Power System Relaying, 3 cr.
E 537: Power Electronics, 3 cr.
EE 542: Power Systems II, 3 cr.
EE 543: Power Systems III, 3 cr.
EE 544: Distribution Systems, 3 cr.
ECON 571. Regulatory Policy and Industry Analysis:
ECON 572. Regulatory Policy and Industrial Analysis: Water and Natural Gas 3 cr.
ECON 573. Regulatory Policy and Industry Analysis: Electricity II 3 cr.
ECON 574. Advanced Seminar Regulatory Policy and Industry Analysis 3 cr.
EE 584: Photovoltaics Devices and Systems
EE 590ST: Smart Grid Technologies, 3 cr.
EE 590ST: Numerical Modeling Methods for Smart Grids.

In each of the classes that we teach, our primary goals are:

(1) to provide students with the most detailed technical description of the subject matter and to describe the relevant engineering fields of this content;

(2) to equip students with analytical techniques and appropriate computer methods to analyze new problems they will encounter in their future professional life;;

(3) to evaluate students’ assignments honestly and fairly;

(4) to help them to develop broader skills, such as critical thinking, efficient communications, and ethical views;

(4) and to motivate students to stay interested in pursuing continuous learning in their chosen fields by exposing them to a variety of engineering issues.

III. Teaching Methodology

A. Modern classroom approach.

The engineering job market is changing at a much faster rate than the engineering education. Therefore, in teaching engineering classes, we must strive to use modern teaching tools and technologies. Flipped classrooms have been gaining popularity in recent years [4], we also utilize flipped classroom learning in our program as well. The discussion below concentrates on our specific approach to teaching Power Systems related subjects.

As part of modernization of the classroom teaching, we strive to implement as many modern effective teaching tools and technologies as possible. While, at the same time, staying focused on the subject matter (engineering) and not distracting and overloading students with more apps (they already have enough apps on their smart phones!). For example, when we are discussing different topics such as phases, frequencies and harmonics amplitudes of single- and three-phase systems, we encourage students to use a Power Quality Tool App [5] on their smart devices. Such interactive app helps students significantly to grasp the concepts in real time (i.e. during the class). At the same time, such real time interaction with the instructor (myself in this case) ensures that students are actively participating in the class, rather that passively listening.

B. Online lectures and assignments.

Successful teaching of interactive classroom and online-specific classes means that the teacher not only needs curriculum and pedagogical skills for virtual classroom and web-specific courses, but also needs to have technological knowledge and use a number of online, interactive and social media resources. Online courses must provide multiple multimedia elements and/or activities to enhance student learning using different modalities.

Most of the classes named in Section I-*D* are already available as online classes to NMSU distance students. These lectures are also made available to students taking the class in regular classroom. Students feedback was univocal approval and appreciation of having the online material available to them. Students expressed that, while some other classes make their power point slides of lectures available online, it was much more productive to have a live recording of the actual class. Students liked the following:

(i) that the real-time narration was recorded simultaneously with what is on the screen,

(ii) that if any questions are asked in class, the recording captures it, together with the instructors' answer. Some of the questions can not be anticipated and answered if there are only power point slides, or if the instructor records the classes off-line, before or after the class.

(iii) Several students expressed approval of the fact that only material, not the instructor's persona, were recorded. Previously, most distance learning courses will record (and then show on a split-screen) both the professor, what he / she writes on the white board, and the computer screen. Hence, the students expressed that observing the instructor, pacing there and back, was not contributing to the material, and hence was not needed.

C. Adding a "twist".

Sometimes, traditional and even "flipped" classroom modalities may lead to students losing interest. Researchers Laurie Berry and Kristin Kowal of University of Wisconsin Extension suggested to add a "twist" to assignments [5]. Such "twist" could be challenging students to go on location and take a photo or a selfie with an object related to a particular question in a homework. Such assignments leverage a different technology, and photos are a great visual tool to solidify class insights. We have introduced such "twist" in our homeworks and, as part of a one of the homeworks, challenged students to turn in a selfie with one or another type of electric utility infrastructure (for example, a pole-mounted transformer, or a capacitor banks). Students were uniform in the response that they truly enjoyed this part pf the homework, which felt more like a scavenger hunt, than homework, to them.

D. Hands-on learning and field assignments

The El Paso Electric Power System laboratory (shown in Figure 3) supports both instruction and research for the Power and Control group in the Klipsch School of Electrical and Computer Engineering at NMSU. In addition to standard instruments, the laboratory has six LabVolt test benches which can be configured using motor-generator sets as generating sources or loads. Each bench is tied to its substation and interconnected via transmission lines as a complete power system. A seventh station feeds power from a rooftop PV array. The substations can be remotely controlled using a wireless network.

A set of SEL relays and EPOCH test set support teaching and research in Power System Protection. An Opal-RT simulator is also available and is interfaced (as HIL) to the relays the

Fig. 3. Power Systems Teaching and Research Laboratory at the New Mexico State University

Labvolt benches and to experimental power electronics.

Students are able to utilize LabVolt setup for the laboratory component of their classwork, as well as conduct independent research for their graduate research topics.

On top of regular teaching duties, we encourage students to take part in community and outreach programs and projects. Such projects include students' participation in events such as STEM competitions, IEEE student contests, etc. Another example of such extra-curriculum project NMSU's team participation in the Department of Energy competitions, such s Solar Decathlon and Solar District competition. Students which survived this strenuous challenge mention that this was the best hands-on learning experience they have had so far.

IV. Results

Figure 2 shows current students demographics of the Power Systems Track students at NMSU (Fall 2019 data). It can be seem that we have a significant diversity across multiple ethnic and racial groups, as well as almost 25% female participation in the program.

Table 1 is a summary of employment of all of the graduates. The table shows that 52% of the total graduates accepted employment with member companies, and 67% of the EUMP Fellows accepted employment with member companies. Table 2 is a breakdown of the number of EUMP graduates employed by member companies. Industry and utility companies from the Southwest regions have employed the largest number of graduates. However, it is satisfying that in the last five years all sponsors of the EUMP program have employed our graduates. Without a doubt, the member companies have derived the maximum benefits of the program by hiring quality engineers who have made significant contributions to their employers.

TABLE I
INITIAL STUDENT AND FELLOW PLACEMENT.

Student Placement	All Students		Fellows	
Member Companies	173	51%	150	67%
Non-Member Utility Companies	13	4%	11	5%
Non-Member Companies	155	45%	64	28%
Totals	341	100%	225	100%

TABLE II. GRADUATE PLACEMENT BY SPONSORING COMPANY

Company	
Electric Utilities	159
Electric Co-Ops	13
Power Electronics and Components manufacturing companies	31
Total	**195**

VI. CONCLUSIONS AND FUTURE WORK.

As academics we recognize we must wear three hats. The "instructor" who insists that the engineer must repeatedly, consistently and correctly apply facts and methods, as we know them today. The 'teacher' brings to light that these facts and formulas are not magic, and helps students learn the thought process, aka critical thinking, behind current practice. And the 'educator' creates an environment and culture in which students experience the cutting edge in collaboration with others who provide the context for our engineering.

The electric utility industry recognizes the need for fresh talent but the economic conditions force caution in hiring. Yet the opportunities are amazing. We may be witnessing fundamental changes is in the Power system from technology to business models to policy. We are excited to be in the business of training the new talent that industry needs and see opportunity for expanding EUMP.

Employment Opportunities for EUMP were excellent last year (data as of Fall 2019) and the jobs picture continues to be great. Our recruitment and retention strategies resulted in a diverse graduating cohort of engineers. Our students continue to find employment with sponsors as well as broader segments of the power industry Interest in power systems enrolments are strong.er than ever. The faculty remains committed to attracting students into power through outstanding teaching and challenging research opportunities.

First and foremost, we must continue to motivate students to consider power engineering as a career through what we do in the classroom. That is our job, and our commitment is to maintain an outstanding and exciting teaching program. It is critical to strengthen industry efforts to attract students through internships and coop programs, and to attract them to full time positions through competitive salaries and challenging careers. And, together we must define the new skill sets our students must acquire and create curricula that deliver these skills. We remain committed to meeting this challenge.

ACKNOWLEDGEMENT

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