The "Practicum" for Attracting, Retaining, and Better Educating Power Engineers

(An Alternative to Spending Spring Break in Mazatlán or Fort Lauderdale)

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What Is the Problem?

It is well known that

- many engineering colleges either have completely dropped their power engineering programs or offer only severely limited course options in this area [1]. Hence there are fewer graduates with adequate backgrounds in power engineering and
- there will be a significant need for more power engineers to replace retiring engineers (estimated at 20% to 30% over 10 years) and to add new engineers as the power grid is modernized with new (and renewable) systems for power generation and new tools for power grid automation [2].

Hence, engineering colleges and industry must do more to

- *recruit* more students who are interested in studying power engineering,
- *retain* students who are studying power engineering, and
- *offer* a sufficient number of relevant courses and **complementary hands-on experiences**

in order to ensure that a larger number of graduates have the appropriate education and experience to enter the power engineering workforce.

What Can Be Done?

Engineering colleges can offer a more comprehensive education in power engineering by hiring more faculty in this area and offering a more complete set of power engineering elective courses. However, the options for colleges to provide **hands-on experience that is complementary** to the theoretical education obtained from elective courses are more limited and a place where industry can assist. First, power engineering programs can (and should) offer more (and better) **laboratory experiences**. While this is very good, it is expensive. Second, industry can offer students **visits to power engineering facilities**. Again, this is very good, but these usually do not allow the students to get hands-on and to integrate their theoretical knowledge with practical

experience. Third, students can participate in **paid internships and co-ops.** These can be excellent experiences, but there are often more limited opportunities because companies must budget and plan for them and, hence, not as many positions are available as needed to support the increasing numbers of power engineering students. A fourth alternative is the **Power Engineering Practicum** that is described in the following paragraphs.

What is the Power Engineering Practicum?

Washington State University (WSU) offers a power engineering program that has grown significantly in the last few years and now offers 6 undergraduate courses in power engineering of which 3 have laboratory components. Its students have traditionally complemented their programs with visits to power engineering facilities as well as through numerous internships that have been offer to its students. Each of these options has limitations as mentioned earlier.

To supplement these opportunities for industrial experience, WSU has instituted a 1 credit course entitled Power Engineering Practicum held over Spring Break at participating companies[1]. (We like to think of this as an educational alternative to spending Spring Break in Mazatlán or Fort Lauderdale and …..) During this week-long residential course, students have the opportunity to learn real-world power engineering applications and gain exposure to engineering careers that span the range of working with power marketers, designing transmission and distribution systems, examining generation facilities, hands-on introduction to automation software, facing siting issues, and meeting with customers, executives and commissioners. Details of some of these programs will be given later in the paper.

The Practicum is between a full-edged summer internship and a field trip, and has the benefits of both without requiring the extensive coordination of an internship or the lack of hands-on experience in a field trip. Because the Practicum is a course and unpaid, the Power Engineering Program (PEP) at WSU subsidizes travel or housing for students so that their participation is not limited by the cost of relocation. The Practicum is organized during Spring Break to take advantage of a full week of experience and because most students can obtain credit for the course for no extra expense. (This is because at WSU payment of full time tuition entitles students to enroll in up to 18 semester credits of coursework. Since most students enroll in between 15-17 credits, it is possible to enroll in one additional credit without having to pay additional tuition[2].)

Because it is a course, students are expected to read ahead, do homework and be evaluated at the end (may be written or oral).

[1] Part of the reason for offering this as a course is to protect utilities from rules that prohibit unpaid internships.
[2] In some cases, students participate without enrolling in the course either because they are already enrolled in 18 credits or it might affect the amount of student financial aid they receive.

Who and What is Involved?

2105 was the third year that the program has been conducted and this year 18 students participated at 5 different sites (one with multiple companies). Companies who have been involved include Avista, Puget Sound Energy, Potelco, PSC and Alstom Grid as well as Snohomish, Cowlitz and Lewis County PUDs.

Each site has a unique curriculum that reflects the type of companies involved at the site. Each day the students learn about a different aspect of the industry from the employees who work in that area. The employees become instructors for the day and expose students to their respective fields of expertise, the challenges they face, and teach students about the tools they use and the processes as they are happening. Examples of different curricula follow

Table I. Cowlitz County PUD

	Subject Area	Concepts
Day 1	Utility Operations	Utility organization. Public Private, etc, Power Scheduling, Dispatch Operations, Construction/Safety, Materials/Storeroom, Rates/Utility Economics
Day 2	Substation	Substation Design, Loading Criteria, Protective Relaying, SCADA/Controls, Voltage Control, Environmental compliance,
Day 3	Transmission	Transmission Design, Standards/NESC, Loading/Power Flow, Right-of-Way,
Day 4	Distribution	Distribution Design UG/OH, Standards, Loading/Voltage, Protection, Transformers, NESC/NEC, Joint Use
Day 5	Customer	New Customer connections, Design Coordination/Residential/Commercial, Cost

Table II. Avista

	Subject Area	Training Concept
Day 1	Substation Protection Transmission	Substation Design, Loading Criteria, Protective Relaying, SCADA/Controls, Voltage Control, Environmental Safety, Transmission Design, Standards/NESC, Right-of-Way
Day 2 – Morning	Distribution	Distribution Design UG/OH, Standards, Loading/Voltage, Protection, Transformers, NESC/NEC, Joint Use
Day 2 - Afternoon	Customer	New Customer connections, Design/Coordination, Residential/Commercial, Cost
Day 3 - Morning	Network and System Operations	Local and Wide area networks, Relay Scheme Communication, System Operators, Reliability / NERC

Day 3 - Afternoon	System Planning	Transmission Planning, Loading / Power Flow, Cost
Day 4 - Morning	Power Supply and Generation Engineering	Utility organization. Public Private, etc. Power Scheduling, Dispatch Operations, Generating Plant Operations & Maintenance, Capital Planning
Day 4 - Afternoon	Generating Plant Operation	Field Trip to a work site.
Day 5 - Morning	Participating Students	Student Presentation on what they Learned, De-brief with students about their week

Table III. PSE, Alstom Grid, Potelco and PSC

	Subject Area	Concepts
Day 1	Wind Integration and Tour	Wind power/turbine/farm fundamentals, Generator types, Real/reactive power control, connecting to the grid, Practical aspects of wind plant operations
Day 2	The Utility Electrical System	Appartus, Devices & Equipment: Function, Purpose and operational integration within the system, Electrical Codes and Jurisdictions, Power Quality (PQ)
Day 3	Distribution System Design	Substation siting, lighting and street lighting, load balancing, phasing and rotation, engineering and operational/construction issues
Day 4	System Operator (Hands-On)	Interface Overview & Additional Key Functions, Outage Identification and Dispatching, Place Tags, Planned Switching & Alarms, Manual Switching, Fault Indication, Isolation, and Restoration (FISR)
Day 5	System Design for Renewables & HVDC Integration	Evolution of the Electric Grid, What is System Planning?, Integration of Renewable Energy Sources, Regulatory environment, Emerging technologies

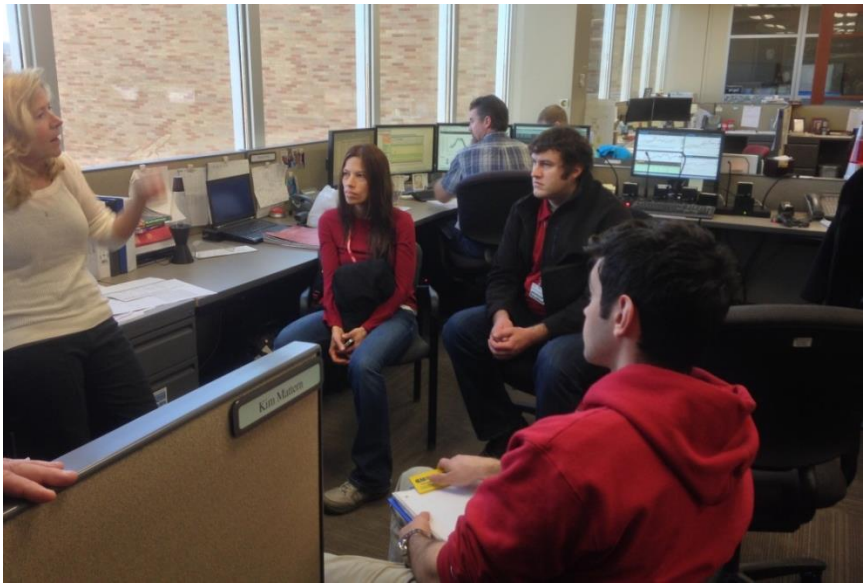

Fig. 1. Group of Practicum students learning about power marketing at Avista.

What is the Feedback from the Program?

The Practicum has received tremendously positive comments from industry and students. It has been very successful both because the students experience how their classwork translates into the realities of the power industry and because industries have a chance to meet students, who they may want to hire, for an extended time. Again, this is an experience that complements classroom education with motivating exposure to hands-on practical experiences at participating companies.

From the Companies

Cowlitz County PUD

Cowlitz PUD has participated in the program from its inception. It became involved in the program because the development of future engineers for the utility industry is a growing concern as the existing workforce ages. Further, they welcomed the opportunity to invest in this training of future utility engineers. Following the practicum, they noted that the experience was rewarding not only for the students, but for the staff as well. They found that the students were very energetic and attentive toward learning about the utility business.

Avista

Avista has also participated in the practicum since its inception. While they have found it to be a challenge to organize the internal staff, their actual time commitment to host the students is

relatively short. From a staff perspective, it has afforded a number of their engineers the opportunity to not only share what they do with the students, but to use what they develop to prepare "on-boarding" types of material that can be used for new hires.

Avista staff has enjoyed its time with the students who have been hosted at their site. One plus is the setting that is less formal than guest visits, guest lectures, or interviews that usually define those interactions. Collectively, the feedback from the teams that work directly with the students during the week as well as those at their final presentation has been excellent. They report that the students have been very engaged and have come away excited with what their future in power engineering might hold.

From the Students

The overall student response to the program has been overwhelmingly positive. The best evidence of this is the steady growth in the program: Enthusiastic students who have completed the program are our best recruiters.

This section will be completed by repeating a number of quotes from students.

"Being a senior electrical engineering student in the power system track, the experience of the practicum will help me in making more educated decisions about where my skills and interest fit best in the utility business. It was especially inspiring to find out that learning does not stop after we graduate from school, and that the different disciplines can create great outcomes by working together."

"In conclusion, this practicum was one of the most valuable extracurricular activities I have had the pleasure to be a part of. Being able to see the business end of electrical transmission and distribution to consumers is invaluable experience for prospective engineers….. Having the opportunity to see all of the different facets of a power company in a somewhat rural area, faced by some different problems than other more urban utility companies was a great example of how the power industry can adapt to any environment."

"The practicum was generally great experience for me, it was different environment than our school in many ways…. Besides learning the four major power segments of source, transformers, transmission lines, and the load, the presenters discussed safety, government regulations, and the economic side of the power engineering."

"I found it the most meaningful experience in order to confirm that I am in the right industry. Everyday complimented what we learned the other days and the progression of knowledge helped us learn about every step in the power process. It was an extremely invaluable

experience in order to understand even a little bit about the whole industry and how each piece works together. I feel undeniably fortunate to have been able to participate in this opportunity."

Conclusion

This effort can be summarized by describing the winners and losers.

The Winners:

The students: they have gained motivational experience and good contacts that will provide motivation in further courses and help them in both their job search and the transition

The faculty: faculty report that their students better understand the relationship of their courses to their chosen profession and, hence, are more motivated to learn

The companies: they will have increased the motivation of students to remain in the power engineering program and will have developed relationships with students who are potential interns and full time employees

The WSU Power Program: having motivated students helps recruit more students into the program and hence to be able to sustain its growth.

The Power Engineering Profession: The program is playing a part in solving the coming shortage of power engineers

The Losers: Mazatlán and Fort Lauderdale

Overall, we believe that this program has been a great success and a great investment on the part of all who have participated in planning and carrying out the program

References

1. Brahma, S., H. Louie and D. Ray, "State of Power Engineering Education in the U.S. and Canada," Presented at the IEEE PES General Meeting 2014
2. Hardcastle, A and K. Kester, "The Power Engineering Workforce in Washington and the Pacific Northwest," Report to the WSU Energy Systems Innovation Center, 2013